Figuring rural development : concepts and cases of land use, sustainability and integrative indicators

Hobbes, M.

2

Slopes, Markets and Patrons: Explaining Land Use along a Lowland-Upland Gradient in the Philippines

Abstract
Transitional lowland/upland areas display strong land use differences on a small scale. Focussing on the area between the Cagayan River lowlands and the global biodiversity hotspot of the Sierra Madre forest in the Philippines, the present chapter describes and causally unravels these land use differences and dynamics. Markets, slopes and population density play a central role in the resulting explanatory scheme that represents an adapted version of a classic land use theory. Mixed with auxiliary insight into the roles of roads and patronage, this scheme supports not only the development of scenarios of local futures and policies, but also the understanding of lowland/upland histories and patterns elsewhere in the Philippines.

Published as: Hobbes, M. and de Groot, W.T. (2004) Slopes, markets and patrons: Explaining land use along a lowland-upland gradient in the Philippines. *Pilipinas,* 43, pp.71-91 [published in 2006].

2.1 Introduction

Theories of land use change often focus on either population density or markets as the dominant factors driving agricultural change. The well-known idea of Malthus, for instance was that as population density increases, land per capita goes down, over-exploited soils degrade, and out-migration is finally the only option left to escape from ever deepening poverty. The seminal work of Boserup (1965) has greatly nuanced this picture and the study of Tiffen et al. (1994) on Machakos district in Kenya has even shown evidence of a reverse relationship; greatly facilitated by the lower transaction cost that came with the steep rise of population density, farmers massively invested in landesque capital such as terraces, and realized higher incomes per capita than in the low-density situation. Interesting for the Philippines too, Conelly (1992) describes a case where farmers in Palawan, facing an influx of new migrants, successfully intensified their land use system, investing in irrigated rice and fruit trees (partly using income gained from previous illegal logging and stimulated by the DENR[7] that, somewhat unexpectedly, took forest protection seriously).

Market-based theories of land use change, on the other hand, put the emphasis on the external influence of market forces, sometimes emphasizing that these markets emanate from the major metropolitan centres, thus giving rise to zones of different land use types hinging around distance-to-market as the central variable, as first defined by Von Thünen (1826). Growth of urban-based markets then results in an expansion of these land use zones as discussed, with a Philippine example on the history of Cagayan Valley, by De Groot (2003). This dynamic version of classic Thünian land use theory has the capacity to undermine the population-based visions on land use change. The miracle of Machakos might as well be explained to a large extent by the proximity of Machakos to Nairobi and the world (coffee) market, by urban remittances and by urban pensioners returning to the countryside (Murton, 1999) rather than population densities. And was the intensification on Palawan not caused primarily by the new road that connected the village to the Puerta Princesa market? (De Groot and Kamminga, 1995).

Classic Thünian distance-to-market patterns, e.g. because of distance to Manila, are certainly discernable in the Philippines, if a relatively large scale is chosen for the analysis. This holds for De Groot on the Cagayan region but also in the analysis of Romero (2005), for instance, who compares villages with travel times of 2, 4, 9 and 13 hours from Manila.

[7] Department of Environment and Natural Resources.

In the present chapter, however, we are interested primarily in differences on a much smaller scale. Typically in the Philippines, large differences of land use can often be found at quite a small distance, especially between lowlands and uplands. Would population density or distance-to-market explanations suffice to understand these differences, or do other factors play a decisive role? That is the leading question for the present chapter.

The chapter focuses on a comparative description of land use, and especially the explanation of that land use, in four villages with areas adjacent to each other but on varying positions on the lowland-to-upland gradient. Based on these local descriptions and explanations, we will develop a more general explanatory scheme and look at future prospects and options to address a sustainability problem identified along the way.

2.2 Methods

This chapter is the result of a study that took place in the framework of project "Southeast Asia in transition", funded by the European Union. Two methodological frameworks were applied, one for describing the physical basis of socioeconomic systems (Material Flow Analysis; MFA) and one for explaining key components of that physical basis (Action-in-Context; AiC). MFA is a form of material input-output analysis widely used for the characterisation of the physical aspects of social systems on scales varying from households to whole nations; see Eurostat (2001) for the national level and Grünbühel *et al.*, 2003 for a local level application. In the present chapter, we will focus only on material flows associated with land use, such as those of crops and timber, put in kg per capita per year. AiC is an actor-based framework, inspired by Vayda (1983) and described in De Groot (1992), integrating aspects of the capacities and motivation of actors, embedded in the culture and structures of society and connected to other actors exerting power over capacities and motivations. In the present chapter, only the latter element is explicit, under the term of 'actors field'.

Researchers from Leiden University (the Netherlands) and Isabela State University (the Philippines) gathered the data between July 2001 and June 2002 with the support of the Cagayan Valley Program on Environment and Development (www.cvped.org), a joint undertaking of the two universities. Data on material flows, basic socio-economics and livelihood activities were gathered by semi-structured interviews covering all households in one of the selected upland villages (Dy Abra) and a sam-

ple in three other, adjacent research sites. For the other data, interviews followed techniques from Participatory Rural Appraisal such as option ranking, historical diagramming and participatory mapping (Chambers, 1994), topical interviews with key respondents, informal interviews for sensitive issues and focus group discussions.

With 1,828 inhabitants covering a total area of some 9,000 hectares, the population density of the four villages together is 20 people per square km, as compared to the 180 persons per square km in Isabela province as a whole (excluding the protected area in the Sierra Madre). The variable of population density does require some methodological attention here, however. Population density plays a double role in models of land use change. First on the level of the households, high population density tends to go together with land scarcity and hence with motivation to intensify land use. Second on a larger scale, high population densities tend to reduce transaction cost (e.g. for the diffusion of innovations), attract connections with urban markets and urban ideas (Turner *et al.,* 1993). On the small scale of our investigation, the land scarcity factor certainly plays a role but the other effect of population density does not come into view. Furthermore on our small scale, land scarcity is not validly estimated by simply dividing the official village territory by the number of inhabitants, since land inside the borders may well be inaccessible (e.g. due to unequal division of land) or unsuitable (e.g. forests and rocks) and farmers may well have access to land outside these borders. For these reasons, we have taken land scarcity as the proxy of population density, assessed by two indicators: people's own views (e.g. complaints) and the existence of an internal land market with renting, mortgaging and so on.

2.3 The villages and land use types

The villages were chosen in Isabela province, close to each other and selected on the basis of their position between the edge of the Cagayan valley lowlands and the forest of the Sierra Madre (see Figure 2.1). Van den Top (2003) gives a general account of the history of this region. The villages are Masipi East, Dy Abra and Puerta, to which we added some recent clusters of houses near the forest, here called the 'pioneer village'. Their territories mainly comprise some (irrigated) paddy land, white and (mostly) yellow corn, grasslands, banana plantations, swidden fields and secondary forest. Some details of geography and people of the villages are given underneath. After that, we give some general information on the major land use types in the region. Greater detail on the land use of the villages is provided in the next section.

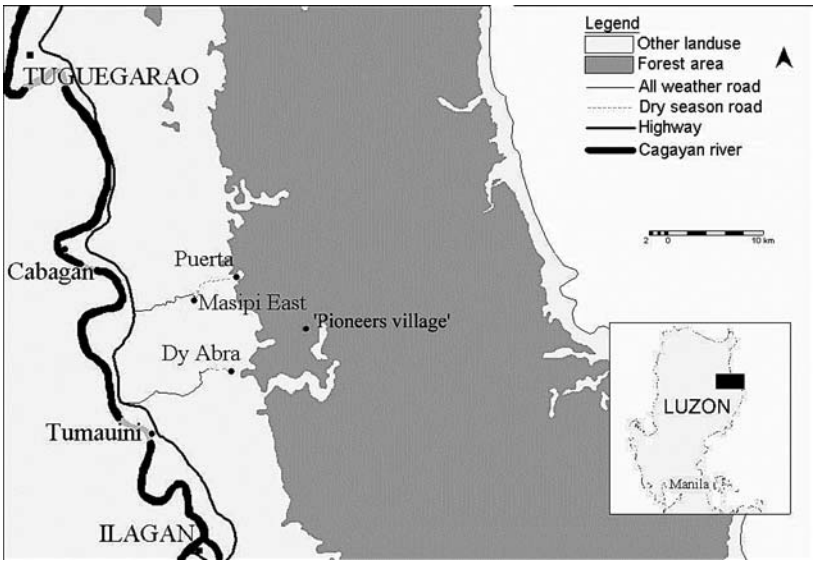

Figure 2.1 Map of research area in the Philippines. The locations of Masipi East, Dy Abra and Puerta are accurate. The location of the 'pioneers village' is a guesstimate.

(1) Masipi East, with a total population was 980 people grouped in 187 households at the time of the research, lies in the transition zone between lowland and upland, connected to the central (Maharlika) highway of the Cagayan Valley by 8 km of paved road with regular traffic. It is a community of Ilocano settlers who arrived with 5 families in the 1940s. From 1979 until 1988, more people arrived to work for the WESCA logging company and many of them stayed afterwards as a farmer. The village was declared an 'agrarian reform community' in 1984, due to which much attention was paid to agricultural development, such as irrigated rice and hybrid corn cultivation, by government and NGOs. During the time of the research it was the only village with electricity. Contrary to the other research villages, agriculture was not the only source of livelihood; traders, furniture makers, drivers etc. were also found in Masipi East.

Masipi East has about 90 hectares of fertile and titled flat land, irrigated by a scheme constructed by the National Irrigation Authority. Land scarcity was felt by most of the inhabitants and many of them feared that more land conflicts would occur in the future, especially since mortgaging of land had become fashionable which is open to conflicts. A cooperative had been set up in Masipi East to obtain a logging license under the Community Forestry Program (CFP) in exchange for reforesta-

tion. No reforestation took place, logging continued illegally and people lost their faith in the co-operative.

(2) Dy Abra, with 549 people in 94 households at the time of the research, is situated on moderately sloping land that also includes 39 ha of flat area that is planted with rice (partly irrigated by hand and partly with a small gravity system). The village lies at 17 km from the central highway to which it is connected with an unpaved road. Once a day a truck goes to the highway, which takes one bumpy hour, and more in the wet season. The founders of Dy Abra belong to the Tinguian ethnic group from the Cordilleras. They migrated to the area in the 1960s, settling first in a location called Banig, where they opened the forests to practice their traditional slash and burn farming. Many inhabitants worked for the large-scale logging operations between 1972 and 1982. The village was resettled in 1989 to its present location in order to move it away from influence of the New People's Army (NPA). The connectedness to the forest was still present; many households of Dy Abra were involved in small-scale logging activities and still some 30% of the households practiced some swidden farming in the far away areas (up to 4 hours on foot). At the time of the resettlement, the government gave out Certificates of Stewardship Contract (CSCs) issued under the Integrated Social Forestry (ISF) programme in order to provide a reasonable land tenure security (officially a 25 years usufruct right) on the sloping (hence public) land. The rich obtained more land than the poorer people, but interfamily ties are still strong, indicated, *inter alia*, by the intensive use of exchange labour. As people said, "*we are still one community*". Land scarcity was felt less than in Masipi East and a real land market had not developed yet. Some families had moved back to the forest, however, due to lack of enough land in the village proper and this indicates that the lower strata of village society did experience land accessibility problems.

(3) Puerta's name means 'gate' (to the forest). The first of the 209 inhabitants (in 45 households and of mixed Ybanag, Tinguian and Ilocano origin) settled around 1960, with other families arriving to work for the logging companies between 1979 and 1988. Although only 4 km from Masipi East (hence 12 km from the highway), the village was difficult to reach. No normal motorised vehicles reached the place and people brought all the products down to Masipi East on foot or carabao (*Bubalus bubalis carabanesis*), crossing many creeks and rivers, taking about 1.5 hours. The small trucks of banana traders came to the farthest place they could reach from Masipi-East, supplying food and drinks in exchange for banana. Also timber was transferred here. The village has a total of 12 hectares of irrigated, flat and titled land under rice. The rest

is moderately and steeply sloped, and largely under CSC tenure. These areas were all occupied by the time of the research with permanent agriculture. About 90% of the households had a banana plantation on their former swidden fields while only some of the inhabitants still practiced swidden farming. Some land scarcity was felt, because no nearby land was left for making swidden.

(4) The pioneer village was not an administrative entity, but consisted of newly built houses situated very close to the protected forest, roughly between Puerta and Dy Abra. Flat land is absent and all of the area is steeply sloping, covered with grass, shrubs and patches of secondary forest where people made swidden fields. The 90 people living here, partly in regular households and partly in households of recently arrived men aged between 18 and 25 years, were immigrants of the Ifugao ethnic group from the Cordilleras mountains in the West. The first settlers arrived around 1990, but most of them only a few years before the research took place. Land scarcity was not felt at all yet; people marked the borders of about 3 to 5 hectares per farmer with trees (enough for 4 to 5 years since a farmer can clear almost one hectare per year). Access to the highway leads through Masipi East, to which it is about 2.5 hours on foot. People used the same trading point as the inhabitants of Puerta.

A few words are in order here to introduce the major land use types of the region.
(a) Rice was grown in two major variants: upland rice and lowland rice. Upland rice was sown on freshly cleared land (swiddens) and can be productive at these sites for one or two years. Lowland rice can be rainfed or irrigated. Rainfed fields may be bunded in order to retain more water. Irrigation may be small-scale (pumped or manual), or a medium-scale scheme that taps a local creek and is often shared between several households, or a large-scale scheme which may be planned by the state or may be a community-based *zanjera*. Valley bottoms are the logically preferred place for irrigated fields, but when the need arises and water sources allow, terraces may be constructed progressively more uphill until complexes such as the famous landscape of Banaue arise. Rice does not require substantial capital inputs. Lowland rice can easily be marketed but as long as households have no surplus, all rice is consumed by the family.

(b) Corn was mainly grown on rainfed ploughed fields *(bangkag)*. Two types were present in the region. White corn is a traditional food crop and is grown by poorer families for own consumption. Yellow corn is grown from hybrid seeds and largely used as livestock feed for the urban meat markets. It requires larges doses of fertilizer to be productive

and jointly with the seeds and pesticides, this implies a significant capital input for each cropping cycle. Yellow corn decays rapidly after harvesting and must therefore be sold immediately after harvest.

(c) Banana can grow anywhere provided the roots are not too wet, hence avoiding flat land and heavy soils. Usually, farmers first try the species 'lakatan' (*Musa accuminata)* that has high returns but needs good soil. Less preferred but still well-doing species are 'latundan' *(Musa paradisiaca)* and 'saba' *(Musa balbisiana*).

(d) Logging is illegal in the region but the thriving furniture industry along the highway testifies that the Sierra Madre forest is still entered by small-scale logging operations. Usually, the wood is ordered by a trader and a logging trip is then organised by a middleman, usually also the owner of the chainsaw. Profits for the organiser amounted to some 3000 pesos per trip, at the time of the research. The team is made up of a chainsaw operator and two helpers, who received some 400 and 100 pesos per day, respectively, excluding the food, gin an cigarettes provided by the organiser. Trips usually took three to five days, leaving some 2.4 cubic metres of squared and sliced logs to be hauled to the village. A hauler was then sent to transport the logs to the village, using the river or carabao, receiving some 300 pesos per man-plus-carabao day. All people going into the forest are farmers, using the slack time especially in the dry season to earn some extra cash. After the timber was hauled in, the trader came to the village to pick it up. The trader maintained good connections with the police, the army and the DENR, assuring that the timber would not be confiscated and the necessary bribes would not run too high.

One thing may be clear already from this overview, namely, that markets were essential for three of the four major land use types in the research area. The next section will give more information on where the land use types were located.

2.4 The major material flows of the villages

The data of the previous section are summarized in the first four rows of Table 2.1. Following the MFA methodology, land use will be described in this section by way of material flows, in kg per capita per year, of the various land use products. They are gathered in the middle of Table 2.1.

Table 2.1 Major material flows and other characteristics of the four villages

	Masipi East	*Dy Abra*	*Puerta*	*Pioneer village*
Population (no. of people)	980	549	209	90
Distance to highway (in minutes of travel time)	15	60 (more in wet season)	100 (on foot to Masipi East)	160 (on foot to Masipi East)
Land scarcity (proxy of pop. density)	Significant	Some	Some	None
Slopes	Flat plus some moderate	Moderate plus some flat	Steep, moderate plus some flat	Steep only
Main material flows (kg/cap./year)				
Lowland rice (irrig. and rain fed)	890	263	260	0
Upland rice on swiddens	0	20	70	300
Yellow corn on bangkag	900	1506	460	0
Yellow corn on swiddens	0	70	40	0
Banana	0	almost 0	1000	250
Fuel and construction wood	230	330	Appr. 400	Appr. 400
Commercial timber	50	1572	0	0
Manure (carabao and cattle)	318	762	485	Almost 0
Fertilizer	167	150	35	0
Gross income (PHP/cap./year)				
From corn, rice, banana	13,000	12,000	8,000	3,000
From commercial timber	150	8,000	600	0

See section 2.3 for the first four rows. PHP = Philippine Pesos (1 US$ = 45 PHP = 0.7 euro). Of the flow and income figures, the first two digits are significant. The flow figures of Masipi East, Puerta and the pioneer village are less precise than those of Dy Abra. The rice figures give the weight of milled rice. Weight of the wood is calculated with a moisture content of 35 percent. Weight of manure is calculated with a moisture content of 15 percent. Source: For the flow data: Hobbes and Kleijn (2007).

Overall, the figures show the predominance of irrigated rice, yellow corn, banana and logging. Looking at the figures village by village, the Table shows the first place of Masipi East in rice production, reflecting the presence of the irrigated rice scheme there. The other lands of the village were planted with yellow corn, leading to an almost equal flow per capita. Dy Abra may be called a yellow corn village, not only compared to other crops in the village, but also if the villages are compared in terms of corn production. Puerta, on the other hand, had much more focus on bananas. The figures of the pioneer village reflect its focus on swidden agriculture. Its banana production was not very high but on a steep rise because new plantations were bound to become productive.

The two flows of wood almost fully concern extraction from forest areas, because there were no significant plantations in the villages. The figures for fuel wood and timber for domestic construction are relatively low in Masipi East because relatively many people there cook on gas. Commercial timber was (illegally) extracted by farmers in Masipi East and especially Dy Abra, in the form of 400 to 500 logging trips as described in the preceding section per year.[8] In Dy Abra, men from more than two-third of the households were involved in logging as chainsaw owner or operator, helper or hauler.

Non-timber forest products (NTFP) consisted mainly of cogon (*Imperata cylindrica*) grass and bamboo used for the maintenance of housing or sometimes collected for tobacco curing in the lowlands. When in the forest for logging, bamboo cutting or burning the swidden, people also spent some time on hunting and gathering. The total flows were negligible in kilogram terms, however, with 11 kg per capita per year in Dy Abra and probably less in the other villages.

The total manure production by the village livestock, expressed in kg per human inhabitant per year, is taken up here only for later discussion. The relatively high figures of Dy Abra and Puerta, caused by high numbers of carabao especially, may be associated with the strong demand for draught power for the ploughed corn fields and for the hauling of logs. In Masipi East, ploughing is mainly done by tractor.

Overall, it may be noted that of the first three villages, the total production per capita of the three major crops (rice, corn and banana) was almost equal or close to 1.8 tons per capita per year, with Masipi East equally divided over rice and corn, Dy Abra mainly in corn and Puerta mainly in bananas. In terms of the resulting gross income, differences show up. Given the prices of an average of 8 pesos/kg for rice, 6.50 pesos/kg for corn and 2 pesos/kg for banana, and shadow-pricing subsistence production, gross agricultural incomes per capita were as shown in Table 2.1, with Masipi East and Dy Abra in the lead and the pioneer village at only 3,000 pesos per capita per year.

The low incomes during the pioneer stage are an expected thing; people were in fact investing in land expansion and planting bananas. Moreover, the swidden soils do not require fertiliser; if the cost of fertiliser

[8] Although 20% of the households in Puerta were involved in hauling and 6 % of the men were chainsaw operator, the logging trips they participated in were organised in Masipi East. In Table 2.1, the flows are allocated to the main actors (i.e. Masipi East) but the income has been partitioned over the two villages.

(about 8 pesos/kg) is subtracted from the gross income in the other villages, the difference becomes somewhat less pronounced. Incomes from commercial logging, on the other hand, were a substantial addition to incomes especially in Dy Abra. With an average timber price of 5,000 pesos per cubic metre at the trading sites, the gross income per capita from logging in Dy Abra amounted to 8,000 pesos per year.

In terms of our search for factors that drive land use in the lowland/upland gradient, we may now go one step further than the first conclusion that markets are essential. Looking at the distance to the highway, which is a good proxy for distance to urban markets, this factor does not seem to exert a major differentiating force between the villages. Yellow corn and banana, the two most commercial crops and not easy to transport at all because they are heavy and prone to rot, are not grown closest to the highway. Distance to market only appears to exert some influence within the pioneer village, where people planted banana preferably at places with best access to the trading point.

Also, population density does not seem to be a good candidate for explaining the land use differences between the villages. Table 2.1 shows that the major crops of yellow corn and banana, with peaks in Dy Abra and Puerta, respectively, are distributed quite different than the population density gradient from Masipi East to the pioneer village.

Rather, slopes appear to be pivotal. The village with the most flat land is most devoted to rice; the village with most moderate slopes is most devoted to yellow corn and the villages with the most steep slopes harbour the most bananas. And indeed if one looks at a smaller scale within the villages, one sees this pattern in full; all lowland rice on available flat land, almost all corn on moderate slopes and all banana on the steep slopes.

Several questions remain, however. Banana grows perfectly well on moderate slopes too, for instance, and why is it not found there? And markets and slopes, both being somehow 'key', obviously must interact; how do they? As Elster (1989) has pointed out, true explanatory insight requires that not only causal factors are identified, but also the causal mechanisms, the processes that link the factors to each other and to the *explanandum*. Gathering this insight is the aim of the next two sections.

2.5 First explanation: options and motivations of the primary actors

In Action-in-Context, primary actors are defined as the first social entities that are identified as having a decision-making influence on the action in question. In our case, these are simply the village households deciding on the main land use options. For a proper explanation, insight is needed in all of the household's main livelihood options, because for their decision-making, actors compare the merits of all these options. In this section, we distinguish between two main actor groups, the pioneer households focussing on swiddens and the households focussing on permanent agriculture, because they differ considerably in motivational terms. We grouped the main motivational factors that were identified during the interviews for choosing between the different land use activities as follows:

- Returns to labour: the net returns in pesos per working hour.
- Returns to land: net returns (in pesos) per hectare for the land use activity.
- No risk (of losing investments due to government intervention, typhoons or other hazards).
- Prestige: the cultural benefit a farmer receives from a particular activity.
- Food quality: the cultural value of having this crop in the meal.
- Adventure: the appeal of the activity as a breakaway from daily life.
- Independence: the pride one takes in being one's own boss.

Most values are expressed on an ordinal scale.

The pioneer farmers

The pioneer village is part of a persistent flow of Ifugaos migrating from the Cordilleras to the Sierra Madre (Van den Top, 2003). The main drive for the pioneers was to be independent and to start a new life. They like to be in the forest and know quite well how to deal with sloping swiddens since these are also present (above the rice terraces) in the traditional Ifugao land use system Conklin, 1980; Gonzalez, 2002). Table 2.2 gives an overview of the specific motivations. We have added yellow corn grown on swiddens to the Table, not because the pioneer farmers grew it but for analytical reasons. Contrary to yellow corn on ploughed land, it grows on swiddens without fertilizer (but, like upland rice, for a few years only).

Swidden farming is looked down upon in Philippines society but as the neutral values on 'prestige' in Table 2.2 indicate, the villagers them-

Table 2.2 Activities and motivational factors of farmers with swiddens

	Returns to labor (PHP/day)	*Returns to land (PHP/ha/year)*	*No Risk*	*Prestige*	*Food quality*	*Adventure*	*Independence*
Swidden yellow corn	30	2000	+	0	n.a.	0	+
Swidden rice	30	3600	+	0	++	0	++
Banana	80	9600	-	0	+	0	+

The numbers are taken from the calculations of Hobbes and Kleijn (2007) and rounded off. PHP = Philippine Pesos (1 US$ = 45 PHP = 0.7 euro). The returns of the lower quality of banana are displayed. The swidden rice is used for home consumption; the returns to land and labor are calculated using the market price of normal rice of 8 PHP per kilo. Explanation of quantifications: ? = unknown; n.a. = not applicable; 0 = neutral; + = positively corresponding with the motivational factor; ++ = strongly positively corresponding with the motivational factor; - = negatively corresponding with the motivational factor.

selves did not find this an issue of importance. Rather, they highly valued their independence, as reflected by the positive value in the Table. People were content not having to deal with the rules and regulations of the government, the social control of neighbours and the whims of traders.

The pioneers occupied public land. This land was locally regarded as fallows owned by inhabitants of Puerta and Dy Abra. The pioneers did not fear eviction, however, neither by the villagers nor by the government. Government in general ignored swiddens, even though prohibited by law. As people said, forest animals raiding the crops were more dangerous than government officials. The risk factor in Table 2.2 therefore only relates to agricultural risk.

Comparing the crops in the Table, banana turns out to be the best economic option by far. In fact, it was the only one that could be grown with a rate or return higher than the daily wage of agricultural labour in the villages at the time of the research (60 pesos per day in Puerta and Dy Abra and up to 100 in Masipi East), and planting yellow corn is no alternative. It takes about three years after planting before the trees give significant numbers of fruits, however, and in the meantime, farmers have to survive. Most swiddeners therefore did plant upland rice, together with the banana shoots, after opening the swiddens. (If more rice calories were expected to be needed and soils appeared to allow, they sometimes waited with the bananas for one year.) The banana plantations were developed especially on places with best access to the trading point, because bananas are heavy and get easily damaged during the difficult way down. Banana plantations have relatively high returns that are

quite steady, but they are susceptible to typhoons, wild animals and diseases as is reflected by the negative value on the risk factor in Table 2.2.

Upland rice can be grown for only one or two years on the same field before it is outshaded by grasses or, in our case, banana. Theoretically, it would be quite profitable for the swidden farmers to sell their upland rice varieties and buy lowland rice with the revenues, since upland rice goes for a price of 22 pesos per kilo and lowland rice costs only 8 pesos per kg. There is no steady demand, however, and the pioneer farmers also said that they so preferred the taste of their upland varieties that they were prepared to sell only incidentally for special reasons. In that sense, the swidden farmers were rich. They felt no need to go running for cash if subsistence food need was satisfied and the bananas would soon bear fruit and bring cash anyway.

The figures of Table 2.2 show that the pioneer farmers, although making swiddens, were no swidden farmers in the sense that they had any intention to go into a rotational system of rice and fallows. Their swiddens were the cutting edge of the expansion of banana plantations into the forest, planted with rice to cover food needs until the bananas matured.

Farmers focussing on permanent agricultural fields

Table 2.3 gives an overview of all the motivational factors for the major material flows of farmers with permanent agricultural fields in Puerta, Dy Abra and Masipi East.

In Puerta, 14 households had titles (covering between 0.25 and 2 hectare) for the 12 ha area that was suitable for irrigated rice. These households were members of the irrigation association of Masipi East. Rice was grown for own consumption.

Two thirds of the households of Puerta cultivated yellow corn. Some of it was on remaining flat land that was unsuitable for rice, and most of it was on the moderate and somewhat steep slopes. However, yellow corn was not very popular. People complained about the risks inherent in this crop, for instance that all fertilizer can be washed away in cases of early rains on the steeper slopes. Table 2.3 shows the low returns to land of only 3,000 pesos per hectare per year, and these depict in fact the average of relatively lucky cropping cycles without wash-out or other mishaps. In such cases, farmers run at a big loss because of the capital inputs needed for this crop. One example is a farmer saying: *"Last year we had to sell our carabao to pay back the debt to the trader because the corn harvest was lost".*

Table 2.3 Motivations for the major material flows in the three non-swidden villages

	Returns to labor	*Returns to land (PHP/ha/year)*	*No risk*	*Prestige*	*Food quality*	*Adventure*	*Independence*
Irrigated rice in Masipi East	+++	20,000	++	++	++	–	+
Irrigated rice in Dy Abra	+++	40,000	++	++	++	–	+
Irrigated rice in Puerta	++	13,000	++	++	++	–	+
Yellow corn in Masipi East	++	16,000	–	+	n.a.	–	–
Yellow corn in Dy Abra	++	20,000	–	+	n.a.	–	–
Yellow corn in Puerta	+	3,000	–	+	n.a.	–	–
Banana in Puerta	++	9,600	-	-	++	-	+
Logging	+++	n.a.	-	+	n.a.	++	++

The numbers are taken from the calculations of Hobbes and Kleijn (2007) and rounded off. PHP = Philippine Pesos (1 US$ = 45 PHP = 0.7 euro). The returns of the lower quality of banana are displayed. The irrigated rice is used for home consumption; the returns are calculated using the market price of 8 PHP per kilo. The returns to land are net results, i.e. with capital inputs subtracted. Explanation of quantifications: ? = unknown; n.a. = not applicable; 0 = neutral; + = positively corresponding with the motivational factor; ++ = strongly positively corresponding with the motivational factor; +++ = extremely positively corresponding with the motivational factor - = negatively corresponding with the motivational factor; – = strongly negatively corresponding with the motivational factor.

Most people in Puerta had a banana plantation that yielded more on average than yellow corn and formed a steadier source of income although, as said, there are also risks involved. People then only loose their labour investments, however, hence the better value on the risk criterion in Table 2.3. As for the logging trips that people from Puerta often participated in, Table 2.3 shows the high returns to labour and the appreciation that participants have of the male fun and adventure with lots of food, drinks, smokes, and forest camping during these trips. Risks are not perceived as very high in spite of the illegal character.

In Dy Abra, most households cultivated a rice field (rainfed, watered manually or watered by gravity). It was grown of the flat valley floor lands and solely used for own consumption. Rice cultivation was highly valued for the economic returns, the steadiness of the income, the high prestige and food quality, as reflected in Table 2.3.

Most households cultivated yellow corn on the rolling ploughed fields *(bangkag)*. Net returns are much higher, on average, than in Puerta due to better soil quality and more favourable average slope. The cost of wage labour was low in comparison to Masipi East and relatively much family and exchange labour was used on the cornfields. Some people cultivated white corn for own consumption as well. In spite of the obvious success of yellow corn for the individual actors (Table 2.3) and in the village as a whole (Table 2.1), opinions on this crop were often negative, with farmers especially referring to ever-larger quantities of fertilizer needed to maintain yields, saying, for instance: *"Our corn soils have become addicted to vitamins and chemicals"*.

In Masipi East, both irrigated rice and yellow corn gave lower net return in than in Dy Abra. This was not caused by lower yields but by a higher price of hired labour. Moreover, farmers in Masipi East apply more inputs in the yellow corn cultivation without getting much higher yields. The superiority of rice over corn remains, however. As in Dy Abra, the soils under yellow corn appeared to become exhausted. Farmers said, for instance: *"The corn soils are getting old. I have to apply more and ever stronger fertiliser each year"*.

Overall explanation of the land use pattern, primary actors level

This subsection will analyse the motivational factors as displayed in Table 2.2 and Table 2.3 pertaining to the major land use types, focusing on the primary actors.

Overall, we see a pattern emerging that resembles the explanation of land use in Tat hamlet, Vietnam, as described by Hobbes et al. (2007; Chapter 3), where "the key to the explanation of the land use...., appeared to be the limited availability of favoured options". In our case study area, irrigated rice was the superior crop on almost all accounts in the three main villages. The net returns of this crop sharply drop when land is not flat however, and corn then takes over. Therefore, people fill the flat areas with irrigated rice as much as possible, and if there are energies left (e.g. because households have only little flat land, or possibly none because this land is all occupied already), yellow corn is planted on the sloping land. The same mechanism then repeats itself with corn and banana, because the profitability of corn declines sharply when slopes are too steep. Banana, that does well enough on moderate but also on steeper slopes, then takes over, again planted to the extent that households still have energies left after satisfying first their rice and then their corn options, if they have any.

Logging is a special case due to its adventurous character and good returns to labour. Limitations of availability of this option also play a determining role, however. First, the local demand from the furniture shops in the valley is limited. Secondly, logging can only be done in the dry season when transport is not too slippery and dangerous. And third, chainsaw ownership and social networks determine who can join.

Upland rice or corn on steeply sloping swiddens had a low return to labour – so low, in fact, that swiddens, contrary to what is usually assumed when *kaingin* (slash-and-burn) farming is discussed, did not function as part of a swidden/fallow system, but only as the cutting edge of the expansion of banana plantations on the steep slopes. The forest trees had to go, and working on that and waiting for the banana trees to mature, some crops like upland rice or yellow corn were planted that assured subsistence for one or two years. This is analogous to the role that swiddens used to have in the lowlands as the cutting edge of paddy land expansion (Fegan, 1982: 97).

This then is the economic mechanism how markets, slopes and population density appear to interact in lowland/upland transitions zones of the Sierra Madre. Markets of crops, logs and labour set the maximum profitability of the major land use types. These maxima have a sequence, in our case with irrigated rice first, then yellow corn and then banana. Slopes then subtract from these maxima, because they imply lower yields, more labour or more risk. On that basis, the landscape fills up with people first going for the best crop at its site of maximum profitability (in our case, irrigated rice on the valley floors), up to a slope level that a next crop becomes more profitable. In our case: yellow corn, already at relatively weak slopes. Then the next crop follows (in our case banana), each time with swidden crops for temporary survival at the frontier if forest is encountered there. Figure 2.2 visualises this.

In a perfectly concave landscape, *i.e.* a landscape with increasing slopes at increasing distance from the valley bottom as tends to be roughly true in the Sierra Madre lowland/upland gradient, a perfect zonation from the valley bottom outwards is the theoretical result, with empirical reality determined by the details of the terrain. In all this, population density plays a major role in the background because it largely determines up to what slopes the landscape will in fact be filled. Due to village-level land scarcity, the village poor may be pushed upward to the frontier, and due to regional-level land scarcity elsewhere, new migrants may move the frontier further out and up.

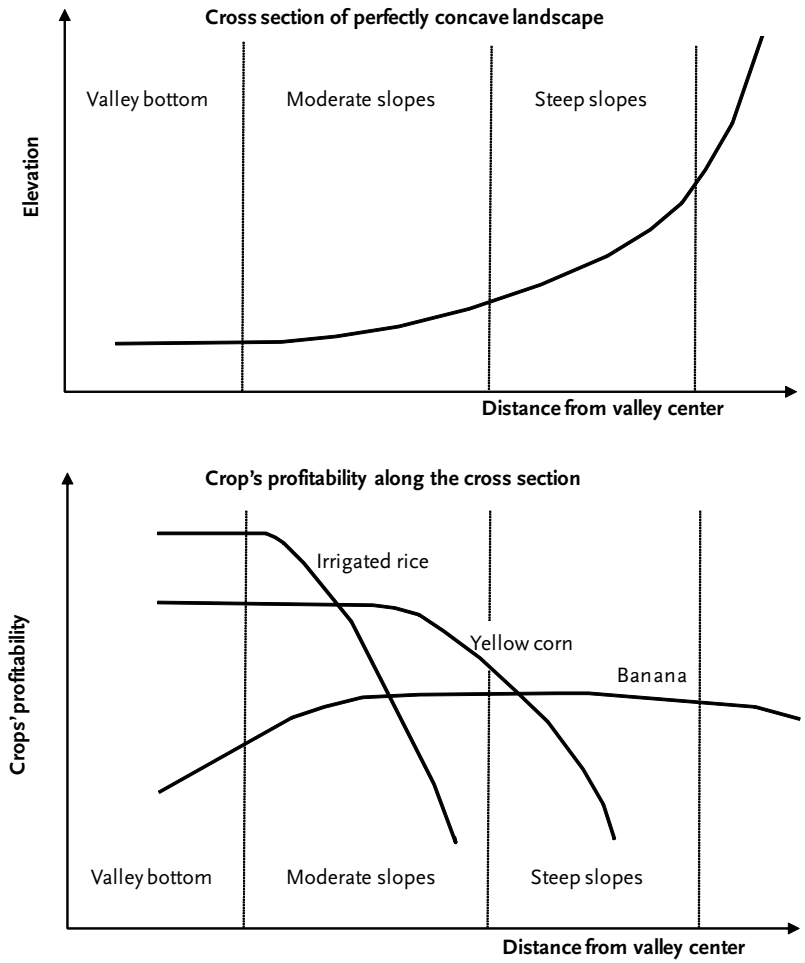

Figure 2.2 Slope-dependent profitability of the three major crops. In a perfectly concave landscape (top figure), where elevation and slopes increase monotonously with distance from valley bottom, the curves result in a zonation of rice, corn and banana going from the valley bottom outward (lower figure). Note that the abscissa does not denote distance to market but the distance from the valley center.

Figure 2.2 looks remarkably Thünian, only with slopes in stead of distance to market (major roads, cities) on the X axis. It is Von Thünen in the mountains, so to speak. Contrary to large-scale flat landscapes such as Brazil (Cleuren, 2001) or North Germany – the native land of Thünian theory – vertical slopes dominate over horizontal distance in the lowland/upland gradient. Distance to roads does play an auxiliary role, however, as we have seen. The end points of rural roads determine to

which distance banana plantations and logging are profitable (see next section), and this, in turn, is an all-pervading factor for the Sierra Madre forest at present due to the lack of any non-economic regulation.

Looking out to other regions with this explanatory scheme in hand, it may be obvious that, depending on factors such as scale, migration histories, culture, markets, soils, slopes and many others, each region will have its own particular story and deviations from the scheme. The famous rice terraces of the Cordilleras show, for instance, how far irrigated rice terraces can go up in different times and circumstances than those of the present chapter (e.g. higher population density, no yellow corn market). It is as Brox (1990) has asserted about the utility of 'grand theory': explanatory schemes should be seen as analytical tools rather than as claims to truth. That way, we believe, that the scheme can serve as a template for better understanding many other upland/lowland histories in time and patterns in space.

In a later section, we will use our data and explanatory scheme to look at the future of the case study region, in which we will take continuing population growth as the key characteristic of that future. In order to do so properly, however, we must first somewhat deepen our foundation and explore a number of phenomena that causally underlie the primary actors, factors and mechanism identified up till now.

2.6 Second-layer explanation: secondary actors and structural elements

As said, the Action-in-Context framework defines secondary actors as those who exert power over the options and/or motivations of the primary actors. Other actors, in turn, have an influence over these secondary actors' options and/or motivations. These are then simply called tertiary actors, and so on. Here, we will explore some relations in these actors fields connected with structural processes, with a special view to relevance for future scenarios.

Irrigated rice

Due to its central place in the Asian economies, farmers growing irrigated rice are connected to a large and tightly woven actors field comprising landlords and traders, urban consumers, central government deciding on price policies, IRRI (International Rice Research Institute) developing new breeds and so on. In our field study area, irrigated rice was not really a cash crop and thus not very interesting for traders. Rice grow-

ing was connected to government agencies as secondary actors however, that strongly supported rice especially by supplying irrigation projects, tenure security on irrigated land, agricultural extension and so on.

Due to high production cost and protection of farmers against the world market, Filipino consumers pay two or three times as much for rice as do Thai and Vietnamese (USDA, 2001). Under pressure of WTO, the government is ostensibly liberalising rice imports and if this would really be effective, prices will plummet. Theoretically then, our subsistence rice growers could devote their irrigated land to some cash crop and buy rice on the market, but since millions of other farmers are bound to do the same, this is unlikely to be successful. The most likely assumption for irrigated rice in the study region therefore appears to be that rice will stay on the present irrigated land, possibly with some further intensification due to population growth but without any real push upwards terracing of sloping land.

Bananas and 'pulled in-migration'

Central in the actors field of banana growing are the relatively small-time traders that connect the farmers to local and regional consumer markets. Government agencies that should regulate land use on the public lands are absent. For the future, it can be assumed that it will remain profitable to convert steeply sloping land to banana plantations. We may note here, however, that plantations tend to stay close to the trading points due to the weight and vulnerability of banana during transport. With that, local government deciding on expanding and improving the local road network is an important secondary actor with respect to the expansion of banana on the forested slopes. As we saw, bananas are key to the influx of pioneer migrants. As also Van den Top (2003) found during his field research six years before us, these *kain-generos* were not destitute people pushed out of their home region, but well-organized groups with entrepreneurial spirit, pulled to the Sierra Madre by the profits and the lack of any government willing to stop them, in spite of decades of discussion on swiddening and forest loss.

Logging

Contrary to the regulation of migration, government at least has some track record in the Sierra Madre with respect to logging (Van den Top, 2003). At the time and place of the field work, however, government in logging meant only that some bribes were paid, some threats were made and some logs hidden sometimes, so that the actors field was composed only of the private actors described in Section 3. Seen this

way, the future of the great Sierra Madre forest depends solely on the Thünian market forces; the farther from the pick-up point where the truck will reach, the more the carabao hauling will cost, and some economic break-even distance will one day be reached (provided the road is not extended). At present, however, illegal logging already reaches deep inside the Sierra Madre Nature Park and the break-even distance still seems to be beyond the horizon. This is especially because rivers running out of the nature park act as logging transport highways greatly reducing the distance that actual hauling needs to take place. The long-term trend for the Sierra Madre forest also contains some positive elements, however. The national GO and NGO commitments to forest protection begin to receive authentic responses also on the regional and even local levels (Van der Ploeg, 2003), and logging flows along the rivers are easy to control once political will would present itself.

Yellow corn

Corn traders were the most important secondary actors in the economy of the research villages. Virtually all yellow corn (except on the swiddens) was grown with loans for inputs (fertilizer, seeds, pesticides, hired labour; up to 10,000 pesos per hectare) extended by various traders in Tumauini, either directly or through 'guarantors' in Masipi East, on the basis of crop collateral. The latter meant the trader did not want cash back but requested that the whole harvest be sold to him, so that he was assured he could fulfil his contract with the stockfeed mills. The trader deducted the loan plus possible outstanding debt plus interest (usually 40 percent per cropping) before paying the farmer out (if anything happened to be left). If the crop had failed due to typhoon, fertilizer wash-out, decay or other reasons, the crop collateral still stood, implying that farmers entered into debt bondage with the trader that, due to the crop collateral, is also a crop bondage. The guarantors and traders mutually assured that farmers did not easily escape to an other trader. The result is, as one farmer said: *"If you have many debts you are forced to plant yellow corn on large scale"*.

No wonder that farmers often complained about the traders. In all villages, many farmers repeated: *"We are the victims of corn"*. At the same time, only very few of them actively tried to escape from the system if they could (*i.e.* if they did not have too many debts already).[9] The reason

[9] One example is a farmer in Puerta, the same one quoted already on the loss of the carabao, who said: *"Now, we only cultivate a small field of yellow corn with inputs bought without a loan. We are afraid to borrow money again. On the other fields we plant rainfed rice and white corn. And we focus on our bananas*".

was that the traders were the farmers' only access to credit, and farmers with good track records could even get consumptive credit and instant help in acute needs. Thus around corn in the uplands, a system of patronage had developed comparable to that around rice in the lowlands and around tobacco in the past (Van den Top, 2003).

Within the traders group, those owning transport and a warehouse sold the corn directly to the stockfeed mills in Manila and Bulacan, and small traders sold to the larger ones. A trader who financed his farmers could buy for around 6.80 pesos per kg and sell for around 8.20 pesos to the mills. With a turnover of about a million kg/year and after paying the bank, labourers, trucks, warehouse rent, taxes and other cost, a profit is left of some 500,000 pesos per year. The trade is not without risk, however, and especially vulnerable to massive crop failures due to, for instance, typhoons.

Looking at the future of yellow corn in the region, two structural aspects are of importance. One is the market, which can be assumed to be quite steady because the demand is driven by the urban preferences for animal proteins, and these are only expected to rise, along with urban population as such. A much more problematic phenomenon is that the yellow corn farming appears to be unsustainable, as the farmers indicate. This may well point at a well-known phenomenon connected to ploughing and fertilizer. Ploughing exposes the organic matter in the soil to air and sunlight. The ensuing mineralization and nutrient release is of short-term benefit to the plants but if the post-harvest rotting of roots and crop residues does not sufficiently replenish the organic matter, the soil needs more and more external supply of nutrients (fertilizer), until its structure has deteriorated such that even heavy doses do not work any more and yields begin to drop rapidly in spite of the fertilizer. Given the pivotal place of yellow corn in the local economy, massive poverty will be the result. The patronage system would exacerbate this problem. In the early stages of declining yields in spite of high inputs (hence loans), all farmers would become bonded in debt, without the freedom to switch back to subsistence crops or other alternatives. Research into the soils under yellow corn is urgently needed. For the time being, it would be irresponsible to ignore the unsustainability risk.

2.7 Future scenarios and policy options

The insights built up in the preceding sections allow look into future scenarios and explore possibly effective policies for this area.

As has been found, slopes determine much of the land use in this lowland/upland region, and slopes do not change. There is an inherent stability in the land use pattern, therefore, with population growth as a slow but steady driving force. Without an unsustainability drama in the yellow corn and without (unexpected) market crashes, population growth may slowly move the irrigated rice somewhat up the slopes where water and soils allow. On the other end of the slopes spectrum, population growth will exert a significant pressure on the 'banana frontier', that will tend to move ever closer to and then into the Sierra Madre forest, destroying this last large-scale stronghold of endemic Philippine biodiversity. Since banana plantations display a dependency on distance to market, roads must follow the bananas for this scenario to come true. If roads are not extended, the banana expansion will tend to peter out due to decreasing profitability at growing distance from the market – provided, of course, that migrants are profit-oriented as the current banana pioneers are. If migrants would be not, that is to say if they would be pushed out of their home areas by sheer poverty and be happy enough with bare subsistence, this mechanism would not work, and deeper action than benevolent inactivity would be needed from the government.

We have seen as well that illegal logging is another threat to the forest, which is likely to continue (independent of population growth) as long as forest policies are not implemented. Up to the present day all over the Sierra Madre, the cumulative effect of countless small-scale logging trips is disastrous. Market demand for planted fast-growing exotics such as *gmelina* may help change the timber supply picture in the near future. *Gmelina* appears to do satisfactory on the market provided it is old enough when cut and well dried, and plantations may be internationally certified. Government commitment is necessary too, however, in order to prevent that plantations will only make their quantum leap after the natural forest is gone. During our interviews, respondents often expressed that they wanted the behaviour of themselves, their neighbours and their government to become more future-oriented, more work-oriented and more rules-based. *"People are lazy and they don't organise. They only organise for the immediate gains of illegal logging"*. And: *"The government should implement the law, otherwise you cannot blame the illegal loggers. The authorities do not implement it and even take the money"*.

Unsustainability of the yellow corn would pull the economic carpet from under the whole upland system. Hobbes and De Groot (2003) sketch three land use scenarios for the area based on the dynamics of corn, keeping constant the other factors. The first scenario has a Mal-

thusian character, the second is characteristically Boserupian and the third represents a more opportunistic wriggling out of debt's embrace.

Option 1: Going Down. One scenario is based on the assumption that most farmers will remain within the corn system as it works at present, forced by debt and crop bondage to continue planting yellow corn on a large scale. In that case, it is quite unlikely that farmers will have the means to invest in measures that might avert the ongoing process of soil degradation. Initially, fertiliser use may continue to rise in order to compensate the soil degradation. With that, however, profits will go down, until profits hit the zero mark and the whole system crashes, ending on a soil quality level where corn is simply not profitable anymore. The loss of the high-value crop will cause out-migration as well as greatly increase the pressure on the forest of farmers seeking to find some last livelihood option there. Farmers might be lucky if some crop such as banana would grow on the degraded soils, but a more likely possibility is that the degraded lands will revert back to grassland or bushland, which appears to be the almost universal fate of overexploited soils.[10]

Option 2: Sustainable Yellow Corn. A second scenario is that farmers would continue to maximise their area of yellow corn for economic reasons, but manage their farming practices in such a way that they remain free of debt and the soil free of degradation. One step towards this is to devote all vulnerable slopes to banana, *gmelina* or some other permanent cover.[11] On the remaining less sloping land, soil management should focus especially on maintenance of organic matter content, being the key of intrinsic soil fertility. Well-known *in situ* options in this respect are, for instance, green manure, mulching, trees on field boundaries, intercropping and short fallows. Farm-level options are to mix some grassland and cattle into the farming system to provide manure, or to make compost from leaves and residues including those from the permanently covered steep slopes. Finally, supra-farm options may involve the concentration of (composted) products from forest patches or even rice husks from the lowlands on the corn land. Basic circum-

[10] A recent discussion concerns cassava grown, as corn ultimately, for large-scale companies. Cassava used as a follow-up of corn, exploiting the cassava's capacity to eke out a soil's last nutrients, may be regarded as just another end point of the 'going down' scenario.

[11] This is probably more profitable than trying to prevent soil erosion by combining relatively complicated soil conservation techniques with an annual crop such as corn. In spite of the development of a model farm exemplifying such techniques in Puerta, they remain un-adopted. As one respondent said: *"[If you apply anti-erosion measures,] your neighbours laugh at you, and have higher yields with less labour input"*.

stances for more organic farming do not appear to be unfavourable. In Dy Abra, for instance, there is enough space left for more livestock grazing, and the present 762 kg per capita per year of (dry) manure is already sufficient for 3 tons of dry manure per hectare of corn field per year, which is a substantial contribution to fertility upkeep (De Haan *et al.,* 1997)

Option 3: Sustainable Livelihood Diversification. The third scenario is that farmers may drop the emphasis on yellow corn altogether and diversify livelihoods, with help of components such as white corn, vegetables, banana, *gmelina*, upland rice, cattle, forest patch management and so on. Some farmers in Puerta were in fact designing such strategies already. Other farmers especially in Dy Abra are shifting attention from yellow corn on the ploughed fields back to their old swiddens where they can farm without fertilizer. Close to the highway, fruit trees and vegetables might be feasible, analogous to Conelly's (1992) case, and *gmelina* might be of help farther from the road. If the high price of upland rice would appear to hold if a true market would be developed, it could become part of the picture as well.

All three scenarios have their consequences for the Sierra Madre rainforest. Especially the 'going down' case is a great risk not only for the farmers but for the forest as well, setting the frontier in rapid, poverty-driven motion again. We hope to have shown with this chapter, however, that the explanatory analysis of land use in this lowland/upland gradient has not only generated theory for understanding many other of such areas in the Philippines and elsewhere, but also for a more stable future of nature and people alike.

Acknowledgement

We are grateful to our to all our respondents in Dy Abra, Masipi East, Puerta and the people living near their swiddens for their valuable time they gave to co-operate with the research and their hospitality. Much of the data presented here was gathered by Liesbeth Denis, Orlando Balderama and Sietske Veenman. We would like to thank Arnold ('Every step you take ....') Macadangdang for his translations, information and company. Finally, thanks are due to René Kleijn for his co-ordination, to Maarten van 't Zelfde and Cecille Mangabat for additional contributions, and to CVPED for being both a support system and a home.

References

Boserup, Ester. 1965. The Conditions of Agricultural Growth. London: Allen and Unwin.

Brox, Ottar. 1990. "The Common Property Theory: Epistemological Status and Analytical Utility." Human Organisation, 49: 227-235.

Chambers, Robert. 1994. "Participatory Rural Appraisal (PRA): Analysis of Experience." World Development, 22: 1253-1268.

Cleuren, Herwich M.R. 2001. Paving the Road for Forest Destruction: Key Actors And Driving Forces of Tropical Deforestation in Brazil, Ecuador and Cameroon. PhD dissertation, Leiden University.

Conelly, W. Thomas. 1992. "Agricultural Intensification in a Philippine Frontier Community: Impact on Labour Efficiency and Farm Diversity." Human Ecology, 20: 203-223.

Conklin, Harold C. 1980. Ethnographic Atlas of Ifugao: A Study of Environment, Culture and Society of Northern Luzon. Connecticut:Yale University Press.

De Groot, Wouter T. 2003. "Thünian Land Use Theory, Visions of Nature, and the Future of the Sierra Madre Forest," in Jan van der Ploeg, Andres B. Masipiqueña and Eileen C. Bernardo (eds.), The Sierra Madre Mountain Range: Global Relevance, Local Realities, pp. 381-408. Tuguegarao City: CVPED/Golden Press.

De Groot, Wouter T. and Evelien M. Kamminga. 1995. Forest, People. Government. A Policy-Oriented Analysis of the Social Dynamics of Tropical Deforestation. CML report 120, Leiden University.

De Groot, Wouter T. 1992. Environmental Science Theory. Concepts and Methods in a One-World, Problem-Oriented Paradigm. Amsterdam: Elsevier.

De Haan, Cees, Henning Steinfeld and Harvey Blackburn. 1997. Livestock and the environment: finding a balance. FAO. http://fao.org/WAICENT/FAOINFO/AGRICULT/aga/lspa/LXEHTML

Elster, Jon. 1989. Nuts and bolts for the social sciences. New York: Cambridge University Press.

Eurostat. 2001. Economy-wide Material Flow Accounts and Derived Indicators. A Methodological Guide. Luxembourg: Statistical Office of the European Union.

Fegan, Brian. 1982. 'The social history of a Central Luzon barrio" in Alfred W. McCoy and Ed. C. de Jesus (eds.), Philippine Social History, pp 91-127. Sydney: George Allan and Unwin.

Gonzalez, Rhodora M. 2002. "GIS-assisted Joint Learning: A Strategy in Adaptive Management of Natural Resources" in James Oglethorpe (ed.), Adaptive Management, pp 15-39. Sui Technical Series Vol. 3. IUCN, Gland, Switserland and Cambridge, UK.

Grünbühel, Clemens M., Helmut Haberl, Heinz Schandl and Verena Winiwarter. 2003. "Socioeconomic Metabolism and Colonization of Natural Processes in SangSaeng Village: Material and Energy Flows, Land Use, and Cultural Change in Northeast Thailand." Human Ecology, 31(1): 53-86.

Hobbes Marieke and Wouter T. de Groot. 2003. "Corn and Beyond: an Exploration of Sustainability, Indebtedness and Future Land Use of The Sierra Madre Forest Fringe, Philippines," in Jan van der Ploeg, Andres B. Masipiqueña and Eileen C. Bernardo (eds.), The

Sierra Madre Mountain Range: Global Relevance, Local Realities, pp. 161-174. Tuguegarao: CVPED/Golden Press.

Hobbes, Marieke and René Kleijn (eds.). 2007. Local Material Flow Analysis in Social Context at the Forest Fringe in the Sierra Made, The Philippines. Vienna. Working paper 98, Institute for Interdisciplinary Studies of Austrian Universities—IFF, Vienna

Hobbes, Marieke, Serge I. P. Stalpers, Jiska Kooijman, Thanh Le Thi Thu, Chi Trinh Khanh and Dao Phan Thi Anh. 2007. "Material Flows in Social Context: A Vietnamese case study combining the Material Flow Analysis and Action-in-Context frameworks." Industrial Ecology.11 (1):141-159

Murton, John. 1999. "Population growth and poverty in Machakos District, Kenya." Geographical Journal, 165 (1): 37-46 pp.

Romero, Marino R. 2005. Investing in the Land. Agricultural Transition towards Sustainable Land Use in the Philippines' Forest Fringe. PhD dissertation, Leiden University.

Turner II, Bill L., Goran Hyden and Robert W. Kates. 1993. Population growth and agricultural change in Africa. Gainesville: University Press of Florida.

Tiffen, Mary, Michael Mortimore and Francis Gichuki. 1994. More people less erosion: environmental recovery in Kenya. London: John Wiley.

USDA (2001) http://oryza.com/asia/philippines/index.shtml

Van den Top, Gerhard M. 2003. The Social Dynamics of Deforestation in the Philippines. Copenhagen: NIAS Press.

Van der Ploeg, Jan. 2003. "Of Ducks, Desire, and Discovery channel: Emerging Environmentalism in the Sierra Madre Mountain Range," in Jan van der Ploeg, Andres B. Masipiqueña and Eileen C. Bernardo (eds.), The Sierra Madre Mountain Range: Global Relevance, Local Realities, pp. 409-427. Tuguegarao: CVPED/Golden Press.

Vayda, Andrew P. 1983. "Progressive contextualization: methods for research in human ecology." Human Ecology, 11(3): 265-281.

Von Thünen, Johann, H. 1826, Der Isolierte Staat. Translated, adapted and re-printed as P. Hall. 1966. Von Thünen's Isolated State. Oxford: Pergamon.

Tat: road, rice fields, swiddens