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Micro-hydropower impact on communities' livelihood analysed with the capability approach

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ABSTRACT

Isolated developing communities in mountain ranges can generate electricity with the help of micro-hydropower schemes. The arrival of electricity to communities can bring numerous socio-economic benefits as well as improved livelihood, but there is a lack of international studies on livelihood improvements brought by the implementation of micro-hydropower schemes. This study aims to identify the most significant livelihood improvements associated with the implementation of micro-hydropower schemes and highlighted the capacities communities have to make an effective use of such improvements. The analysis is based on the evaluation of 17 communities from Bolivia and the Philippines. Visits to communities, engagement with local developers and community interviews were used to evaluate 22 livelihood indicators from five broad categories: health, education, safety, community engagement and economy. The capability approach was used as a framework to identify the most common livelihood improvements. Results show significant improvements in all aspects, especially in education, community engagement and economy. Improved lighting is identified as the most influential factor across the five aspects, but developing organizations implementation techniques and electricity usage differ between countries. Women appear to benefit more from drudgery reduction and men from community engagement opportunities. In conclusion, livelihood improvements were clearly observed and these might have a positive impact in the future sustainability of schemes.

Introduction

Access to electricity is one of the cornerstones of human development (UNDP, 2001). The lack of access to electricity in remote areas in developing countries has been identified as a key factor that jeopardizes progress towards better livelihoods (Gurung, Bryceson, & Oh, 2010). The electrification of households can produce improvements in health, safety and education. It can also promote the creation of small enterprises or boost the production and efficiency of existing ones, reduce drudgery, lower the cost of lighting and other energy services and provide higher levels of comfort to its beneficiaries (Bastakoti, 2006). Electricity is, thus, a means towards achieving economic growth, social progress and increased human well-being.

Micro-hydropower (MHP) schemes can produce electricity for isolated communities which are not connected to national electricity networks. The implementation of a MHP project is a cost-effective solution that has less environmental impact than traditional fossil fuel generators (Huang, Chang, Hwang, & Ma, 2014; Mainali & Silveira, 2013). MHP brings improvements in livelihoods which are often more significant than community and household economic development (Murni, Whale, Urmee, Davis, & Harries, 2013). Measuring livelihood improvements, however, presents multiple challenges, particularly for remote communities of developing countries where material assets may be less important than cultural or social dynamics.

Two developing countries where remote communities can benefit from MHP are Bolivia and the Philippines. Both countries have good hydrologic resources and steep mountain ranges and this has allowed for the construction of over a hundred MHP schemes in each country since the mid 1990's. The socio-economic characteristics of remote communities in these countries, where basic food and education needs are generally covered, have made the arrival of electricity a necessary step towards development.

The objective of this study is to outline the most common livelihood improvements afforded by MHP schemes in Bolivia and the Philippines. The capability approach (Sen, 1993) is used in this study to quantify the livelihood improvements that schemes bring to communities.

Methods

To evaluate the social impact of MHP schemes on communities, 17 remote communities from Bolivia and the Philippines were studied

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during 2015 and 2016. Data was collected throughout a study of 35 schemes between Nepal, Bolivia, Cambodia and the Philippines (Arnaiz, Cochrane, Calizaya, & Mahabharat, 2018). These schemes represented a range of active and non-functioning schemes implemented by local developers in each country. Local developers were contacted to obtain key information on scheme and community characteristics. Schemes varied in years of operation, households serviced by MHP, regions, and power generation (Table 1). Subsistence agriculture was their main activity and all communities visited appeared to be around the poverty threshold (WorldBank, 2017).

Interviews on scheme implementation and community livelihood were carried out during the site visits (Table 2). Participants had to be adults, residents of the community, and users of the electricity generated by the scheme. Interviews were held casually and individually (avoiding social desirability biasing).

Scheme implementation interviews were carried out in the nine communities in Bolivia. Individual interviews provided qualitative information on the community's response and engagement during the phases prior, during, and post implementation of the scheme. Information was recorded on the social effects, barriers, issues and limitations of the implementation process of schemes.

Interviews on community livelihood, defined here as the combination of the individual well-being of the members of the community, were carried out in all 17 communities in Bolivia and the Philippines. The interviews allowed for additional qualitative comments that helped understand the rationale behind the answers. Interviewees were further asked to rate five basic aspects of their life: health and diet, safety, education, community engagement and leisure, and economy (named 'livelihood sub-set perceived importance' in this study). Measuring well-being is a complex task, thus, this study used the capability approach (Robeyns, 2005), as a method to measure well-being by evaluating the well-ness of the person's state of being, or, how much a person is succeeding in 'doing' or being' (Sen, 1993). The measure of what a person is capable of being (happy, healthy, educated) or doing (work, study, learn) are called 'functionings' and they "represents the diverse aspects of life that people value" (Alkire, 2005). The capability set of an individual are the functionings that the individual has actual access to. Achieved functionings are those functionings that individuals choose make use of. Individual semi-structured interviews on 22 livelihood indicators (i.e., functionings and achieved functionings) revealed which things the community could do or be as a direct result of MHP.

Results and discussion

The 'Scheme implementation' interviews in Bolivia revealed key information on engagement with MHP:

i. Developers initiate community-scheme engagement by giving a series of workshops to the community, explaining the benefits of the technology, familiarizing the community with the physical principles of MHP generation, and preparing them for the construction and maintenance of the scheme. During the preliminary workshops, 90% of the people said they had an active participation, and 93% said that they enjoyed such meetings. When asked if they enjoyed learning about the technology, 89% answered positively, and 85% said they'd like to learn more.
ii. When the construction process starts, the community is asked to participate with the acquisition of materials and construction of the civil works. 78% of the interviewed people in Bolivia participated in building the scheme, with 90% enjoying the process.
iii. After the construction of the scheme, operators are chosen to conduct regular maintenance and community members are asked to contribute to major repairs. 63% affirmed having participated with the repairs of the scheme during the life of the scheme.

Table 1
Synopsis of the micro-hydro schemes studied in Bolivia and the Philippines.

Scheme	Years Operating	Household number	Region	Power (kW)
Bol.1	7	25	Andean	6
Bol.2	2	14	Andean	8
Bol.3(nf)	8	80	Sub-Andean	100
Bol.4(nf)	14	30	Sub-Andean	16
Bol.5(nf)	12	40	Sub-Andean	8
Bol.6(nf)	6	120	Sub-Andean	38
Bol.7(nf)	11	180	Llanos	40
Bol.8	1	60	Sub-Andean	35
Bol.9	7	313	Sub-Andean	100
Phi.1	7	58	Cordillera	15
Phi.2	9	14	Cordillera	5
Phi.3	14	43	Cordillera	6
Phi.4	16	52	Cordillera	7
Phi.5(nf)	6	100	Negros Island	32
Phi.6(nf)	5	30	Negros Island	5
Phi.7	8	200	Negros Island	32
Phi.8	8	150	Negros Island	32

(nf) – MHP scheme not functioning.

The arrival of a MHP schemes generates in the community a sense of empowerment, offers an opportunity to work together, and fosters communal problem solving and decision making.

When questioned on 'overall well-being contribution', 68% of interviewees responded that electricity contributed to general comfort, a fact mainly explained by the improved lighting. However, electricity was seldom reported to extend free time (32%), as interviewees reported working longer hours at night and spending too much time watching TV. Only 30% responded that electricity helped towards doing their chores more effortlessly, with only a few reporting that cooking and house cleaning duties could be done easier.

The percentage of positive responses to semi-structured household interview done in Bolivia and the Philippines for the 22 indicators of the 'Community livelihood' were varied (Fig. 1).

Some of the benefits brought by the implementation of MHP schemes are directly related to the utilization of electricity, and thus, other energy sources could provide similar benefits. However, when and how this energy is generated has different impacts on the community.

The only two other common sources of energy that communities have access to are solar photovoltaic (with no large battery systems due to high cost) and diesel generators. Communities make most use of electricity early in the morning and late at night, when men and children wake up and come back from work or school. Multiple livelihood improvements are exclusive to the use of energy at night time, making MHP significantly more convenient that solar generation. Additionally, other livelihood improvements such as the creation of jobs for the operation and maintenance of the scheme or the creation of the MHP committee and the opportunities for socialization through the community meetings are unique to MHP schemes.

Health & diet

Only three communities, all in Bolivia (27%), reported having an improved health post facility as a direct consequence of the MHP scheme, which allowed refrigerated medicines and a place for outside doctors to come and do workshops on health practices, nursing, disease treatment and vaccinations.