CHAPTER II

MATERIALS AND METHODS

2.1 Conceptual framework

Figure 2.1 illustrates the conceptual framework for this research. The sources of energy are classified as biomass and non-biomass. The biomass sources are firewood, and charcoal, and the non-biomass sources include electricity, LPG, and gasoline. Household energy uses are for cooking, living, transportation, agriculture and other income generation activities. Different households are expected to differ in energy utilization, both in the absolute quantity and the relative shares of the different energy sources. Possible factors causing the differences in household energy utilization include size of household, size of land cultivated, occupation of household members, and level of income. These factors can be used to classify households into groups that may have distinctive patterns of energy use, including the total amount and the type of energy they use. Communities at different stages of urbanization are expected to display different proportions of different types of households which will contribute to the differences in energy utilization patterns among these communities.

2.2 Study approach

The study was conducted in three villages in Khon Kaen province in Northeast Thailand that represent different points along the rural-urban continuum of communities, i.e., rural, suburban and urban, to assess changes in energy use associated with urbanization. Ideally, it would be best if changes in energy use in rural villages over many years could be monitored as they gradually undergo urbanization. However, such a longitudinal study is time consuming and very expensive and does not provide useful results in a timely fashion. Instead, this study substituted space for time by employing a design based on studying current energy use patterns in selected

communities located at different points along the rural-urban continuum. This research strategy (sometimes called the "folk-urban continuum") has been used in many studies by anthropologists (Redfield, 1947), rural sociologists (Miner, 1952), and geographers (McGee, 1964). This approach is based on the assumption that there is a developmental lag between urban and rural communities so that changes begin to appear first in urban areas and then gradually are adopted by nearby suburban communities before finally becoming evident in more remote rural villages. The city, thus, represents the most advanced state of development, while the suburban village represents the area that has already undergone some changes in the urban direction, and the rural village represents more traditional patterns of energy use. In future years, it can be assumed that the suburban communities will continue to shift toward being more like the city while the rural villages will come to resemble the current state of the suburban ones.

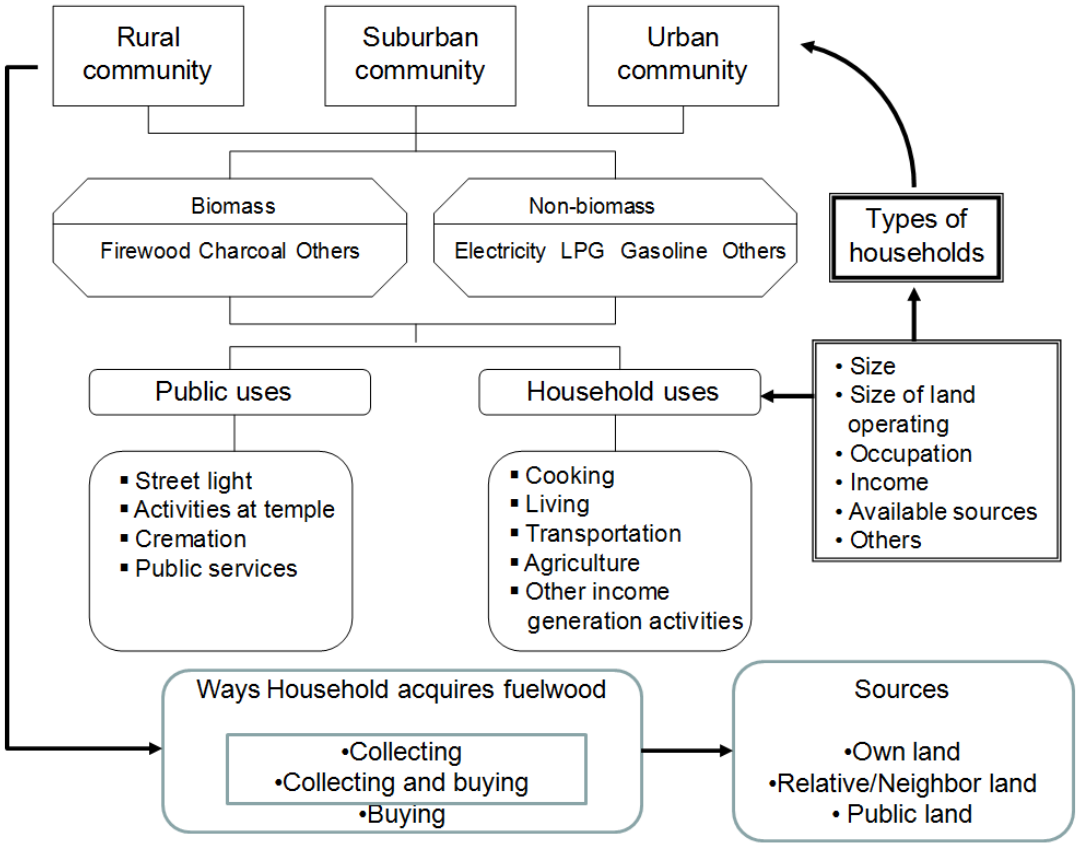

Figure 2.1 Conceptual framework for this research.

2.3 Selection of study sites

Khon Kaen province was selected for this research because it includes communities ranging from quite rural to highly urban. The provincial capital, Khon Kaen city, is the sixth most populous city in Thailand (DPA, 2008) and displays a high level of urbanization. Khon Kaen city is large enough that its impact is strongly felt in surrounding villages, with many having developed a strongly suburban character in recent years. However, some villages, which are located in more remote districts, and enjoy less easy access to the city, still retain a rural character.

In selecting the three study sites that represent three points along the spectrum of urbanization in the province, the village database of 2007 (RDIC, 2008), the Khon Kaen geo-database of 2006 (Anonymous, 2006) and the aerial photograph of Khon Kaen province in 2006 (Point Asia Public Company Limited, 2007) were used. Twenty candidate villages were initially selected based on the distance from Khon Kaen city and the proportion of agricultural land to the total area of the community. This was followed by preliminary surveys and ground checking in candidate communities with informal interviews of key informants, selected villager groups and members of some households. Finally, Ladna Piang, Nongbua Deemee and Srijan communities were selected to represent the rural, suburban and urban communities, respectively (Figure 2.2). Additional criteria used in selecting these villages were the number of households (100-400), population density, total community area, level of infrastructure and diversity of occupation of households within the community.

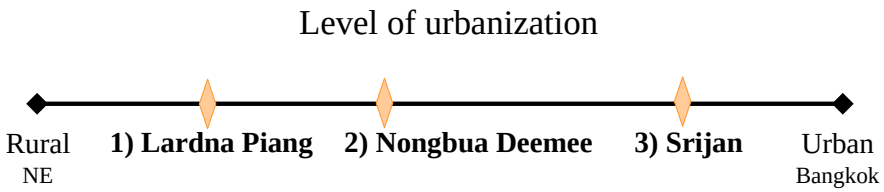

Figure 2.2 Positions of the three study communities along the rural-urban continuum.

2.4 Data collection

Data were collected on energy uses at the household level using a formal questionnaire survey, field observation and field measurements. For Ladna Piang and Nongbua Deemee, the rural and suburban communities, randomly selected samples of 50 % of the households were interviewed and observed to record their uses of different energy sources. The 50 % sample was employed to make sure that the sampled households represented all of the different types of households living in the communities. In the case of the urban community of Srijan, which has a smaller number of households, data were collected for all the households. The questionnaire was pretested before conducting the actual survey.

The questionnaire consists of three parts. The first part comprises information on the household, which includes name of the household head, address, number of members and their sex, age, occupation, and income earned. The second part covers number of fields they farm, area and crop grown in each field, numbers of different types of electrical appliances they use, and numbers of stoves, agricultural machines, motorcycles, and cars or trucks they own. The third part deals with the amount of energy used from each source and the activities for which that energy source is used. The sources of energy are divided into biomass, which includes firewood, charcoal, and others, and non-biomass, which includes electricity, LPG and gasoline (including diesel oil used for tractors and some trucks). The uses of energy are divided into cooking, living, transportation, agriculture and other income generation activities.

The amount of firewood and charcoal consumed by each household were measured by asking the appropriate member of the household to make a separate pile of the amount of wood or charcoal that he or she anticipated that it would be used in the following seven days. That amount was weighed and kept separately from the main supply. After five days, the household was re-visited and any unused wood or charcoal was weighed and recorded.

The amount of electricity which consumed by individual households were determined from their monthly electricity bills. The numbers and wattages of all electrical appliances were also observed and recorded.

The amount of LPG used by each household was obtained by asking the appropriate member of the household on how long a tank of LPG would normally last.

The amount of gasoline used for motor vehicles (automobiles and trucks) and motorcycles were obtained by the interview, asking how much money was spent for gasoline in a month for each motorcycle and for each car or truck, and then converting to volume using the average price of the month.

The amount of gasoline used for agricultural production by a household was derived by determining the standard amount of gasoline used by farm machinery per hectare for each crop, i.e., rice, cassava and sugarcane, and then multiplying the amount used per hectare with the corresponding planted area of that crop. Determination of the amount used per hectare for each crop was done by interviewing tractor operators and tractor dealers for each type of operation, i.e., plowing, harrowing and combine harvesting, and then summing all operations respective to the crop. The average figure over those obtained from all key informants was used as the standard amount of gasoline use for a particular crop.

The amount of gasoline used for other income generating activities was collected by interviewing appropriate household members.

All the data obtained were converted into a standard energy unit (Mega Joules, MJ) for further analysis, using conversion factors as shown in Table 2.1.

2.5 Data analysis

The absolute quantities of the different types of energy and their relative shares of the total energy mix used by each household were computed. These were used to calculate the average absolute quantities and their relative shares of the different types of energy used by all households in each of the individual communities. Comparisons were made among the three communities on the amount and share of energy used from different sources, and the changes in functional roles of different sources of energy with increasing urbanization were assessed.

Table 2.1 Conversion factors used in converting measurements from different energy sources to a standard energy unit (Joule, J).

Source of energy (Unit)	Joule (J)
Gasoline (litre)	31.48
Kerosene (litre)	34.5.3
Diesel (litre)	36.42
Electricity (kWh)	3.60
Fuel wood (kg)	15.99
Charcoal (kg)	28.88
General	
1 m^3 of solid wood = 600 kg.	
1 m^3 of charcoal = 250 kg.	
5 kg of fuel wood = 1 kg of charcoal.	
1 litre of LPG = 0.54 kg.	

Source: Thailand energy situation 2006, Department of Alternative Energy Development and Efficiency (DEDE, 2006), Thailand Ministry of Energy.

Variations among individual households in energy uses were examined and households were classified into different groups, both within the community and across the three communities, based on occupation, size of household, level of income and area of fields cultivated. Four occupational groups were identified, i.e., households having regular income, having their own business, having irregular income, and making their living from agriculture. Regular income households have

members who receive a monthly salary as employees of government offices or private enterprises, while irregular income households have members who work for daily wages when employment opportunities are available. The households were grouped according to size, i.e., small (<3 persons), medium (3-5 persons) and large (>5 persons). Households were also assigned to groups according to income, i.e., below poverty line (<439 US$/yr), medium (439-3,864 US$/yr) and well-off (>3,864 US$/yr). The latter two groups were separated by two standard deviations from the poverty line. Households were also assigned to four groups based on the area of land they cultivated, i.e., very small (0-1 ha), small (1-2 ha), medium (2-4 ha) and large (>4 ha). For each type of classification, differences among groups in their consumption of the different types of energy were assessed, from which the effect of the grouping factor on household energy utilization was determined. One-way analysis of variance (ANOVA) and Duncan multiple range test (DMRT) were performed using SPSS software (SPSS, 2008) to analyze and test for statistical differences in average household energy consumption among the three communities and among the types of households in different classifications. The results were used to determine the factors that caused the differences in energy consumption among communities at different levels of urbanization.

The absolute quantities of the different sources of energy and their relative shares for each household were computed. In this study, variations in the relative shares of biomass energy for the individual households were examined. Households were divided into groups defined according to the different levels of the share of biomass energy to total energy consumption by the household. They were also divided by occupations which included employees of a government office or private enterprise with regular income, business owners, daily wage workers with irregular income and those earning their living from agriculture. These household groups and occupations were analyzed for their patterns of biomass acquisition which included (1) obtained from collecting their own land (paddy fields, uplands, house plot), land belonging to neighbors, and public land (community forest, river forest, and roadside), (2) purchased and (3) both collected and purchased. The extent of household self-sufficiency in producing biomass was determined. Selected households that were self-sufficient in terms of producing all of their own biomass energy were interviewed to

obtain information on the ways in which they acquired biomass for household use and the ways in which they managed production of fuelwood for household uses. Assessment was then made of the long term prospects of biomass as a source of energy for household consumption.