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Towards an ethnography of small hydropower in China: Rural electrification, socioeconomic development and furtive hydroscapes

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ABSTRACT

This paper critically analyzes the disjuncture between rural electrification initiatives, utilization and socioeconomic development resulting from development of small hydropower (SHP) operations in rural Yunnan Province. Across China, a contemporary rapid and sustained proliferation of SHP is driven by government-led programs endorsing the technology as a means to provide energy for isolated communities in areas where grid connectivity is deficient or absent. Through SHP development, rural electrification programs (REP's) are purported to raise quality-of-life indicators in some of the country's poorest and most marginalized areas. Currently, there is a significant dearth of research critically analyzing the success or failures of SHP based REP's in China to improve livelihoods for ethnic minority communities in rural and remote areas. This paper adds to a shallow body of China based research by analyzing outcomes of SHP development through a comparative study undertaken in two rural village communities in the upper Nu River Valley. The study analyzed a range of quantitative economic data before undertaking a suite of qualitative methods such as participant observation, household surveys, semi-structured interviews and focus groups, staggered over multiple field visits. Findings indicate substantial scope exists for SHP based REP's to achieve stated objectives for improving socioeconomic indicators in rural and remote communities. Due to a range of challenges, however, projects often underachieve or further marginalize residents, commonly mired by failures in strategic planning, lack of implementation frameworks and genuine engagement with community members. A number of recommendations are offered as pathways to improve SHP based REP's as a means to provide conditions for more equitable modes of socioeconomic development across rural and marginal China.

1. Introduction

On January 29, 2013, China Daily published an article reporting that every household in Yunnan province had achieved connection to the power grid a few weeks prior [1]. Erroneously titled "Power Grid Now Covers all Yunnan households," the article reflects a common trope surrounding electricity supply, utilization and measurable impacts on living standards in rural China. While all villages across Yunnan have gained connection to an electrical supply (in many mountainous areas connection has come via micro-grids, rather than connection to a local or provincial grid), rates of effective utilization that improve socioeconomic indicators for residents through small hydropower (SHP) generated electricity are often low. Furthermore, in much SHP based literature emanating from China, a disproportional amount of attention is focused on positive effects in newly connected villages. Often, there is little to no discussion of adverse corollaries (see for example [2–5], [103]), and hence a research gap exists.

There is a well-developed body of literature addressing similar issues in other regions (see for example; Nepal: [6]; Turkey: [7,44] Chile: [8]; India: [9–11]; Canada: [12]). However, the overwhelming majority of research emanating from China has been developed through approaches centered in modelling that draw extensively on analysis of statistical data [13–17]. Such approaches are valuable for understanding broader and more generalizable factors, however, they can be limited in scope as they often do not adequately capture—and sufficiently measure—a host of subtleties that go beyond what aggregated socioeconomic data elucidate. Standard socioeconomic metrics such as GDP often cannot account for complex circumstances inherent in small, remote marginal communities when analyzed through models. Consequently, research to date completed in China has not done enough to illuminate the idiosyncratic nature of relationships coupling SHP generated electricity, income generation and impacts on poverty alleviation [5,13–17].

There are a few empirical studies of SHP in China, however, which must be noted; for example Ptak [18], investigates the relationship of hydroelectricity and development in Yunnan. Wang et al. [19] critically

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analyze the relationship between SHP, local governments and environmental consequences, while Hennig and Harlan [20] explore challenges linked to the recent over-development of SHP. These studies, while important, represent only a small fraction of the numerous communities and regions impacted by programs utilizing SHP for rural electrification. Consequently, there is a dearth of ethnographic studies employing mixed-methodologies that critically analyze a range of effects resulting from SHP based programs in a country as geographically, culturally and biophysically diverse as China [21].

Establishing a sufficient understanding of such empirical complexities demands more emphasis on what [22] detailed as human-centered approaches. This paper responds to calls for more integrative human-centered social science energy research [23,24], employing an ethnographic approach and mixed-methodology to answer the following question: how can empirical research analyzing socioeconomic indicators in China's ethnic minority communities shed light on the uneven distribution of benefits and marginalizing effects resulting from SHP based rural electrification programs (REP's)? This research offers fresh insights into contemporary initiatives utilizing energy as a tool for reducing poverty in rapidly developing countries; a key theme driving social science based energy research [23,25–30,111].

The research discovered that while scope exists for SHP based REP's to enhance socioeconomic indicators for a wide range of residents and marginalized communities more broadly, projects often underachieve, benefit particular individuals, marginalize others and polarize small communities. Adverse consequences result due to projects being mired by inadequate or absent implementation frameworks and a lack of genuine efforts to engage widespread community participation. A number of recommendations are offered for enhancing the ability of SHP based programs to deliver more equitable and sustainable modes of community-scale development.

This paper offers a salient contribution to a rapidly emerging body of critical SHP literature. While recent research has addressed policy frameworks [31,32] and environmental dimensions [20,33–35], not enough critically evaluating impacts on socioeconomic conditions in affected communities. Furthermore, while there has been a recent groundswell in energy specific ethnographic research (see for example; Bioenergy: [36]; Solar: [37]; Gas: [38]; Nuclear: [39]), hydropower—and particularly SHP—has not been sufficiently represented. The research then, addresses the lack of critical SHP scholarship in China and adds to a growing body of ethnographic studies that advance energy-based social science research. Finally, by providing fresh empirical evidence to understand nuance and challenges in programs deploying small-scale energy facilities for rural electrification and socioeconomic development, insights from this study may be used to inform other research across rural and marginal regions of the global south.

1.1. Situating small in the hydropower landscape of China and Yunnan

Attempts to understand the global hydropower landscape must pay attention to China as the world leader in terms of currently installed capacity and projected future development. China has approximately 694 Gigawatts (GW) of total hydropower potential, with 542 GW technically exploitable [40]. By 2016, China had exploited 331 GW of its total capacity, including 27.6 GW of pumped storage. These figures represent more than one quarter of the total installed capacity worldwide [41]. Additionally, it is critical to consider future projections, as China is aggressively developing its domestic hydropower resources, targeting 34 GW of increased capacity and 40 GW of pumped storage by 2020 [42].

China's southwest province of Yunnan is a hydroelectric powerhouse, due to immense resources [104] and sustained development [43]. Watersheds across Yunnan are endowed with 222.2 billion cubic meters of hydrologic resources, representing approximately 101 Gigawatts (GW) of exploitable hydroelectricity. Yunnan's three major river basins, the Jinsha (upper Yangtze), Lancang (Mekong) and Nujiang (also known as the Salween), represent approximately 92 GW of exploitable capacity (Liu et al., 2018). Development of hydroelectric resources in Yunnan has been rapid and sustained. In 1997, total installed hydroelectric capacity in the province was a mere 4.75 GW, which had risen dramatically to 60.69 by 2016, an average annual growth rate of 15.3% (Liu et al., 2018). It is crucial to pay attention to future plans, as hydroelectric resources in Yunnan are still relatively underdeveloped when compared to other provinces. Less than 60% of Yunnan's hydroelectric resources have been developed, with an additional 40 GW of installation set to occur by 2023 (Liu et al., 2018).

In many parts of the world, SHP is proliferating rapidly. The contemporary surge is driven by a range of dynamics; however, a principal impetus is the potential for small operations to shape heterogeneous outcomes beyond generating energy [44,45]. Currently, SHP development is anchored firmly within the carbon mitigation strategies of national governments, and represents a central component of the United Nations Clean Development Mechanism (CDM) movement [10,46–49]. Furthermore, many governments promote SHP as a strategy to raise socioeconomic indicators in poor, rural, often isolated communities [50–53]. In comparison to the body of research analyzing large hydropower in China [54–56], SHP is by comparison underrepresented.

SHP plays a significant role in China's hydropower landscape, representing a total exploitable potential of 120 GW [57]. In 2014, 73.22 GW of China's installed hydroelectric capacity came from SHP [57], and installed capacity is projected to reach 75 GW by 2020, 93 GW by 2030 and 100 GW by 2050 [58]. While there is no globally agreed upon definition of what constitutes small, there is a growing consensus SHP is designated as systems with a generating capacity between 1–10 Megawatts (MW). In China, however, SHP is classified as hydroelectric installations with a capacity between 2 and 50 MW. Consequently, hydropower designated small in China, is likely considered medium or even large in other parts of the world.

1.2. Socioeconomic development and rural electrification in China

Socioeconomics is understood by identifying and measuring how individuals or communities either prosper and progress, regress, or remain steady due to economic influences at a range of scales (see for example [59–62]). Determination of the socioeconomic status of individuals or families is commonly assessed by measuring three key indicators; occupation, income and education [63]. While additional factors such as housing, gender equality and safety, human, food and water security, mental and physical health can also be evaluated to develop a more holistic determination [63], the three key indicators were determined as the most appropriate means to assess changes in the quality of life for residents of ethnic minority communities living in proximity to SHP operations.

Socioeconomic indicators are frequently measured to assess particular outcomes regarding quality of life conditions. For the purposes of this study, I categorized outcomes into three key modes; direct, indirect and causal. Direct socioeconomic outcomes are those which are a direct result of electrical provision, for example, utilizing electricity to establish businesses that generate income. Indirect outcomes are those which are a result of SHP development more broadly that enhance socioeconomic indicators in measurable ways, for example, tax revenues generated from SHP facilities which flow back to local residents. Finally, causal outcomes are defined as those which are unintended, and tangentially related to SHP development. An example of a causal outcome is accompanying infrastructure developed to facilitate a SHP installation that local residents have found ways to benefit from. In order to understand the distribution of benefits and marginalizing effects of SHP generated electricity, it was necessary to undertake ethnographic research that measured all three key socioeconomic indicators.

Since the birth of the People's Republic, various governmental agencies across China have undertaken a series of rural electrification