ການນຳໃຊ້ຄວາມຮູ້ທ້ອງຖິ່ນ ແລະ ວິທະຍາສາດ ໃນການແກ້ໄຂ ບັນຫາດິນເຊື່ອມຄຸນ: ການສຶກສາແບບມີສ່ວນຮ່ວມ ກໍລະນີ ຢູ່ ບ້ານຫຼັກສິບ, ແຂວງຫຼວງພະບາງ

ເລສເຕີລິນ, ເປເຕຣ, ວິຊຽກ, ແກ້ວຫາວົງ, ວາເລນຕີນ

ບົດຄັດຫຍໍ້

ບົດນີ້ ໄດ້ເວົ້າເຖິງການປຽບທຽບຂໍ້ມູນທາງດ້ານກາຍະພາບ ແລະ ຄວາມຮັບຮູ້ຂອງຄົນທ້ອງຖິ່ນ ກ່ຽວກັບບັນຫາການເຊື່ອມຄຸນຂອງດິນ ທີ່ບ້ານຫຼັກສິບ, ແຂວງຫຼວງພະບາງ. ຂໍ້ມູນ 2 ຊະນິດ ໄດ້ນຳມາໃຊ້ ເພື່ອຕັ້ງບັນຫາທີ່ກ່ຽວພັນກັບການເຊື່ອມຄຸນຂອງດິນ ໃນເຂດດັ່ງກ່າວ. ຈາກນັກວິຊາການ ແລະ ອົງການພັດທະນາສາກົນໃນລາວ ເຫັນວ່າ ການເຮັດໄຮ່ ເປັນສາເຫດເຮັດໃຫ້ດິນເຊື່ອມຄຸນ. ຈາກການເກັບກຳຂໍ້ມູນທາງດ້ານກາຍະພາບ ເຫັນວ່າ ການສູນເສຍດິນຈາກການເຊາະເຈື່ອນ ແມ່ນໄປຄຽງຄູ່ກັບ ການຂະຫຍາຍເນື້ອທີ່ປູກພືດປະຈຳປີ. ເຊັ່ນດຽວກັນກັບຄວາມເຫັນຈາກປະຊາຊົນທ້ອງຖິ່ນ ເຫັນວ່າ ການເຊື່ອມຄຸນຂອງດິນ ແມ່ນມາຈາກການເຮັດໄຮ່. ແຕ່ກົງກັນຂ້າມ ການກັດເຊາະດິນ ບໍ່ແມ່ນປັດໄຈ ຕົ້ນຕໍທີ່ເຮັດໃຫ້ດິນເຊື່ອມຄຸນ. ປະລິມານການສູນເສຍດິນ ຈາກການເຊາະເຈື່ອນ ທີ່ໄດ້ເກັບກຳມາເປັນ ເວລາ 5 ປີ ແມ່ນຖືວ່າ ບໍ່ຢູ່ໃນຂັ້ນອັນຕະລາຍ. ໃນຕົວຈິງ ຄົນທ້ອງຖິ່ນເຂົ້າໃຈວ່າ ການເຊື່ອມຄຸນນະພາບ ຂອງດິນ ແມ່ນມາຈາກໄລຍະປ່າເຫຼົ້າສັ້ນລົງ ເຮັດໃຫ້ຄວາມອຸດົມສົມບູນຂອງດິນ ແລະ ຜົນຜະລິດຫຼຸດ ລົງ ແລະ ຕ້ອງໃຊ້ແຮງງານເພີ່ມຂຶ້ນໃນການເສຍຫຍ້າ. ສະຫຼຸບໄດ້ວ່າ ຕ້ອງເຂົ້າໃຈບັນຫາສິ່ງແວດລ້ອມ ຂອງທ້ອງຖິ່ນໃຫ້ເລິກເຊິ່ງ ໂດຍນຳໃຊ້ວິທີການສຶກສາແບບປະສົມ ເພື່ອສຶກສາການປ່ຽນແປງຂອງສະ ພາບແວດລ້ອມ.

Integrating scientific and local knowledge of land degradation: a participatory case study in Ban Lak Sip, Lao P.D.R.

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Abstract

The results of a study comparing biophysical measurements and local perceptions of land degradation in Ban Lak Sip, Luang Prabang Province, Lao PDR are presented. Two data sets were used to question the role of environmental policy in the uplands with respect to the land degradation issues. In line with the view shared by the Laotian authorities and a number of international development agencies, upland shifting cultivation does appear to be a primary cause of land degradation in our study area. Biophysical measurements have indicated a significant statistical correlation between the spatial extent of annual crops and sediment yields. Similarly, a large majority of farmers interviewed perceive that the main causes of land degradation are all related to shifting cultivation practices. However, in contrast with a frequent viewpoint, soil erosion is not necessarily a primary factor in land degradation in Ban Lak Sip. Sediment yields recorded over a 5-year period at the outlet of the Houay Pano catchment dó not appear to be at a critical level. In fact, villagers' perceptions suggest that land degradation is related to shortened fallow periods and hence to reduced soil fertility and yields, and increased labour, than perceived soil erosion. We conclude that a better understanding of local environmental issues can be gained by using a 'hybrid research' approach to study environmental change.

Key words: *Participatory approach; Land degradation; Farmer perception; Upland shifting cultivation; Soil fertility Lao P.D.R*

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Introduction

Since the late 1980s, the Laotian state has placed environmental conservation at the core of its rural development strategy and emphasised the importance of natural resources for economic growth and poverty reduction. Laotian authorities and international development agencies active in the country, agree that Laos' development is threatened by a 'chain of degradation' which includes deforestation, increased runoff, soil erosion and related downstream impacts such as the increased frequency and intensity of floods and droughts, sediment accumulation in streams and siltation of wetlands and reservoirs (e.g. GoL 1999, 2003; UN 2000; UNEP 2001; MRC 2003).

The upland areas of Laos are often described as having embarked on a 'downward spiral' of environmental degradation and poverty, and are therefore attributed a particular role and importance in this issue. In a general context of ecological fragility, arable land scarcity and endemic poverty, traditional shifting cultivation practices are believed to combine with population growth to engender deforestation and land degradation which, in turn, undermines farming activities and exacerbates poverty. Increased poverty may drive upland populations to further intensify their pressure on natural resources in order to maintain a decent living (e.g. GoL, 1999; UN, 2000; UNEP, 2001). This 'chain of degradation' is believed to threaten the national economy; in particular, two of the country's major sources of revenue: lowland agriculture and hydroelectricity. Indeed, siltation of wetlands and reservoirs, downstream water shortages and floods are often cited as the main consequences of 'improper' management of the uplands (e.g. GoL, 2003; MRC, 2003). The main objectives of this study were 1) to gain insight into the 'local reality' of land degradation in the uplands and 2) based on these findings, to assess whether upland agriculture really represents a threat to downstream activities and, more generally, the Laotian national economy.

Centred on a case study in Ban Lak Sip, an upland village in the Luang Prabang province, our methodological approach involved both quantitative monitoring of biophysical indicators of land degradation and the collection of more qualitative insights from local land managers. Two reasons motivated

this 'hybrid research' approach. Firstly, as pointed out by various authors (e.g. Murdoch and Clark 1994; Ericksen and Ardon 2003; Stringer and Reed 2007), neither scientific nor local knowledge of land degradation is comprehensive. Biophysical monitoring provides very precise measurements related to land degradation processes. However, these measurements are often limited to a particular set of indicators and/or a short time scale. They are also difficult to link to broader social, contextual information that is necessary to understand how and why degradation is occurring. Complementing biophysical approaches, local knowledge provides an alternative perspective on land degradation. However, the use of local knowledge is not straightforward. Practical experience and local perceptions can be quite different, even contradictory, depending on e.g. individuals' social background. Thus, relying exclusively on local accounts may reflect changes in local populations' concerns and expectations rather than actual land degradation dynamics. Hence, cornbining biophysical measurements with an approach that draws on local perceptions allows information triangulation, verification and complementation, thus leading to a more accurate and comprehensive understanding of land degradation.

Secondly, while it is now widely recognised that farmers possess an important body of knowledge concerning soils and their use for agriculture (e.g. Blaikie and Brookfield 1987; Zimmerer 1994; Wrinklerprins 1999), this knowledge is often only partially exploited. As Niemejer and Mazzucato (2003) pointed out, most of the studies related to local knowledge of soils "focus on either correlation and comparison of local classifications with scientific soil classification systems and methods or on agricultural adaptation and decision-making in relation to local soil classifications" (2003: 404). By contrast, very few studies focused on the 'theories' that local populations have on soil formation and land degradation processes. While commendable, the few attempts made to capture local soil knowledge in Laos clearly reflect these shortcomings (e.g. Douangsavanh et al. 2006; Saito et al. 2006). Lastly, adopting a research approach that integrates not only local perceptions of soil differences but also local actors' definition of land degradation is one way of working towards the empowerment of local populations.

Biophysical measurements

A survey of linear soil erosion in the Houay Pano watershed was conducted from 2001 to 2003. The survey consisted of rill and gully counts, length measurements and assessment of their volumetric evolution during the rainy season (Chaplot et al., 2005a). Fourteen, twenty-five and thirteen rills and gullies were observed during the first, second and third year of survey, respectively. Most of the rills appeared in fields cropped with annuals during aggressive rainfall events and stretched from mid-slope to footslopes (Valentin et al., this issue). While a few rills expanded and deepened gradually over the three years to form gullies, sometimes exposing bare rock on the surface, most rills disappeared within one year, either because they got filled in with branches and vegetation debris brought in by farmers or because they were covered by fallow vegetation. In this watershed, overall annual soil losses due to linear erosion were estimated to be 2.4, 1.5 and only 0.1 ton per hectare in 2001, 2002 and 2003, respectively (Table 1). A significant correlation between linear erosion and the spatial extent of annual cultivation was found in 2001 and 2002, but not in 2003. Even though 2002 and 2003 had similar annual and monthly rainfall amounts and comparable proportions of land covered by annual crops, linear erosion decreased in 2003 rather substantially. These results illustrate the major role played by rainfall intensity in triggering linear erosion. In fact, the positive correlation between the area of annual cropping and rill formation exists only when rainfall events reach a particular intensity threshold and, in 2003, rainfall events were of consistently low intensity throughout the year.

From 2001 to 2005, soil losses at the outlet of the Houay Pano watershed were measured continuously. Total sediment yields per hectare ranged between 0.7 tons in 2005 and 3.4 tons in 2001 (Table 1). Sengtaheuanghoung et al. (2006) investigated the relationships between soil losses and various environmental factors (i.e. annual rainfall, mean slope, soil structure, soil depth, land use distribution) monitored at this main outlet station and in another seven weir stations, set up in eight nested sub-catchments. Annual and monthly rainfall amounts did not have a significant influence on sediment yields. Statistical analysis showed a clear correlation between sediment yields and land use. In particular, the areal extent of annual

crops in sub-catchments appears to be the best predictor of soil erosion. However, in contrast with linear erosion, no correlation with rainfall intensity was identified.

Depending on the reference they are compared to, these sediment yields can be considered low to average (e.g. Pimentel and Kounang 1998; Douglas 1999; Gafur et al. 2003), but because a 'universal' scale of erosion rates does not exist, this does not add much to our understanding of the local significance of these values. In fact, due to their limited temporal extent, such biophysical measurements provide limited information on long-term environmental change in the village. Does the observed positive correlation between soil erosion and the extent of annual cultivation mean that the land is undergoing significant degradation? Or are we simply observing a cycle whereby land is exploited during a period of extensive cultivation and later regenerated by a period of extensive fallow? In this regard, experience from local populations can provide essential information.

Local perceptions

A survey of local perceptions of soil erosion and land degradation was undertaken in Ban Lak Sip over a 3-year period (2004-2006) based on two questionnaires, seven group discussions and many informal conversations with farmers. During the first questionnaire survey carried out in March 2004 with 16 of the 27 farmers working in the Houay Pano watershed, 87 percent answered that erosion had generally increased in their fields. The questionnaire did not include an investigation of the links made by farmers between soil erosion and agricultural yields. However, 85 percent of the interviewees also reported that their yields had declined over the previous fifteen years.

To collect more detailed information, group discussions were organised in July 2004 and December 2006, each time involving three or four key informants selected among the farmers working in the Houay Pano watershed. Discussions focused on the identification of local indicators, factors and impacts of soil erosion. According to the farmers interviewed during the first series of discussions, an 'ideal' upland field satisfies the following criteria: gentle slope, dense and green

vegetation cover (i.e. old fallow or forest) and moist and black soils. By contrast, they consider a red soil surface, the development of gullies, the presence of stones and particular weed species (e.g. Erigeron sumatrensis, Microstegium ciliatum, Thysanoleana maxima) as the main indicators of erosion. Using pictures of the watershed, the second series of group discussions gave comparable results. The farmers again identified the density and colour of the crops, the presence of stones on soil surface, the presence of rills and/or gullies and the colour of the topsoil as main indicators for determining the soil erosion level of a plot (Table 2).

Regarding the causes and consequences of soil erosion, farmers identified and sorted in order of importance: intense rainfall events, long history of agricultural rotations, annual cultivation on steep slopes and high elevation areas, and short fallow periods as the main factors leading to high soil erosion rates. Decreasing crop yields (due to impoverished soils and land lost to gullies) and increasing workload (due to invasion by hardier weeds and, to a lesser extent, the time spent filling rills) were identified by farmers as the main adverse impacts of soil erosion on their farming activities.

Reconstruction of upland rice yield and annual cultivation workload based on survey data shows a notable decline in rice yield since 1990 and a significant increase in workload after 1995 (Figure 1). At the same time, fallow periods have decreased by almost two thirds since 1970 and cropping periods (number of years a field is cropped before being fallow) have nearly doubled since 1995 (Figure 2 and, for further details, Lestrelin and Giordano 2007).

A second questionnaire survey was undertaken in November 2005. It reiterated the set of questions used during the 2004 survey but included an investigation of the causality linkages perceived by the villagers. Two direct links clearly emerged: one between increased rainfall intensities and soil erosion, and the other between shortened fallow periods, decreasing soil fertility and declining crop yields. Out of 31 individuals interviewed on the development of soil erosion in the entire village land, 52 percent reported increased erosion. This change was attributed primarily to more intense rainfalls (62 percent of the respondents), short fallow periods (18 percent of the respondents) and increased weeding frequency (12 percent of the

respondents). Again, a large majority of the villagers interviewed (i.e. 94 percent of the interviewees) reported a decrease in soil fertility essentially reflected in declining agricultural yields. However, soil erosion was not identified as a major driver of fertility loss. In fact, among the 29 farmers who reported decreasing yields, 23 mentioned short fallow periods as the main proximate cause, while soil erosion was cited only once. More generally, as illustrated in Table 3, while short fallows, in relation to land shortage and high population density, were considered as significant issues by 16 percent of the villagers interviewed, soil erosion appeared clearly as a secondary issue.

To Ban Lak Sip farmers, soil erosion is not the only or the primary factor of land degradation. In fact, while the group discussions showed that farmers considered that soil erosion negatively impacts agricultural productivity, the results of the second questionnaire survey suggested agricultural yields depend most on the quality of the vegetation cover that is cut and burned so as to make up part of the substratum for crops. As the following quote illustrates, this perceived link between fallow vegetation, soil/land fertility and crop yields appeared rather explicitly in a number of interviews:

"Compared with ten years ago, current annual crop yields are much lower. The products are good but the production is low. If the fallow vegetation is not dense enough and if the trees are too small, then the fertility of the fields will be low" (Mr. Lae, 33, farmer).

Group discussions also focused on the definition of different stages of land degradation representative of the past, present and future of the watershed. The farmers defined five successive stages ranging from brown soils, dense-green crop cover and no noxious weeds to red-orangey soils, sparse-yellow crop cover, surfacing stones, and high densities of hardy weeds and gullies (Figure 3). Once this last stage is reached, fields are unproductive and must be abandoned. The interviewees reconstructed the history and predicted the evolution of the Houay Pano watershed, showing a continuous degradation trend that, without land use change, would lead to the impossibility of cultivating upland annual crops in ten to forty years' time. For instance, one of the farmers interviewed in 2004 estimated that, under the current land use cycles (i.e. on average, a three-year fallow period followed by two years of annual cropping), his field would reach the last degradation stage by the end of

the next cultivation cycle, that is, within six years.

Overall, the aggregated information indicated that a majority of villagers believe that: (1) the village land has followed a degradation trajectory over the past forty years, (2) soil erosion has increased over the past fifteen years, (3) soil fertility and annual crop yields have declined during the same period, and (4), if soil losses have definitely played a role, the main cause of degradation is the shortening of fallow periods (Figure 4).

Comparison of the two data sets

According to local perceptions, the village land is on a continuous degradation trajectory characterised by two dynamics: an increase in soil erosion rates over the past fifteen years and a gradual loss of fertility of the upland fields. With regards to the first perceived trend, biophysical measurements do not exactly confirm a regular increase in soil erosion rates. Indeed, both linear erosion rates and sediment yields appear to vary importantly from year to year, without a clear trend of increase over the five years of survey. This inconsistency should not be considered as discrediting entirely local knowledge. Firstly, the time scale of the biophysical records and that of villagers' perceptions are different. Five years of biophysical monitoring is insufficient to characterise environmental dynamics while local populations have experienced these dynamics for several decades. Secondly, local perceptions may reflect the importance of soil fertility transfers which occur within the watershed, when soil erodes from the cultivated slopes to sedimentation areas located downhill. As shown experimentally, the quantity of soil that is displaced from the upper part to the bottom of the slopes can be very significant, but it may only have a minor impact on sediment yields at the watershed outlet (Dupin et al. 2002; Chaplot et al. 2005b). Nevertheless, the mismatch between the two data sets suggests that, rather than being used as unquestionable evidence, local knowledge is probably best employed to provide further insight into measured processes and/or identify new scientific hypotheses.

The second environmental trend perceived by the villagers cannot be directly addressed by the scientific experiments carried out in Houay Pano because the measurements made do not give a clear indication of the cumulative

impact of soil erosion on land fertility. However, even if the sediment loads monitored at the outlet of the Houay Pano catchment are low in absolute terms, analysis of their composition shows that an important transfer of carbon (i.e. a crucial element conditioning soil fertility) has occurred from the watershed to downstream areas (Chaplot et al. 2005b; Rumpel et al. 2006). In this regard, the very short fallow periods currently practised by farmers are not likely to counterbalance the process.

This last observation brings us back to an important causality linkage perceived by villagers, that is, the major role played by shortened fallow periods in the reduction of soil fertility and the associated decline in annual crop yields. This perception is in line with scientific experimentation undertaken elsewhere in the Luang Prabang province. As highlighted by Roder et al. (1995, 1997b), in slash-and-burn shifting cultivation systems practised on relatively poor soils only a minor part of the soil fertility decline could be attributed to soil erosion . In contrast, the quality of the secondary vegetation growing during the fallow period appeared to strongly influence fertility. With litter degradation, vegetation regrowth plays an essential role in the production of soil organic carbon which, in turn, is crucial for maintaining the physical, biological and chemical properties of the soil. Once slashed and burned, fallow biomass provides a stock of nutrients easily assimilated by the crops. Furthermore, if its duration is longer than the dormancy period of weed seeds present in the soil, the fallow period also plays a significant role in limiting weed germination and potential competition with the crops (de Rouw 1995; Roder et al. 1997a). Thus, even if the relationship between fallow length, soil fertility, soil erosion and crop yield is neither simple nor linear (Mertz 2002; Ickowitz 2006), the fallow period appears to be an important driver of land productivity in shifting cultivation systems, possibly more significant than soil erosion.

Conclusions

If we consider the case of Ban Lak Sip in light of the general issue of land degradation in Laos, we can draw two main conclusions. Overall, the generally accepted view that shifting cultivation is a major cause of land degradation also appears to be the locally relevant situation. In Ban Lak Sip, both biophysical measurements and local perceptions indicate that this practice is the main

proximate cause for land degradation. On the one hand, there is a significant statistical correlation between the areal extent of annual crops and sediment yields recorded along the Houay Pano stream. On the other hand, a large majority of farmers think that the main causes of land degradation are all related to cultivation practices.

However, our results also raise questions as to whether upland agriculture is really the main culprit of the 'chain of degradation'. In Ban Lak Sip, sediment yields recorded over a 5-year period at the outlet of the Houay Pano catchment do not appear critical. They can even be considered as relatively low when compared to similar studies in the uplands of northern Thailand (e.g. Douglas 1999). Besides, while soil erosion may have significant impacts at the catchment scale (i.e. the erosion of organic matter and nutrients redistributes soil fertility along the hillslope, thus depriving upslope farmers and possibly 'enriching' farmers downhill), it is not necessarily the only nor the primary issue for upland farmers. Villagers' perceptions suggest that, rather than the shifting cultivation system per se, it is the ever shortening length of the fallow period, and its negative impact on soil fertility and yields, that lies at the core of the upland degradation issue in Laos. Studies in Nepal (Ives 2004) and northern Thailand (Forsyth 2007) draw similar conclusions regarding the excessive emphasis placed on the issue of upland soil erosion in the political agenda of these countries. Thus, rather than asking "how can we limit the downstream impacts of upland shifting cultivation", a more relevant question for policy-makers should perhaps be "how can we circumvent the shortening of fallow periods in the uplands?" In this regard, reconsidering the actual land allocation process may help (e.g. Ducourtieux et al. 2005; Evrard 2004). Farmers could also be encouraged to adopt improved land management systems. Finally, encouraging economic diversification in the uplands could also contribute to reduce land use pressure and maintain sustainable shifting cultivation systems (Lestrelin and Giordano 2007).

While this study remained limited to an examination of a generally accepted viewpoint on upland degradation, 'hybrid research' approaches can also be used as a valuable practical tool. By integrating both local and scientific views into a common framework, communication between development agents and local populations is likely

to be greatly facilitated. And so are development interventions. In the end, such an integrated àpproach appears to be an essential, yet often neglected stage of any approach to combat land degradation.

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Table 1 – *Annual rainfall, linear erosion and annual crop distribution in the Houay Pano watershed, sediment yields in the Houay Pano watershed (Station 4). 2001-2005 (Source: Sengtaheuanghoung et al. 2006).*

Year	Annual rainfall (mm)	Linear erosion (tons/hectare/ year)	Sediment yields (tons/hectare/ year)	Annual crops (% of the total surface)
2001	1774	2.3	3,36	9,6 %
2002	1221	1.4	6,83	40,4 %
2003	1308	0.1	2,03	31,5 %
2004	1383	n/a	4,67	32,1 %
2005	1377	n/a	0,74	14,7 %

Table 2 – *Main indicators of soil erosion identified and sorted by order of importance by the farmers of Ban Lak Sip interviewed during two series of group discussions. Note: the actual ranking has been calculated by summing the classifications determined during each group discussion.*

Rank	1st series (July/August 2004)	2nd series (December 2006)
1	Colour of the topsoil	Crop cover (density and colour)
2	Gullies	Surface stones (presence)
3	Surface stones (size)	Gullies, rills and landslides
4	Weed species	Colour of the topsoil
5	Rills	Weed species
6	Vegetation cover (density)	Surfacing roots of crop
7	Landslides	-
8	Weed density	-

Table 3 – *Main livelihood issues perceived by the population (percent of households interviewed), 2005.*

Main livelihood issues in Ban Lak Sip	Total
Drought	52%
Decreasing rainfall amounts	52%
Low agricultural yields	42%
Labour shortage	35%
Land shortage	19%
Shortened fallow periods	16%
Poverty	16%
High population density	13%
Food shortage	13%
Lack of income sources	13%
Hot weather	10%
Theft	6%
Soil erosion	6%
Difficult environmental conditions	6%
High dependency ratio	6%
Lack of access to credit	3%
Remoteness	3%
Prices fluctuation (production)	3%
Increased weed density	3%

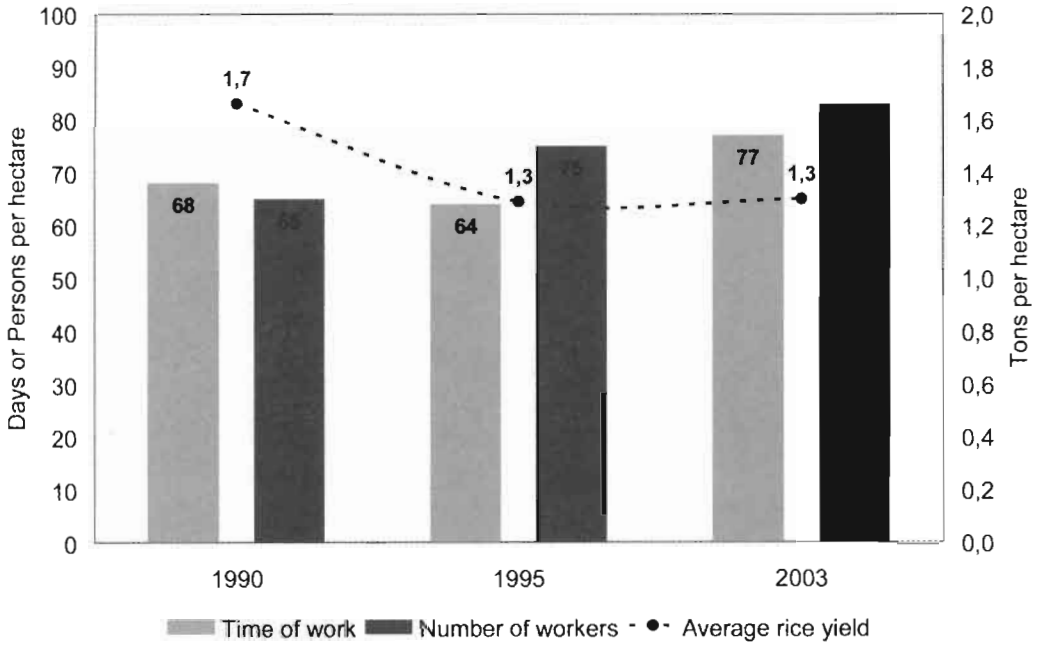

Figure 1 – *Annual cultivation average work time, number of workers and upland rice yield, per hectare and per year, 1990-2003.*

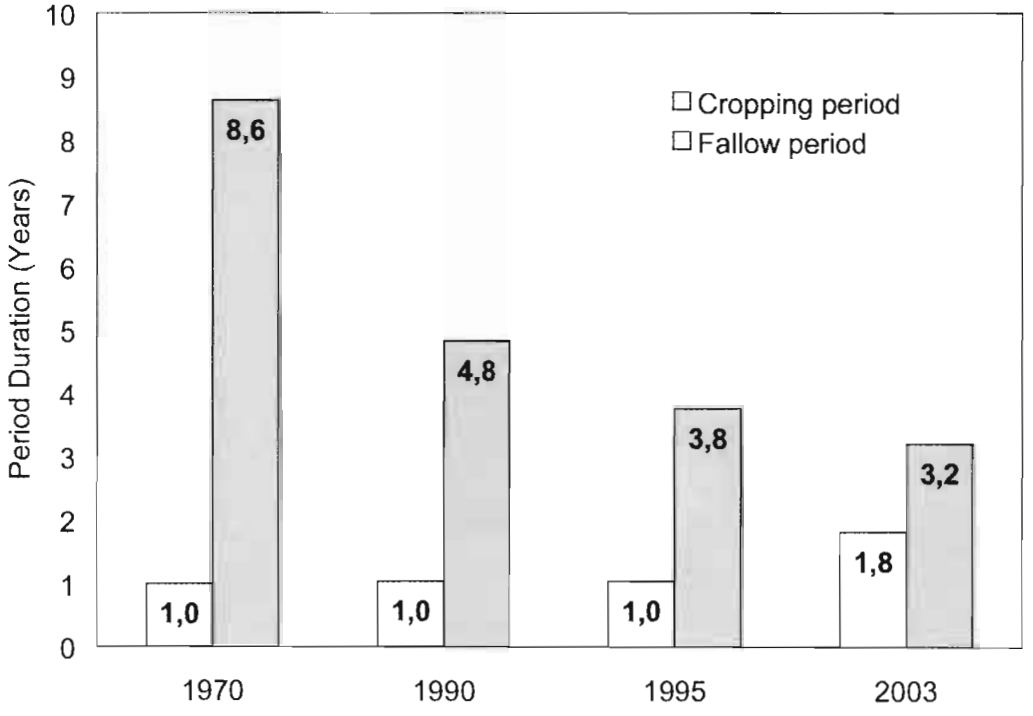

Figure 2 – *Average fallow and cropping periods for the fields under shifting cultivation, 1970-2003.*

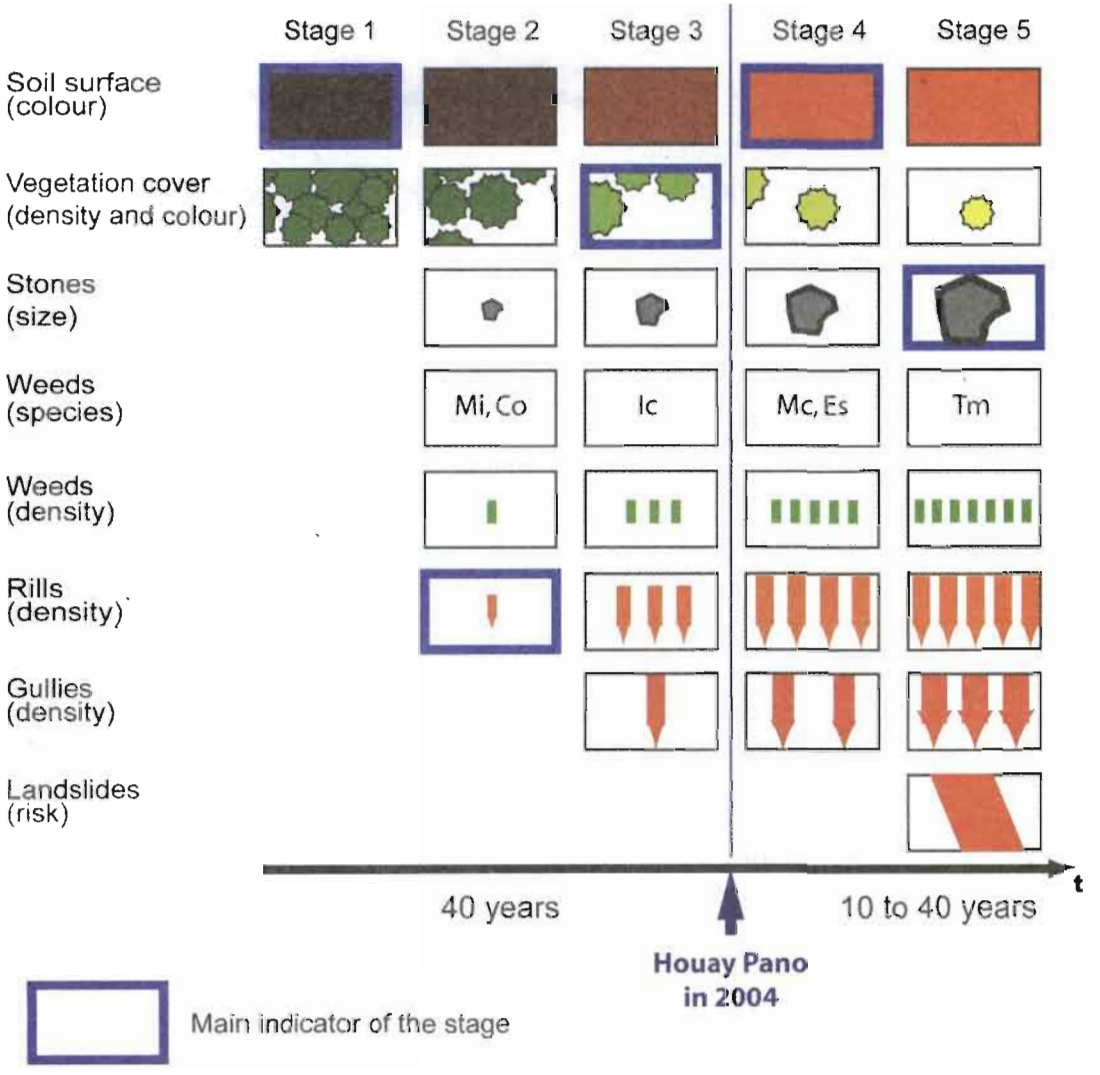

Figure 3 – *Perceived stages of land degradation in the Houay Pano catchment (adapted from Pelletreau 2004). Note: Mi, Mimosa invisa; Co, Chromolaena odorata; Ic, Imperata cylindrica; Mc, Microstegium ciliatum; Es, Erigeron sumatrensis; Tm, Thysanoleana maxima.*

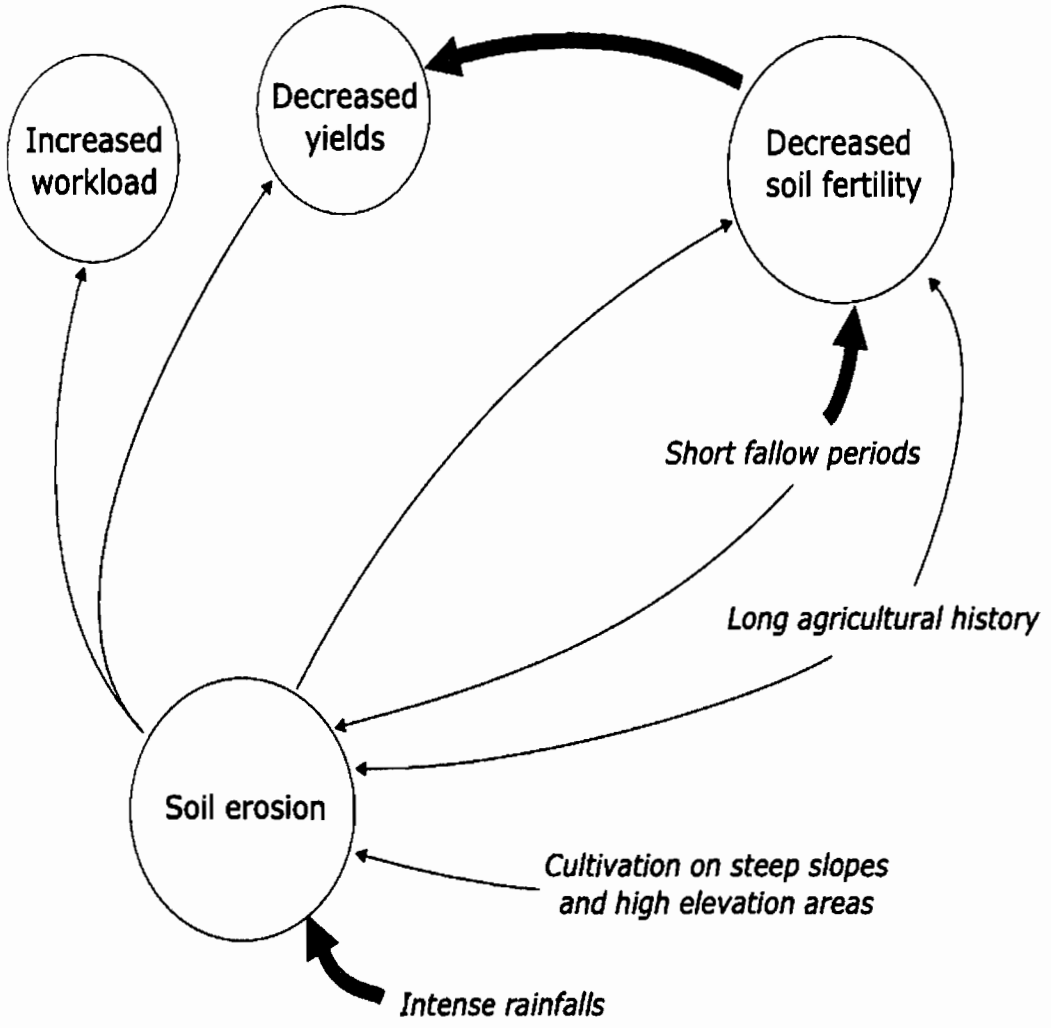

Figure 4 – *Land degradation-related causality linkages perceived by the farmers in Ban Lak Sip.*

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