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Time-geographic Analysis on Natural Resource Use in a Village of the Vientiane Plain

NISHIMURA Yuichiro*, OKAMOTO Kohei** and Somkhit BOULIDAM***

Abstract

This study aims to describe the spatio-temporal aspects of rural daily lives based on natural resource use. We developed new research methodologies using GPS and GIS to collect person-trip data in regions where it is difficult to use questionnaires. By applying the methodology to research conducted in the Vientiane plain, Laos, we have found that this new methodology makes it possible to obtain detailed information about people's daily activities, specifically: what activities were carried out, at what time, where, and with whom. The research site was Dongkhuwaai Village, Xaithany District, located about 30 km by road from Vientiane. The villagers live traditionally, depending on rice crops in the rainy season and use various natural resources. We analyzed their daily activities both in the rainy season and in the dry season. As a result, we found that the daily activities of the villagers had nature-related constraints. They spent all their time in the settlements and there were no modern forms of time discipline (synchronized activity by household members).

We also investigated the influence of urbanization on rural lives. In recent years, a growing number of foreign companies have begun investing in Vientiane and the vicinity, hoping to take advantage of low labor costs. Commuting to such factories has started from Dongkhuwaai Village. However, the number of commuters is not increasing because villagers already have other sources of income from selling natural resources such as aquatic products, mushroom, bamboo shoots, insects, firewood and so on.

Keywords: daily activity, natural resource use, time-geography, urbanization, Laos

I Introduction

In recent years, Vientiane municipality has been experiencing the rapid penetration of the market economy and urbanization. As a result of this, village economies in the surrounding areas have been seeing a shift from a subsistence based economy to a cash-oriented one as the chances to explore emerging opportunities of income generation have arisen. Although the potentiality and risks of this shift are often discussed from an economic perspective [Nonaka *et al*. 2008b], the shift in itself is affecting the social life of

* 西村雄一郎, Aichi Institute of Technology
e-mail: nishimura@aitech.ac.jp
** 岡本耕平, Graduate School of Environmental Studies, Nagoya University
*** National University of Laos

villagers in Dongkhuwaai village where our study was carried out. Villager's daily life consists of working, commuting, consuming and enjoying leisure with their family, relatives, neighbors, and friends at home, within the village territory, and outside the village. This study focuses on the daily life of peri-urban village people and examines changes in their lives induced by the penetration of the market economy based on a spatio-temporal analysis of their behavior. In order to collect the necessary information including where, when and how long each individual's activities continue for various job activities such as farming, hunting and gathering, fishing, housekeeping social interaction and communication such as shopping, sales, and visiting friends or relatives, this study adopted a time-geography approach. Special attention is paid to natural resources use because it has and will characterize Laos' development [Kono *et al*. 2010].

Time-geographic, which was originally developed by the Swedish geographer Torsten Hägerstrand, describes the relation between individuals and natural and social environments as an interaction among "matters" in time and space [Hägerstrand 1970; 1989]. That is to say, an individual's daily life is structured through their relationships with various things in nature and other individuals in society. By using a time-geography approach, matters such as human beings, animals, plants and things can be described as "paths" in time and space, and the interactions between these matters can be represented as connections of paths. Furthermore, paths themselves are under a variety of constraints which can be classified into the following three types [Hägerstrand 1970; 1989; Gregory 1981].

(a) Capability constraints, which limit the activities of individuals through their own physical capabilities and/or the facilities they can command.
(b) Coupling constraints, which define where, when and for how long the individual has to join other people, and use tools and materials in order to produce, transact or consume.
(c) Authority constraints, which impose certain conditions of access on particular space-time domains.

The paths of matters change under various temporal scales, being subjected to daily, monthly, seasonal and annual rhythms and furthermore, they are constrained temporally as well as spatially. Matters can exist or act only within specific places that are changeable in various temporal scales. As such, spatio-temporal change and constraints come not only from nature but also from society [Hägerstrand 1970; 1989].

Pred has described how workers in nineteenth-century U. S. cities who were employed in factories and large-scale shops, were forced to follow a time discipline that they had not experienced previously during the early stages of industrial capitalism. "Factory and large-scale shop work inculcated a sense of time that was greatly different from the sense of knowing, for example, when cows were to be milked or when fires were to be fed in order to maintain a smelting or heating process" [1981: 9–10]. This was the emergence of nine-to-five work, and such work is described in the time-geographic notion as the

trajectory of a worker's path which must meet that of a factory machine located in a specific place. However, paths choreographed by the modern factory mode of production are very different from paths in agriculture or hunting and gathering. Paths in production directly using natural recourses are swayed by the influence of nature, but are more flexible and impromptu.

This paper presents an analysis of time-space allocation in the daily lives of the villagers in the Vientiane plain, Laos, from a time-geographic perspective. Previous time-geographical studies have focused on the quality of life of urban residents in developed countries. This study tries to bring a time-spatial perspective to the studies of rural life depending on natural resource use.

In order to fully understand people's daily lives, precise and detailed data is needed about people's paths in time and space, but it has been almost impossible to get such data in Laos using previous survey methods. Therefore, we first develop a new methodology to collect information on people's daily lives then analyze the differences in daily activities between the rainy season and the dry season. Under the tropical monsoon climate, the natural environment in the Vientiane plain drastically changes from the rainy season to dry season, which places constraints on villager's natural resource use. In this paper, we focus on social change. In recent years the penetration of the market economy and the spread of urbanization into the suburban area of Vientiane has been influencing people's daily lives which had previously been dependent on the subsistence complex of agriculture, hunting and gathering, fishing and so on. In focusing on these dynamics, this paper examines the actual circumstances of influence as observed in the field.

II　Research Area and Methodology

Research Area

The area we researched was Dongkhuwaai Village, Xaithany District, located about 30 km by road from Vientiane, the capital city of Laos (Fig. 1). The number of households was 263 as of October 2005, all of which stood close together, centered around a Buddhist temple, and surrounded by rice fields and forests. The village's main economic activity was rice cultivation in the rainy season, primarily for self-consumption. Various natural resources were utilized in securing cash income: fishing in the rivers, ponds, or rice fields, the hunting and gathering of plants, insects and small animals in the forests, and the production of charcoal, salt, and the grazing of cattle and buffaloes [Ikeguchi and Nishimura 2007].

The village had one car, 25 motorbikes, 98 bicycles, and 52 hand tractors as of 2006. For public transportation, a bus called a *songteo* ("two-row coach" in Lao) connected the village to Vientiane with journeys twice a day, which took about 1.5 hours on the

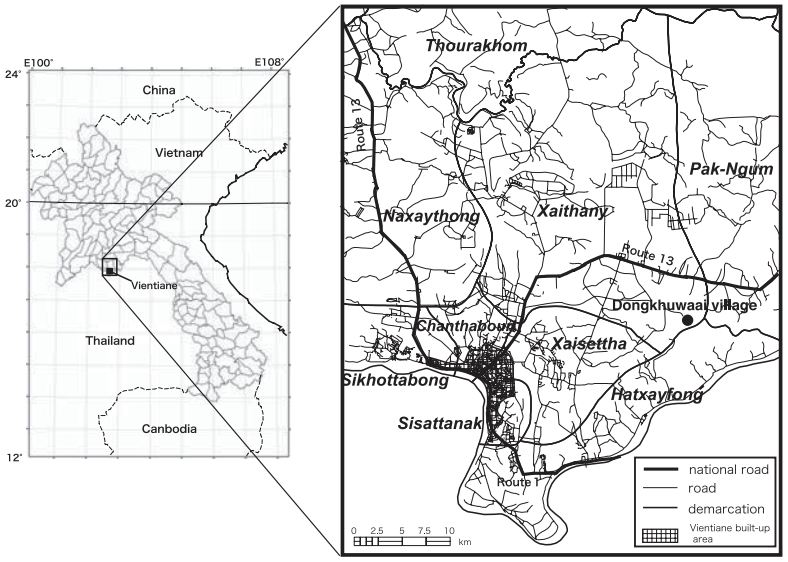

Fig. 1 Research Area
Source: Nishimura *et al*. [2008]

one-way trip along the long unpaved road. Because of the limited transportation means, there were very few who commuted outside the village.

Survey Method

Many time-allocation studies have adopted questionnaires (activity diaries) or direct observation of informants [Noma 1988]. However, it is difficult to use questionnaires in the rural areas of developing countries due to problems such as illiteracy, the fact that few people possess watches, and the lack of detailed place names in these areas. Direct observation also has limitations, as it is not possible to obtain information from many informants simultaneously. We developed a new survey method combining interviews with the use of GPS and GIS [Nishimura *et al*. 2008].

The procedures were as follows. (1) Each informant was asked to carry a wristband GPS receiver for an entire day. The GPS unit recorded information relating to the spatio-temporal aspects of the informant's activities. (2) After 24 hours of GPS recording was completed, the data was stored and represented visually using GIS software (Arc View 9.1). The investigator worked out the shape of the spatio-temporal path of each informant through the mapping of track points with time information. (3) Subsequently, as GPS data reveals almost nothing about the content of activities, the investigator interviewed each informant to clarify the details of the activities; what activity was carried out, at what time, where, and with whom.

By carrying out a pilot survey in May 2006 in which four households in Dongkhu-

waai Village participated, we verified that the new survey method had the following merits. (1) The use of GPS improved the accuracy of the spatio-temporal data. (2) GPS data could be easily correlated with satellite images and map data, which enabled us to consider people's daily activities in combination with various geographical phenomena. (3) Investigators could obtain information outlining an informant's movements from GPS data before conducting interviews, thereby improving the efficiency of interviews.

The investigation required three days per household. On the first day we visited each survey household and explained the methods of investigation, and obtained consent for the survey. On the second, we visited the household surveyed when the household members woke up, and asked each of them to put a portable GPS on his/her wrist or waistband. On the third, we visited the households surveyed in the morning and retrieved the GPS devices from them. We took the GPS to the research station, and extracted the track log and displayed the location and time of tracks of each surveyed person on satellite images of Dongkhuwaai Village using GIS. After this, we worked out each person's chart of travel of the day surveyed (the second day) and visited the informant's home again in the afternoon or evening interviewing them in detail about their movements while showing them their GPS track logs on the laptop PC display.

This method required three investigation days for each household. If we staggered the survey schedule (i.e. on the second day, begin the first day for another household), we could investigate 10 households in 12 days. Because we investigated four households concurrently, we were able to collect data from 40 households in 12 days. We prepared 40 portable GPS devices for the survey (for each day we used 40 GPS for eight households, considering the average number per household is about five in the village).

The main surveys were both conducted in the rainy season (August 27 to September 7, 2006) and the dry season (March 4 to 22, 2008) with 40 households participating. The households surveyed were the same in both seasons and all of the members of the households except infants who were living in these homes at this time were surveyed. The 40 households for the survey were chosen so that each of the following five household types were represented: 1) Households engaged in fishing, 2) Households engaged in grazing, 3) Households engaged in retail or brokerage work, 4) Households receiving wages from manual labor, 5) Households engaged in neither fishing, grazing, retail, brokerage nor wage labor.

The number of participants in the rainy season was 154, and there were 149 in the dry season. Five of the 40 households were excluded in the rainy season survey since all of the members were living in a hut in the rice fields in the eastern area of the village. Therefore the data included 138 persons from 35 households for the rainy season survey. Table 1 shows the number of informants by sex and age.

Table 1 Number of Informants by Sex and Age

In Rainy Season 2006

Age	Male	Female	Total
under 10 y	13	14	27
10 y–	8	18	26
20 y–	13	14	27
30 y–	12	12	24
40 y–	4	10	14
50 y–	8	8	16
60 y–	2	2	4
Total	60	78	138

In Dry Season 2008

Age	Male	Female	Total
under 10 y	10	12	22
10 y–	14	9	23
20 y–	13	20	33
30 y–	12	16	28
40 y–	8	10	18
50 y–	6	8	14
60 y–	4	2	6
70 y–	1	2	3
80 y–	0	1	1
Total	68	80	148

Data: activity survey

III Data Construction

Debugging GPS Data

A GPS device records the informants' "track log" which contains information about a series of track-points along routes that the informant travels, including latitude, longitude and time. This study used *Garmin Foretrex 101* as GPS devices and set the mode of track-point recording interval on "automatic." In this mode, the device records many track-points while an informant is moving and no track-points when there is no movement.

GPS devices might record mistaken track points when the conditions for receiving a satellite signal are weak. Generally, acquiring a signal tends to be difficult inside buildings and in the jungle. In Dongkhuwaai Village, devices easily picked up satellite signals almost everywhere because the houses were wooden and ventilated and the forests were not dense. Since data was recorded with high precision, deviate data could be identified easily. Based on verification of the track logs, we removed a track-point as mis-recorded if it was located over 50 m away from the point recorded just before.

Merging GPS Data with the Data from Activity Diaries

As mentioned above, on the third day of the investigation, the researcher interviewed informants about their behavior for the preceding day. A laptop PC displayed the informants' tracks on satellite images of Dongkhuwaai Village, which enabled them to recall their actions more easily. While interviewing, the researcher wrote down the information from the interview and completed the activity diary of each informant. The sheets of the activity diary gave details of the informants' behavior in chronological order, together with the behavior of other members of the household (Fig. 2).

A form of person-trip data was made from these activity diaries. In the case of a person-trip survey in urban areas,[1] the destination of the trip is generally a facility and it is not hard for the traveler to recognize the arrival time. But in rural villages such as Dongkhuwaai, especially in areas where hunting and gathering or grazing is carried out, it is not that easy to clarify the trip or activity for the traveler and to identify the arrival time at the destination place. Therefore, this study presumes that a unit of outdoor

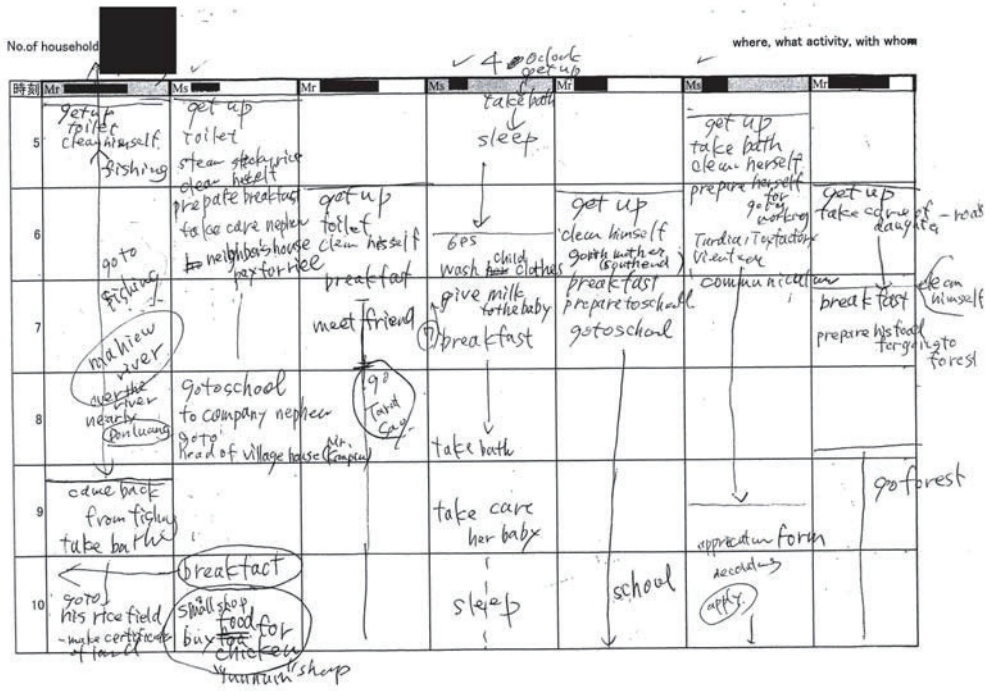

Fig. 2　An Example of Activity Diary by Interview

1) In Japanese metropolitan areas, large-scale person-trip surveys have been conducted every 10 years by administrative organizations for transportation planning.

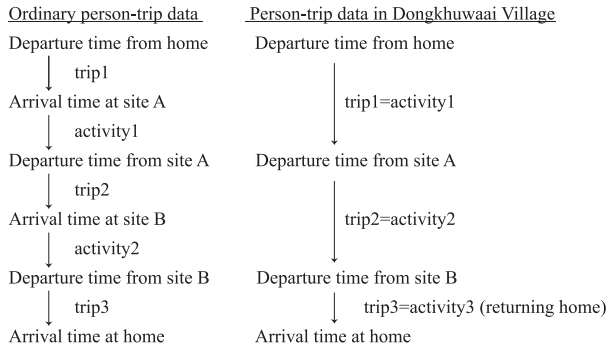

Fig. 3 Person-trip Data in Dongkhuwaai Village

behavior began with the departure from a certain site and ended with the departure from the next site that the informant traveled to, without dividing the time between the trip and the activity, as seen in Fig. 3.

Next, various activities which the villagers performed outdoors were classified into seven categories; i.e. work, shopping, leisure, social communication, attending school, other activities, and returning home. In addition, "work" activities were divided into subcategories; fishing, hunting, gathering, agriculture, grazing, trade, wage labor, lumbering/making charcoal. In regards to the classification of activities, the international time budget study by Szalai [1972] is well-known. As its classification has too many categories, mainly based on daily lives in industrial cities, this study employs its own classification of activities.

Finally, person-trip data made from the activity diary was merged with the GPS data. Categorized activity codes were assigned to all outdoor track points of GPS data by comparing the time information of both data.

Merging GPS Data with Land Use Data

Land-use data was polygon data which divided Dongkhuwaai Village into seven categories such as settlements, paddy fields, vacant lands, forests, artificial forests, riparian forests and water areas. Settlement means a housing area. Since the housings of the Dongkhuwaai Village were agglomerated, the settlement was included in one polygon. A vacant area was an uncultivated grass field mainly used for grazing. Riparian forest is a low-dense forest that is flooded in rainy seasons. For all of the track points a judgment was made about whether they were located inside the boundaries of the village, and also the track points inside the village were assessed to decide which land-use polygon they belonged to using ArcView 9.1.

IV Analysis

Number of Trips

Table 2 shows the number of trips by kinds of activity. The average number of trips in a day was 7.7 in the rainy season and 9.5 in the dry season. These figures are extremely high in comparison with the results of other surveys conducted in the urban areas of developed countries. In surveys conducted in Japanese metropolitan areas, the number was approximately two to three in the person-trip survey and two to four in the activity diary survey [Arai *et al*. 1996]. Even in Japan, the average number of trips was relatively high in rural areas. According to the activity diary survey conducted by Arai in Kiyomi Village in Gifu Prefecture [Arai 2001], the average number of trips amounted to more than six. Especially in the case of full-time farm households, the average number was around nine. Thus the number of trips in rural areas is high both in Laos and Japan.[2)]

According to the activity diary surveys conducted on weekdays in Japanese cities, the number of trips by married females was considerably higher than those by married males because of the frequent outdoors activities the women engaged in for housekeeping and child rearing. When the married females had jobs, the number of trips increased further [Arai *et al*. 1996]. A similar result was obtained among part-time farmers' households and non-farmers' households in Kiyomi Village in rural Japan. On the other hand, among full-time farming households, the number of trips by both males and females was high as full-time farmers managed to carry out multiple farming activities in various sites in the village, for example rice fields, vegetable fields, livestock barns, etc. which were located separately to each other. That made the number of their daily trips high.

Moreover, most full-time-farmers went back home for lunch and went out again for farming after lunch, which was also the reason why daily trips by Japanese full-time farmers were more frequent than those by both office workers and part-time workers. In Dongkhuwaai Village, farmers were engaged in various kinds of jobs related to natural resource use. Also, they returned home for lunch and a nap around lunchtime. Almost all adult villagers in Dongkhuwaai could be regarded as full-time farmers, excluding a few exceptions. The total number of trips was high, with a small gender difference, which is consistent with the result in Kiyomi Village in rural Japan.

Table 2 shows the contents of the outdoors activities (purposes of trips) by the

2) The average trip number in metropolitan areas of Southeast Asia like Phnom Penh and Jakarta was two to three. These are similar results to those for urban areas of Japan. (EASTS ICRA Project Report —A Comparative Study on Urban Structures and Transportation Systems in Asian Metropolitan Cities— 2003–05 http: //www.easts.info/activities/icra/2003/ICRA-Hyodo.pdf)

Table 2 Average Number of Trips (by Kinds of Activity, All Informants)

		Rainy Season (2006. Aug.)				Dry Season (2008. Mar.)			
		Adult male	Adult Female	Child	Total	Adult male	Adult Female	Child	Total
Work	all work	2.02	1.68	0.64	1.59	1.84 (0.18)	1.90 (0.45)	1.58 (0.45)	1.82 (0.23)
	fishing	0.45 *+	0.02 *+	0.04	0.17	0.14+ (0.30)	0.13+ (0.10)	0.00 (0.10)	0.11 (▲ 0.05)
	hunting	0.04	0.08	0.07	0.07	0.13 (▲ 0.08)	0.03 (▲ 0.03)	0.31 (▲ 0.03)	0.11 (0.05)
	gathering	0.13	0.24	0.29	0.21	0.09 (0.04)	0.12 (▲ 0.07)	0.31 (▲ 0.07)	0.14 (▲ 0.07)
	agriculture	0.28	0.14	0.04	0.17	0.18 (0.10)	0.19 (0.05)	0.08 (0.05)	0.17 (▲ 0.00)
	grazing	0.30	0.32	0.11	0.27	0.59 (▲ 0.29)	0.37 (0.11)	0.31 (0.11)	0.44 (0.17)
	trading/retailing	0.36	0.65	0.11	0.44	0.18* (0.18)	0.74* (0.18)	0.35 (0.18)	0.46 (0.02)
	paid work	0.11	0.06	0.00	0.07	0.11 (▲ 0.00)	0.10 (0.04)	0.00 (0.04)	0.09 (0.02)
	lumbering/charcoal making	0.34	0.16	0.00+	0.19	0.39 (▲ 0.05)	0.15 (0.03)	0.23+ (0.03)	0.25 (0.07)
	other	0.02	0.02	0.00	0.01	0.04 (▲ 0.01)	0.07 (0.05)	0.00 (0.05)	0.05 (0.03)
Shopping/household work		0.79	1.24	0.54+	0.94+	0.91* (▲ 0.12)	1.51* (0.33)	1.35+ (0.33)	1.26+ (0.23)
Leisure/playing		0.49	0.32	2.54	0.83	0.36 (0.13)	0.24 (▲ 0.05)	2.42 (▲ 0.05)	0.66 (▲ 0.20)
Social communication		0.91	0.94+	1.14+	0.97	1.29 (▲ 0.37)	1.43+ (0.18)	0.54+ (0.18)	1.22 (0.13)
Attending school		0.11	0.13	0.50+	0.20	0.27 (▲ 0.16)	0.07 (0.01)	1.27+ (0.01)	0.35 (0.16)
Other		0.38	0.25	0.11	0.27	0.41 (▲ 0.03)	0.22 (0.13)	0.15 (0.13)	0.28 (0.15)
Returning home		2.72+	2.95+	3.04+	2.89+	3.73+ (▲ 1.01)	3.74+ (0.93)	4.38+ (0.93)	3.85+ (0.96)
Total		7.43+	7.51+	8.50+	7.68+	8.80+ (▲ 1.38)	9.10+ (2.08)	11.69+ (2.08)	9.44+ (1.77)

Note: Parentheses indicate the difference from the rainy season
(child: preschool children and elementary school student/the number of informants (rainy season 2006 male: 47, female: 63, child: 28) (dry season 2008 male: 56, female: 66, child: 26))
* indicates statistical significance at 0.05 between male and female
+indicates statistical significance at 0.05 between the seasons
Data: activity survey

people in Dongkhuwaai Village. Work trips dominated over returning home trips. Although there were more work trips by males than females on the whole, a gender difference was seen according to the kind of work. The gender difference was striking in the field of fishing in the rainy season. On the other hand, trading (vending of natural resources, operating small shops and so on) and shopping/household work were high among females in the dry season.

More trips were counted in the dry season than the rainy season, which means the people are more active in the dry season. The total number of trips by males and females were not so different. Fishing activity decreased among males and increased among females in the dry season. Social communication increased among females in the dry season. Lumbering/charcoal making was very popular among children in the dry season. Such work sometimes means play for children.

Spatial Distribution of Trips

Figs. 4a and 4b show the spatial distribution of all the GPS track points of the surveyed villagers. The white dots represent the tracks of 138 persons in the rainy season and the black ones represent the tracks of 149 persons in the dry season. The base map exhibits the land use classification that Professor Ono of Niigata University produced from the

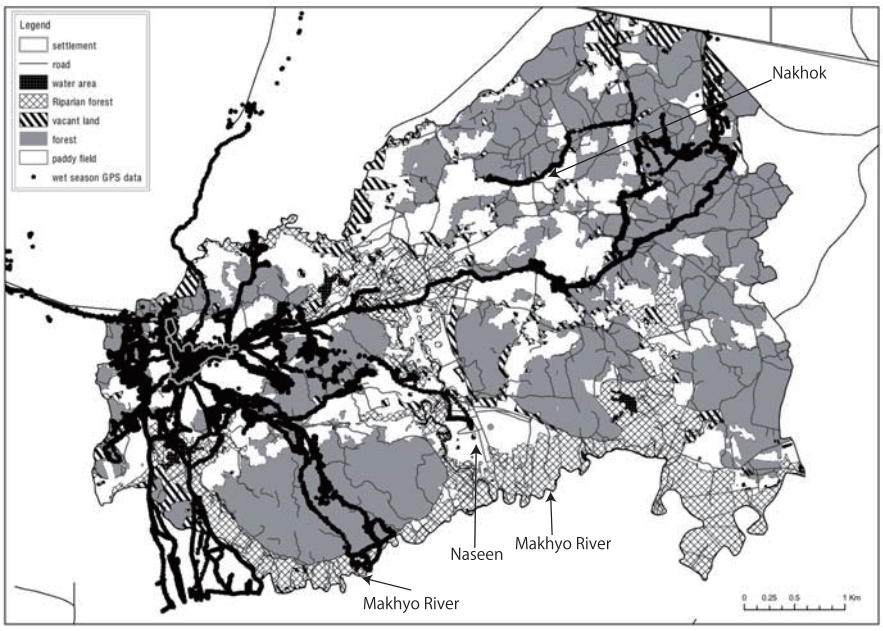

Fig. 4a Spatial Allocation of Activity by All Informants and Landuse of Dongkhuwaai Village in the Rainy Season (2006)

Data: GPS survey by authors, land use and village border data, Dr. Eisuke Ono, road data (outside of village) form Mekong GIS data, JICA

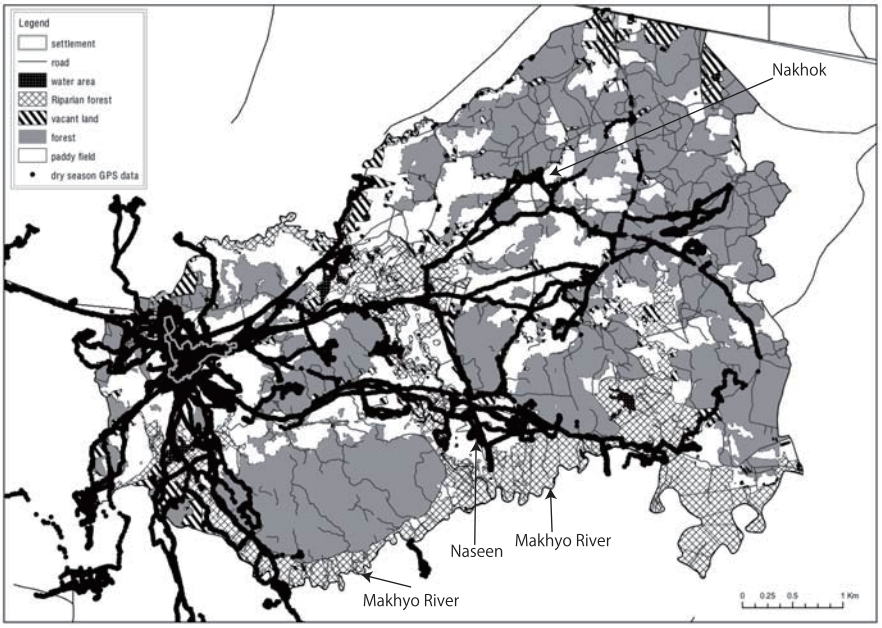

Fig. 4b Spatial Allocation of Activity by All Informants and Landuse of Dongkhuwaai Village in the Dry Season (2008)

Data: GPS survey by authors, land use and village border data, Dr. Eisuke Ono, road data (outside of village) form Mekong GIS data, JICA

satellite image taken on February 2006 with ground truth.

The track points have concentrated on the settlement area located in the west of the village. Many white points are distributed near the northeast edge of the village. That is the area called Nakhok where many *tienna* exist. A *tienna* is a villa used for cultivation. It is a raised flooring type of house, and below the floor level is a feeding area for cattle and buffaloes. Village people live within a settlement area in the dry season and some of them live in the *tienna* or commute there in the rainy season. *Tiennaes* are scattered among the rice fields in the village, mainly in the Nakhok area several kilometers northeast away from the settlement. In the rainy season, the region between the settlement and Nakhok is submerged so the people go via Route 13 in the north of the village by tractors, taking a very roundabout way to get to their *tienna*, Some walk straight there, chest-deep in water.

The southern part of the village along the Makhyo River, where land use is riparian forest in the dry season, floods and becomes a fishery in the rainy season. Many white-dotted lines reach there in Figs. 4a and 4b. Most of them are tracks made by for middle-aged and old-aged males going fishing in the rainy season. Waters move to the south in the dry season, so black-dotted lines stretch to the south to find the fishery. As for the central southern region of the village called Naseen, dry-season rice cultivation is possible

because the Makhyo River is near there. Some villagers visit Naseen for agriculture in the dry season. The rice fields in Naasen are completely submerged in the rainy season.

Outdoor Activity and Land Use

Table 3 shows the duration of outdoor activities for each land use. It indicates the relationship between land use and activity from the combination of GPS data, land use data and activity information from the interviews. The activity time in Table 3 shows the total time for travel to the destination and time spent at the destination. For example, the activity time for fishing includes the time the person spent traveling to the fishery and the time spent fishing there. So the activity time for fishing is distributed not only in water land use but also in settlement land use and so on.

Table 3 shows that the total time spent on fishing, hunting and gathering was more than the time for the agricultural tasks in both the rainy season and the dry season. It is supposed that agricultural tasks do not consume much time except during the season for transplanting and harvesting. The rainy season starts from the beginning of May and ends at the beginning of October. Transplanting of the paddy fields starts at the beginning of May, and finishes at the beginning of August in Dongkhuwaai village [Nonaka *et al*. 2008a]. The research period was from the end of August to the beginning of September and it did not correspond to the busy season for rice cultivation.

The activity time for fishing is longer than the time spent on agriculture time in the rainy season. Fishing activity is carried out in the rice fields or riparian forests flooded by the river near the southern village boundaries in the rainy season.

As for grazing and taking care of cattle and buffalo, the method of pasturing differs between the rainy and the dry season. In the rainy season, villagers take the cattle and buffalo to the forest to graze them and ensure that they do not eat rice in paddy fields. On the other hand, cattle and buffalo are pastured without guard in the dry season because there is no such danger. However, the villagers wait for their cattle and buffalo to come back at the end of the settlement for a long time every evening and they sometimes go to look for their animals. According to Table 3, the main land used for grazing is paddy fields and forest in the rainy season, while about 80% of land used for grazing is settlements in the dry season, which means the villagers spend a long time within their settlements after leaving their home to wait for their cattle and buffaloes to return. Thus, the activity time for grazing is longer in the dry season than in the rainy season. Lumbering and charcoal production also occupies most of the time in the dry season.

Activity time for wage labor is not long compared with fishing and agricultural tasks. The opportunities for wage labor are very limited within the village and most wage labor is conducted outside the village, and some villagers commute to Vientiane. Although the working hours are long for a person who engages in wage labor, the average activity time is shortening because few people engage in wage labor. The average working time is longer in the rainy season due to long overtime work in the

Table 3 Outdoor Activity and Landuse

Rainy Season (by all informants)

Main Category	Sub Category	Inside Village (%)								Outside Village (%)	Total Outdoor Activity Time (minute) (%)	
			Water area	Riparian forest	Vacant area	Settlement area	Artificial forest	Forest	Paddy field			
Work	fishing	74.4	0.1	10.4	2.7	28.3	0.0	2.4	30.7	25.6	4,314	(6.3)
	hunting	98.7	0.1	3.5	6.8	39.3	0.0	22.1	27.0	1.3	927	(1.4)
	gathering	100.0	0.0	0.5	3.5	48.9	0.0	18.0	29.2	0.0	1,986	(2.9)
	agriculture	98.4	0.3	0.3	9.0	25.4	0.0	43.0	20.7	1.6	2,749	(4.0)
	grazing/care of	98.5	0.0	0.4	15.1	20.4	0.0	27.2	35.4	1.5	3,508	(5.1)
	trade	92.7	0.0	0.0	0.7	90.4	0.0	0.1	1.6	7.3	6,310	(9.2)
	wage work	24.3	0.0	0.0	0.0	22.3	0.0	0.0	2.0	75.7	3,199	(4.7)
	lumbering/charcoal	98.0	0.0	1.6	0.6	22.7	0.0	46.2	26.9	2.0	4,283	(6.2)
	other	4.7	0.0	0.0	0.0	4.5	0.0	0.0	0.2	95.3	754	(1.1)
Shopping/household work		82.0	0.0	0.0	0.5	78.2	0.0	1.1	2.3	18.0	3,921	(5.7)
Leisure/playing		98.3	0.0	0.0	2.9	86.2	0.0	0.5	8.7	1.7	12,559	(18.3)
Social communication		77.8	0.2	0.0	0.8	72.5	0.0	0.4	4.1	22.2	11,944	(17.4)
Attending school		65.4	0.0	0.0	3.1	60.9	0.0	0.1	1.4	34.6	3,570	(5.2)
Other		98.0	0.2	1.1	12.6	53.2	0.0	6.1	25.4	2.0	8,519	(12.4)
Returning home		98.9	0.0	0.0	0.4	93.0	0.0	0.8	4.9	1.1	58,050	
Unknown		93.7	0.0	0.0	0.3	79.0	0.0	1.5	13.0	6.3	5,104	
Total		91.8	0.1	0.5	2.3	74.9	0.0	4.5	9.6	8.2	131,696	

Note: Parentheses indicate the proportion to total activity time excluding returning home and unknown

Dry Season (by all informants)

Main Category	Sub Category	Inside Village (%)								Outside Village (%)	Total Outdoor Activity Time (minute) (%)	
			Water area	Riparian forest	Vacant area	Settlement area	Artificial forest	Forest	Paddy field			
Work	fishing	46.5	1.7	10.6	2.8	18.8	0.0	10.6	3.7	53.5	2,539	(2.8)
	hunting	75.3	0.1	2.6	26.0	40.7	0.0	2.3	3.6	24.7	1,583	(1.7)
	gathering	81.6	0.0	0.5	1.2	47.3	0.0	10.3	22.4	18.4	5,021	(5.5)
	agriculture	76.8	0.5	17.0	5.3	32.3	0.0	6.2	16.0	23.2	4,618	(5.0)
	grazing/care of	94.1	0.1	5.6	0.4	79.9	0.0	1.5	6.7	5.9	10,347	(11.2)
	trade	85.5	0.0	0.6	3.5	77.9	0.0	0.3	3.2	14.5	5,601	(6.1)
	wage work	13.4	0.0	0.0	0.7	11.8	0.0	0.3	0.6	86.6	1,486	(1.6)
	lumbering/charcoal	90.6	0.0	0.8	1.1	75.3	0.0	2.8	10.6	9.4	6,955	(7.6)
	other	76.8	0.5	1.8	15.5	16.2	0.0	34.3	9.0	23.2	1,152	(1.3)
Shopping/household work		92.6	0.0	0.1	2.6	82.8	0.0	1.9	5.2	7.4	15,898	(17.3)
Leisure/playing		98.6	0.0	0.0	0.9	91.1	0.0	0.8	5.8	1.4	5,781	(6.3)
Social communication		96.7	0.0	0.9	1.6	88.0	0.0	3.4	2.8	3.3	16,733	(18.2)
Attending school		64.1	0.0	0.0	6.5	55.5	0.0	0.4	1.7	35.9	4,082	(4.4)
Other		91.4	0.0	0.3	0.8	85.8	0.0	0.6	3.8	8.6	10,227	(11.1)
Returning home		95.9	0.1	0.3	0.5	88.9	0.0	1.0	5.1	4.1	55,121	
Unknown		89.1	0.0	0.0	0.1	84.5	0.0	0.3	4.2	10.9	22,139	
Total		90.4	0.1	1.3	1.6	79.8	0.0	2.1	5.7	9.6	169,281	

Note: Parentheses indicate the proportion to total activity time excluding returning home and unknown

factory where some villagers worked to produce Christmas goods, as will be mentioned later.

Both males and females stayed within the village most of the day and spent more than 70% of the time surveyed in the settlement. The percentage of time spent in the settlement was six percentage points higher among females than males (table omitted). This shows that females are more involved in housekeeping jobs, child rearing, and social activities in the settlement. On the other hand, males are relatively more involved in the jobs of hunting, gathering, and cultivating outside the settlement. So the time spent in the riparian forest, water area, and the paddy fields was longer among males.

V　Seasonal Changes of Natural Resource Use

Most villagers spent time inside the village, and natural resource-based activities without employment were common in the village. We focused on one of the households whose members have a direct connection to the natural environment. We drew the daily paths of the household members and analyzed the time-spatial relationship between human activity and the natural environment. Figs. 5a and 5b shows the daily paths in which the

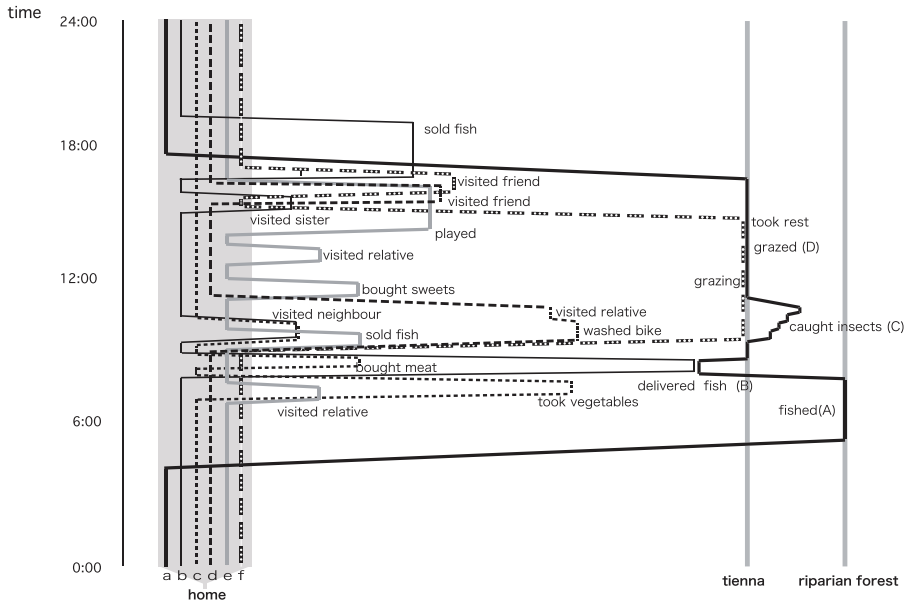

Fig. 5a　Daily Paths of One Household (Rainy Season, 2006)
Note: a: husband (52), b: wife (51), c: daughter (21), d: daugher's husband (25), e: grand daughter (6), f: son (19)
Data: activity survey (2006)

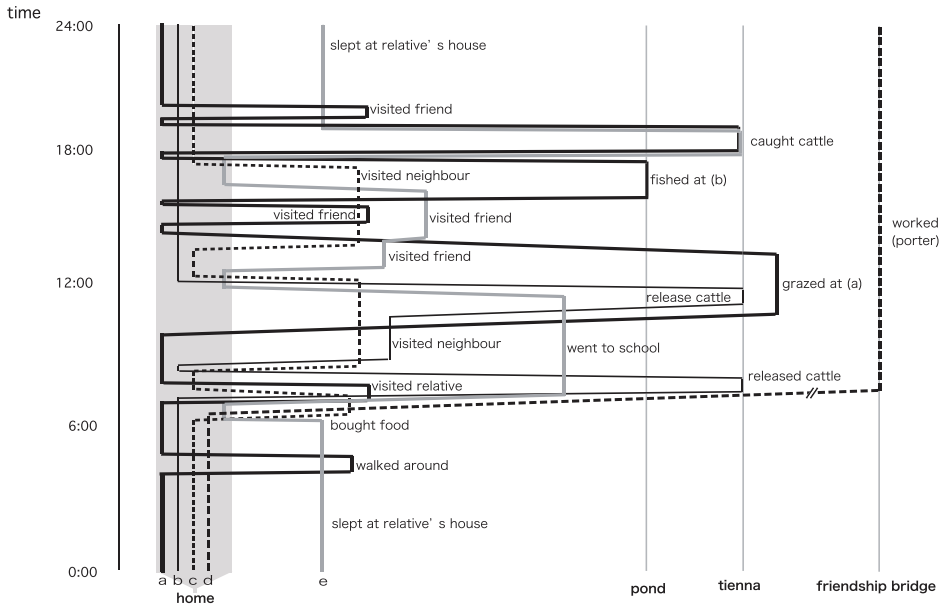

Fig. 5b Daily Paths of One Household (Dry Season, 2008)
Note: a: husband (54), b: wife (53), c: daughter (23), d: daugher's husband (27), e: grand daughter (8)
Data: activity survey (2008)

time-space movement of each household member is arranged. The vertical line indicates the time of day, while the horizontal line represents each different location in which outdoor activities were practiced and the relative distance from the home [Carlstein 1982; Arai *et al*. 1996]. Fig. 5a shows household members' activities in the rainy season, while Fig. 5b shows them in the dry season.

The activities of the household indicate that the human behavior of this village is adjusted to the seasonal change of the natural environment. The water area and riparian forest becomes a fishing spot in the rainy season, and the forest and riparian forest become grazing spaces in the dry season. The people's livelihood changes seasonally to fit the ecological setting.

Here, we present example data from one household, which consists of six members. The husband (52 years old in 2006), the wife (51 years old), the daughter (21 years old), the daughter's husband (25 years old), the granddaughter (six years old) and the son (19 years old) spent most of their time inside the village in the 2006 rainy season. The husband in particular used the natural environment for fishing, hunting or grazing. The husband woke up very early in the morning around 4 am to prepare for fishing. The reason for going fishing very early in the morning was to get a big catch of fish. His activity was adjusted to the ecological cycle of fish activity. The fisherman set the fishing net the previous evening. In the heat of the day, the fish hid in the shade of the trees and they

became more active at nighttime as they searched for food. In the early morning, the fisherman drew in the net to catch the fish before they lost freshness [Akimichi *et al*. 2008].

Fig. 6 displays his GPS tracks. The black dotted line indicates his travel in the rainy season. He went to the river located to the south of the village; he checked the fishing net and caught fish at five places (around Point A in Fig. 6). After that, he delivered these

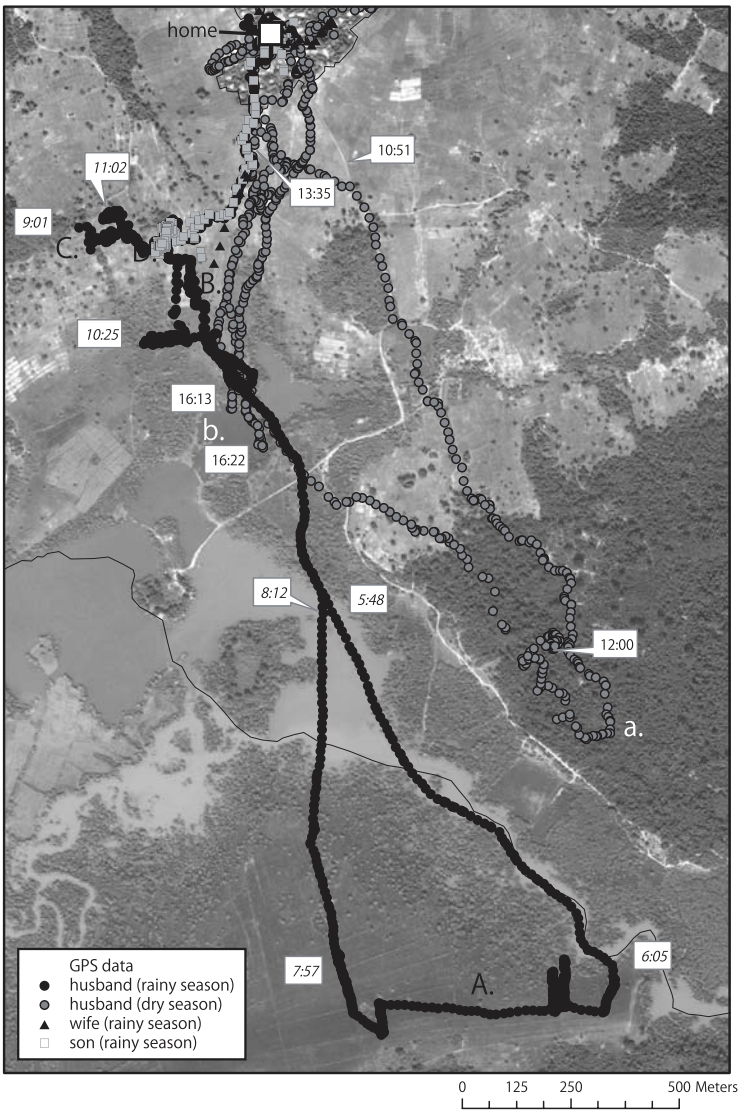

Fig. 6　Detailed Spatial Allocation of the Activities
Data: GPS survey by authors, QuickBird satellite image (October, 2006)

fish to his wife. The husband and the wife met at point B and he went to the *tienna* in point C. At the *tienna* he took care of his cattle and after that he went to the forests near the *tienna* to catch insects to feed to the cattle. He spent some time at the *tienna* to graze the cattle and took some rest, returning back home around 4 : 30 pm. His son also came to the *tienna* to graze cattle at around 10 am and they worked together and rested for about four hours.

In the dry season of 2008, the activity of the husband changed to fit the seasonal change of the natural environment. He did not go fishing in the early morning because the volume of river water became very low and they could not catch any fish in the river. The husband went to the forest and the riparian forest (he could not go there in the rainy season because the river water covered that area) to feed his cattle (around point a. Fig. 6). He returned home and went to a pond for fishing in the afternoon (around point b. Fig. 6). In the dry season he could catch fish at several big ponds located to the southwest of the village.

As seen from this example, the seasonal changes of the natural environment influenced the changes in the daily paths of the people. This situation is analyzed from the time-geographic concept of the constraints.

The daily path of the husband in the rainy season was affected by several related constraints. Fishing in the very early morning meant that if he took the chance to get a good catch, he had to fit his daily path to meet the activity patterns of the fish. Their activity patterns followed the daily, seasonal and ecological cycle of the river environment. The morning is when the fishermen can make the time-space bundles with the path of the fish, and most fishermen in the village wanted to go to the river very early on in the morning. The end of August is the main growing season of the fish that come from the Mekong River from May to July, and this was why the fishermen spent a long time at the river during our research period.

The fishermen had another coupling constraint. The selling of fish has to be done at an appropriate time. Small cyprinid fish caught with tangle nets have to be sold quickly because they have already died when they are caught [Ikeguchi and Nonaka 2008]. Many fishermen in this village sold the fish in the research period, and freshness and adjusting to market demand were important for selling them at a good price. The selling of fish is assigned to the women as part of the gender division of labor in the village. This situation, the coupling constraint between the husband and wife, affects the daily time-space path. The wife went to the meeting point near the river to sell the fresh fish in the village, and this was the time-spatial peg of the activity of both husband and wife. It was the strategy of the family to meet the market demand and this was one of the main constraints on the husband's daily path.

The daily life of the villagers in the natural environment is not like the slow, calm village life. The rainy season was a busy time for the fisherman because his daily path had several constraints related to the natural environment and the economic environ-

ment, and he needed to adjust and coordinate his daily activities.

On the other hand, such constraints were not shown in the dry season. The husband went fishing in the late afternoon because there was not a severe coupling constraint with fish. The activity patterns of the fish were not affected by the daily ecological cycle and the husband had the flexibility to be able to time his fishing activity.

The environmental setting also constrained the capability of human and buffaloes' activities. The water and riparian forest areas lost water in the dry season and the villagers had no barrier to their activities. They could easily enter these areas and use the land as a grazing area. The paddy field also changed to vacant land and they used it as a place for feeding buffalo. These changes indicate that the capability constraints were reduced and the flexibility of activities was increased in the dry season.

The analysis indicates that the daily activities of the villagers were still closely related to the seasonal/daily ecological cycle of the natural environment. The activities of the household members are separated from each other and the rigid constraints did not exist with other members inside both the settlement and/or home. The home was not a time-space peg of the daily activities and the settlement or activities outside of it were more important than the home. Such loose coupling constraints between villagers shape the character of their daily living.

VI　Influence of Urbanization

Recently, many labor-intensive industries have been established in Laos. They are export-oriented, and some of them are financed by foreign capital. Most employees in these factories are young women. Since the 1990s, there have been an increasing number of such factories located in Vientiane municipality. Sewing factories are typical of such industries. According to the member list of Lao association of textile industries in 2004 (92 member companies), 26 members (28%) are direct foreign-invested and 10 members (11%) are joint corporations of Lao and foreign companies. Eighty-eight members (96%) are located in Vientiane municipality [Nishimura and Okamoto 2007]. There are a growing number of employment opportunities in and around Vientiane. However, the areas within commuting distance of the factories are restricted due to the poor transport system. Dongkhuwaai Village, which is located about 30 km from Vientiane, was beyond the commuting distance of the factories. Small-scale commuting started in February 2006 in this village. A factory near Friendship Bridge, which connects with Thailand, offered commuting jobs to the village. Founded in 2005 by Thai direct investment, it makes 3-D picture books for children. Moreover, commuting to a French garment-washing factory started in February 2007. These factories run commuter buses (*songteo*). Dongkhuwaai is the furthest village that the buses reach and it takes approximately one hour and a half each way to the factories.

Monthly basic pay is 30–35 US$ in the factories. Allowances for overtime work are added. Regular working hours are 8 : 00–17 : 00, but workers often come back to the village at midnight to do overtime work to meet the market demand for Christmas in the US and European countries. Almost all the commuters are young females. Commuting to the factory has brought cash earnings to young women in the village. However, the turnover rate of these young women is relatively high for the following reasons:

1) Wages are so low that they cannot regard work at the factory as a rewarding job.
2) There are alternative ways to get cash in this village, such as fishing, hunting and gathering. The selling price of natural resources is relatively high (Table 4).
3) They are burdened with long overtime work, a long commuting time, and work on the weekends.
4) They have to spend weekdays in a different place and on a different schedule from other members of their household.

The last reason is very time-geographic. To clarify the time-space constraints in the daily lives of factory workers, we provide an example of one household in Dongkhuwaai Village in which one member commutes to the factory.

Fig. 7 shows the daily path of the household in the rainy season. This household consisted of the mother (53 years old), the eldest son (26 years old), the daughter (19 years old), and the second son (16 years old). The daughter was a worker at the picture book factory. She left the village by commuter bus before 6 : 00 in the morning, and worked at the factory all day long. The time she returned home was usually around 10 pm when her mother and brothers had already gone to bed. She came home later than usual at 10 : 30 pm on the day surveyed. Other members of the household were staying in the village. The eldest son went to a *tienna* in Nakhok to take the cattle to the forest in the morning. The mother in the household surveyed also went to the *tienna*, and collected firewood and nuts called *Makbokk* near there in the afternoon. The second son com-

Table 4 Income by Hunting/Gathering

Products	Household	Income (/month, US$) (10,000 kip= 1 US$)
Aquatic products	84	63.6
Mushroom • bamboo shoots	76	38.9
Wild edible plants	9	30.2
Insects	43	31.5
Mammals	7	30.6
Firewood	21	56.9
Salt	18	14.7
Vegetables	3	153.3
Rice	51	63.1 (/year)

Note: Most active month of households whose members engaged in hunting/gathering. Incomes from vegetables and rice were not deducted from the cash cost.
Data: Socio-economic survey (all households in DK village in 2005)

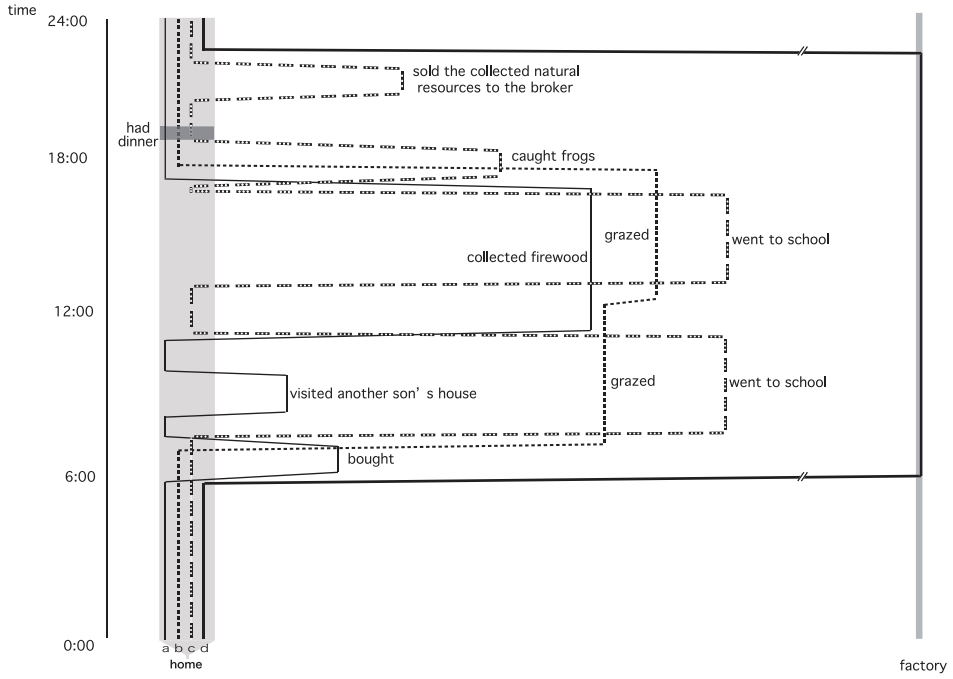

Fig. 7　Daily Paths of the Wage Worker and Her Household Members (Raing Seeson, 2006)
Note: a: mother (53), b: son (26), c: daughter (19), d: son (16)
Data: activity survey (2006)

muted to the junior high school in Huaxien village neighboring Dongkhuwaai Village. He went to catch frogs after school on the day surveyed, and after supper he visited a middleman in the village to sell *Makbokk* that his mother had collected that afternoon. He sold Makbokk weighing 1.3 kilograms for 7,500 kip (75 cents).

Thus, the household members other than the daughter spent the day with nature in the village; hunting and gathering and cattle grazing. On the other hand, the daughter worked far from the village from the early morning to midnight. This shows how the time-space of her daily life was quite different to the other household members.

The reason for the time-spatial distinction between the daughter and the other household members was that there was a severe coupling constraint on the daughter's daily activity. The daughter's daily path and the path of the facility of the factory make the bundle [Hägerstrand 1970] that restricted the daughter's activity. The long time commuting and the lack of her-own transport removed the possibility of flexible use of break time. She had very limited possibility for activities with members of the village on workdays because the most of the villagers' activities did not have such a severe coupling constraint (Table 5).

What we can see from the above example is how globalization is introducing a new

Table 5 The Change of Livelihood and Work Place, Timing of Work and Use of Space

Kind of Work	Working Place	Timing of Work	Living Space	Social Communication
work related natural environment	mainly working inside village	seasonal cycle ecological cycle	seasonal cycle ecological cycle contiguous use of ecotone	closely connected, longterm
paid work	working outside village	factory and global market demand	segmental use of space	limited opportunity, short

type of wage labor to Dongkhuwaai Village. It ties up the laborers with the worktable of the factory for long hours and forces them into the same work routine day after day; a routine that sees them leave the village early in the morning and return late at night. The time-space paths of factory laborers are simple and stiff depending on the commuter bus schedule, which are very different from the diverse and flexible paths of other villagers. In the time-geographic diction, laborers have to be riveted to the factory (a coupling constraint) under the supervision of a manager (an authority constraint) without their own means of transportation (a capability constraint).

Thus factory labor outside the village creates severe constraints and makes communication with family members and neighbors almost impossible on weekdays. Wages are too low to be an incentive for them to continue this unhappy labor. Low wages brings about a high turnover rate. Factories try to hold employees more than the necessity to cope with a high turnover rate. In the case of the factory making picture books, they kept about 600 laborers for 400 persons workload in 2006 when we interviewed the personnel director of the factory. Over-employment depresses the wage. Turnover rate is higher in the farmers' busy season. In Dongkhuwaai Village, not a few females were absent for rice planting from factories before quitting their factory job. The factories are subject to the seasonal fluctuation of the workforce and the management have to coordinate their production not only in changes in the demand of the global market but also to the seasonal changes of the workforce and their relation to the natural environment of the Vientiane plain [Nishimura and Okamoto 2007].

VII Conclusion

This study aimed to clarify the spatio-temporal aspects of daily lives based on natural resource use on the facing market economy. We have analyzed the spatio-temporal structure of rural daily lives based on natural resource use, and examined the influence of urbanization on rural daily lives.

We developed new research methodologies using GPS and GIS to collect person-trip-

data in a region where it is difficult to use questionnaires. By applying the methodology to research in the Vientiane plain in Laos, we found this new methodology made it possible to gain detailed information about people's daily activities, namely what activities were carried out, at what time, where, and with whom. The research field was Dongkhuwaai Village, Xaithany District, located about 30 km by road from Vientiane where the villagers lived traditionally, depending on rice crops in the rainy season and use of various natural resources. We analyzed their daily activities both in the rainy season and in the dry season.

We found that the villagers spent most of their day in the village, and their activity paths were closely connected to each other in a narrow settlement space. However, there were a small number of synchronized activities among the household members and the coupling constraints on them were not clear. The settlement was more important than home for their activities. The home was not time-space pegs of the daily activities. The villagers spent much time in other places in the settlement apart from their own houses as the starting and ending points of activities. There seemed not to exist a modern time discipline in which all of the household members had dinner or watched television together at a fixed time. The loose coupling constraints between villagers affected their daily activities.

The daily activities of the villagers were still closely related to the seasonal change of the natural environment. At present, the activities related to natural resource use such as fishing, hunting and gathering still continue to occupy a considerable part of the time-spatial allocation of rural daily lives. There were also some important constraints with the natural environment, land use, animals, or plants.

On the other hand, the penetration of the market economy has increased the opportunity for various types of wage earning near Vientiane. In recent years, a growing number of foreign companies have invested in Vientiane and the vicinity because of low labor costs. Dongkhuwaai Village has found itself become a source of laborers commuting to factories. That might be a cause of the radical changes in the rural lives in Vientiane plain which can be summed up in the three following points: first, the introduction of wage work means not only a change in the income generating method, but also transitions of the activity patterns and living time-space. Secondly, the daily lives of the household members doing wage jobs are in sharp contrast to the daily lives of other household members who depend on natural resource use even though they live in the same household. In such households, the daily paths of the members have severe coupling constraints and there is a lack of daily communication time. Finally, these changes imply that the penetration of the market economy could cause changes in the social relationships in the village and change how a household/family ought to be.

At the turn of the 21st century, "global factories" have finally reached Laos for cheaper labor. Laos is the one of the latest developing countries to be pulled into the global economy. Today, Laos, Cambodia, and Vietnam are replacing the former cheap-

wage countries of Thailand, Philippines, and Indonesia in Southeast Asia.

The cheap-labor-oriented enterprises newly established in these countries have absorbed unskilled workers not only from urban areas but peri-rural areas. In the 1980s, many factories including the foreign invested were located in local cities in Thailand. According to the long-term observation studies in Don Daeng Village in northeast Thailand, the villagers' daily lives have been dramatically changed since the 1980s due to the increase of commuting to the factories in and around Khon Kaen city [Fukui 1996]. Farmers in Don Daeng Village were split into many part-time rice farmers and few full-time vegetable farmers. In Funahashi's study, the proportion of the off-farm income in annual household income of all the villagers has increased from 21.3% in the 1960s to 57.8% in the 1980s to 82.0% in 2002 [Funahashi 2006]. What this indicates is as the villagers became commuters, their living space are segmented into workplace and home, and their living time are segmented into working hours and non-working hours.

Is Dongkhuwaai village following the same road as Don Daeng village? The beginning of small-scale commuting to the factories could be a symptom in Dongkhuwaai. Although many villagers experienced factory work from 2006, most of them stop going to the factories. It implies that the villagers are showing anxiety in the face of socio-economic change that such work brings, reacting against the risks and undesirable influence to family/ village life.

On the other hand, the wage labor is not the only way to earn cash in this village. Fishing, hunting and gathering bring the villagers respectable income (Table 4). These activities are flexible in space and time. Unlike factory labor, they do not bind people to a certain place for long hours of the day. These activities are also initial-cost-free, unlike vegetable production that needs the irrigation facilities.

The marketing of fish, insects, small animals and wild plants have increased since the 1990s, along with the introduction of a cash economy into rural areas showing that many villagers, including children, have become involved in fishing, hunting and gathering for cash-income. The construction of social relationships between the family or other persons in the village through natural resource use remains important activities. However, if too many people become engaged in these activities, this may lead over-exploitation and the deterioration of bio-diverse habitats. We would have to further think about how to balance the natural resource use, the villagers' activities and these risks.

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