11

Irrigated Agriculture and Rural Change in Northeast Thailand: Reflections on Present Developments

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Irrigation development, in Northeast Thailand (Isaan) and elsewhere, is justified by the additional benefits that a water supply generates through increased crop production and related activities, and under the climatic conditions of monsoonal Southeast Asia, the facilitation of dry-season cropping. For the last half-century, much attention and funds have been channeled into the development of water resources in Northeast Thailand. This drive to develop irrigation infrastructure has been spread across technical-scales (large-, medium-, and small-scale), types of techniques (storage/gravity, run-off-river diversions, pump-irrigation, small-scale tanks) and bureaucratic institutions (Molle et al. 2009).

With the exhaustion of suitable sites for water storage projects in the late 1970s, the Government of Thailand began allocating ever larger budgets to the construction of pump-irrigation schemes, seen as a central option to increase irrigated areas in Isaan. The development of pumping schemes was economically justified by the benefits that dry season cultivation would generate, while also stabilizing agricultural production in the rainy season. At the same time, the heavy investment in irrigated agriculture was also justified by a host of other political and

security considerations that permeated the policy discourses of irrigation development in Northeast Thailand from the onset (see e.g. Bruns 1991; Sneddon 2003; Molle and Floch 2008).

In this chapter, we analyze the changing context of irrigated agriculture, as well as past and present irrigation policies and future plans. To do so, we scrutinize changes in household structure, farming systems, on- and off-farm employment opportunities and on-farm work environments. We link these findings on rural change in the case-study irrigation systems, to the more general performance of irrigation in the region, and in particular to dry season cropping. We highlight the dominant physical and socio-economic constraints to dry season cultivation, the dynamics of state and non-state water resources developments and adjustments to water scarcity. Finally, we provide some analysis of the changing faces and economic realities of irrigation development in Northeast Thailand.

Northeast Thailand and the Study Area: A Brief Introduction

Agriculture and Economy

Northeast Thailand (168,894 km^2) is dominated by the Korat Plateau, a large saucer-shaped plateau bordering the Mekong River. Most of the area varies in height between 170 and 300 m in altitude, with the surrounding mountains rising to as high as 1000 m. Rainfall is characterized by a distinct wet and dry season, with 85–90 percent of the total annual precipitation falling in the months of April to November, and considerable variability within seasons, months, and from year to year (Floch and Molle 2009). Heavily weathered and leached sandy and alluvial soils, that are low in fertility and organic matter, limit the potentials of agricultural production. This in turn makes rainfed rice cultivation marginal and limits upland crop production to those cultivars that can withstand periods of soil-moisture deficit (Rigg 1985).

Most agricultural production, including rice (the region's most important crop) takes place under rainfed conditions, while the total irrigable area in Northeast Thailand is confined to 1.18 million ha (Boonlue 2005) with limited utilization during the dry season (Floch et al. 2007). With the closure of the land-frontier in Northeast Thailand

towards the 1980s, and with government policies focused on agricultural intensification, irrigation has remained high on the agenda. As potential water storage sites in Northeast Thailand were largely exhausted by around 1970, the government of Thailand (in 1978) shifted its focus to the completion and upgrading of existing medium- and large-scale infrastructure and to developing small-scale hydraulic infrastructure, including pump irrigation projects (AIT 1978). Consequently, between 1980 and 2000, close to 1,000 small-scale pumping schemes were constructed in Northeast Thailand, and the total potential irrigable area served by these schemes totaled around 230,000 ha (Boonlue 2005).

During the last half-century, the population of northeast Thailand grew from 8.8 million in the 1950s to over 20 million in 2000. The region's population is largely rural, with the urban population constituting around 15 percent of the total. This, however, is changing rapidly and it was estimated that by 2020 around 30 percent of the projected population would be located in urban areas (PCD 1997). At the same time, Northeast Thailand underwent rapid economic growth as the wider non-agricultural economy absorbed larger numbers of rural people, drawing them increasingly permanently away from their farm operations (Coxhead and Southgate 2000). A recent study on the economy of the region found that (a) since the 1970s the northeastern region witnessed an average per capita growth rate of 3.3 percent; that (b) the region's per capita GDP grew from 11,000 baht in 1970 (expressed in 1988 prices) to 34,000 baht in 2004; and that (c) GNI per capita increased more than sevenfold from US$94 to US$720 during the same period (World Bank and NESDB 2005). These changes were accompanied by shifts in the composition of output: agriculture now accounts for only one-fifth of GDP, just as much as industry, while an impressive three-fifths originates from the service sector.

The Pump Irrigation Schemes

To garner an understanding of the dynamics of pump-irrigation systems and their actual utilization and farm operation under changing economic realities, we compare three pumping schemes on the Lam Se Bai River in Northeast Thailand. The river is a left-bank tributary of the Mun River near the town of Ubon Ratchathani. The Chi-Mun basin is Northeast Thailand's largest continuous river system, and feeds into the Mekong River. The Lam Se Bai sub-basin mainly overlaps with three provinces

(Amnat Charoen, Yasothon and Ubon Ratchathani), and covers an area of 4,174 km^2 with a total mean annual runoff of approximately 1,600 mm^3 (Binnie and Partner 1995).[1]

At present, the total installed irrigation command area in the sub-basin is 8,994 ha in small-scale systems and 6,341 ha in medium-scale irrigation projects. Two significant irrigation projects—Fai Lam Se Bai and Fai Amnat—are currently being implemented, both as part of the larger Khong-Chi-Mun Irrigation and Interbasin Transfer Project (KCM),[2] with gated weir structures installed on the Lam Se Bai River, and large-scale pump-irrigation schemes. At full development, the two KCM schemes would add an additional 23,630 ha, and raise the total area under irrigation to 38,967 ha. Out of the total 85 small-scale (state-sponsored) irrigation projects, 26 are pumping projects, while the remainder are weirs. The majority of the pumping stations were installed by the Department of Energy Development and Promotion (now dissolved), and only recently did the Royal Irrigation Department (RID) take over responsibility for the development of pumping schemes. Small-scale weirs, on the other hand, have been mostly developed by RID (under the Ministry of Agriculture) and the Ministry of the Interior.

Field research for this paper was conducted during the dry season, from November 2007 to March 2008. For comparative analysis we selected three pumping schemes, based on the particularities of the sub-basin, the location of the newly constructed weirs, the average utilization of existing infrastructure, and the year of construction. The most salient features of the three schemes are listed in Table 11.1.

Table 11.1 Basic Data on the Case Study Irrigation Schemes

ID	TKN	SP	TYC
Village	Tung Khon Noi	Som Poi	Ta Yang Chum
Province	Ubon Ratchathani	Ubon Ratchathani	Amnat Charoen
Year of construction	1980	1987	2005
Project area (ha)	480	240	160
Avg. farm size (ha)	1.9	3.9	3.9
Avg. size of household	5.7	5.6	4.8

A detailed questionnaire covering around 15 percent of the households was developed to cover: (a) technical issues of irrigation water use, water conveyance, on-farm and farm-owned water infrastructure and

scheme adaptations and preferred options for water resources utilization, (b) agronomic data on crop production, choice of crops and cropping techniques, changes in farm-land, limits and constraints to production, levels of agricultural input, and labor requirements, and (c) dynamics in household compositions and main economic activities, including family structure, in- and out-migration, fertility decline, and major occupations across the last farm-generations.

Utilization of Infrastructure, Agricultural Production and Rural Transition

Actual Irrigation Water Use

Based on data provided by the Provincial Pump-Irrigation Centre in Ubon Ratchathani, we estimate that the average pump irrigation project in the study area covers an area of 320 ha, with roughly 150 ha of irrigation command area. Between 2005 and 2007, wet season cultivation in all pumping stations in the Lam Se Bai sub-basin was dominated by the cultivation of wet-season rice under supplementary irrigation. During the same period, an average pumping station in the Lam Se Bai sub-basin supported dry season production on 11.7 percent (17.5 ha) of the command area. The dominant crop-types cultivated in the dry season were vegetables (85 percent) and rice. Thus, on average 88.3 percent of the constructed command areas remained idle during the last three dry seasons, confirming earlier findings on pump irrigation (under-) utilization in Northeast Thailand (Kamkongsak and Law; 2001; Limpinuntana 2001; UBU 2002).

On average, dry season water use per pump-irrigation scheme averaged a total (over 4 months of operation) of 0.147 mm^3, around 50 percent of the targeted water delivery, totalling an estimated 4.26 mm^3 of diverted water in the Lam Se Bai basin. The three studied pumping stations, however, diverged from these averages: while the most downstream Tung Khon Noi pumping schemes showed dry season cultivation at around 12 percent of the command area (including rice), both at Som Poi and Ta Yang Chum rice was not cultivated in the dry season, and cultivation was restricted to vegetables. Pumped water in the dry season, in most pumping stations on the Lam Se Bai (albeit not in Tung Khon Noi) was almost exclusively supplying the numerous farm-

ponds which subsequently supported the cultivation of vegetables, the raising of fish and feeding of livestock. This indicates the importance of buffer storage for vegetable production which allows farmers to draw water from on-farm storage at will—a degree of flexibility not provided by canal water distributed by gravity.

Crop Selection, Yields and Fertilizer Use

The majority of wet season cultivation in the irrigation schemes was devoted to rice, with the most dominant cultivated varieties being the glutinous *khaaw khaaw* 6 on 47 percent and the non-glutinous *khaaw dok mali 105* (KDM 105) on 20 percent of the farm plots. Among the favoured non-rice commercial crops cultivated in the three pumping schemes were chilli, flat onion and the upland crop cassava. Almost all the interviewed farmers practiced noncommercial cultivation of mixed vegetables and fruits around their farm ponds or in home gardens. The selection of rice varieties was largely determined by the crop's flexibility to comply with the heterogeneity of the topography and the related agro-environment.[3] KDM 105 is prominently cultivated in the lower terraces that are more flood-prone, as farmers started to feel comfortable with the variety's flood resistance. *Khaaw khaaw 6* (RD 6) is equally cultivated in the upper, middle and lower terraces of the irrigation scheme.

Average wet season rice yields in the three pumping schemes was found to be only 1.6 t/ha— below the average wet season yields of roughly 1.9 t/ha for Northeast Thailand. Dry season rice yields were found to be considerably higher at 2.9 kg/ha (although the sample size was very small, as dry season rice cultivation was limited to the particular environment of Tung Khon Noi). Much of the low average yields can be attributed to the cultivation on the flood-prone lower terraces, which are (almost invariably) seasonally flooded and experience frequent reduction in yield or even total loss of crops.

But while the irrigation system can technically provide supplementary irrigation for the upper terraces (thereby stabilizing production and yields), flooding of the lower terraces is not technically controllable on the Lam Se Bai. The cultivation of crops in these areas is encouraged by compensation payments for crop losses incurred through annual flooding of lowland areas, thereby reducing the financial risk of failure. It appeared highly likely that without these, much of the most flood-prone land would not be cultivated. Dry-season rice cultivation is significantly a function of

the available farmland that individual farmers are operating. In the more intensified Tung Khon Noi pumping scheme, farmers (especially in the lower flood-prone terraces) substitute their insecure (and frequently flood-damaged) wet-season harvest for home consumption by a more stable dry season. This is accentuated by the fact that only about 30 percent of the farmers cultivating in the dry season sold the larger part of their rice production, the majority keeping the harvest for consumption.

The generally observed low yields are also a function of the low-input agriculture practiced in the Lam Se Bai sub-basin, and Northeast Thailand more generally. Average fertilizer use in the study area was limited to 30.3 kg/*rai* in the wet season and 36.6 kg/*rai* in the dry season, (that is, half the quantity typically observed in the central region). This low input was found across the three schemes, irrespective of topography and farm size.

Cropping Practices

The shortage of labor is clearly visible in the cropping practices employed in rice cultivation. In the 1960s, transplanting of rice was predominant in Northeast Thailand (Platanius 1961) and the study area.[4] Nowadays, however, the practice of transplanting has increasingly been substituted by wet broadcasting of rice, although this is subject to changes from year to year. In the pumping schemes studied wet broadcasting of rice was practiced on more than half of the paddy area (51.1 percent). The highest percentage of transplanting was found in the lowland areas of the pumping schemes, where water accumulated early in the growing season, while broadcasting was mostly favoured in the middle and higher terraces. The spread of direct seeding in lieu of transplanting is a clear indication of a labor shortage in the study area (Konchan and Kono 1996).

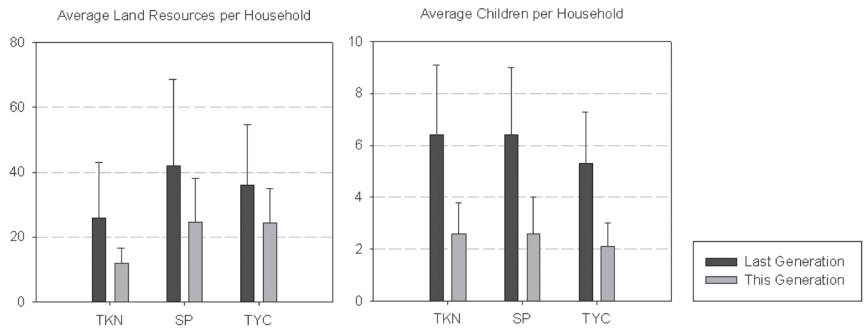
Rural Transition: Land Resources, Household Composition and Economic Change

Demographic transition in Thailand has been found to be extremely sharp with annual population growth now less than 1 percent, and both the "exodus of young labor" (Funahashi 1996) and the increasing feminization and ageing of the farm population (Binnie and Partner 1995) has been vividly described. The decline in the population with agriculture as a main activity in the Northeast has been accompanied by increasing percentages

of urban population, and it has been estimated that by 2015, an average of 35 percent of the northeastern population will be concentrated in and around urban centers (PCD 1997). This trend of urbanization has also been accompanied by rising opportunities for non-agricultural activities in rural Northeast Thailand, and from the late 1980s to 2000 non-agricultural employment increased from under 10 percent to over 20 percent.

These regional trends are all observed in the pumping schemes of the Lam Se Bai River. From the last to the current farmer generation,[5] available land resources per household have dropped from an average 33.9 *rai* to 19.9 *rai* (Figure 11.1). This dramatic decline in available land resources reflects the closure of the land frontier, with diminishing options for expansionist strategies, and subsequent division of land amongst family members from one generation to the next. This division of land is most acute in the peri-urban Tung Khon Noi pumping scheme, which saw average farmland reduced from 26.0 to 11.7 *rai* in one generation. The decrease in available land resources was of course a major justification for the development of irrigation infrastructure, as increasing production could no longer be met by opening up new land, and irrigation was seen as the key to further increase production. During the same period, population growth averaged 1.7 percent in Northeast Thailand, though starkly reduced in the latter part of this period. This means that while an average farm family in the study area sheltered around 6.1 children in the 1980s, this figure has dropped to an average of 2.4 children per household at present (Figure 1); a pattern that is consistent throughout the three different locations studied.

Figure 11.1 Land Resources and Average Children per Household



At the same time, the younger generation that would possibly be able

to take over farming operations is predominantly migrating out of agriculture or out of the region or both. On average, 34.7 percent of the current farmers' children have migrated out, with the remainder being mostly under-aged and still going to school. In Ta Yang Chum, 63 percent of the young generation has left the village, and 59.3 percent have left the province of Ubon Ratchathani.

In the other two pumping stations, just under 40 percent of the population have left the village permanently, while just over 30 percent have left the province. Perhaps the most important feature of this migration are the remittances which supplement total household incomes: more than half of northeastern households benefited from such payments in 2002, and among the receiving households, these remittances amounted to around one-third of household income, lowering poverty from 17 to 12 percent (World Bank and NESDB 2005). This is equally true in the areas irrigated by pumping schemes, in which, remittances—when received—make up 46 percent of incomes. Individual farmers received up to 6,000 baht/mth from their migrant, and often better-educated, children. For the relatively older-aged active farm population this influx of money makes up the major part of non-agricultural income, and in some cases provides the only secure cash income.

Present Irrigation Development: A Discussion

Irrigation development in Thailand is still a high-ranking government priority, especially in Isaan (Molle et al. 2009). The largest implemented regional irrigation scheme (partly) implemented in the region has so far been the Khong-Chi-Mun (KCM) Project, planned in 1992 (ASEAN et al. 1992), and implemented ever since. The KCM Project suggested that it was technically feasible to irrigate 796,000 ha of additional farmland in 15 provinces of Isaan, storing water in the mainstream and the floodplains of the major rivers and diverting it to significant tracts of land by means of large-scale pumping units that feed the distribution networks. On the Lam Se Bai River, as indicated above, two in-stream regulation and storage facilities (weirs or '*fai*') were implemented: the upper Fai Lam Se Bai, and the lower Fai Amnat. However, and much like other components of the KCM project, the implementation of in-stream storage was not accompanied by an equally fast implementation of main canals and related irrigation infrastructure. Both KCM weirs were (during the time of

fieldwork) not serving any newly constructed irrigation areas, because of budgetary constraints (following the Asian economic crisis in 1997), and of lengthy processes of negotiating land compensations (the land needed for canal construction).[6] At present, however, RID is engaged in completing parts of the irrigation infrastructure, although with a comparatively more modest target (with regard to the enormous scale of the overall KCM Project) as only parts of the initially planned command areas and large-scale pumping systems are being developed.

It remains unclear how the new infrastructure will benefit farmers, whose cropping patterns should ideally be adapted to make the investments worthwhile, and how farmers will engage in agricultural production in the respective irrigation areas. A recent internal publication (RID 2007) listed possible cropping intensities, cropping patterns and envisaged yields for the two KCM schemes. According to this report, cropping intensities in both projects would reach 150 percent, with wet season cultivation dominated by rice (70 percent), field crops (20 percent) and other crops including vegetables, flowers and fruits (10 percent). During the dry season the envisioned cropping patterns include field crops, vegetables and flowers at 50 percent of the planned command area. Such patterns frequently include a degree of wishful thinking in that they overestimate the extension of cash crops in order to make the project appear economically worthwhile. Similarly, agronomic yields were assessed to be as high as 5.0 t/ha for non-glutinous rice, and 4.4 t/ha for glutinous varieties. At least in unofficial discussions with staff of the Royal Irrigation Department, the official assumptions regarding cropping in the now under-construction irrigation projects were considered unrealistic. A high-ranking local official, with responsibilities in the study area, noted that he expected cropping intensities in the project areas to be in line with other irrigation schemes in the region, and "at best at 120 percent".[7]

To better understand the recent claims for the KCM schemes, it is worthwhile to reflect on the assumptions and challenges faced by the operational (smaller-scale) pump irrigation schemes studied here. The targeted cropping intensities of 150 percent at full development (on which the economic viability of the project rests) are, of course, a matter of the rate of adoption of irrigation by the farmers: a parameter with "a high uncertainty margin" in the case of Northeast Thailand, with market prices significantly impacting on the actual extent cultivated (DHV et al. 1991).

Studying pump irrigation projects in Northeast Thailand, DHV et al.

(1991) also argued that the "profitability of dry season cropping is low" and that it should be expected that the "actual adaptation rate will be very dependent on product prices". This has been reconfirmed later by Nesbitt (2005). Also, an agronomic yield assumed for the Khong-Chi-Mun irrigation schemes of 4,375 kg/ha for glutinous rice varieties and 5,000 kg/ha for non-glutinous varieties are hardly realistic in a *real-world* setting in Northeast Thailand. Such optimistic assumptions are, of course, not unique to the KCM project, and are well documented for irrigation planning and development more generally. This is accentuated by the fact that potential yields of the most widely grown rice varieties have been acknowledged to be only moderate (DHV et al. 1990).

Moreover, our study suggests that the low actual yields observed in the study area, and Isaan more generally, are not a function of the lack of water. Actual yields are much more a function of the topography and belie a frequent assumption that areas selected for irrigation development are better suited for the cultivation of rice and other crops than the average rainfed area.

Summary and Conclusion

Since the initiation of pump-irrigation development 30 years ago, Northeast Thailand has changed substantially. Initiated when the expansion of farmland was reaching its limits and the land-frontier was closing, and with possibilities for large-scale gravity irrigation developments exhausted in the region, providing small-scale pump irrigation to farmers in the northeastern region appeared (at least at first glance) a viable option to trigger agricultural intensification, and help lift farmers out of poverty by providing more stable and productive agricultural environments, thereby limiting out-migration to urban centers and abroad.

However, as the most labor-intensive sector, Thai agriculture found itself increasingly unable to compete when the rapid expansion of labor demand in other sectors pulled up wages. The boom in labor-intensive manufacturing, construction as well as in services thus accelerated agriculture's relative decline. From 1989 to 1995 nearly three million workers out of the total Thai agricultural labor force of about twenty million walked off the land, and as a result, planted areas, which had increased steadily since the 1960s, stagnated and even began to decline

(Coxhead and Southgate 2000). This, in turn, has left farm management more and more in the hands of the remaining elderly farmers, and in a lot of cases, these are women (Binnie and Partners 1995).

Farmers shifting out of rainfed agriculture to other economic sectors are a long-known phenomenon in Northeast Thailand. Hence irrigation has long been seen as a way to limit out-migration by providing livelihood opportunities to the rural poor and incentives to stay (or even attract people back to rural Northeast Thailand). We have argued elsewhere (Molle and Floch 2008), that the possibility of attracting labor back to agricultural is doubtful, judging from the differences in wages between agricultural and non-agricultural labor, and even more so from (the higher) differential between wages in Isaan and Bangkok, the former being half of the latter. This macro-level observation is confirmed by our field-level study: both the actual transition of occupational preferences from one generation to the next and the importance of remittances as supplemental family income show that non-agricultural off-farm employment is becoming an indispensable source of revenue in rural Northeast Thailand.

In the three pumping stations, larger policy goals of limiting migration and triggering agricultural intensification cannot be observed. Also, yields in the pump-irrigation schemes suggest that the agro-environments in which pumping schemes are generally installed are not more favorable than general rainfed areas, but that frequent (non-controllable) flooding in the lower terraces limits production. Judging from cropping practices, cultivated farm sizes and prices for hired labor, we argue that today there are also considerable constraints to agricultural expansion in the labor market. In addition, judging from the rapid fertility decline in the region and the continuous push of the young rural population out of the agricultural sector, we expect this to intensify. At the same time farmers have shown a high adaptability to rapid changes in their economic environment, such as changing market demand for agricultural products and labor (Barnaud et al. 2007). In summary this means that with many ageing farmers, economic diversification, and migration opportunities, the future of farming in the region is—if not threatened—then at least in a phase of considerable change, with patterns of agrarian change to be heavily shaped by tensions in the labor market as time goes by.

But while these changes are apparent, it has been recently observed by a joint-study of the World Bank and the National Economic and Social Development Board of Thailand (World Bank and NESDB 2005) that:

> The Northeast's image has seen little changes over the last decade. It has a reputation of being a tranquil and backward region, far distant from Thailand's economic hubs, for a life burdened by the toils of the field rather than the stresses of modernity. But the image is misleading; its economic record suggests a rather different reality. Aided by a dynamic and rapidly changing economy, the region has had three major accomplishments: it has grown quickly, it has noticeably reduced poverty and it has still preserved its strong communities.

This is a remarkable conclusion since much of the current discourse on irrigation expansion through large-scale transbasin diversion schemes (see for example: Molle et al. 2008, Floch and Blake 2010) are justified by the image of water-scarce rural communities that have missed (or have been left out of) the development-train. Our research on the irrigation system of the Lam Se Bai River confirms these observations: rural Northeast Thailand is a very lively economic place, in which economic opportunities are both created and taken, but where farmers increasingly see their children's future in off-farm employment.

In view of this, it appears high time that decision-makers and planners appreciate the rapid transition that farmers in Northeast Thailand are both initiating and a part of, to appraise the impacts of rural transition on the sustainability of investments into irrigated agriculture. Who will be using the substantial infrastructure that is currently being put in place: the rural poor who often serve as a means to justify the massive investments, or agro-business companies? This will require that taken-for-granted planning assumptions supporting the installation of the Khong-Chi-Mun and other irrigation project developments are scrutinized in light of the rural transitions that are taking place and more openly discussed and evaluated in the public sphere.

Notes

1 Mm = Mega-cubic meters ($10^6 m^3$).

2 For more details on the KCM project see: Sneddon (2003); Floch et al. (2007).

3 For information on the agro-environments for rice production in Northeast Thailand refer to Rigg (1985).

4 December 2007; names of interviewees are withheld for anonymity.

5 To capture long-term changes in rural Northeast Thailand, we interviewed farmers equally about their present situation ("This Generation"), as well as on the available resources of their parents ("Past Generation"). On average, the farmers interviewed were 47.5 years old, representing the present farm generation. In addition, to

foresee possible future changes, we did question the current farm operators about their children's current occupation ("Next Generation").

6 Personal communication, February 2008, RID Regional Office, Ubon Ratchathani.

7 Personal communication, December 2007, RID Provincial Office, Amnat Charoen.

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