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Household energy consumption patterns in agricultural zone, pastoral zone and agro-pastoral transitional zone in eastern part of Qinghai-Tibet Plateau

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ABSTRACT

Despite the rapid development in fossil fuel, biomass is still the main energy resource in rural China. However, the research on household energy consumption on the Qinghai-Tibet Plateau is limited. We investigated the differences in household energy consumption pattern, the influencing factors of fuel type choice, and the willingness to use clean energy in agricultural, pastoral and agro-pastoral transitional zones in eastern part of Qinghai-Tibet Plateau. Information was collected through Participatory Rural Appraisal (PRA) and Physical Monitoring (PM). We found that biomass was the main energy resource in pastoral regions while fossil energy was the main fuel in agricultural regions. Energy consumption per capita in pastoral regions was higher than that in agricultural regions in our study area, and annual household energy consumption in pastoral regions was much higher than the provincial average. Altitude, livelihood and education level were main factors affecting domestic fuel type choice, while altitude and household size were two factors determining energy consumption per capita. The use of biomass as fuel could have negative influence on the material cycle in ecosystem and affect the carbon budget on the Qinghai-Tibet Plateau. Householders were willing to use clean energy and most interviewees chose electricity as their favorite fuel type. Therefore, the modern utilization of biomass and the exploration of renewable energy are promising in future energy development in eastern part of Qinghai-Tibet Plateau. However, energy transition might be constrained by poor local transportation and traditional consumption habit of indigenous community.

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1. Introduction

Energy issue has aroused increasing interests and become a key point in economic growth and national welfare in the past

decade. Despite the rapid development and exploration of fossil energy, biomass is by far the major domestic energy in many rural areas in developing countries [1–6]. China has experienced sharp increase in economy and energy demand in recent years, and become the largest emitter in the world

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since 2009, however, biomass energy is still widely used in the rural area [7]. China Energy Statistical Yearbook mainly focuses on fossil energy supply and consumption, with little concern on biomass consumption in rural areas. Several researches have been done on rural household energy consumption in eastern and central China, however, energy consumption patterns in most areas of China are yet unknown [8–18].

The Qinghai-Tibet Plateau is recognized as the third pole of the Earth with average altitude over 4000 m above sea level (asl). Scientists have predicted that the Qinghai-Tibetan Plateau experiences “much greater than average” increase in surface temperature and regarded increasing anthropogenic green house gas (GHG) emission as the main reason for recent climate warming [19,20]. Due to the particular role it plays in climate regulation and social-economic welfare, the energy issues of the Qinghai-Tibet Plateau have attracted interests from many researchers and policy makers. Among them, most studies are conducted in Tibet with little attention being paid to energy supply and consumption in Qinghai Province in eastern part of the plateau [16,21–25].

Herdsmen and farmers living on the plateau have used yak dung, sheep fecal pellets, firewood and crop residues as fuel for thousands of years. Such biotic energies are still the main energy resources for household energy consumption on the Qinghai-Tibet Plateau due to the financial constraints, lack of alternative energy resources and traditional custom [26]. However, the specific energy consumption pattern of rural households on the Qinghai-Tibet Plateau is poorly understood. Household interview and questionnaire are two effective ways of gathering information on the energy use patterns of rural households which have been used in many areas like India, Bangladesh, South Africa and China, etc [1,16,17,27–29].

The present study used open-structural questionnaire and interview methods to investigate the fuel use pattern at household level in five counties with different livelihoods in Qinghai Province. We tested the hypothesis that energy consumption per capita was higher in the pastoral zone than that in the agricultural zone due to the colder physical environment and coarser energy consumption mode. We compared the energy consumption per capita in five counties to study how household energy consumption structure changed from agricultural regions to pastoral regions and investigated influencing factors of fuel type choice. Finally, we discussed the ecological impact of energy consumption pattern and the direction of future energy choice in rural Qinghai.

2. Materials and methods

2.1. Study area

Qinghai Province lies in northeastern part of Qinghai-Tibet Plateau (31°39′–39°21′N, 89°35′–103°04′E) with area of 717,400 km² and population of 5.54 million in 2008 [30]. Pastoral lands account for 59.11 percent whereas farming lands and woodland account for 0.79 percent and 3.90 percent in whole lands. This area is characterized by strong solar radiation with long cold winter, short cool summer and a short frost-free period. Mean annual temperature is 6.8 °C and mean

annual precipitation varies from 14.9 mm in northwest to 774.3 mm in southeast with most falling between June and September. Annual evaporation is about four times greater than the annual precipitation [31].

Qinghai Province could be divided into three parts: eastern part of the province is agricultural zone with altitude between 1700 and 2500 m and about 3.5 million people living in this zone; areas around the Qinghai Lake are agro-pastoral transitional zone with altitude between 2500 and 4500 m and approximately 100 thousand people whose majority are Tibetan living in this zone; areas in southern Qinghai with altitude above 4500 m are alpine meadow with sparse population and majority of population are Tibetan.

We carried out our survey in five counties: Huzhu, Wulan, Gangcha, Gonghe, and Tianjun from April to August 2009 (Fig. 1). These five counties could be divided into three groups according to livelihoods of local people. Huzhu is located in agricultural zone; Gonghe and Tianjun are located in pastoral zone; Wulan and Gangcha are located in agro-pastoral transitional zone. Wulan is mainly agricultural zone with relatively less people living on livestock stocking while Gangcha is mainly pastoral zone with less people living on agriculture. The main crops grown in agricultural regions are *Brassica napus* and *Hordeum coeleste* and the trees in agricultural regions are mainly *Populus tomentosa* and *Betula platyphylla*. Farmers often took stem and stalk of crops, trunk and branch of trees which were not far away from their houses as fuel. The dung, crop residues and firewood were often dried under sun light, stored outside their houses in the open air without further processing before burning.

2.2. Data collection

We chose household as the basic survey unit as it was the basic socioeconomic unit of decision-making and consumption. We collected energy consumption data in the following two ways: (a) Participatory Rural Appraisal (PRA); and (b) Physical Monitoring (PM). We chose one *Xiang* (township, an administrative level below county level in China) per county in our survey and the households were randomly chosen to cover all the income levels.

PRA has been proved to be an acceptable methodology of participation in rural survey [32]. This was conducted by using an open-structured questionnaire. The original version of questionnaire was firstly used in a household energy consumption survey in four nature reserves in southern China in 2004 [15] and further refined to the local situation in Qinghai Province for this study. We are interested in family structure, education, annual income, expenditure, energy supply and consumption, cooking preference and the perspective on energy choice, with emphasis on household energy consumption. We did not split cooking, water boiling, lighting, heating and domestic animal food preparation from domestic energy uses in our study since these activities were closely related that rooms and tent space could be heated during cooking and water heating. The energy supply and consumption were got through practical expenditure and estimation. We limited the recall period to one year before the interview since shorter recall period might produce more accuracy and less variance [33].

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