Pump Irrigation Development and Rural Change in Northeast Thailand

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Abstract

Since the late 1970s, and with diminishing potentials for the development of storage-gravity irrigation in Northeast Thailand, the Royal Thai Government has engaged in the development of pump irrigation schemes. Small in scale, fast implemented and independent of larger hydraulic regulations of the natural flow regime, this type of irrigation project became a defining feature of the waterscapes of the region. At the same time, Thailand has undergone rapid economic growth, and while the north-eastern region lagged behind other regions, it increasingly became integrated into the wider national and regional economy. While pump-irrigation is still seen a worthwhile investment by state agencies and decision-makers, the actual benefits possibly generated by these systems have been increasingly challenged. Through a comparative case study of three pumping stations in northeast Thailand, we assess the utilization of hydraulic infrastructure, look at the cropping practices employed in pump-irrigation schemes, and trace the dominant changes in on-farm realities of pumping schemes. We highlight the increasing importance of non-farm incomes and remittances from out-migrated family members, changes in agricultural production induced by shortages on the labour market and constraints to diversification and dry-season agriculture. Our findings suggest that while investments into pump irrigation have been economically marginally sound from the onset, more recent investments into pump irrigation are implemented in almost complete disregard of the profound and dynamic changes of farming realities in northeast Thailand.

Introduction

Irrigation development, in northeast Thailand and elsewhere, is generally justified by the additional benefits that water supply generates through increased crop production and related activities, and in dry-land agro-ecosystems and large parts of monsoonal South-East Asia the facilitation of dry season cropping. For the last half-century, much attention and funds have been channelled into the development of water resources in northeast Thailand. This drive to develop irrigation infrastructure has been equally 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. With the exhaustion of topographical and socio-economically feasible construction sites for storage in the late 1970s, the government of Thailand has allocated increasing budgets to the construction of pump-irrigation schemes, seen as a central option to augment irrigated areas in Northeast Thailand. In order to alleviate poverty and generate opportunities for rural and agro-industrial employment, the main goal of this type of hydraulic infrastructure was to spread the benefits of irrigation development to communities which had so far not benefited from developmental investments by concerned government agencies. 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, investments in irrigated agriculture were 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 paper, we analyse the changing context of pump-irrigation development in northeast Thailand; scrutinize changes in household structure, changes in farming systems, on- and off-farm employment opportunities and on-farm work environments. We then link these findings on rural transition and agrarian change in pump irrigation systems in northeast Thailand, to the primary economic performance of pumping schemes in the region through the facilitation of dry season cropping. We highlight the dominant physical and socio-economic constraints to dry season agricultural, the dynamics of state and non-state water resources developments and adjustments to water scarcity. To do so, we have selected three pumping stations on the Lam Se Bai River in Northeast Thailand. In a comparative study of these stations, all located in slightly different hydrological settings, we hope to arrive at a coherent analysis of the changing faces and economic realities of irrigation development in Northeast Thailand.

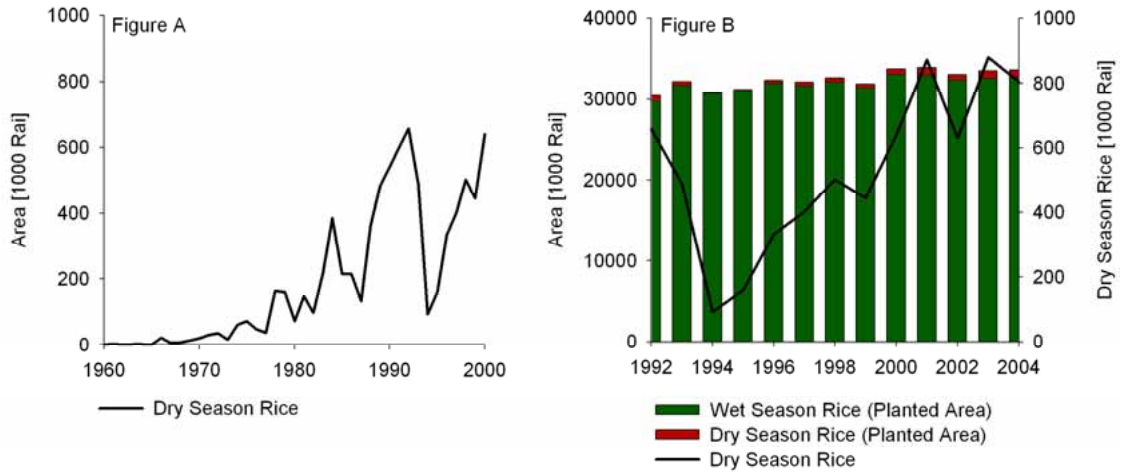
Northeast Thailand: Introducing the Region and the Study Area

Northeast Thailand, the second largest administrative region in Thailand with 168,894 km2, is dominated by the Korat Plateau, a large saucer-shaped plateau, bordering the Mekong River in the north and east, and the Phnom Damrek and Phetchabun mountain ranges to the south and west respectively. 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. Physiographically, the landscape of the region consists of hilly areas, undulating land, non-flood plains, floodplains and river levees, with each of these agro-ecosystems providing environments for particular landuse and agricultural production (KKU-FORD 1982, Limpinuntana 2001). Rainfall is characterized by distinct wet and dry season, with 85-90% of the total annual precipitation falling in the months of April to November, and the remainder of the year being particularly dry. The seasonality of rainfall is accompanied by considerable variability within seasons, months, and from year to year. 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 temporal soil-moisture deficits (Rigg 1985). In view of this, northeast Thailand has frequently been depicted as a marginal agro-environment.

Most of agricultural production, including rice (the regions most important crop) takes place under rainfed conditions, with limited irrigation development (Figure 1). The total irrigable area in Northeast Thailand is around 1.18 million ha (Boonlue 2005), with limited utilization during the dry season (Floch et al. 2007).

Figure 1: Dry-Season Irrigation in Northeast Thailand



With the closure of the land-frontier in northeast Thailand, and with government policies focused on agricultural intensification, irrigation has remained high on the agenda. In 1978, the government of Thailand adjusted its official water policy through the introduction of the "Two-Pronged Water Policy" (AIT, 1978), shifting its focus to the completion and upgrading of existing medium- and large-scale infrastructure and to developing small-scale hydraulic infrastructure. The National Energy Authority of Thailand (NEA) was entrusted with the task of implementing small-scale electric pump irrigation schemes, covering roughly 240 ha of irrigated land per pumping scheme. The following 5th National Economic Development Plan (1982-1986) set up a target of 80 stations or 32,000 ha per annum to be implemented in the country (NESDB, 1981). 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 totalled around 230,000 ha (Boonlue, 2005)[1].

At the same time, Northeast Thailand underwent rapid economic growth and the wider non-agricultural economy absorbed larger numbers of rural people, drawing them increasingly permanently away from their farm operations. During the last half-century, population in northeast Thailand increased from 8.8 million in the 1950s to over 20 million in 2000, with the highest population densities found around the economic hubs of the region, most notably Nakhon Ratchasima, Khon Kaen, Udon Thani and Ubon Ratchathani. The region's population is largely rural, with urban population constituting around 15% of the total population. This, however, is changing rapidly and it was estimated that by 2020 around 30% of the projected population would be located in urban areas (PCD 1997). Also, and significantly, a recent study on the economic performance of the region by the World Bank and Thailand's National Economic and Social Development Board (2005) found that since the 1970s the north-eastern region witnessed an average per capita growth rate of 3.3 percent, its economy being now three times as large as then. The region's per capita GDP grew from THB 11,000 in 1970 (expressed in 1988 prices) to THB 34,000 in 2004, and GNI per capita increased more than seven-fold from USD 94 to USD 720 during the same period. 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-fifth originates from the service sector (World Bank and NESDB 2005).

The Lam Se Bai River: General Information and Irrigation Infrastructure

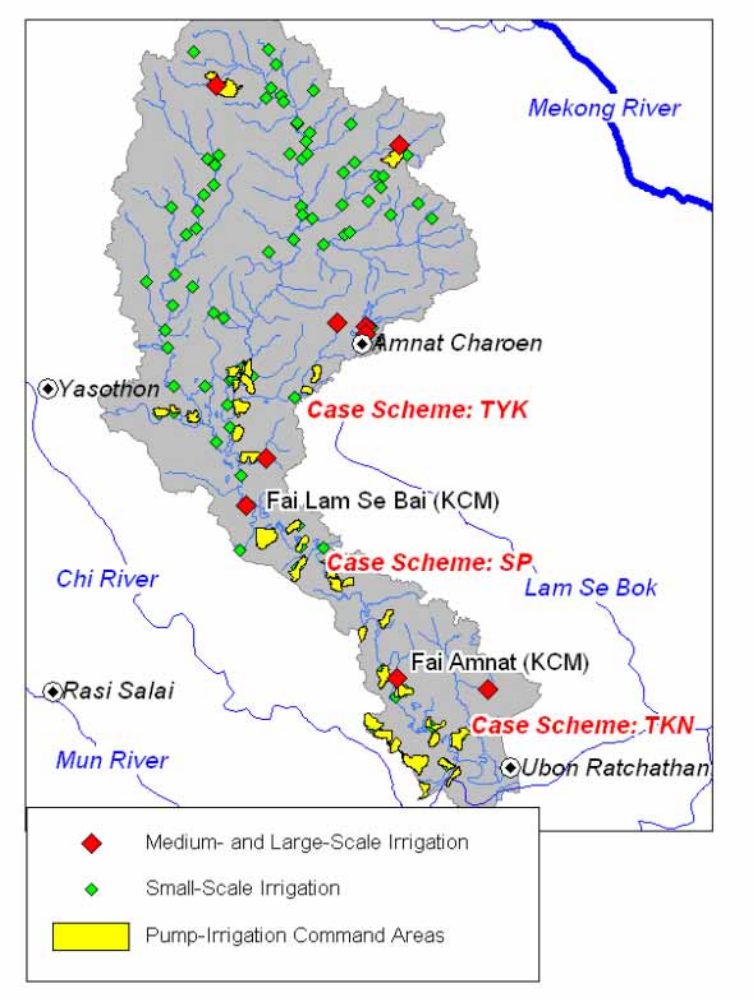
To garner an understanding of the dynamics of pump-irrigation systems, their actual utilization and farm operation under changing economic realities, we compare three pumping schemes on the Lam Se Bai River in Northeast Thailand. The river is a left-hand tributary of the Mun River and joins the larger Mun River near the town of Ubon Ratchathani (Figure 2). The Chi-Mun basin is northeast Thailand's largest continuous river system, and feeds into the Mekong River. The sub-basin mainly overlaps with 3 provinces (Amnat Charoen, Yasothon and Ubon Ratchathani), and covers an area of 4,174 km^2 with a total discharge of approximately 1,600 Mm^3 leaving the subbasin (Binnie and Partner 1995).

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 in the stage of implementation, both as part of the larger Khong-Chi-Mun Irrigation and Interbasin Transfer Project (KCM), with gated weir structures installed on the Lam Se Bai River,

[1] At the same time and with potential sites for additional storage/gravity irrigation developments in Northeast Thailand becoming increasingly unavailable, channel and floodplain storage became the cornerstone of larger development plans for the region (e.g. the Khong-Chi-Mun Irrigation Project). Necessitated by the topography of the regions largest rivers, the actual distribution of the water resources was (again) to be facilitated by pumping schemes: this time, however, considerably larger in scale. In this paper, however, we are mostly concerned with the small-scale pumping stations.

and large-scale pump-irrigation schemes currently implemented[2]. 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.

Figure 2: The Lam Se Bai Subbasin - Irrigation Infrastructure and Case Study Locations



The majority of the pumping stations were installed by the Department of Energy Development and Promotion, and only recently did the Royal Irrigation Department take over responsibility for the development of pumping schemes. Small-scale weirs, on the other hand, have been mostly developed by the Royal Irrigation Department and the Ministry of the Interior.

Most of the pumping schemes along the Lam Se Bai River are located in the middle and lower parts of the sub-basin, the areas that (at least marginally) convey dry-season flows.

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[2] For more information on rationales and particularities of the Khong-Chi-Mun Irrigation and Interbasin Transfer Project see for example: Sneddon 2003, Shannon 2005, Floch et al. 2007, Molle and Floch 2008.

The upper tributaries, are dominated by strictly seasonal streams that carry no water during the dry season (December through April), and are restricted to diversions by weirs during the wet season. Only the two most upstream medium-scale reservoir projects in the upper Lam Se Bai sub-basin provide irrigation water for dry season irrigation.

Study Area Selection and Methodology

Field research for this paper was conducted during the dry-season, from November 2007 to March 2008 in the provinces of Ubon Ratchathani and Amnat Charoen. 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 1.

Table 1: Basic Data of Case Study Pumping Schemes

	Case Scheme 1	Case Scheme 2	Case Scheme 3
Village	Tung Khun Noi	Som Poi	Ta Yang Chum
Identification	TKN	SP	TYC
Province	Ubon Ratchathani	Ubon Ratchathani	Amnat Charoen
Year of Construction	1980	1987	2005
Project Area [ha]	480	240	160
Average farm size [ha]	1.9	3.9	3.9
Average Size of household	5.7	5.6	4.8

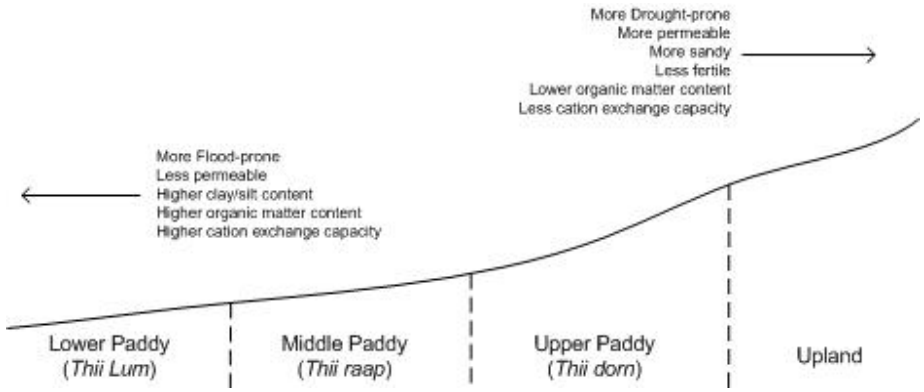
A detailed questionnaire covering around 15% of the households was developed to cover: (i) technical issues of irrigation water use, water conveyance, on-farm and farm-owned water infrastructure and scheme adaptations and preferred options for water resources utilization, (ii) agronomic data on crop production, choice of crops and cropping techniques, changes in farm-land, limits and constraints to production, levels of agricultural input, and labour requirements, and (iii) 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.

The selected irrigation schemes and their differences in terms of geographical location, histories of settlement and landuse allow for a better understanding of agricultural intensification. At Ban Tung Khun Noi (TKN), located in the peri-urban zone of the town of Ubon Ratchathani, land fragmentation has far progressed with average farm-land holding now as low as 1.9 ha. This is well below the average land holding in the province of Ubon Ratchathani of 3.4 ha given in the 2003 Agricultural Census Report (NSO 2003). The other two schemes, on the other hand, are located in more peripheral environments towards the upper parts of the watersheds, and present different states and dynamics of fragmentation and intensification. These selected pump-irrigation schemes also allows reflecting on the rationale for their development. TKN was part of the first batch of pumping schemes implemented in 1980, while the pump at Ban Ta Yang Chun (TYC) was set up only 3 years ago by the Royal Irrigation Department, replacing an earlier

diesel-powered pump located at the same location and upgrading canals and distribution facilities.

Within pumping schemes, land suitability varies greatly following patterns typical of northeast Thailand (Rigg 1985). From river levees to uplands, the different land classes change from flood- to drought-prone, from less permeable to more permeable and higher organic matter to lower organic matter (Figure 3). Choice of crops and farmers' understanding of potentials for production are determined by this topographical progression and the risks associated with the different locations of farm plots.

Figure 3: Topography and Agro-Ecosystem (adopted from Rigg 1985)



Pump-Irrigation: Utilization, Agricultural Production and Rural Transition

The rapid implementation of pumping projects in the region, although considered a favourable development option by policy-makers up to recent times, eventually led to increasing doubt about their actual benefits, economic and otherwise: accounts of underutilization, with dry season cropping reportedly stagnant at 10 to 15 percent (Kamkongsak and Law, 2001); induced competition for limited water resources (Gibb and Partners, 1988); implementation without proper investigation of dry season flows (Sriswasdilek, 1983) and lack of inter-agency coordination (Palanisami and Apinantara, 1984). In addition, and this holds for irrigation in Northeast Thailand more generally, shortage of labour and salinization constraint irrigated agriculture in the region (Molle and Floch, 2008). These are all considerable reported shortcomings that impede the economic performance and – in turn – weakens the rationale that guide irrigation development policies in northeast Thailand.

Utilization of Infrastructure: Pumps and Ponds

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. During the last three years (2005-2007) wet season cultivation in all pumping stations in the Lam Se Bai subbasin 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% (17.5 ha) of the command area. The dominant crop-types cultivated in the dry season were vegetables (85%) and rice. Thus, on average 88.3% 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).

Dry season water use in one pump-irrigation scheme averaged 0.147 Mm^3, around 50% 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 *TKN* pumping schemes showed dry season cultivation at around 12% of the command area (including rice), both at *SP* and *TYC* rice was not cultivated in the dry season, and cultivation was restricted to vegetables (Table 2).

Water pumping in the dry-season, in most pumping stations on the Lam Se Bai (albeit not in *TKN*) was almost exclusively supplying the numerous farm-ponds which subsequently supported the cultivation of vegetables, the raising of fish and feeding of livestock (see below). 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.

Table 2: Water Use and Productive Areas (Average 2005-2007)

	TKN	SP	TYC	Total
Target Water Use	0,48	0,15	0,10	0,29
Actual Water Use	0,43	0,15	0,02	0,15
Target Dry-Season Paddy (Rai)	215	0	150	100
Actual Dry-Season Paddy (Rai)	150	0	0	10
Target Dry-Season Vegetable (Rai)	80	75	50	96
Actual Dry-Season Vegetable (Rai)	33	63	20	79
Average Days of Pumping	45	28	20	31.8

Crop Selection, Yields and Fertilizer Use

The majority of wet season cultivation in the irrigation schemes is devoted to rice. The most dominant cultivated varieties are the glutinous *khaaw khaaw 6* (47 %) and the non-glutinous *khaaw dok mali 105* (KDM 105) on 20% of the farm plots. Among the favoured non-rice commercial crops cultivated in the three pumping schemes were chilli and flat onion and the upland crop cassava. Almost all interviewed farmers practised non-commercial 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. KDM 105 is prominently cultivated in the lower terraces which are more flood-prone, as farmers stated 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 yield in the three pumping schemes was found to be only 1.6 t/ha. This is below the average wet season yields for northeast Thailand which is roughly 1.9 t/ha. Dry season rice yields were found to be considerably higher at 2.9 kg/rai (although the sample size is considerably low, as dry season rice cultivation was limited to the particular environment of TKN). 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 through compensation payments that reduce the financial risk of failure, and it appears highly likely that without these, much of the most flood-prone land would not be cultivated.

Table 3: Wet-season rice yields across different farm topographies

Unit: (t/ha)	TKN	SP	TYC	Total
Upper Paddy	1.9	2.5	1.8	2.0
Middle Paddy	1.3	1.8	2.1	1.6
Lower Paddy	1.2	1.6	1.5	1.5
Total	1.4	1.8	1.8	1.6

Dry-season rice cultivation is significantly a function of the available farm land that individual farmers are operating (Table 4). In the more intensified *TKN* pumping scheme, with average farm land limited to 2.3 ha, farmers (especially in the lower flood-prone terraces) substitute there 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 % of the farmers cultivating in the dry-season sold the larger part of their rice production, the majority keeping the harvest for consumption.

It was observed that the middle terraces, under rainfed conditions, provide the most suitable areas for rice production (see e.g. Riggs 1985). This relation is somewhat more complex in pump irrigation systems. Due to the layout and topography of pumping schemes, the upper terraces are often located closer to the main irrigation canals and farmers often found it easier to use water and store it in farm ponds, thereby experiencing more stable cropping environments than in purely rainfed systems.

The generally observed low yields are also a function of the low-input agricultural 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.

The shortage of labour is clearly visible in the cropping practices employed in rice cultivation. In the 1960s, transplanting of rice was predominant in northeast Thailand (Platanius 1961, USBR 1965) and the study area (RID Regional Office, Ubon

Ratchathani[3]). Nowadays, however, the practice of transplanting has increasingly been substituted by wet broadcasting of rice, although this is subjected to changes from year to year. In the pumping schemes studied wet broadcasting of rice was practised on more than half of the paddy area (51.1%). The highest percentage of the practice of transplanting was found in the low land areas of the pumping schemes, where water accumulated early in the growing season, while broadcasting was mostly favoured in the middle in higher terraces. The spread of direct seeding in lieu of transplanting is a clear indication of labour shortage in the study area (Konchan and Kono 1996). DHV et al. (1991), in studying pump-irrigation schemes in northeast Thailand, explained that "broadcasting needs both better land preparation and water control, and the total amount of required labour is only little less than for transplanting. However, the reason for the popularity of broadcasting is that it requires a more even labour use over time, whereas labour use for transplanting requires a high labour peak at transplanting time. Because of this, one person can grow only about 4 rai of transplanted rice compared with 10 rai of broadcasted rice" (DHV et al. 1990). This is well reflected in the studied sample, with cropping practice significantly determined by the size of cultivated farm land (Table 4).

Table 4: Chi-Square Test of Farm Parameters

	Chi-Square (χ^2)
Wet Season Yield vs. Topography	0,383
Wet Season Yield vs. Fertilizer Input	0,281
Wet Season Yield vs. Cropping Practice	0,344
Wet Season Yield vs. Farm Size	0,414
Farm Size vs. Fertilizer Input	0,317
Farm Size vs. Cropping Practice	0,001
Farm Size vs. Dry Season Rice Cultivation	0,008

Rural Thailand: Land Resources, Household Composition and Economic Change

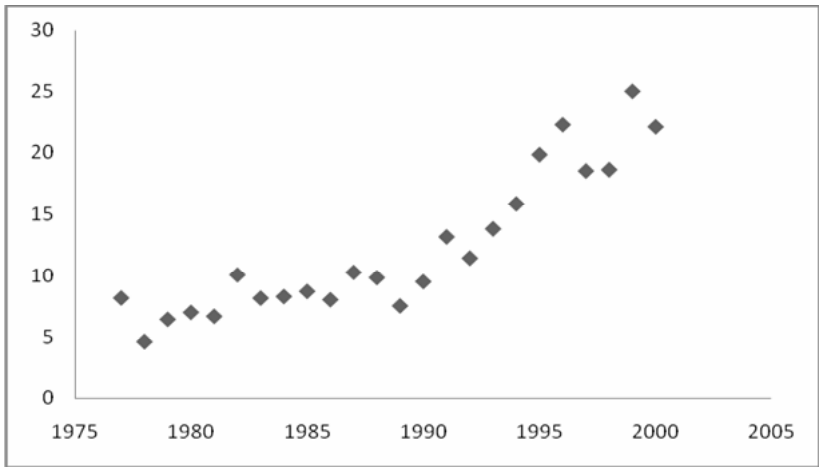
The history of agricultural expansion and development has been well documented (see e.g. Rigg 1985; Baker and Phongpaichit 2005). The closure of the land frontier put an end to land expansion in the late 1970s, which – in turn – implies that since that time, the still increasing rural population had to farm ever smaller plots of land.

The intensification of production through irrigation, higher yielding varieties and increasing farm inputs, was therefore considered key to the well being and development of the region. Between 1990 and 2000, agricultural expansion markedly declined as a result of the increasing importance of non-agricultural economic sectors (Coxhead and Southgate 2000). The closure of the land frontier in the early 1980s was also the start of a fertility decline in the northeastern region, with population growth starting to decline.

[3] December 2007. Names of interviewees are withheld for anonymity.

The 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 labour" (Funahashi 1996) and the increasing feminization and aging 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 is accompanied by increasing percentages of urban population, and it has been estimated that by 2015, an average of 35 percent of the north-eastern population will be concentrated in and around urban centres (PCD 1997). This trend of urbanization is 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 % to over 20 % (Figure 4).

Figure 4: Non-Agricultural Employment in Rural Northeast Thailand



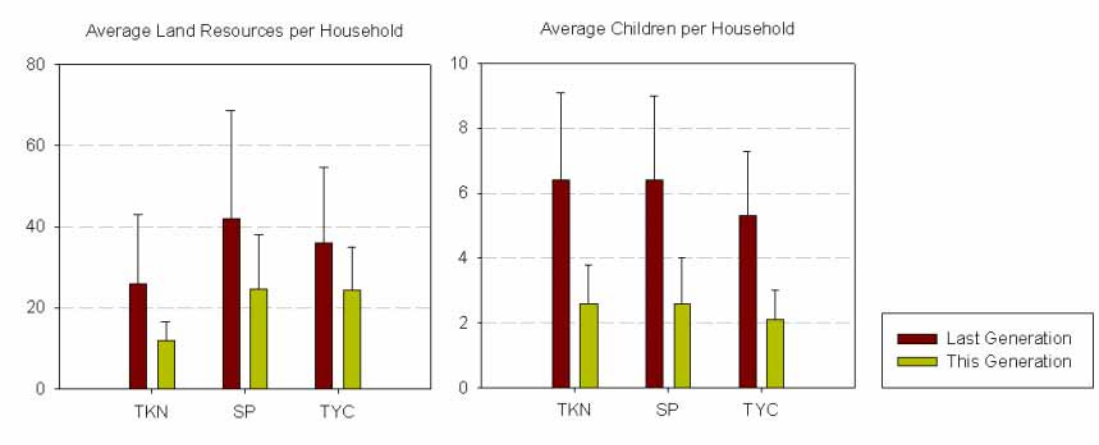
Source: Fan et al. (2004)

These regional trends are all observed in the pumping schemes of the Lam Se Bai River. From the last to the current farmer generation[4], available land resources per household have dropped from an average 33.9 rai to 19.9 rai (Figure 5). 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 TKN 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

[4] 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").

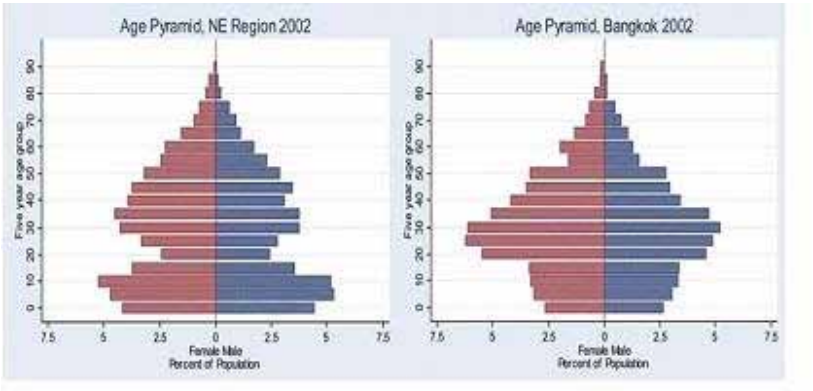
figure has dropped to an average of 2.4 children per household at present (Figure 5); a figure that is stable throughout the three different locations studied.

Figure 5: Land Resources and Average Children per Household



During the last 30 years, average economic growth rate in northeast Thailand was around 3.3 percent, and GDP per capita in 2004 amounted to THB 34,000, compared to only THB 11,000 in 1970 (both values in 1988 prices; World Bank and NESDB 2005). Along with the economic growth came a shift in the sectoral composition of output, with the agricultural share dropping from close to two-fifth in 1970 to just under one-fifth at present. On the other hand, the service sector expanded by more than 15 percent since the 1970s and accounted for over three-fifth in 2004. The rapid changes in rural northeast Thailand, of course, triggered a wide array of transitions. Given the lack of jobs and lower wages, workers turned to migration, especially among the young. This led to a two-peak population structure in the Northeast (Figure 6), with low figures around the 35-year old, against and a single-peak structure in Bangkok, with a higher concentration of the 20 to 35 year-old (World Bank and NESDB 2005).

Figure 6: Population Pyramid – NE Thailand and Bangkok 2002



Source: World Bank and NESDB 2005

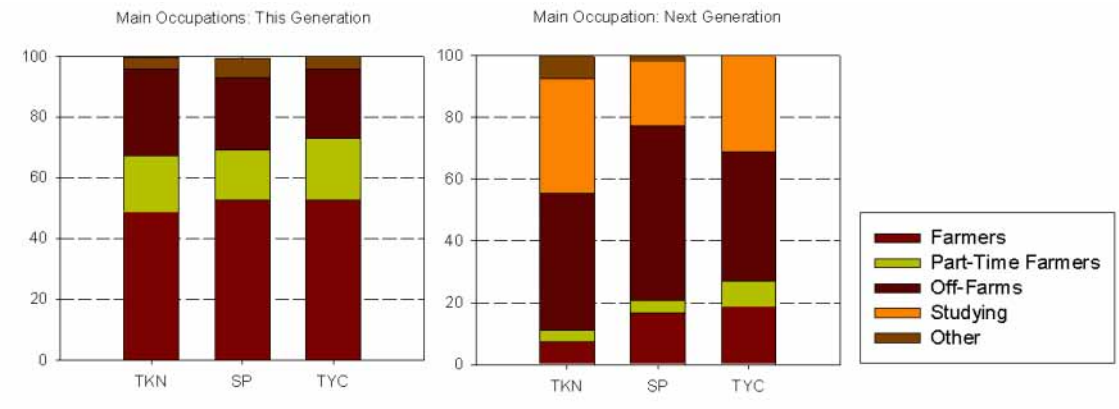
The same situation is observed in our three pumping schemes. The younger generation, that would possibly be able to take over farming operations, is predominantly migrating out: either out of agriculture, or out of the region, or both. On average, 34.7% of the

current farm holders' children have migrated out, with the remainder being mostly under-aged and still going to school. In *TYC*, 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, people leaving permanently outside the village is just below 40 percent, and people who have left the province just over 30 percent. The variations among the three pumping schemes is both a function of the age structure of the remaining children (both in *TKN* and *SP* most of the remaining children are still going to school), and the proximity to the provincial cities of Ubon Ratchathani and Amnat Charoen, which provides the younger generations with welcomed labour opportunities.

Perhaps the most important feature of migration are remittances which supplement total household incomes: more than half of Northeast 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 pumping schemes, in which, remittances – when received – make up 46% of incomes. Individual farmers received up to THB 6,000 per month from their migrant, and often better educated, children. For the relatively aged active farm population this influx of money makes up the major part, of non-agricultural incomes, and in cases provides the only secure cash income.

These regional shifts in the composition of sectoral output, also translated in the villages of the Northeast, and are well visible in the pump irrigation schemes (Figure 7). While almost 70% of the currently active farm generation in the irrigation systems perceive themselves as farmers (51.4 percent) or part-time farmers (18.5 percent), only 7.5 percent of their adult children have taken up farming on a full-time basis, and only around 13.6 percent see themselves as either full or part-time farmer. Importantly, a quarter of the population in the irrigation areas is nowadays working predominantly off-farm and in non-agricultural labour sectors, while 41.2 percent of the future generation has already shifted to off-farm work, with another 40.4 percent still at school.

Figure 7: Main Occupation - Present and Future Generation



Discussing Pump-Irrigation Developments: State and Non-State Initiatives

Irrigation development in Thailand is still a high-ranking government priority; especially in the northeastern region and at times of general elections (Molle and Floch, 2008). Like in other regions, irrigation development is carried out by both the state via its concerned water agencies, and by farmers themselves, who are constantly re-shaping their farmland to make it best suited for their productive purposes. These local adjustments most notably include the bunding of paddy fields, the installation of small pumps, the drilling of boreholes and the digging of farm ponds. The state, on the other hand, mostly focuses on larger-scale irrigation development, which requires larger capital investments and often larger-scale spatial planning efforts, by interconnecting rivers and waterscapes. In northeast Thailand, and the study area, the largest ongoing irrigation plans by the Royal Thai Government developments unfold under the banner of the Khong-Chi-Mun Irrigation Project, which was commenced in the early 1990s.

A State's Approach: The Khong-Chi-Mun Project in the Study Area

Building on earlier ideas to import water either from a storage dam constructed on the Mekong mainstream (notably the Pa Mong dam upstream of Vientiane), or directly pumped out of the Mekong River, in 1989 the Royal Thai Government proposed, approved, and entrusted the National Energy Administration (under to Ministry of Science and Technology) with the study and implementation of a massive interbasin transfer and irrigation scheme: the Khong-Chi-Mun (KCM) project. The study that was later presented (ASEAN et al. 1992) suggested that it was technically feasible to irrigate 796,000 ha of additional farmland in 15 provinces of northeast Thailand. Although, the implementation of the water import component of the overall project did not so far materialize, construction of gated weir structures to regulate river discharge and create in-stream storage on the major rivers of northeast Thailand was initiated in the early 1990s.

On the Lam Se Bai River, as discussed above, two in-stream regulation and storage facilities (weirs or 'fai') were implemented: the upper Fai Lam Se Bai, and the lower Fai Amnat (Figure 2). However, and much alike 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 are (so far) not serving any newly constructed irrigation areas, because of budgetary constraints (following the Asian financial crises in 1997), and of lengthy processes of negotiating land compensations (the land needed for canal construction; RID Regional Office 2008[5]). At present, however, the Royal Irrigation Department[6] is engaged in completing parts of the irrigation infrastructure, although with a more modest target (with regard to the enormous extent of the overall KCM Project) as only parts of the initially planned command areas and large-scale pumping systems are being developed.

[5] Personal communication February 2008: RID Regional Office, Ubon Ratchathani, Thailand.

[6] In 2003, and in a governmental re-shuffle, the originally implementing Department of Energy Development and Promotion was discontinued, and the Royal Irrigation Department was entrusted with the continuing implementation of the Khong-Chi-Mun Irrigation project.

Figure 8: Fai Amnat and under-construction main irrigation canal near Fai Lam Se Bai

How the new infrastructure will benefit farmers, whose cropping patterns should ideally be adopted to make the investments worthwhile, and how farmers will engage in agricultural production in the respective irrigation areas, however, is still not clear. A recent internal publication (RID 2007) listed possible cropping intensities, cropping patterns and envisaged yields for the two projects in the study region. According to this report, cropping intensities in both projects would reach 150 % at full development of the projects, with wet season cultivation dominated by rice (70 %), field crops (20 %) and other crops including vegetables, flowers and fruits (10 %). During the dry-season the envisioned cropping patterns include field crops, vegetables and flowers at 50 % 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 economically worthy. Likewise, 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.

Local Approaches: Ponds and Local Adaptations

The crafting of waterscapes by farmers (either individually or collectively), has a long tradition in northeast Thailand. Historically, at least since the decline of the Khmer empire, irrigation works in Northeast Thailand were predominantly small in scale, and with little state control (Bruns 1991). Blending into the landscape[7], earthen cross-stream bunds (called *thamnop*) have been constructed on the basis of informal mobilization of labour, and it was found that in the early 20th century rice lands were frequently equipped with this type of irrigation infrastructure (Neawchampa 1999). Contrary to common knowledge "irrigation of paddy fields around the Mun Basin was the norm rather than the exception, with only the rapid expansion of rice areas in the later half of the 20th century transforming Northeast Thailand into the predominantly rainfed area it is today" (Fukui and Hoshikawa 2003).

Nowadays, these community irrigation systems have mostly vanished from the waterscape of northeast Thailand. In TKN, remnants of such a system are still visible, but the structure have been in disrepair and left unused for more than 20 years. For at least

[7] Bruns (1991) called these small weirs „invisible"

the last 30 years and up to now, the most important adaptation of the farming environment has been the digging of farm ponds, which have become an essential part of farming in northeast Thailand. In all three studied pumping schemes, and similar to the cultivation under rainfed conditions, these farm-ponds are an essential part of the on-farm infrastructure facilitating farm-operations, and farmers have shown continuous interest in their construction, rehabilitation and utilization. This, in turn, contradicts public statements often stating the low interest of farmers to invest into concrete canals and maintenance of the state-sponsored irrigation infrastructure. In the study areas, more than 80 % of the farmers were in possession of at least one farm pond, and 43 % of farmers had two or more ponds within their cultivation area. The ponds were both fed by canal water (which constitutes the most important function of the electric pump and canal facilities), and through natural surface runoff and groundwater recharge, which keeps the ponds full well into the dry-season. This infrastructural shaping of farm land has been accompanied by the widespread introduction of pumps into the everyday life of farmers. These pumps have enabled farmers to draw water (easily) from both their farm ponds, the river itself, the main canals and from shallow groundwater layers, thereby providing farmers with unprecedented flexibility that they have probably not known in earlier times.

The major asset of farm ponds, which in turn makes them attractive to farmers, rests in the flexibility of access to water and the multiplicity of uses they support. Ponds provide farmers both with security of supplies in the wet season (especially during early times when farmers engage in land preparation through supplementing insufficient rainfall), and allow for the cultivation of vegetables for home consumption or cash-crops around the perimeter of the ponds. Many of the ponds (60%) are also used for fishing, especially in the lower parts of irrigation areas (fish are trapped in the ponds when water recedes after the flood), and also for livestock and farm animals (38% of the farms). Farmers showed remarkable initiative to dig farm ponds by themselves. In the study area, almost half of the farm ponds (46%) were excavated through farmers' own investments, while the remainder have been constructed in exchange for soil for the construction of embankments, and through financial support from the Bank of Agriculture and Agricultural Cooperatives. This is remarkable insofar as the lack of farmer interest in up-keeping the pumping infrastructure is generally attributed to the lack of understanding and financial capabilities of the farmers.

Acknowledging the environment: Yields, Cropping Intensities, Labour Costs and Rural Change

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 clearly a matter of discussion. 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 %” (RID Office Amnat Charoen, 2007[8]).

[8] Personal communication December 2007: RID Provincial Office: Amnat Charoen, Thailand

The targeted cropping intensities of 150% 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". The flexibility of farmers to adopt their cropping is well documented on northeast Thailand (see e.g. Kono et al. 1994), and in TKN an interviewed farmer stated that five years ago he was still cultivating vegetables, but now he is growing rice because the price of it went up.

A similar uncertainty is observed regarding assumed yields of rice, both in the studied small-scale electric pumping schemes and the larger developments of the Khong-Chi-Mun irrigation project. In 1990, DHV Consultants and Partners (DHV et al. 1990), studied the economic viability of pump-irrigation projects in northeast Thailand and found that

> *A rainfed yield level for the NEA [Note: National Energy Authority[9]] areas is assumed at 300 kg/rai [1.9 t/ha]. This is more than the average of about 240 kg/rai [1.5 t/ha] for Northeast Thailand, since the NEA schemes are supposed to be in areas with soil qualities and water retention capacities slightly better than average for the region. Input levels are small but nevertheless the net return per rai is low, only slightly higher than 20 percent of the total crop value. […] If an irrigation system is established and normal support is available from regular government agencies, yields will increase to 360 kg/rai [2.3 t/ha] in the second year and input use will moderately increase. […] With a hardware and special support, project yields will increase to 500 kg/rai [3.1 t/ha].*

This planning assumption on yields has not been observed in any of the studied pump-irrigation systems. On the contrary, it has been observed that because of the flow regime of the Lam Se Bai river and topography of the pumping schemes, with the low-lying terraces being frequently subjected to flooding, the average wet-season yield was not higher, with none of the pumping stations visited during this study coming close to achieving an average yield of 360 kg/rai, let alone 500 kg/rai.

Also, an agronomic yield assumed for the Khong-Chi-Mun irrigation schemes of 700 kg/rai for glutinous rice varieties and 800 kg/rai for non-glutinous varieties are hardly realistic in a *real-world* setting in northeast Thailand. Such optimistic assumptions are, of course, not a particularity of the KCM project, and are well documented for irrigation planning and development more generally. This is accentuated by the fact that yield potentials of the most widely grown rice varieties have been acknowledged to be only moderate (DHV et al. 1990).

[9] The National Energy Authority later became the Department of Energy Development and Promotion (DEDP)

Moreover, our study suggests that the low actual yields in the study area are not a function of lack in water; actual yields are much more a function of the topography and belie the planning assumption that areas of pump irrigation 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 northeast appeared (at least at first glance) a viable option to trigger agricultural intensification, help lift farmers out of poverty by providing more stable and productive agricultural environments, thereby limiting out-migration to urban centres and abroad. However, as the most labour-intensive sector, Thai agriculture found itself increasingly unable to compete when the rapid expansion of labour demand in other sectors pulled up wages. The boom in labour-intensive manufacturing, construction as well as in services thus accelerated agriculture's relative decline. From 1989 to 1995 nearly three million workers out of a the total Thai agricultural labour force of about 20 million walked off the land, and as a result, planted areas, which had increased steadily since the 1960s, stagnated and even began to fall (Coxhead and Southgate 2000). This, in turn, has left farm management more and more in the hands of the elderly (and remaining) farmers, and in a lot of cases of women (Binnie and Partners 1995).

Farmers shifting out of rainfed agriculture to other economic sectors are a long-known phenomenon in northeast Thailand. But 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 attracting people back to rural northeast Thailand). We have argued elsewhere (Molle and Floch 2007), that the possibility of attracting labour back to agricultural is doubtful judging from the differences in wages between agricultural and non-agricultural labour, and even more so from (the higher) differential between wages in northeastern Thailand 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 favourable 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 labour, we argue that today there are considerable constraints on the labour 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; patterns of agrarian change will be heavily shaped by tensions on the labour market as time goes by (Bangkok Post, 8. December 2005).

In studying the linkages between water, poverty and livelihoods in Sisaket province (neighboring the province of Ubon Ratchathani), Hall and Manorom (2008) found evidence that although villages were located within a region that has frequently been targeted by the Royal Thai Government for large-scale irrigation schemes "none had benefited from these", and that there was "evidence of small-scale, local irrigation initiatives making a significant difference to farmers' livelihoods, especially when electricity can be used for pumping". In view of this, the two authors argued that "such initiatives are more favored by the farmers than larger schemes and have the added advantages of being more cost effective and less environmentally damaging". This is confirmed by our study that found a remarkable consistency of the farmers to invest in on-farm storage ponds to facilitate a host of different uses.

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 discourses on irrigation expansion through large-scale transbasin diversion schemes is justified by the image of water-scarce rural communities that have missed (or have been left out of) the development-train. Our research in 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, the impacts of rural transition on the sustainability of investments into irrigated agriculture, and to find out who will be using the massive infrastructure that is currently 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 irrigation project and other irrigation project developments, which appear overly optimistic, are scrutinized in light of the rural transitions that are taking place.

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