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SOIL EROSION FROM HILLTRIBE OPIUM SWIDDENS IN THE GOLDEN TRIANGLE, AND THE USE OF KARREN AS AN EROSION YARDSTICK

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Resum

El tipus de cultiu itinerant realitzat per les tribus de les muntanyes així com la cremada regular dels boscos en les àrees productores d'opi del Triangle d'Or, són responsables de seriosos danys en els recursos del sòl. L'estudi de les formes exhumades de lapiaz, que presumiblement s'han desenvolupades sota la superfície en lloc de fer-ho en condicions subaèries, es presenta com a prometedor mitjà per documentar l'erosió del sòl; no obstant això hi ha molts de problemes que romanen sense resoldre, el que fa que encara no es puguin aconseguir resultats segurs.

Abstract

Shifting cultivation by hilltribes and regular burning of the forests in opium-producing areas of the Golden Triangle is responsible for serious damage to the soil resources. The study of exposed karren forms that are assumed to have developed under subsurface rather than subaerial conditions has some promise as a means of documenting soil erosion, although serious problems remain to be resolved before reliable results can be achieved.

Introduction

While the social costs of drug addiction and associated criminal activity are well known, the environmental costs of the illicit drug trade gain far less publicity. A large proportion of the world's illicit heroin supply originates in the opium swiddens of subsistance hilltribe farmers near the common borders of Burma, Thailand and Laos, an area popularly known as the Golden Triangle. The heroin is refined in mobile laboratories under the control of private armies. Shifting cultivation has led to severe environmental deterioration in this region, including serious soil erosion from swiddens (Hurni, 1982; Dunkley, 1985). Coupled with pressures from the western world to stem the flow of heroin this has stimulated efforts by the Thai government to promote sedentary cultivation of alternative crops.

Nonetheless, opium production continues, particularly in remote and insecure parts of the region that lie beyond the control of Thai government forces. Many of these localities are underlain by Permian limestones that have given rise in the wet tropical climate to deep terra rossa soils. This note records an opportunistic reconnaissance of the erosion of these soils in one such remote centre of opium production. It also explores the potential usefulness of certain karren forms as surrogate measures of soil erosion.

Physical Environment

The Red Lahu hilltribe communities of Pha Puek and Pha Daang lie close to the Burmese border in the limestone mountains of far north-western Thailand (figure 1). The area is located at about 19° 14'N at an elevation of 960-1020 m. asl. It is drained by the Huai Pong Saen Pik, a minor tributary of the Salween River. The climate is of Koeppen Agw type and is characterised by a cool-dry season from December to February, a hot-dry sea-

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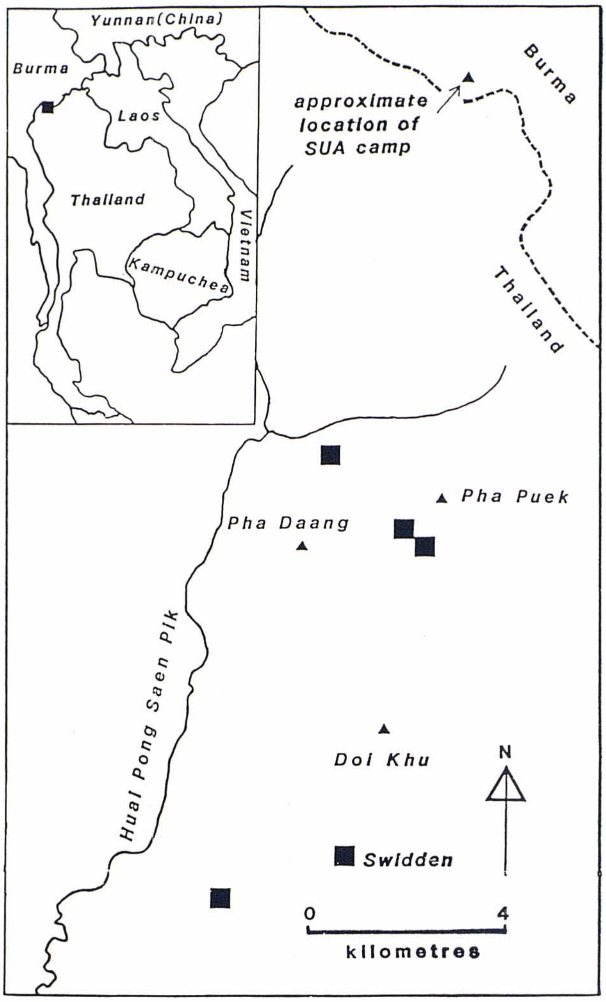

Figure 1. Location of the Pha Puek-Pha Daang area.

son from March to June; and a hot-wet season from July to November. Rainfall data are not available but about 30 km. south-east of the study area at Huai Thung Choa, downwind of the study area, it may considerably exceed 2000 mm. pa. Some 90 % of the annual total falls between May and November (Hurni and Nuntapong, 1983). The mountains are aligned north-south and orographic effects are probably considerable.

Origin and character of the Agricultural System

The production of opium is important to the economies of both Pha Puek and Pha Daang. These opium fields probably lie within the catchment of the notorious Burmese warlord Khun Sa, as his Shan United Army (SUA) maintains a base camp only a few kilometres to the north. Opium forms an important cash crop of low bulk that can be easily transported from remote areas and may be cultivated on marginal lands. Although primitive agriculturalists may have been present in these mountains since the close of the Pleistocene (Gorman, 1966) the advent of increasing population pressures, opium production and the environmental problems associated with its cultivation, are comparatively recent. Opium was probably introduced to China by Arab traders in the seventh century, but imports mushroomed from 1829-1839 when an average of 1841 tonnes of Indian opium was taken to China each year by Britain to pay for silks and tea. Attempts by China to halt this influx led to the Opium War of 1839-1842 between the two. With China's defeat this drug traffic increased further and by the 1880s reached 65,000 tonnes each year. With addiction now widespread, China began to encourage opium production by hilltribes in the South-West in an effort to reduce the drain of money from the country.

When China was subsequently divided between rival warlords opium taxes came to provide a means of financing private armies such as the Kuomintang (KMT). The need to pay these taxes forced the hilltribes to increase production. By the 1920s groups such as the Lahu were escaping southwestwards into the Golden Triangle. Following the communist takeover in China the nacionalist KMT, with support from the USA and Taiwan, made three attempts to recapture Yunnan. When they failed they were abandonned by these allies, and were left almost totally reliant upon opium for funding. This compounded the pervasiveness of the industry. In addition, anti-government forces in the Shan State of Burma, particularly the SUA, are also dependant on opium taxes and heroin refining for finance. Western concern to see the maintenance of an anti-communist buffer on Thailand's northern frontier has further complicated eradication of the illicit heroin industry. However, proposals by some Shan groups to sell all their output to the west for medicinal purposes in exchange for political recognition have been rejected and much of the world's medicinal supply is grown in economically more

Figure 2. Erosion gully 3-4 m deep cut through colluvial deposits south-west of Doi Khu.

advantaged parts of the world, such as Tasmania, were alternative crops are viable.

The opium poppies are cultivated on steep swiddens cut from the forest and burnt prior to planting. Under very favourable situations swiddens may be used for opium production for up to ten years (McKinnon, 1983) but more usually they are cultivated for less than five years. The fallow period never spans less than ten years and may have to last decades. Corn is often first planted as a food staple and cover crop for the young poppies. These flower in January and the opium is later removed by incision of the seed head. The stubble is commonly burnt at the end of the dry season which leaves the ground bare with the onset of the monsoon. Work by Hurni and Nuntapong (1983) suggest that these early rains of late May-Early June may be the most intense of the year.

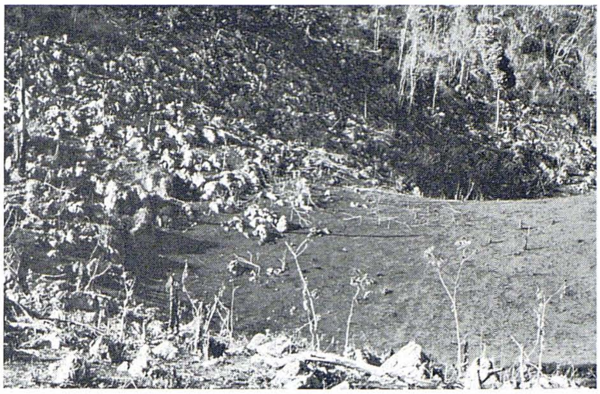

Figure 3. Advanced soil erosion in a swidden 5-8 years old, south of Pha Puek. Soil has been stripped from steep slopes and deposited in the adjacent sinkhole. Karren forms of subsurface origin are common on many exposed outcrops.

Evidence of soil erosion

The heavily sediment-laden rivers that flow from these mountains each wet season attest to the extent of soil erosion. This sediment derives not only from swiddens but also from forest areas repeatedly razed by humanly ignited wildfire each dry season. Erosion gullies 4 m or more in depth have cut through colluvial accumulations near the base of mountain ridges (figure 2). Earlier damage by erosion consequent upon forest burning complicates the assessment of erosion from swiddens that may subsequently be cut. Erosion may also have been initiated during early logging operations by British and French interests that destroyed the teak forests in the area, large parts of which are now cloaked in secondary forest with widespread thickets of bamboo. Areas that have been subject to swiddening appear more seriously eroded than the floors of the burnt forests. Extensive slopes of bared limestone outcrops and thick accumulations of sediment on the floors of sinkholes and caves give the impression that sheet erosion is rapid and continuing (figure 3).

Measuring the soil erosion

Solutional karren fluting on exposed limestone surfaces provides one possible means of estimating the extent of soil loss. Because the rounded morphology of karren that develops beneath a soil or litter cover (eg. rundkarren and solution pipes) contrasts with the sharper crested forms that develop subaerially (eg. rillenkarren and rinnenkarren) the extent to which rounded forms are exposed might provide a measure of the depth of soil lost (Jennings, 1971). However caution is required because some rounded forms may develop beneath a moss, lichen or liverwort cover (Bogli, 1980).

Estimates of cover loss from two swiddens near Pha Puek, based on this approach, are presented in table 1 (n=20 in all cases). These indicate loss of up to 80 cm. of soil and litter, although the proportions of each cannot be differentiated. It is highly unlikely that this loss is attributable solely to swiddening as karren forms also indicate considerable loss elsewhere from steep forested areas subject to regular burning, and there is every reason to anticipate that the area near Pha Puek was burned repeatedly prior to clearing. Reconnaissance of erosion from the forest floor in an area only now being converted to swidden several kilometres south of Pha Puek on the southern slopes of Doi Khu also revealed similar maximum losses in localised areas although the average figure was considerably less (19.6 cm) than at Pha Puek. If it is assumed that a similar average depth may have been stripped at Pha Puek prior to forest clearing, only 20-25 cm of the cover loss there may be attributable to erosion from the swiddens. However, the karren method of estimating cover loss may significantly over-estimate overall erosion due to preferential lowering of the ground surface close to outcrops by runoff from them.

	site	a	b
	aspect	ESE	S
	slope (%)	75	40
cover loss:	range (cm)	2-80	0-80
	mean (cm)	44.4	40.9

Table 1. Estimates of cover loss, Pha Puek.

Any estimation of the rate at which erosion proceeds demands some measure of the time period over which the cover has been lost. Rounded karren forms should undergo progressive sharpening once exposed to subaerial processes. Where exposed outcrops occur in deforested areas this probably occurs fairly rapidly under a monsoonal regime. Precise rates are unknown, but some guide to the order of magnitude may be offerred by Indonesian data (Balazs, 1968) that indicates an overall limestone surface denudation rate of 83 mm. 1000 yrs. Even though flutes represent sites where rock solution occurs more rapidly than the average it seems unlikely from this figure that sharpening would become evident in less than 10-15 years. This means it is unlikely to occur during the lifetime of any swidden. Sharpening will probably be considerably delayed where a forest canopy intercepts much of the rainfall. In addition, because solution processes that give rise to karren proceed most rapidly under warm conditions (Bogli, 1960) the shading of outcrops from the sun by a forest canopy may compound the delay.

Two main problems therefore exist. Firstly, the exposure of rounded karren in this area seems to offer a useful guide to the total depth of rhizosphere lost, but provides no means by which to fix precisely the proportion represented by soil. Secondly, no time control is available. However, local information suggested that the swiddens were cleared 5-8 years ago. If it is assumed that the soil surface has been lowered by 22 cm during this time, a surface lowering rate of between 2.8 and 4.4 cm.year is implied. If this were all soil, which is likely to be substantially the case given annual burning, it would ammount to a loss of between 280 and 440 tonnes. ha.yr.

In a brief attempt to verify this rate, soil loss from a swidden north of Pha Daang was estimated using basal burnlines on stumps left standing in the swidden (figure 4). If the difference in elevation between the base of the burnt wood and the present ground surface is assumed to define the amount of cover lost, burning is assumed to have penetrated to the base of the litter layer, and fresh and well defined burnlines are assumed to date from the preceeding dry season, then the rate of erosion of the soil may be estimated (table 2).

	aspect	NNE
	slope (%)	60-70
cover loss:	range (cm)	1-10
	mean (cm)	3.5

Table 2. Soil loss estimates, Pha Daang, May 1985 - May 1986.

This suggests a mean surface lowering rate of 3.5 cm.year which would imply that soil loss amounts to 350 tonnes.ha.yr which is consistent with the data from Pha Puek. Once again, this figure may well be too high since runoff from the stumps themselves may erode the adjacent ground surface to a greater extent than is typical for most of the swidden. Howing close to the stumps may also be a factor (cf. Hurni, 1983). Nonetheless, erosion at broadly this rate would achieve the surface lowering suggested at Pha Phuek in 5.7-7.1 years, which is consistent with the reported age of the swiddens.

Given that these rates are founded on only a very limited date base gathered on the run, and involve untested assumptions, the coincident nature of the results may be merely fortuitous, and certainly they do not represent a realistic vindication of the use of karren as erosion measures. However, these results do suggest there may be promise in the approach.

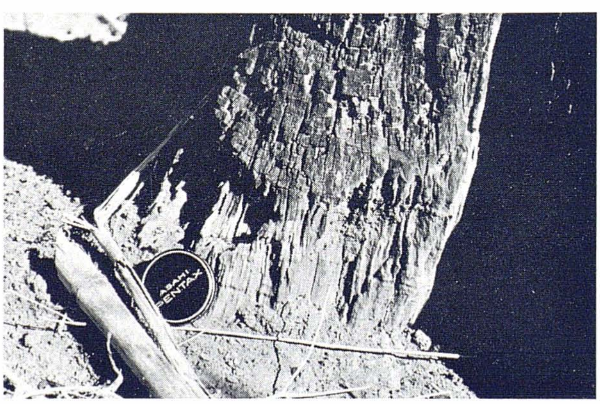

Figure 4. A basal burnline on a stump remaining in a swidden north of Pha Daang. The soil surface has been lowered by several centimetres since the swidden was burnt at the end of the previous dry season.

Conclusion

The principal problems in the use of karren to measure soil erosion include the impracticability of determining the relative proportions of soil, litter, and perhaps moss and lichen within the lost cover; the lack of any presently available time control on the subaerial modification of exposed subsurface karren; and the probability of disproportionately great erosion close to the outcrops themselves. Some of the more extreme subsurface karren exposures recorded may be the result of rounded forms having developed well above the ground surface beneath moss or lichen prior to the advent of regular anthropogenic forest fires. The circumstances of the visit and the very limited amount of time that was available to gather data while moving quickly through the area also meant that only a small number of measurements could be made.

The correspondence between the burnline and karren data suggests that any disproportionate lowering due to runoff from the outcrops and stumps themselves may have approximately balanced out. The suggestion that the determined rates may be excessive is perhaps supported by erosion data from granite soils at Huai Thung Choa where Hurni (1983) has documented an average soil loss of 120 tonnes.ha.yr. Although it might be anticipated that the granite soils would be even more highly erodible than the limestone soils, the rates calculated for the Pha Puek-Pha Daang area are approximately three times those applicable to the granite swiddens, and exceed even the maximum figure of 300 tones.ha.yr obtained by Hurni. It seems improbable that rainfall differences alone could account for this, nor even the fact that the Lisu people at Huai Thung Choa appear to go to greater lengths to minimise soil erosion than do the Red Lahu people in the limestone mountains (Hurni, 1983).

Despite these difficulties it is clear that swidden agriculture, abetted by rampant forest incendiarism, is exerting profound effects upon the limestone soils: destruction of the humus layer; volatilisation of many potential new nutrient inputs; erosional loss of the remaining ash fraction that contains a high proportion of the surviving nutrients; modification of the vegetation cover; and serious progressive reduction of the mineral capital of the soils. Although forest burning causes serious erosion, that caused by swidden agriculture appears to be about 3-4 orders of magnitude greater if the forest floor erosion at Doi Khu is assumed to have occurred over about 40 years and is at all representative.

But however serious their effects, these gentle hilltribe people in their remote mountain communities are merely responding to historical and economic realities that confront them but which were not of their own making. Those who would change the situation must be sensitive to this. The occasional official burning of hilltribe opium crops in response to political pressures from the west may be more likely to create resentment and hardship than changed crop preferences or wiser land management. And, despite the commendable efforts to the Thai government to develop sedentary agro-forestry alternatives to shifting cultivation of opium, remoteness, political instability, and the lack of similar initiatives north of the border remain a stumbling block. With perhaps 30 % of the population of the southern Shan States economically dependant upon the illicit heroin industry, it is likely that unless equitable political and economic solutions can be found to regional problems, physical devastation of the mountains of the Golden Triangle and social devastation in the cities of the western world will continue to go hand in hand for some time to come.

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