Community-Based Micro-Hydro Development in Northern India – Benefits Beyond Lighting?

by

Gurmeet Singh Ghera

A Thesis submitted to the Faculty of Graduate Studies of

The University of Manitoba

in partial fulfillment of the requirements for the degree of

MASTER OF NATURAL RESOURCES MANAGEMENT

Clayton H. Riddell Faculty of Environment, Earth, and Resources

Natural Resources Institute

University of Manitoba
Winnipeg

Abstract

The purpose of this research was to find out how local communities in the Himalayan region of India are benefiting when given the responsibility of managing village-based micro-hydro projects. In this research, a total of 7 cases were studied where the local communities were involved in management and other phases of micro hydro development. Data were collected using interviews with local community members, government officials, NGO officials and local experts in the micro-hydro sector. Results were categorized under social, economic, health and environmental factors.

Results show that, although limited, these projects do produce local benefits. Electricity stays within the village, and villagers, especially children, women and the elderly, are benefited in various aspects of life. Although some local employment is generated and environmental considerations related to river flow are observed, these projects often run into financial difficulties, and with no financial backup the possibility of permanent project shutdown is always present.

Acknowledgments

I take this opportunity to thank all the participants, organizations, friends and academicians. Without their help and guidance this thesis would not have been possible.

I am thankful to my advisor, Dr. John Sinclair for giving me the opportunity to undertake this research and for his continuous support, positive and encouraging attitude. I also thank him for his financial support during my entire study. I also thank my committee members Dr. Kirit Patel and Dr. Alan Diduck for their time to time guidance. My thesis has greatly improved by your review and input.

I am thankful to the people of Bartoo, Yarkashing, Yangthang, Ramgaad, Lamabagar, Toli and Malari for their friendly behavior and participation during my data collection. I also thank all the officials of various government and non-government organizations that provided me with relevant information.

I thank my parents for their continuous support and blessings and the logistical help they provided during my fieldwork. Thanks to my sisters, Princy and Manisha for making my stay at Leh comfortable and the continuous moral support. I thank my friends at the Natural Resources Institute for their help and input. I also thank the administrative staff at Natural Resources Institute for their help throughout the program.

Table of Contents

List of Tables

List of Figures

List of Abbreviations

AHEC	Alternate Hydro Energy Centre
CBNRM	Community-Based Natural Resource Management
DPR	Detailed Project Report
EA	Environmental Assessment
EMC	Electricity Management Committee
GW	Gigawatt
HIMURJA	Himachal Pradesh Energy Development Agency
HP	Himachal Pradesh
IIT	Indian Institute of Technology
J&K	Jammu and Kashmir
JE	Junior Engineer
JKEDA	Jammu and Kashmir Energy Development Authority
KREDA	Kargil Renewable Energy Development Agency
kW	Kilowatt
LAHDC	Ladakh Autonomous Hill Development Council
LCA	Life Cycle Assessment
LEDeG	Ladakh Ecological Development Group
LPG	Liquefied Petroleum Gas
LREDA	Ladakh Renewable Energy Development Agency
LREI	Ladakh Renewable Energy Initiative
MNRE	Ministry of New and Renewable Energy
MoEF	Ministry of Environment and Forests

MW	Megawatt
NCEF	National Clean Energy Fund
NEDA	Non-Conventional Energy Development Authority
NGO	Non-Governmental Organization
NITI	National Institute for Transforming India
NOC	No Objection Certificate
PRI	Panchayati Raj Institution
PSI	People’s Science Institute
Rs.	Indian Rupee
SDGs	Sustainable Development Goals
SPV	Special Purpose Vehicle
SPWD	Society for Promotion of Wastelands Development
T&D	Transmission and Distribution
TERI	The Energy and Resources Institute
UJVNL	Uttarakhand Jal Vidyut Nigam Limited
UK	Uttarakhand
UNDP	United Nations Development Fund
UPCL	Uttarakhand Power Corporation Limited
UREDA	Uttarakhand Renewable Energy Development Agency

Chapter 1 - Introduction

The Indian Himalaya are the source of many rivers and rivulets that can, and already do, contribute immensely to the production of hydroelectric power (Dutt et al., 2015). Conventional, large hydro dams that run on the principle of impounding river water in a reservoir to produce electricity often have severe social, economic, environmental and other consequences (Vancleef, 2016; Friedl & Wuest, 2002; Baxter, 1977). Off-grid, community-based micro-hydro projects are based on the run-of-the-river principle, in which some portion of river water is diverted for rotating a turbine with the water then being directed back to the river without the construction of a dam. These micro-hydro projects can be a sustainable alternative to big impoundment-type hydro projects while offering other community benefits. Unfortunately, most micro-hydro projects in the Indian Himalaya appear to be undertaken by private sector developers, with generated power being wheeled out of local communities and directed beyond the boundaries of local users (Sinclair, Diduck, & McCandless, 2015).

However, a study of a community-based micro-hydro power project in Malari village in the state of Uttarakhand in India, confirms "how effective and equitable micro-hydro projects can be when they are community-led, when there is sufficient community capacity to support such an initiative, and when the socioeconomic circumstances are suitable" (Sinclair, Diduck, & McCandless, 2015, p. 373). In community-based projects, local residents can reap the benefits of the projects through job creation, availability of electricity and a sense of local pride, among other benefits (Sinclair, Diduck, & McCandless, 2015). Such projects can also help with income generation and in reducing the use of wood as a fuel, thus reducing impacts on the mountain ecosystem (Koirala, 2007). The literature on community-based micro hydro, however, is very limited, as this is still an emerging area in the realm of sustainable development. Further, many of the perceived benefits to the community and broader sustainability are yet to be confirmed.

1.1 Purpose Statement and Objectives

The purpose of my research was to understand the sustainability benefits of community-based[1] micro-hydro power projects for local communities in the Himalayan region of India. I have considered sustainability from environmental, social, economic and health perspectives. In order to fulfill this purpose, the objectives set were to:

1. Examine the role of community members in the planning, construction and implementation of community-based micro hydro;
2. Understand the ways that any negative impacts of development and operation are minimized, while positive impacts amplified;
3. Document the ways that these projects have produced sustainability benefits to individuals and communities as a whole; and
4. Explore how communities and associated government agencies are sharing their learning about community-based micro hydro.

1.2 Research Approach

Considering the overall nature of my study and the knowledge I have gained from class lectures, utilizing a qualitative research approach was the most suitable for satisfying the

---

[1] For the purpose of this research the terms community-based, community-managed and community-led are considered synonymous. They all imply the participation of the local villagers at one or multiple stages of the project.

objectives and accomplishing the purpose of my research. I used a case study strategy of inquiry and focused on cases of community-based micro hydro in the Western Himalayan region of India, and collected data through individual interviews, observation and focus groups. In a patriarchal society such as India, this research approach helped me to better understand the benefits of micro-hydro facilities on all segments of society, including women and youth. Using qualitative research methods was also more engaging and helped people feel comfortable in expressing their thoughts and understandings, as the approach is more personal in nature. Moreover, a qualitative approach fits this research as it was conducted in a natural setting and occurred without any alteration to the area of study (Creswell, 2007). The detailed outline of my approach is provided in Chapter 3.

1.3 Contributions of the work

As "public involvement is considered pivotal in natural resource and environmental management" (Diduck, Sinclair, Hostetler, & Fitzpatrick, 2012, p. 1315), this research adds to the growing body of literature considering how community-based approaches (i.e., those that are highly participatory and interactive with local communities) to undertaking micro hydro help in managing natural resources and the environment in a sustainable manner. Thus, this research contributes to understanding the implications of community-based micro-hydro projects. Certainly, the research outcomes also help in better understanding community-based approaches to development in rural and remote parts of India that are in transition, and in particular provide us with a sense of the true sustainability outcomes of micro hydro and under what conditions these are most likely to occur. The findings help to confirm some of the sustainability benefits that are promoted for community-based micro hydro. The findings also help in understanding why some of the anticipated benefits have not been achieved.

1.4 Organization of the Thesis

My thesis consists of six chapters. Following this introductory chapter, chapter two considers the literature related to various topics associated with the thesis, such as the development of small hydro and community-based micro hydro in the Himalayan region and its environmental and social consequences. Chapter three outlines my case study strategy, including how I selected the cases, the region of each case, data collection methods and the processes used for analyzing the data. In chapter four, a detailed description of the area of study and the history of micro hydro in that region are discussed, as well as presenting an outline of the cases chosen. Chapter five gives a detailed description of the findings regarding the involvement of the communities in micro-hydro projects and the benefits of these local projects. It reflects on the benefits that individuals and communities as a whole have observed due to the instillation of these projects and how negative impacts have been abated. Chapter six provides the conclusions of the research as well as recommendations based on the research findings.

Chapter 2 – Sustainability and Micro Hydro Development in India

2.1 Introduction

“Faster, More Inclusive and Sustainable Growth” is the broad vision and aspiration of the 12th five-year plan of India (Planning Commission, 2011). In recent years, the pursuit of sustainable development has become an integral part of central as well as regional planning in India: “Growth and development have to be guided by the compulsion of sustainability, because none of us has the luxury, any longer, of ignoring the economic as well as the environmental threat, that a fast-deteriorating ecosystem poses to our fragile planet” (Government of India, 2013, p.112). The Government of India has accepted all of the 17 Sustainable Development Goals (SDGs) proposed by the United Nations, and has nominated the National Institute for Transforming India (NITI) Aayog as a nodal agency that will bring the 17 SDGs into action across India (NITI Aayog, 2019). India’s sustainability initiative includes: environmental or green taxes for the reduction and optimum utilization of products that damage the environment; sustainable business models with eco-efficiency as their guiding principle; a National Clean Energy Fund (NCEF) that supports projects and policies that promote clean energy technologies; and public, environmental NGO and stakeholder participation through platforms such as Joint Forest Management and Waste Minimization Circles (Planning Commission, 2011).

India’s long-term energy policies and production place emphasis on a shift to renewable energy. Adopting a sustainable development pathway by shifting to environmentally friendly technologies, renewable energy is also the most efficient way to tackle climate change and achieve global greenhouse gas emission reduction commitments (Sathaye, Shukla, & Ravindranath, 2006). India aims to achieve about 40% installed electric capacity from non-fossil-fuel energy sources and reduce the greenhouse gas emission intensity by 33-35% from 2005 levels by the year 2030 (Natural Resources Defense Council, 2017). The Ministry of New and Renewable Energy has implemented various programs related to wind power, biomass power, small hydro and solar power. The National Solar Mission aims to generate 100 gigawatts (GW) of grid-connected solar power by the year 2022 (Ministry of New and Renewable Energy, n.d.; NITI Aayog, 2015). The electricity produced by wind energy is anticipated to be 40 GW by 2019 (NITI Aayog, 2015) and by small hydropower is estimated to be about 20 GW, mostly concentrated in the Himalayan States as river-based projects (Ministry of New and Renewable Energy, n.d.). The Government of India is also targeting complete rural electrification through Deen Dayal Upadhyaya Gram Jyoti Yojana. This scheme, under the Ministry of Power, aims to provide continuous power supply to rural India.

The Indian Himalaya spread from Jammu & Kashmir in the west to Arunachal Pradesh in the east. These are young, fold mountains and hold immense sustainability values in relation to their floral, faunal, ecological as well as aesthetic and hydropower potential (Agrawal, Lodhi, & Panwar, 2010). The Indian Himalayas hold more than 75% of India's estimated 148,700 megawatts (MW) of hydro potential (Agrawal, Lodhi, & Panwar, 2010), which is viewed as a clean and sustainable energy resource for the country. The first small-hydro project in India, of 130 kilowatt (kW) capacity, was set up in the hills of Darjeeling in the state of West Bengal in 1897 (Saxena, 2007). Following this, a number of small-hydro projects were developed in the hilly areas of the country. After independence, various governments placed priority on developing large-scale power generation through big embankment-type hydro dams and thermal power plants (Saxena, 2007). With the recognition of the negative impacts of large dams on sustainability, difficulty in getting them built and the overall focus on exploiting a renewable source of energy, the development of small hydro began. In the 1990’s a comprehensive programme for the exploitation of hydro power in a renewable fashion was designed (Saxena, 2007). The Government of India (GOI) has promoted the harnessing of this potential via private investments in the form of small, micro and mini hydro (Diduck & Sinclair, 2016).

Energy generation is required for nearly all human and economic activities and it plays an important role in the social and economic development of developing nations (Nautiyal, Singal, & Sharma, 2011). However, rapid and unplanned energy generation often leads to environmental degradation and increased pollution. Conventional energy generation by fossil fuels and large hydro dams increases economic and social prosperity in the short term, but renewable energy sources are the most viable solution to long-term development and prosperity. The sustainability of humans is directly proportional to the sustainable exploitation of water resources such as these (Nautiyal, Singal, Varun, & Sharma, 2011).

In India, tapping into renewable energy has assumed great importance in recent years, and although wind and solar power have been the major contributors to renewable energy, small hydro has also been growing at a steady pace (Bhattacharya & Jana, 2009). In the Himalayan region, which is home to perennial flowing rivers and streams, small hydro is getting a boost as the government intensifies its effort to electrify remote, hilly areas (Bhattacharya & Jana, 2009). The state governments of Himachal Pradesh (HP) and Uttarakhand (UK) are also encouraging hydro projects of varying capacity, from small to large (Diduck & Sinclair, 2016). It is often not feasible to connect the remote villages in this region to the electric grid system, and as such small-hydro power is a viable alternative. Many remote villages also have watercourses flowing nearby, which can be used to generate electricity for the community members. These projects can generate income and encourage productive activities based on the use of electricity (Bhattacharya & Jana, 2009).

2.2 Small Hydro

Paish (2002, p.1) notes that "Hydropower on a small-scale is one of the most cost-effective energy technologies to be considered for rural electrification in less developed countries". The definition of small hydro varies throughout the world. In the Indian context, small-hydro projects are ones with a maximum generating capacity of 25 MW. Small hydro can be further divided into mini hydro, with capacity in the range of 101–2000 kW, and micro hydro, having a station capacity not exceeding 100 kW (Ministry of New and Renewable Energy, n.d.). Small-scale hydro is generally based on the run-of-the-river principle, meaning the electricity is produced by rotating a turbine with the free-flowing water available, without storing it permanently. A small (or in some cases large) portion of the flowing river water is diverted through a canal or weir. The river water is then passed through a forebay or settling tank (Figure 1). The speed of the water is considerably reduced in the forebay, which allows the suspended particles to settle down. Moreover, a metal sieve further prevents the lighter debris such as wood and leaves to go any further. After filtering, the water goes to the turbine via a penstock (Figure 2), which is generally an open or closed metal or concrete pipe. In rough terrain, such as in the mountains, sometimes the location of the forebay and the turbine can be far apart, thus increasing the cost of the project. After passing through the turbine, the water is directed back to the river. The 'head' of the project is the height from which the water falls to rotate the turbine. Electricity production is proportional to the head and the volume of the flow.

Figure 1: Settling Tank (Source: Gurmeet Singh Ghera)

Figure 2: Penstock (Source: Gurmeet Singh Ghera)

As noted above, micro-hydro projects are generally based on the run-of-the-river principle, which is considered to be more sustainable as compared to reservoir-based hydroelectric power stations. Their ecological footprint per MW is considerably less than their storage-based counterparts (Kumar & Katoch, 2014). Many researchers advocate the benefits of run-of-the-river projects over dams that require water storage in large forebays and reservoirs. Compared to other hydro developments, these run-of-the-river small projects do not flood areas (only a small concrete/steel forebay), interfere less with migration of fauna (e.g., fish), are less prone to sedimentation, do not displace communities and typically cost less to construct and operate (Kumar & Katoch, 2014). Moreover, due to the proximity of power generation and distribution areas, there are fewer transmission and distribution (T&D) losses, which losses account for approximately 23% of the total electricity generated in India (Doraisamy & Pai, 2016). Some studies by independent agencies like The Energy and Resources Institute (TERI) show that T & D losses can be as high as a staggering 50% of the total production in some areas (Doraisamy & Pai, 2016).

2.3 Effects of Small Private Hydro

Although the development of small hydropower has many benefits as outlined above (e.g., no reservoir required, cost-effective energy solution, power for rural and remote areas and reliable electricity source), the majority of small hydropower projects have also generated negative effects at the local level (Baker, 2014). For example, disruption of local irrigation systems, water-powered mills and fishery-based livelihoods have all been observed in the state of HP (Baker, 2014). Employment generation, which is perceived as one of the most important benefits of small hydropower projects, has not been achieved (Baker, 2014; Sinclair 2003). A case study of the Kothi 200 kW micro-hydro project in HP revealed that only a few people recognized the potential for new businesses in their community and the level of power supply was inadequate for small industries such as a sawmill (Sinclair, 2003). In Himachal, the community-managed gravity flow irrigation systems (khuls), water-powered mills (gharats) and home garden irrigation have been affected negatively by the diversion of water for small-hydro projects, despite the protection guaranteed to the villagers (Baker, 2014). Private investors in these projects have failed to acknowledge the problems and compensate villagers for their losses. These effects have sparked bitterness in local communities towards small hydro and projected the impression that government and developers are earning a profit at the expense of local ecology and livelihoods (Kumar & Katoch, 2015; Sinclair, 2003). Tanks are desilted by flushing the accumulated silt back into the source stream, which causes a surge of sediments that negatively affects the water quality and fisheries downstream (Baker, 2014). A cascade of these effects can also create adverse cumulative impacts downstream, especially when there is more than one project on a nalla (stream/rivulet), which is now not uncommon (Premalatha, Abbasi, & Abbasi, 2014).

In India, an environmental assessment (EA) is required by the Ministry of Environment and Forests (MoEF) for hydro projects greater than 50 MW in capacity. A screening is done to see whether EA is required for projects between 25 and 50 MW, and no formal EA is required for projects that are under 25 MW (Erlewein, 2013). The state governments are responsible to fill in this regulatory gap in relation to small projects. According to Diduck & Sinclair (2016, p.1), "this legal exemption for small hydro has left an important gap in India's EA regime". For instance, the state of HP requires project developers to leave a minimum of 15% constant water flow in the river based on minimum lean-season flow, but compliance with this law is poor (Erlewein, 2013). Thus, as noted by Diduck & Sinclair (2016, p. 1), "improved project-level assessment, catchment-based cumulative effects assessments and better local involvement are needed for small hydro development". Detailed project reports (DPR) prepared by proponents promote such projects on the environmental and economic benefits they would create, but often no benefits are actually realized (Diduck & Sinclair, 2016).

Uncompensated deaths from construction-related accidents and ignoring obligations and commitments made to local communities are common (Baker, 2014). Many developers also do not abide by the labour laws and exclude employees from the benefits and security of regular employment, with workers often being treated as a disposable labour force (Baker, 2014). Most of the employment can also go to external labour that is generally cheap, as noted in the case of the Kothi micro hydro in HP where all jobs went to Nepalese workers as they were considered cheap labour and as having fewer needs (Sinclair, 2003). Taking these consequences into account and documenting them through life cycle assessments (LCAs) leads some critics of small hydropower to argue that, per unit of power generation, small hydropower can be as harmful to the environment and social life as large-scale hydro developments (Premalatha, Abbasi, & Abbasi, 2014).

Local communities have responded to these problems in various ways and at different scales. In most cases, the first course of action is petitioning to the district and state-level administrative officers, along with the project developers themselves (Baker, 2014). Some communities have tried to get justice through the courts when this initial appeal is not heard. In other cases, considering the negative effects of small-hydro development, and the community opposition to it, the village-level governments (Panchayat) refuse to grant a No Objection Certificate (NOC) to the developers. Strikes, public demonstrations, halting project development and threats of physical damage are some of the other measures taken by the public to compel developers to abide by the appropriate policies and procedures (Baker, 2014).

2.4 Sustainability Considerations for Micro Hydro

Despite the existing legal provisions, “all hydropower projects whether mega, large or small should be weighed for sustainability at the time of planning inception,” because “without proper sustainability considerations, the project may face many problems during its construction or/and operational phase(s)” (Kumar & Katoch, 2014, p. 101). In the hydro-rich regions of India, run-of-the-river hydro projects are being undertaken on a large scale (Diduck & Sinclair, 2016; Kumar & Katoch, 2014), and thus a sustainability assessment based on relevant sustainability indicators should be incorporated into the development process. Sustainability is often addressed by considering the social, economic and environmental dimensions of a project (Hansmann, Mieg, & Frischknecht, 2012), with health and cultural impacts often also being included as they form what has been referred to as the ‘five pillars’ of sustainability-based impact assessment (Canadian Environmental Assessment Agency, 2017). These five pillars are conceptually interrelated and often impact each other when examined in actual practice.

The social dimension of sustainability is related to the life of the local communities. It can be addressed in a number of ways, such as considering the local acceptance of a project, equity in compensation and being included in project benefits (Kumar & Katoch, 2014; Kumar & Katoch, 2015). Positive change in the status of women, women’s organisations and other vulnerable sections of the society can also contribute to social sustainability. Having electricity can also have psychological effects on remote villagers, such as increased confidence and not feeling confined by darkness (Diduck & Sinclair, 2016). Long-term effects on the social conditions of the community is also one of the parameters used to measure social sustainability.

Social sustainability has gained considerable importance in recent times as a component of overall sustainability, and is thus vital to assess (Carrera & Mack, 2010).

Cultural sustainability also falls under the umbrella of social sustainability. The indicators for cultural and social sustainability are intertwined and it is often hard to separate one from the other. Changes in cultural pursuits and lifestyles of local communities, aesthetic changes and easy access to sacred sites are part of the cultural indicators of sustainability. For instance, the residents of the whole Kullu Valley in HP became concerned with the effects that a 1 MW hydro station might have on two temples to the Goddess Jogini and a waterfall named in her honour (Diduck & Sinclair, 2016). According to some, the area around the falls and associated region are sacred land and should not be disturbed in any way (Diduck & Sinclair, 2016).

Environmental sustainability can be addressed through considering parameters such as the land area required, construction, including the development of access roads, and other associated impacts that could include harming downstream fisheries, deforestation, increased landslide potential and negative effects from improper debris disposal (Goodland, 1994; Sarkar & Karagoz, 1995; Kumar & Katoch, 2014). Afforestation after the construction of projects and ensuring adequate flow in the stream is maintained are examples of long-term environmental benefits, which if not addressed would result in long-term environmental harm (Kumar & Katoch, 2014). Change in the quality of water is part of both environmental and health impacts.

Economic sustainability parameters include: appropriate compensation for any resettlement and rehabilitation costs for project-affected people; impacts on tourism revenue, commerce and industry; new job creation; and any changes in economic activities due to the project (Goodland, 1994; Kumar & Katoch, 2015; Vera & Langlois, 2007). Impacts on horticulture and damage to orchards (Figure 3) during blasting and construction stages, nonpayment of compensation, and local communities unable to afford the electricity are examples of negative economic indicators (Kumar & Katoch, 2014). As Diduck & Sinclair (2016, p. 15) noted in India's HP "A horticulturist from Goshal village expressed concerns over the cumulative effects of hydro projects and other industrial activity in the Kullu Valley: 'Agricultural practices now are not sustainable, apples have too many diseases, pollinators are all dead due to pesticide usage, ecosystem unbalances, but before paddy production maintained a fine balance but with nallas diverted this balance [between nature and agriculture] cannot be achieved again'."

Figure 3 – Damage to Apple Trees Due to Blasting (Source: Kumar & Katoch, 2014, p. 227)

Indoor air pollution due to the use of coal, biomass and wood for cooking and heat is a major health issue in developing countries (Bruce, Perez, & Albalak, 2000). These materials are burnt in simple stoves with incomplete combustion, and as a result, people are exposed to high levels of indoor pollution, especially women and children. The availability of hydro power can reduce this pollution and thus have major health benefits for a village residents. Electricity from micro hydro can also reduce the consumption of wood in winters for warmth and can help reduce the intensity of cold weather related problems/diseases. However, noise pollution and disturbance from the sound of the hydro power plant can negatively affect sustainability from a health perspective, especially during construction.

2.5 Community-Based Natural Resource Management and Community Approaches to Development

Community-Based Natural Resource Management (CBNRM) is an approach that seeks to encourage the participation of local communities and resource users in decision making, management, regulation and enforcement processes for better resource management and sustainability outcomes (Armitage, 2005). CBNRM aims at: devolving power to local and indigenous institutions, the inclusion of traditional knowledge and values in resource management, and reconciliation of socio-economic development and environmental conservation goals (Kellert, Mehta, Ebbin, & Lichtenfeld, 2000). It is a response to the present widespread resource management paradigm of top-down decisions involving technical expertise, Western science and bureaucratic centralization (Armitage, 2005).

Community-based development actively includes the local beneficiaries in designing and managing projects (Mansuri & Rao, 2004), and the control of decisions and resources is largely devolved to the community. Communities often work in partnership with government agencies and other organizations, such as NGO's and private companies (Dongier et al., 2003). Social and economic development activities and the management of natural resources driven by communities can help ensure the allocation of funding and income is done in a manner that is more appropriate to the needs of the local people. It makes development more inclusive, builds social capital, strengthens governance and empowers the community (Mansuri & Rao, 2004).

In developing countries like India, the adaptive capacity of communities, especially rural ones, is low (Sathaye, Shukla, & Ravindranath, 2006). CBNRM, including in development projects, is one way to enhance the adaptive capacity of such communities (Armitage, 2005), and enhancing adaptive capacity can be regarded a component of sustainable development (Noble et.al, 2014). Community-managed development usually results in more productive employment generation and the building of more useful infrastructure. For example, Dongier et al. (2003, p. 306) note that

> Studies of community-organized irrigation systems in Asia, for example, have repeatedly found that systems constructed and operated by the farmers themselves, often without much external assistance, generate a higher level of agricultural productivity than more modern systems constructed by government agencies with substantial external assistance.

Water also often has strong cultural and spiritual significance that is closely related to local practices, and as a result the involvement of communities in water management is essential (Bakker, 2007). Moreover, the people who are most deeply impacted by any disturbance to the water resource are the local community. Thus, community-based approaches to the development and management of projects like micro hydro can lead to optimal utilization of the water resource through a collective environmental and cultural ethic of solidarity, which will encourage users to refrain from wasteful behavior (Bakker, 2007).

CBNRM also places emphasis on local public participation in planning and decision making. According to Diduck & Sinclair (2016, p. 4),

> Among its many advantages, public participation can improve planning, assessment, and mitigation by bringing to light important local knowledge and values. It can also

> ameliorate local concerns over potential adverse impacts, identify opportunities to optimize benefits, and increase the legitimacy of approval and decision processes.

Effective public participation can foster a sense of empowerment and promote capacity building (Gibson, Doelle, & Sinclair, 2015). Public participation at early stages of the project can overcome the possibility of later conflicts between people and the proponent, and ensures that community needs are taken care of (Doelle & Sinclair, 2006).

Findings of a comparative study of two small-hydro projects in the Himalayan region show that the project where the local community was involved in all stages of project development was very successful (Sinclair, Diduck, & McCandless, 2015). The two projects in the villages of Solang and Malari, in the states of HP and UK respectively, show contrasting results. The Solang project was developed by a private investor with no public consultation, whereas the Malari project was developed following a community-based approach (Sinclair, Diduck, & McCandless, 2015). Solang diverted all of its power to the electrical grid and the villagers were negligibly benefited by the new project. In contrast, the Malari project resulted in improved water supply for domestic and agricultural use, provision of electricity, which it did not have before, and local employment during construction and afterward for running the power house (Sinclair, Diduck, & McCandless, 2015).

2.6 Learning

Instrumental, communicative and transformative are the 3 domains of adult learning as defined by Mezirow (1991), although there is still not a consensus in the literature regarding whether transformative learning is a separate domain or just a result of meaningful instrumental and communicative learning (Diduck et al 2012; Moyer et al 2014). Learning new skills and gaining knowledge constitute instrumental learning, communicative learning consists of understanding others and building trust (Moyer, Sinclair, & Diduck, 2014), while transformative learning constitutes “a holistic and enduring change in how a person effectively experiences and conceptually frames his or her experience of the world in order to apply new actions in life contexts that are personally developmental, socially controversial, or require personal or social healing” (Kasl & Yorks, 2012, p. 509). Transformative learning theory aims to comprehensively explain adult learning.

Instrumental learning deals with carrying out tasks, sometimes modifying the surroundings and predicting the outcomes (Mezirow, 1991). Instrumental learning focuses on increasing work efficiency and performance output (Mezirow, 1998). An increase in factual knowledge and skills are common outcomes of instrumental learning. Mezirow (2003, p. 59) describes instrumental learning as being about “ controlling and manipulating the environment, with emphasis on improving prediction and performance,” which centers on “assessing truth claims that something is as it is purported to be”. The information and skills learned are obtained through logical-deductive means.

Communicative learning, as the name suggests, involves learning through communicating ideas, beliefs and feelings (Mezirow, 1991; Cranton, 2006). Mezirow (2003, p. 59) defines communicative learning:

> Communicative learning refers to understanding what someone means when they communicate with you. This understanding includes becoming aware of the assumptions, intentions and qualifications of the person communicating. … The process of understanding involves assessing claims to rightness, sincerity, authenticity, and appropriateness rather than assessing a truth claim.

Learning can be characterized as communicative when it helps in expressing, negotiating and resolving conflicts (Moyer, Sinclair, & Diduck, 2014). Social interaction is clearly an important ingredient for communicative learning to occur. Communicative learning helps to understand the justification for a belief in a clearer and more understandable manner.

Learning that is generated from the combination of instrumental and communicative learning such that it profoundly changes an individual's perspective, which can also enhance their commitment to and actions favouring sustainability, is termed transformative (Diduck et al., 2012). Learning is transformative when past experiences are reinterpreted, and then these reinterpreted experiences are used to guide present and future decision making (Mezirow, 2000). Transformative learning focuses on the changes and the learning that an individual undergoes. As opposed to instrumental and communicative learning that can be both individual and group based, transformative learning is individualistic in nature.

2.7 Summary

In India, about 80% of the hydropower potential remains untapped, and the race is on to earn quick money by exploitation of this resource (Kumar & Katoch, 2014). The Northern Indian states that hold a large portion of this hydropower potential are also the home to the fragile Himalayan ecosystem. Millions of people in the hilly and downstream areas are dependent for their day to day life on the water from the glacial rivers flowing from these regions, and thus it is of utmost importance to objectively assess and manage the effects of these developments on the environment and society with the aim of achieving long-term sustainability. Private development of small hydro has increased overall electricity output but has also brought many negative consequences and only fleeting local benefits with it.

Implementing community-based development of micro hydro is one of a host of emerging approaches to encourage more local-level decision making and benefit sharing.

Communities are empowered in numerous ways through such approaches, which can help to ensure local environmental, social and economic benefits. Community-based management of resources and related development can also help improve conditions for vulnerable segments of Indian society, such as women and the poor. Moreover, such initiatives can result in projects that are more sustainable and law abiding. Advocates argue that these benefits can be achieved via the development of community-based micro hydro, yet there is still little empirical evidence to support this contention and in fact much of the available literature notes shortcomings.

Chapter 3 – Research Approach and Methods

3.1 Introduction

I approached my research from a social constructivist paradigm because the work that I undertook in the Indian Himalayas was centered around the people and communities involved in micro hydro development (Creswell, 2007). Thus, I relied as much as possible on the participants views to understand the situation being studied. The perspective of social constructivism drew my research focus to the experiences and associated meanings of community members/participants who have been involved in or affected by the development and operation of micro-hydro projects. These meanings are often formed through interaction with others and the historical and cultural customs that form a significant part of their lives (Creswell, 2003). The varied and multiple meanings that the participants shared helped me to understand the complex social phenomenon of micro hydro development and allowed a deeper analysis of the subject matter (Creswell, 2014).

3.2 Qualitative Research

Based on my research purpose and objectives, a qualitative approach was the most suitable for data collection. A qualitative approach fit with my constructivist research paradigm, and helped me to gather data necessary to understand the meaning individuals attached to social and human issues related to hydro development (Creswell, 2014). A qualitative research approach places emphasis on the importance of a participant's experience in a particular situation of interest, which fit well with my research objectives (Creswell, 2003). Most commonly, qualitative researchers collect data themselves by reviewing relevant literature, interviewing people and making observations (Creswell 2014), which helps them to understand the context and reactions of participants in a more informed way. Another reason for selecting a qualitative research approach was that it helped me to build rapport with women, women's organizations and other vulnerable sectors of society (e.g., youth), which was only possible because I spent an extended period in the field getting to know people and interacting with them over the course of data collection. A qualitative study was also suitable because I proposed to establish the meaning of a phenomenon from the views of direct participants, which is fundamentally subjective in nature and hard to establish through quantitative methods. A qualitative research design also helped me to tackle unplanned situations with flexibility and innovation (Creswell, 2014), for example, as I gained experience in the field I was able to modify the interview questions and add locally relevant prompts and thus achieve better understanding and responses from participants. Lastly, after reading past theses describing research in India conducted by students from the Natural Resources Institute and speaking with some of these researchers, it appeared that there is saturation regarding quantative research approaches among the local population in many parts of India, including in the North where my project was located, and it was clear that people prefer more interactive techniques.

3.3 Case Study Strategy & Case Selection

The term 'case' refers to an event, entity or a unit of analysis (Yin, 2014). A case study is a strategy of inquiry that can be used to conduct in-depth analysis of an issue (Crowe et al., 2011). According to Creswell (2007), a case study is a qualitative strategy in which the researcher explores a case (bounded system) over a period of time. Case studies involve empirical inquiry using various data sources to examine a situation in its actual context (Noor, 2008). Instead of a comprehensive, holistic coverage of a topic or phenomenon, the case study approach focuses on a particular subject or unit of investigation (Noor, 2008), and this "unit of analysis is the basis for the case" (Rowley, 2002, p.19). The nature and sources of data gathered depend on the boundaries of the unit being analyzed.

A case study researcher can also use multiple data collection techniques to enhance the credibility of their data (Yin, 2014). According to Yin (2014), a case study is appropriate when the focus of the research is to explore "how" and "why" questions and when you cannot alter the behavior of the participants involved in your study. My study was based in part on exploring and confirming "how" community-based micro hydro can benefit local people and enhance sustainability, and resultantly "why" it should be promoted. As per (Yin, 2014), a case study approach is needed when contemporary phenomena are being examined in a real-life context and the boundaries between the phenomena and the context are not clearly defined, as is the case with my consideration of recent micro-hydro projects in India. A case study approach can also help in identifying and explaining the results of a new policy or service and establish the links and pathways leading to these results (Crowe et al., 2011). Undertaking a case study when working with communities can not only help the researcher gather sufficient information about the community, but also can provide the researcher with understanding of the following types of questions: what happens in a community?; why and how do these things happen?; who from the community takes part in these activities?; and what are the overall effects of these activities?

Using a case study approach also appealed to me as a strategy of inquiry because it is highly versatile. According to Yin (2003), case studies can be categorized as explanatory, exploratory or descriptive. They further can be classified as single, holistic or multiple, and the decision of what type to use depends on the research questions. In this case, I planned a multiple and explanatory case study. Taking advantage of the versatile nature of the case study approach, a variety of data collection methods were used, including interviews, participant observation and focus groups. I was also able to draw relevant information from primary and secondary documents, which further enhanced the range of evidence and helped develop a more holistic view of the topic under consideration (Schell, 1992). Tapping into this variety of data sources helped with triangulation of my findings; gathering multiple viewpoints on the same phenomenon allowed me to improve the accuracy and authenticity of my judgments, as suggested by Baxter & Jack (2008).

As noted in Chapter 1, my research took place in Northern India. I selected this region because of the high density of present and future opportunity for micro hydro development. My case study sites were in the States of Jammu & Kashmir (J&K), UK and HP. With the help of my previous experience in the micro-hydro sector and reading relevant literature, I came to a decision that these states were suitable for case study selection because they have the fastest-growing small-hydro sector in the country. The criteria for selecting individual case study sites included the following:

- The size of the project, with a preference for projects under 2 MW to fit the “micro” designation;
- Local community involvement in some way in the planning, construction and operational phases of the project;
- At least partial local use of the energy generated;
- Communities that were willing to accept a student researcher to come into their community to learn, participate and understand community-based development, and;
- Sites that were accessible and had accommodation and eating facilities or were situated at a distance from a city or town that can be covered on daily basis.

Based on the above criteria for site selection, 3 cases were chosen in the State of J&K and 4 cases in UK, as shown in Table 1 (based on the criteria above I was unable to find any suitable sites in HP).

Table 1: Case Study Sites

NAME	CAPACITY	STATUS At the time of fieldwork (Oct. 2017- Jan. 2018)
Bartoo (J&K)	30 kW	Working
Yarkashing (J&K)	10 kW	Temporarily Not Working (Under Repair)
Yangthang (J&K)	25 kW	Not Working
Ramgaad (UK)	100 kW	Working
Lamabagar (UK)	200 kW	Not Working
Toli (UK)	100 kW	Working
Malari (UK)	50 kW	Not Working

The Bartoo project in the Kargil district of J&K was identified prior to the start of the fieldwork. It was confirmed as a case study site after some investigation into the accessibility to the village and the working status of the project. Yarkshing was selected because it was a working project, although temporarily nonfunctional as it was undergoing repair, and it had the same socio-economic and cultural conditions as Bartoo, thus it was a good opportunity for comparison between the two projects and to see what the villagers were doing to keep their project running. Yangthang was selected in order to study a failed/non-working project.

After searching for projects in UK, Ramgaad was selected due to its unique working arrangement, described in chapter 4, and Lamabagar was chosen in order to study a non-working project in the state. Toli was selected on the recommendation of Uttarakhand Renewable Energy Development Agency (UREDA) officials and because their electricity management committee (EMC) has been working efficiently for more than 18 years. Malari was selected after receiving information that the project was no longer functional, which provided opportunity to investigate what benefits the people had derived from the project since it was commissioned.

In addition to these case study sites, brief visits were made to three other non-functioning projects, namely Tikat (50 kW) in Kargil district, Jagthana (100 kW) and Kanolgad (100 kW) in Bhageshwar district, and Jumma (1.2 MW) near Malari. After initial inquiry, Tikat, Jagthana and Kanolgad were rejected as other non-functional projects, since Yarkashing and Lamabagar, were already selected as case study sites in the nearby area. The Jumma project lies on the road to Malari and I had read about it in the literature, so having the opportunity in the field, I stopped and inquired about the project; however, as it is a private initiative it was not considered for case study selection. Other sites that were considered but rejected are outlined in Table 2.

Table 2: Rejected Sites

NAME AND CAPACITY	COMMENTS
Titang Mini Hydel Power, 800 kW (HP)	Project in Pooh Taluka in Kinnaur district was made by Sai Engineering Foundation, but no significant community involvement was present.
Sach Mini Hydel Power, 900 kW (HP)	Project was made by Himachal Pradesh Energy Development Agency (HIMURJA) near Killar, Chamba, and supplies electricity to surrounding villages. There was a lack of public participation and no road access in winters.
Shyang Hydro Project, 3 MW (HP)	Project in Tshong Tong village in Kinnaur district was made by Sai Engineering Foundation. Privately owned and used for feeding power to the grid.

NAME AND CAPACITY	COMMENTS
Simla Hydro Power Project, 5 MW (HP)	Project located 150 kms north-east of Shimla. Made by Sai Engineering and used for feeding the grid.
Solang Power House, 1.5 MW (HP)	Private project used for feeding the grid.
Agunda Power Project, 20 kW (UK)	Project made with the help of Jansamarth and jointly funded by United Nations Development Fund (UNDP) and Ministry of New and Renewable Energy (MNRE). Damaged during the 2013 UK floods and not working at the time of the research.
Janki Chatti, 200 kW (UK)	The project was made by UREDA, it was earlier managed by the community and electricity was used locally, but now the grid has reached the village and the facility now feeds the grid and is managed by a private contractor.
Spanglung Sapi, 10 kW (J&K)	Project developed by Ladakh Ecological Development Group (LEDeG), but was non-functional at the time of the research.
Purkitchey, 10 kW (J&K)	Project developed by LEDeG, but was non-functional at the time of the research.

3.4 Data Collection

To achieve my research objectives, I used three empirical data collection methods: semi-structured interviews, participant observation and focus groups. These were in addition to my literature and document review.

3.4.1 Semi-Structured Interviews

Semi-structured interviews were my primary data collection tool, used to gain in-depth knowledge and understanding from local people about micro hydro development in their community, and particularly the effect it has had on each of the aspects of sustainability I considered. Semi-structured interviews have a predetermined set of questions, but the order of the questions can be modified and questions can be added according to need (Teijlingen, 2014). As well, the interviewer is at liberty to omit some questions if they seem inappropriate in that particular situation (Teijlingen, 2014). Semi-structured interviews are often referred to as the most popular, effective and convenient means of data collection in qualitative research (Qu & Dumay, 2011). Having a base in human discourse, they allow the interviewer to get the fullest response possible from the interviewee (Qu & Dumay, 2011). Semi-structured interview techniques maintain the formal nature of the interview and at the same time allow interviewees to express their thoughts in a manner with which they feel comfortable. All of these attributes, as well as the success many fellow students working in India have had with the technique, made me regard it as an appropriate and meaningful method of data collection for achieving my objectives.

In terms of question design, I used the literature on micro hydro development reviewed in chapter 2, the expertise of my committee members, the work of previous students and the literature (e.g., Dunn, 2000) to guide the development of the interview schedule, which is included in Appendix A. Using this schedule, I explored the roles that community members played in micro hydro development, the actual and perceived social, environmental, economic, health and cultural benefits of the projects, and the learning outcomes for community members from their association with the micro-hydro project. I used easy and accessible language that was appropriate to the informants, and was careful not to use offensive language or ambiguous terms in my interview guide.

The people selected for interviews were comprised of adult community members of various age groups, including men, women and youth (not under 16 years of age). I interviewed at least six people from the community at each study site, except for Malari as most of the people from the village had already migrated down in the valley for the winter season. Before going for my fieldwork, I tried to contact the village headman/woman (Pradhan) of Bartoo to ask for his/her permission to carry out my research. I was unable to make contact beforehand as I later discovered that there is no phone network connectivity in that area, and as a result I met with the Pradhan when I was in the village for my fieldwork. For the other case study villages I sought and received on-site permission from the respective village headman/woman before starting my work.

The initial interviews at each site were with the village heads or the project operators. I asked these interviewees to suggest other people that have been involved in the micro-hydro project, as well as those impacted by the development and I followed up with some of these. I also interviewed the people who were running the micro-hydro facility in each case. Participants also included members of various organizations in the village, such as the Electricity Management Committee (EMC) and local school teachers. Apart from interviewing the community members, I also interviewed the professionals from outside the villages who were associated with the project development, including: funding and/or assisting agencies, such as the Ladakh Ecological Development Group (LEDeG) in the case of Bartoo, the Society for Promotion of Wasteland Development (SPWD) for Malari; government departments, such as UREDA, Kargil Renewable Energy Development Agency (KREDA), and Ladakh Renewable Energy Development Agency (LREDA); and engineering consultants from SPWD and Jansamarth.

A total of 59 interviews (as shown in table 3) were conducted. I had planned to keep the interview length to approximately one hour maximum, but it varied a lot depending on the mood of the interviewee and the flow of the interview. On average, interviews took 40 minutes and while most were completed in a single sitting, some also had follow-up interviews (e.g., a UREDA Project Officer). I took notes during the interviews and audio recorded them with the permission of the interviewees. The interviews were carried out at a place and time that the participant approved. Some interviews were conducted at the micro-hydro project site and others in the houses of the participants to observe the effects of micro hydro at the community level.

The villagers in these remote western Himalayan regions generally speak their mother tongues. In the J&K case study sites people spoke Ladakhi in Yangthang and Balti in Batroo and Yarkashing, and as such I had to hire a local interpreter for most of these interviews. In the villages of UK, everyone spoke Hindi with a different dialect that I am not used to hearing; nonetheless, I was easily able to comprehend what they were saying. Interviews with all the government and NGO officials were in a combination of Hindi and English.

Table 3: Interview distribution

Case Study	Villagers (Female)	Villagers (Male)	Government Officials	NGO Officials
Bartoo	3	6	1	1
Yarkashing	4	4	1	1
Yangthang	1	4	1	1
Ramgaad	4	9	2	-
Lamabagar	1	4	2	-
Toli	-	4	2	-
Malari	-	2	-	1

3.4.2 Participant Observation

Participant observation is a method of data collection where the researcher either participates in the daily life activities of the people under study or observes them from a distance without becoming actively involved (Becker & Geer, 1957). According to DeWalt & DeWalt (2011), regardless of the degree of involvement, participant observation enhances the quality of both the data obtained during fieldwork and of the researcher's interpretation of that data. Participant observation can help reveal more detailed information about issues that might be missed or misunderstood in other data gathering techniques (Becker & Geer, 1957). Participant observation also helps in establishing rapport with local people, and this close contact and comfort can help in obtaining reliable information (DeWalt & DeWalt, 2011).

While in the field I stayed in the communities of each selected case study site in order to observe the day to day working of the community and how the micro-hydro project affects their daily activities and the sorts of businesses that have emerged as a result. As a participant observer, I watched various activities that were associated with micro hydro development, such as: irrigation and agricultural activities, people holding the job of running and maintaining the power station, the use of light in the community (see Figure 4), the use of energy for various activities, and how having power has affected other common activities such as the collection of firewood from forests.

Figure 4: Cooking after dark, Bartoo (Source: Gurmeet Singh Ghera)

All of the observations were recorded and kept as field notes in a journal throughout the fieldwork. Whenever possible, I took photos of various infrastructure and activities related to the projects, such as the micro-hydro facility, flour mills, damaged canals, diversion channels and community water heaters. Observations also helped in developing appropriate new questions in the field and informed how I asked and understood some of the questions I asked in interviews, as well as verifying some of the data that I collected through interviews. In each case I first visited the micro-hydro facility to get a sense of the community and how power was being used before I started the interview process.

3.4.3 Focus Groups

Focus groups are a form of group interview that generates data by initiating a discussion among research participants on a specific topic (Kitzinger, 1995). The researcher acts as a facilitator who introduces the topic for discussion and regulates the proceedings. Ideally, a group of six to ten people sits facing each other around a table. The literature indicates that fewer participants may result in limited discussion while having too many participants may restrict the participation of all (e.g., Cameron, 2005). The synergist effect, where a comment by a participant can trigger a chain of responses that results in far more information generation than expected, is a main advantage of focus groups (Cameron, 2005). I tried to encourage and capture this effect in my focus groups. Focus groups can also provide insights and real feelings on a topic that might not have been discovered through individual interviews and surveys (Zeigler, Brunn, & Johnson Jr., 1996).

I carried out a total of four focus group sessions as my work was wrapping up, one with each community (except for Malari, Yangthang and Ramgaad). Focus groups were held in the house of the village head and the general outdoor area where villagers usually sit together. I treated it as a bit of a celebration, including some sweets and chai in order to share and gain further insight into the preliminary results of my study and to verify what I had understood. I invited all who had participated in the study to join the group. Most of the participants were people who had been interviewed, and some were involved exclusively in the focus group. My focus group sessions consisted of 5-10 participants and so I did not utilize break-out groups.

All the focus group conversations (e.g., Figure 5) were audio recorded after receiving the permission of the participants, and this was supplemented with note taking. In Bartoo and Yarkashing, the villagers were comfortable with conversing only in their local language, so I relied on my interpreter to lead the group. Notes were not taken during the focus group sessions at these 2 villages. The recordings were translated immediately after the session with the help of the interpreter. At Lamabagar and Toli, I led the group myself and took brief notes/key pointers during these focus groups.

Figure 5: A Focus Group Session in progress at Bartoo (Source: Gurmeet Singh Ghera)

3.5 Data Analysis and Verification

I began my analysis in the field by transcribing my interviews, observation notes and focus group sessions, and completed this upon my return to Winnipeg. The transcription process helped me to become even more familiar with the data before I began the formal analysis. I also started to think about themes that were grounded in the data as I did the transcription. Later, a detailed analysis of the data was done with the assistance of NVivo Computer Assisted Qualitative Data Analysis Software. Coding the data in NVivo was done by using themes from the literature as well as emergent themes in the data. Some of the themes from the literature, as outlined in chapter 2, included gender roles in micro hydro development, people's perceptions of micro hydro, the effectiveness of community-based micro hydro as a means of sustainable development, as well as the various impacts that have been noted, such as impacts on milling, fishing, irrigation systems and employment generation. I also looked for grounded themes in the data following techniques outlined in the literature for identifying such patterns (e.g., Lapan & Quartaroli, 2009). Using a software package to aid with coding also helped increase the efficiency of storing and locating data. As well, the process of analysis was faster and more efficient as compared to hand coding (Creswell, 2014). NVivo helped me in compiling and sorting the interview data by creating multiple nodes under various themes. Returning back to data organized under various themes and headings helped me in writing my thesis.

In terms of data verification, I used triangulation as the main strategy. Triangulation was done through comparing data collected via the multiple data collection techniques implemented, i.e., semi-structured interviews, observation, focus groups and literature/document review. This meant that I looked for overlapping data through each of the techniques I used. Since I spent an extended period of time at each case study site, I also used member checking to verify my data, meaning I checked back with people regarding what they have told me during interviews. I also did a group member check of the main points I had noted during the focus group sessions.

3.6 Anonymity and Confidentiality

All participants were made aware that the interview and focus group would be audio recorded, with their permission, and the information collected was to be used for a Master's thesis and resulting publications. Names of the participants were not recorded beyond in my field notes. Participants were given an informed choice whether they wanted their name mentioned in the thesis or not. The ranks/position of government and NGO officials were noted with their permission. Participants were required to sign a consent form and a copy of the form was given to them for their records. The form briefly explained the research and the freedom to not to answer any question or to stop the interview without any negative consequences. The consent form was translated to Hindi and the Hindi version was used wherever appropriate (see Appendix E for the consent forms used). As all the participants willingly gave their true name for the research, no pseudonyms were used. The consent forms are stored in a lockbox at my residence and the transcripts in a password protected computer and hard drive and will be destroyed/deleted in January 2023. This project was reviewed by the Joint Faculty Ethics Review Board of the University of Manitoba and all the necessary approvals were obtained from the University of Manitoba before starting the fieldwork.

3.7 Dissemination

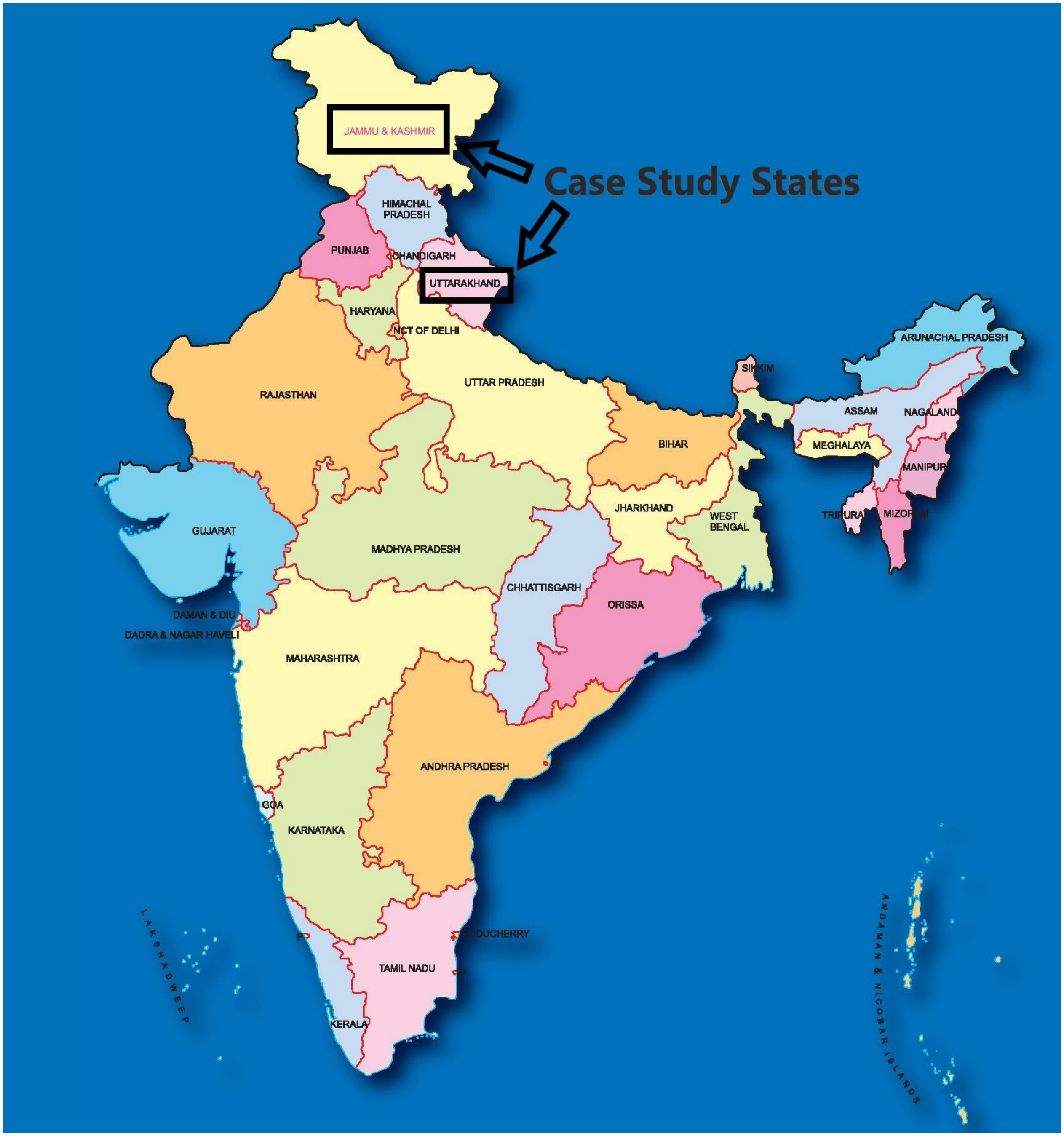
I shared my preliminary findings with the communities while in the field in the form of a brief presentation before the focus groups. After my thesis is complete, I will present a poster to the villagers, which will be translated into their local language and include pictures to enable a better understanding of the research outcomes. I also intend to publish my research in the form of papers in academic journals.

Chapter 4 – Micro Hydro in Northern India

4.1 Introduction

Small-hydro development is on the rise in all the three northern Himalayan states – J&K, UK and HP (See Figure 6). Since water comes under the jurisdiction of the state government (Kumar & Singhal, 2008), different states have varying models for promoting small and micro hydro development. For instance, HP has a privatized model where private investors are encouraged to build and operate hydro projects to sell electricity onto the grid. As per the state government's data, there are 655 projects in HP in various stages of development, and most of them being privately owned (HIMURJA, 2018). Conversely, in UK, the government agency UREDA is the main organization responsible for constructing and operating micro-hydro projects or handing them over to communities for operation and maintenance. In this model the role of private entrepreneurs is usually limited to construction. Most of the micro-hydro projects in UK are for local village electrification and not for grid supply, but projects in the mini and small categories are being constructed with the purpose of feeding the grid. As per UREDA, UK has about 80 projects with a capacity of 200 kW, and approximately 55 of these are for local village electrification (Uttarakhand Renewable Energy Development Agency, n.d.). Under the mini- and small-hydro categories, apart from the projects operated by Uttarakhand Jal Vidyut Nigam Limited (UJVNL), there are more than 60 projects in the operational and construction phases (Details of Allotted and Under Construction Projects of Private Developers, n.d.; Alternate Hydro Energy Centre, 2016; Policy on Hydropower Development By Private Sector in the State of Uttaranchal, n.d.). The state government has also adopted various measures, such as a single window clearance system and wheeling of electricity to streamline and facilitate the growth of the small-hydro sector (Welcome to Single Window Clearance System, n.d.; Policy on Hydropower Development By Private Sector in the State of Uttaranchal, n.d.).

Figure 6: Case Study States (Source: www.censusindia.gov.in/2011census/maps)



So far, the state of J&K has relied on government-driven development in the small-hydro sector through Ministry of New and Renewable Energy (MNRE) nodal agencies and state utilities. However the new state policy on small hydro was drafted to attract investment and new technology in this sector (Policy for Development of Small Hydro Energy for Power Generation up to 10 MW). In the last few years, Jammu and Kashmir Energy Development Authority (JKEDA) has allotted about 60 projects under the micro and mini categories to various independent power producers for a period of 40 years. Most of these projects are reserved for state residents, i.e. a permanent resident of J&K must directly or indirectly hold not less than a 51% stake in the project, while others are in the open category (Competitive bidding process for development of micro/mini hydro power projects in the state of Jammu & Kashmir, phase – 5th, 2015). Apart from the above mentioned projects, about 45 projects are in different stages of development in the Leh and Kargil regions of the state. MNRE's 2017 'Power From Renewables' report states that in addition to projects already installed and under implementation in the state of J&K, there is a potential for 302 projects in the small-hydro category.

The states of J&K and UK fall under the 'special category' of Indian states. Some states in India are given this status owing to their economic backwardness, hilly terrain, strategic location along the international border or other such factors (Planning Commission, 2011). Relative to other states, special category states get more assistance from the central government. In the small-hydro sector, special category states get higher per-MW subsidies for hydro projects. For instance, small-hydro projects in special category states get monetary support of 1.5 crore[2] Indian rupees (Rs.) (approximately 300,000 CAD) per MW, limited to a maximum of Rs.

[2] Crore denotes ten million in the Indian numbering system.

5 crores (1 million CAD) per project, whereas other states get Rs. 1 crore (approximately 200,000 CAD) per MW (Ministry of New and Renewable Energy, 2014).

Uttarakhand has an estimated hydroelectric potential of 20,000 MW, of which only 3900 MW has been tapped (Agarwal & Kansal, 2017). The state of J&K has a hydropower potential of about 25,000 MW, with only 3100 MW harnessed so far. In total, India has an estimated 15,000 MW of hydro power potential for small hydropower projects (Joshi, 2007), and the states of UK, HP, J&K and Arunachal Pradesh have about 50% of this total (Ministry of New and Renewable Energy, 2015). The state of UK has harnessed only about 170 MW of hydro power in the small, mini and micro categories, although the total estimated potential in the state for these categories is about 3000 MW (Government of Uttarakhand, 2015). Jammu & Kashmir produces approximately 111 MW from small hydro out of approximately 1500 MW of potential available for small hydro (Ahad, 2017; Jammu and Kashmir Energy Development Agency, 2017).

As seen above, these Himalayan states have enormous hydroelectric potential, yet a survey by the Government of Uttarakhand noted that while all the urban households in the state are electrified, there are still over 100,000 village households that are not (24*7 Power for all Uttarakhand, 2015). In 2017, the Government of India's ongoing policy on rural electrification, Deen Dayal Upadhaya Gram Jyoti Yojana (2017) that falls under Rural Electrification Corporation Limited, noted that there are approximately 100 unelectrified villages in the state of J&K.

4.2 Micro Hydro in Jammu & Kashmir

The state of J&K consists of 3 main regions, namely Jammu, Kashmir Valley and Ladakh. This study was based in the Ladakh area. Ladakh, also known as the 'land of high passes' and 'little Tibet', is India's northern-most territorial frontier and shares boundaries with both China and Pakistan (Pareek et.al, 2007). Ladakh has 2 major cities and districts, Leh and Kargil. Shia Muslims and Buddhists form 95% of the population of this region; Christians and some Hindu and Sikh families make up 1-2% of the total population (Pareek et.al, 2007). The whole Ladakh region is sparsely populated. As per the Indian Census, 2011, Kargil is the 7th least densely populated district of the country and Leh is the 3rd, but in terms of area, the districts of Leh and Kargil cover more than half the area of the state. People in the region speak Ladakhi, but the accent differs in Kargil and locals there refer to the language as Balti (Pareek et.al, 2007). With its remote mountain beauty, trekking routes and untouched areas, Ladakh has become a preferred destination for Indian and international tourists alike. Although peaceful, Ladakh has a strong presence of the Indian Armed Forces.

Unlike most states that have only one, J&K has three agencies responsible for small-hydro development: JKEDA for the Jammu and Kashmir valley regions, KREDA for Kargil and LREDA for Leh districts of Ladakh (State Nodal Agencies, n.d.). J&K has great hydro power potential, but due to the Indus Water Treaty with Pakistan there are major constraints on the use of water. The treaty restricts the storage of water on the major rivers in J&K, such as the Indus, Jehlum and Chenab, thus restricting hydroelectricity production through large reservoir projects. However, there is no restriction of run-of-the-river projects on these rivers (The Indus Waters Treaty, 1960).

From the 1990's to late 2000's, micro-hydro construction picked up pace in Leh and Kargil districts through the work of LEDeG, as can been seen in Appendix D. However, due to lack of funding, LEDeG is no longer involved in the hydro sector, and the MNRE nodal agencies KREDA and LREDA are the main organisations involved in the development of small hydro in

Kargil and Leh (Sonam Dawa, President LEDeG, personal communication, October 2017). Thus, the development of small hydro in Ladakh is currently dominated by the public sector. At present, the pace of small-hydro development is faster in Kargil than in Leh. KREDA and LREDA hire private consultants for Detailed Project Report (DPR) preparation and construction purposes, but the projects in this region are not owned and operated by private agencies. The new small-hydro development policy in Kargil does not include communities in projects. In reference to an under-construction project of 1.5 MW in Khandi, near Bartoo, Mr. Kachoo Ahmad Khan (Director, KREDA) observed:

> *There is no direct community involvement in any stage of this project, after commissioning this project, we will have a power purchase agreement with the Power Development Department (PDD). We will give the project to the PDD and they will interconnect all the villages in the entire Barsoo nallah, after that PDD will collect the tariff as per government norms*.[3]

In 2009, MNRE commissioned the Ladakh Renewable Energy Initiative (LREI) to develop various renewable energy schemes, including solar photovoltaic plants, wind energy and micro and mini hydro power projects. The nodal agencies got special grants for the implementation of this initiative. Under this initiative, LREDA has been allotted six and KREDA seven mini-hydro projects. In recent years, KREDA has boosted the development of mini hydropower in the district. More than ten plants (e.g., Figure 7) are under various stages of construction, with seven of these under the LREI initiative, and feasibility studies for approximately 30 more have already been completed (Kachoo Ahmad Khan, Director KREDA, personal communication, October 2017). Commenting on the slow pace of development of micro hydro in Leh district, Mr. Sonam (Junior Engineer, LREDA) said:

[3] Direct quotations from interview participants are in italics.

There are potential for projects based on the subsidy provided by MNRE, under which there is subsidy of Rs. 1 lakh[4] per Pico watt (5 kW). But the problem is that the cost of transporting material up to Leh from the plains is very high. So resultantly the tendering values were very high. We have administrative costs of Rs. 10,000, we even gave that away and put out the tenders at 1, 10,000 for 5 kW projects. But still the lowest tender values were around Rs. 1, 50,000. So we requested the villagers to pay the remaining 40-50,000 and that is hard to do.

Figure 7: 1.5 MW Khandi Small-Hydro Power Plant Under Construction (Source: LREI Report)

4.2.1 LEDeG's Working Procedure

The LEDeG is an NGO headquartered in Leh. In addition to working in the micro-hydro sector, they are also involved in the promotion of handicrafts, improved agricultural practices

[4] Lakh denotes 100,000 in the Indian numbering system.

and integrated watershed programs among other initiatives in Ladakh region (Pareek et.al, 2007). The organization started working in the micro-hydro sector in the late 1980s in the districts of Leh and Kargil, and, although presently inactive in the micro-hydro sector (Sonam Dawa, President LEDeG, personal communication, October 2017), LEDeG completed a considerable amount of micro-hydro development over the past three decades. As an experienced micro-hydro developer, LEDeG's Standard Operating Procedure is similar to what is found in other micro-hydro developments described in other case studies and the literature (e.g., Standards/Manuals/Guidelines for Small Hydro Development, 2012). This starts with a baseline survey or pre-feasibility study. A demographic study of the region and the specific village is done that includes features like total population, population density, location, weather, gender ratio, road connectivity, main source of income, present lighting sources and willingness to participate in the micro-hydro initiative with both cash and in-kind support (Interview, Kachoo Ahmad Khan, Director, KREDA). Concurrent with the demographic study, the technical aspects are also assessed, including the quantity of the water in the stream, potential project site, approximate penstock length and water availability over the year. If these baseline survey results are satisfactory, a feasibility study is the next step, followed by DPR preparation.

Where LEDeG really differs from government and private development planning is in the steps it takes with affected communities to ensure social mobilization in relation to a project. Unlike the private and government micro-hydro developments that I looked at and those described in the literature in chapter 2, LEDeG spends an extensive amount of time meeting the local community and discussing the terms and conditions of the development, for example, contributions needed from the villagers in the form of labour and local raw materials such as sand and stones for concrete mix, and an Energy Management Committee (EMC) is formed before construction starts. The empowerment of women is also one of LEDeG's goals, but, according to respondents, there has been limited success in this area thus far. Since the land for the powerhouse is always given free of cost, the owner of the land or one of his family members (usually a male) is appointed as the operator, and their salary is fixed in a democratic manner at a village meeting.

Being an NGO, LEDeG gets its funding from various organization, and in recent years the funding available for the micro-hydro sector has been cut off and this has restricted the efforts of the organization to implement any more projects.

4.2.2 Study area in Ladakh

As noted in chapter 3, three case study sites – Bartoo, Yarkashing and Yangthang – were selected in the Ladakh region. Bartoo and Yarkashing (Figure 8) are in the Sankoo tehsil of Kargil district and Yangthang (Figure 8) is in Leh district. Kargil city was used as the base for working in Bartoo and Yarkashing.

Figure 8: Case Study Sites in Jammu & Kashmir (Source: www.censusindia.gov.in/2011census/maps)

4.2.2.1 Bartoo

Bartoo is a village of about 70 households. It is a two-and-a-half-hour car ride from the city of Kargil, with the first half hour being a surfaced road and the rest unsurfaced. Bartoo is connected to the nearest town of Sanku by an unsurfaced road. It takes about 2 hours to cover the 27 km distance from Sanku. The area receives heavy snowfall and in such instances is cut off from neighboring cities as there are no snow clearing measures in the area. The high Zanskar mountain range surrounds the area. The whole village follows the Shia Islam faith that is prevalent in the Kargil district. The villagers usually welcome visitors in their houses with savory tea, naan bread and homemade butter.

Villagers carry out subsistence agriculture, with wheat as the dominant crop. The cropping season is limited to a maximum of 6 months as in winters fields get covered with snow. Villagers also rear sheep and fur goats (Bhedu).

Project Overview

The project at Bartoo was developed by LEDeG, who provided the necessary technical support and equipment, with the help of the local villagers. Two Civil Engineering Diploma students from the University of Applied Sciences, Northern Switzerland, were also involved in the project design and project. All the labour was provided by the villagers. Field observations show that poles for transmission were made with local wood, and the councilor of the area contributed some money from his Constituency Development Fund for wiring and other parts. At the time of installation of this 30 kW project in 2009, there was no road to the village. The road ended at a village called Tikat that is 5 km from Bartoo, and as such all the equipment, such as the turbine and penstock, were carried to the project site on donkeys and by the villagers themselves.

Bartoo has a seven member EMC (including 2 women) that monitors the electricity usage by the villagers. All the members of the EMC have remained the same since the project was commissioned. One of the female EMC members recently got married into another village and she had not been replaced at the time of the research. There is one operator (Figure 9) and he is paid Rs. 1500 per month as salary. People are allowed to use the electricity for lighting and television only. The number of bulbs that can be connected is also limited. Everyone is charged Rs. 20 per bulb per month. Electricity available is reduced during the winter as the water flow in the nallah is reduced. The members of the EMC often conduct surprise checks to see if there is any misuse of electricity. There are provisions for penalties, but no one has been monetarily penalized so far. The usual punishment is that the EMC members reprimand the defaulter in public meetings and gatherings and ask for an explanation and assurance of the misuse not happening again.

Figure 9: Landowner/Project Operator, Bartoo (Source: Gurmeet Singh Ghera)

Issues

The villagers at Bartoo feel that the generating capacity of the project is lower than required. The village is gradually growing and the day to day energy requirements of the people are also increasing. For instance, although the area has no mobile connectivity, some villagers like to keep mobile phones and use them as flashlights at night and for phone purposes when they go to Kargil. The transmission wires and poles are also getting old. Old poles can be replaced with new ones made with the locally available wood, but the EMC does not have the funds to buy new transmission poles and wires. The project has no insurance and no financial backup in case of any major breakdown. The project sometimes gets financial help from the area councilor as he hails from the village, but in future if he is not in this position the limited but critical help from the councilor's office may stop. Due to a lack of education and training, project record keeping is absent.

4.2.2.2 Yarkashing

This project caters to 2 settlements – Yarkashing and Pangbar. Both of the villages are on mountain slopes and it takes about half an hour trek upslope from the road's end at Yarkashing to reach the houses. Yarkashing has 11 households and Pangbar has approximately 18. Both are surrounded by the Zanskar range on three sides, and Yarkashing provides a magnificent view of steep and high rising mountains to the north and north-east. This area gets heavy snowfall and is cut off from the rest of the region for most of the winter. The whole village follows the Shia Islam faith and, like Bartoo, residents welcome visitors in their homes with savory tea, naan bread and homemade butter. The main occupation is agriculture, which is subsistence in nature. Sheep and goat rearing are also prevalent in the village, as well as cows that provide milk.

Project Overview

Yarkashing is one of the oldest projects in this region that was made with the help of LEDeG. The project started operation in 2002-03 and has been functional since then. All the civil work for the project was done free of cost by the villagers (powerhouse is shown in Figure

10). Interview data showed that Yarkashing had a 5 kW turbine installed at first, but that was replaced by a 10 kW turbine that was bought by the villagers at a subsidized rate from LEDeG. The water of the Yarkashing nallah comes from a hot spring and resultantly they do not face the problem of frozen water in the winters, despite the cold weather. Yarkashing also has an EMC that consists of members from both Yarkashing and Pangbar and has a total of 5 members, including 2 women. There is one operator for the project and he is paid Rs. 600 per month. Electricity is used for home lighting, television, an electric cereal grinding machine and a community water heater in winters. At the time of the research, the hydro facility was under repair and nonfunctional. The village does not have any electricity supply from the grid to this point.

Figure 10: Yarkashing Power House (Source: Gurmeet Singh Ghera)

Issues

People in the village say they need more electricity for other activities. For instance, the project operator, Md. Ibrahim, wants to run a washing machine and charge a fixed sum for every round of clothes, but according to him the capacity of the existing project is not enough to support any extra load. He also suggested installing weaving machines powered by electricity, but the lack of power is a big constraint. The village project has no financial backup and the lack of record keeping is also an issue, for instance, there was no record of the contributions taken from the villagers for repairs done over the years, no receipts for the repair work done and no written record of the project and issues faced so far.

4.2.2.3 Yangthang

Yangthang is a small village that is located about a two hour car drive from Leh city in the north-west direction. There is no public transportation that goes to the village so one must travel there by private vehicle. The whole village follows Buddhism and has about 40 permanent residents. A significant number of adult males from the village are working in the army, and only a handful of youth live in the village permanently. Agriculture is again prevalent, but the cropping season is a maximum of six months only. The villagers sell apricots and almond oil to visitors and in the Leh market. The village also serves as a base for trekking enthusiasts and as such many homestays have been set up.

Project Overview

The 25 kW project at Yangthang was sponsored by the J&K government (Figure 11) and technical support was provided by the NGO Jansamarth. The villagers did all the non-technical work and were partly paid for their labour. Project electricity was mainly used for home lighting, television and water heating (Figure 12). The project used to operate from sunset to sunrise and on request for special occasions such as marriages or religious celebrations. Two local men were selected as operators, who were taken to New Delhi and trained by Jansamarth in project operation and repair. There was no clarity on the salary of the operators. According to Mr. Tashi (Project Operator), their salary varied from month to month. The project developed some technical fault that was not repairable by the operators, and it seems that the only step taken to correct this was to call Jansamarth for help, but due to a lack of funds they were not able to help. Resultantly, the project has been non-functional for a few years (Figure 13). Since three years ago, the village has been connected to grid power supplied from the 44 MW Alchi Power Project.

Figure 11: Project Inauguration Stone (Source: Gurmeet Singh Ghera)

Figure 12: Water Heating System at the Project (Source: Gurmeet Singh Ghera)

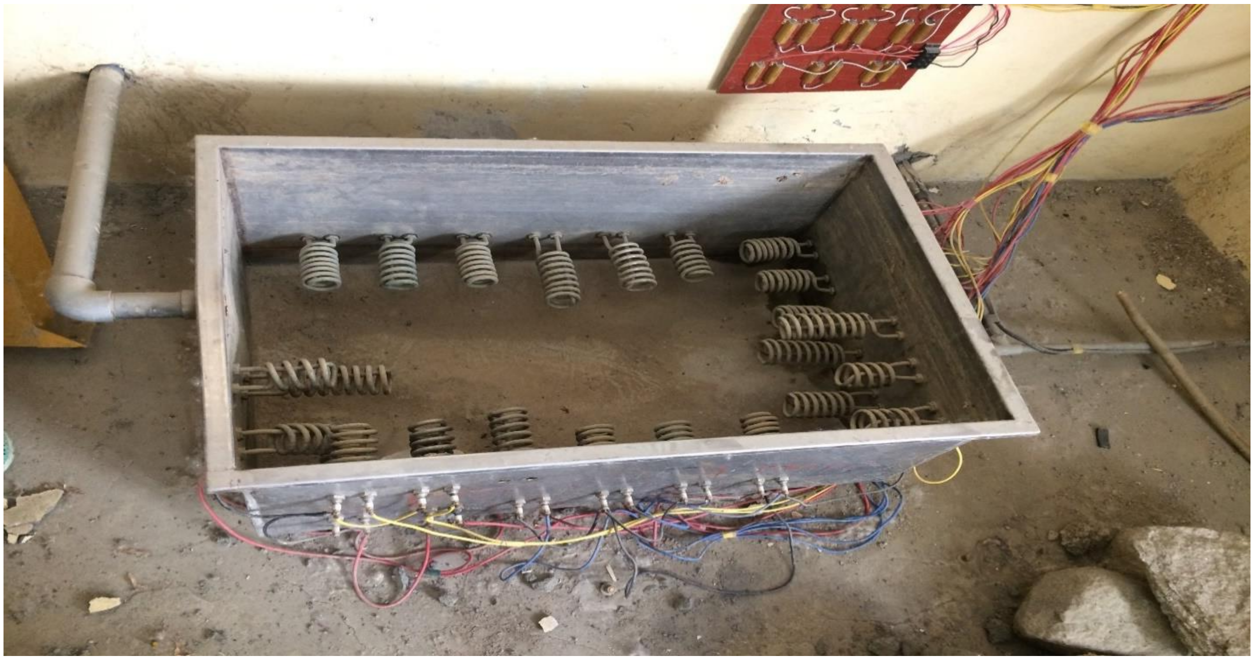


Figure 13: Dry Forebay (Source: Gurmeet Singh Ghera)

Issues

As noted above, the project had a technical issue keeping it from functioning, but it seems that not much effort was put forward to resolve this. One of the walls of the powerhouse suffered damage as a big boulder from the hill slope fell and broke it. Since there are numerous rocks and boulders uphill, field observation shows that the powerhouse remains vulnerable to such an incident happening again. There seemed to be a lack of leadership in the village, and most of the regular inhabitants of the village are old. Less than 10% of the youth population stays permanently in the village. Most of the men are in the army and young people move to Leh, Srinagar or Jammu for work and studies. Resultantly, no concrete efforts had been made to make the project functional again. The main reason for this is that the resident population now gets electricity from the grid, and access to this power has reduced motivation for repair efforts.

4.3 Uttarakhand

Uttarakhand, also known as 'Devbhumi' (land of the gods), is a state with enormous hydroelectric potential. Many rain and glacier-fed rivers originate in this state, including the Ganges and Yamuna and their tributaries. So far, state utilities, such as UREDA, Uttarakhand Power Corporation Limited (UPCL) and UJVNL, have been the main agencies initiating small-hydro projects. UREDA is the designated state nodal agency of the Government of India's MNRE (State Nodal Agencies, n.d.), and has the mandate for the implementation of all renewable energy programs in the state. Earlier, both UREDA and UJVNL administered micro and mini-hydro projects, but now UREDA exclusively oversees and regulates projects that are up to 2 MW (Interview, Mr. Gautam, Junior Engineer, UREDA, December 2017). UREDA has handed over the administration of all its projects over 2 MW to UPCL and UPCL has handed over the projects up to 2 MW to UREDA.

The presence of the private sector is rapidly increasing in projects that are higher in capacity (2-25 MW), which are being built for direct grid feeding. For instance, three private projects, namely Sarju I, Sarju II and Sarju III with capacities of 7.5 MW, 15 MW and 10.5 MW respectively, were in operation for grid feeding in the Kapkot area of Bhageshwar district. Responsibility for extending the grid lines to the unconnected areas of the state lies with UPCL, and the electricity provided by UPCL is synonymous with grid electricity in the context of this research. Field observations and interviews show that the presence of the civic sector in micro and mini-hydro development is very low. This is reflected in the fact that, apart from Malari and two other non-functional micro-hydro projects by Jansamarth, there were no projects found in the state that involved the civic sector in their development and maintenance.

Until recently, hydro development in UK was primarily carried out by the public sector, but presently a lot of private contractors are developing and running small-hydro projects (2-25 MW) and feeding the grid. In reference to micro and mini hydro, after 2005 the approach of UREDA was to involve communities in the development, operation and maintenance of such projects. This was done to create a sense of ownership amongst the villagers. Under this approach, 10% of the total cost of the project was covered by the villagers and 90% by UREDA. The villagers’ share was mainly in the form of labour (Personal Communication, Mr. Gautam, Junior Engineer, UREDA, December 2017). The Alternate Hydro Energy Centre (AHEC) of the Indian Institute of Technology (IIT) at Roorkee prepared DPRs, and project construction was generally awarded to a private contractor through tendering. In 2015, the UK state government introduced a new policy for the development of micro and mini hydropower projects up to 2 MW capacity. As per the new policy:

> There is a huge untapped potential of generating power from micro/mini hydro projects of capacities up to 2 MW. This potential, if harnessed efficiently, can help to meet Uttarakhand government's goals of rural development, viz-a-viz, electrification, revenue generation and livelihood development. Community managed micro/mini hydro power projects with effective support and partnership with public and private sector has the potential to sustainably address the unmet demand of energy in rural areas of Uttarakhand. Therefore, to promote micro/mini hydro power projects in the state, it is essential to formulate a comprehensive policy which aims to accelerate the growth of micro/mini hydro power projects in Uttarakhand by providing a favorable environment for all the stakeholders (Policy For Development of Micro & Mini Hydro Power Projects up to 2 MW, 2015, p2).

Under the new policy, mini and micro hydro projects will be reserved for the Panchayati Raj Institutions (PRI's) of UK. First preference will be given to the Gram Panchayat in whose area the project will be made. If a project comes under the area of two or more Gram Panchayats, priority will be given to the one where powerhouse is to be located. If none of them are willing to take the project, adjacent Gram Panchayats are next in priority. If none of these local government institutions take the project, the Block Panchayat under whose area the project falls can take the project, and failing that, the Zila Panchayat is next in priority.

The PRI's can execute the project on their own or with the help of a Special Purpose Vehicle (SPV) partner selected by a bidding process. The bidder who offers the maximum share of revenue to the PRI will be declared the successful SPV partner. Even if an SPV is selected, ownership of the project will remain with the concerned PRI. A SPV can be any organization, society, registered firm/company, state/central power utility or other government-owned entities, including UREDA. The nodal agency, i.e. UREDA, will be responsible for identifying potential sites and preparing the DPR. The eligible PRIs will be invited to apply for the project. Under this policy, the PRIs do not have to give any statutory levies, such as royalties or water usage charges. There is also an exemption from court fees for document registration. According to Mr. Sharma (Project Officer, UREDA), as of early 2018 some potential sites for hydro plants have been identified under this new policy, but no projects have yet been initiated.

4.3.1 UREDA's Working Procedure

UREDA is the nodal agency of MNRE in the state of UK. The state of UK was carved out of Uttar Pradesh in November 2000. Until this division, public micro-hydro projects in the state were developed by the Non-Conventional Energy Development Authority (NEDA), and projects like Ramgaad and Toli were made under its supervision (Personal Communication, Mr. Gautam, Junior Engineer, UREDA, December 2017). After UK's creation, two agencies came into existence, namely UPNEDA for Uttar Pradesh and UREDA for UK. In the initial years of work, UREDA's mandate was simply to provide electricity to remote villages, but this policy has undergone substantial changes as this mode of providing electricity was not proving economically sustainable. As per Mr. L. D. Sharma (Project Officer small-hydro, UREDA),

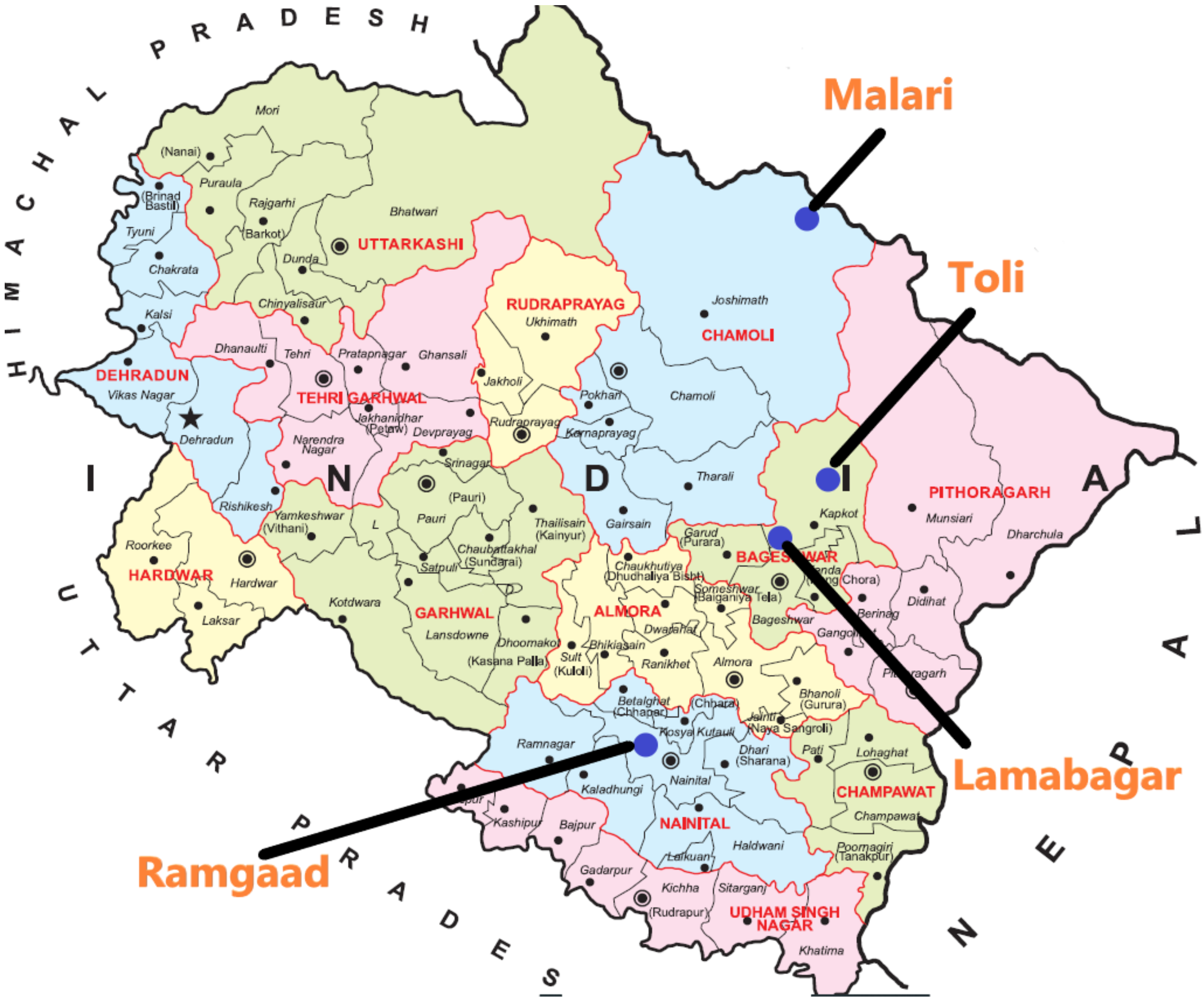
> *In the first phase of development, we constructed the projects ourselves and handed it over to the villagers for operation, e.g., Ramgaad. In the 2^nd^ phase we involved the villagers in the construction as well, we contributed 90% of the cost and the villagers contributed the rest mainly through labor work, e.g., Lamabagar. Now in the 3^rd^ phase, we are asking the villagers to do everything, we will allot the land according to the DPR and they'll be free to do all sorts of commercial activities.*

AHEC is responsible for DPR preparation under the new policy as they were under the old policy. As per the 2015 policy of UREDA (mentioned above), the role of the villagers will only start after the DPR has been made, which means that project design, the location of the powerhouse and all other details would already have been finalized. It is unlikely that the villagers will have an opportunity to express their thoughts on early phases of the project.

4.3.2 Study area in Uttarakhand

Four case study sites (Figure 14) – Ramgaad, Lamabagar, Toli and Malari – were selected in the state of UK. These sites were located in three different state districts. Garampani, Bhageshwar, Kapkot and Joshimath were used as the base cities for data collection at Ramgaad, Lamabagar, Toli and Malari respectively.

Figure 14: Case Studies, Uttarakhand (Source: Source: www.censusindia.gov.in/2011census/maps)



4.3.2.1 Ramgaad

The Ramgaad project (see map, Figure 14) lies in the Nainital district of UK. The project is very well connected to the road, being located a few meters off of National Highway 109. The project lies in the hamlet of Ramgaad but provides electricity to 6 more villages. People in these villages mainly practice horticulture, agriculture and own small business shops. Villagers rear cows and most of them sell the milk to the milk committee of the village that transports it to the block milk cooperative. Since Nainital is not too far from Ramgaad, a lot of village youth go there to work. People also do labour work in road and other local construction.

Project Overview

Ramgaad is one of the oldest projects financed by UREDA/NEDA and was built by a private contractor. It was commissioned in 1990 and has been working since then. In addition to Ramgaad, Jakh, Budlakot, Vargal, Kaphulta, Jogyadi and Garjoli are the six villages that draw electricity from the project. The EMC members consist of 1 representative from each village elected democratically by the public at a meeting for this purpose, and the president and treasurer are chosen from amongst the elected members. Interview data shows that in September 2017 fresh elections were held and there is 1 woman now on the EMC. The Junior Engineer of UREDA, Patwari (local revenue officer) and Block Development Officer are also ex-officio members of the EMC. 4 permanent operators are employed by the project with salaries ranging between Rs. 8000-10000 per month. The project presently provides electricity to approximately 470 households and two mobile towers. There is no restriction by the EMC on the use of electricity. All the minor and day-to-day repairs are done by the EMC with the money they collect from bills and sale of electricity. The operators go to individual houses in all the villages to take meter readings and give the monthly bill. The consumers are responsible to deposit payment for their bill at the office in the powerhouse (Figure 15). The EMC charges Rs. 2.20 per unit of electricity, whereas the rate of UPCL electricity varies between Rs. 2.85-3 per unit. There is a penalty for late payment, and nonpayment of bills for a prolonged period of time can lead to disconnection.

Figure 15: Powerhouse Building, Ramgaad (Source: Gurmeet Singh Ghera)

The project has a unique arrangement with UPCL as it is synchronized with the grid line with the help of a jumper. This means that the project is able to sell electricity to UPCL during periods of low village consumption. This is usually in the day time as the village electricity demand is very low. Whenever the stream water level is low and electricity generation is inadequate, the project buys electricity from UPCL. The rate of purchase and sale is the same. Out of the total sale of electricity, 75% goes to UREDA and 25% is kept by the village EMC.

Project synchronization with the grid was done in the year 2004 (noted on the board in Figure 16), and there was a complete overhaul of the project, including new parts for the turbines, new electric panels and repair of the penstock and diversion canal. This renovation was done by UREDA at their own expense, but the role of the previous EMC head was instrumental in getting the synchronization and repair done.

Figure 16: Onsite Board Highlighting Project Details (Source: Gurmeet Singh Ghera)

Issues

The nallah on which the project is based is rain-fed and the head operator indicated that they have been unable to generate adequate electricity in the summer season for the past few years due to continuously low rainfall. A few villagers said that the voltage of electricity is often low, and as such they are unable to use anything beyond lights and television. Some local experts in the field of micro hydro have a viewpoint that Ramgaad is a showpiece project for UREDA and they try to keep the project running at any cost, and contend that it should not be taken as a benchmark for assessing the general condition of UREDA projects.

4.3.2.2 Lamabagar

The Lamabagar project (see map, Figure 14) lies in the Bhageshwar district of UK. It takes about one and a half hours to get to the village from the city of Bhageshwar. Lamabagar is one of three projects on the Lamabagar stream, the other two being Jagthana and Kanolgarh. All three projects were UREDA initiated. The project is in the village of Lamabagar and while no longer operational, provided electricity to 4 different hamlets and a total of approximately 300 families spread across many kilometers. The villagers mainly practice agriculture on the slopes of the mountains. Many villagers live and work in Bhageshwar for long periods. Some of the villages rear sheep and sell their wool in Bhageshwar, and sometimes the buyers come to the village to purchase the wool. Potato and rice are the main agriculture products.

Project Overview

For the Lamabagar project, UREDA acted as a funding facilitator and provided a Junior Engineer to supervise the on-site work. As per the EMC head, a committee consisting of nine villagers was put in charge of the construction and procurement of all the equipment, including turbines and penstock. The committee was established in 2003-04 and construction started in 2005. However, if the villagers were unable to do any of the above responsibilities, they could seek assistance from UREDA. In the end, the villagers themselves did all the construction work along with the help of some hired technical and non-technical labour from outside. Machine buying was also channeled through the committee, and the turbines were bought from Nepal by UREDA on their behalf. The village Samiti[5] head went with UREDA officials to buy the turbines. According to Mr. Mohan Singh (Samiti Head), *"We got money in 3 installments, the 1st installment was for machinery, 2nd for construction work and 3rd for administrative expenses. We got it from UREDA in a joint bank account under the name of UREDA and Samiti head."*

None of the projects on the Lamabagar stream were functioning at the time of the research. The Lamabagar project started operating in 2010 and was working until 2016 when UPCL's grid electricity came to the villages. The project had two operators; the initial monthly salary of the operators was Rs. 1500 each, which remained the same for three years. After continuous demands for an increment, their monthly salary was increased by Rs. 500 each, and Rs. 2000 was their salary at the time the project stopped working. The project has two turbines with each having a generating capacity of 100 kW, and as indicated by the head project operator Mr. Madan Lal, *"Even when the project was working, the peak load was 60-70 kW in total and was sufficiently produced by 1 turbine."*

As a result, each turbine was operated on alternate days. Electricity was mainly used for home lighting and television. Apart from regular maintenance, the plant machinery never required any major repair or replacement through its duration of operation.

Issues

Although the turbines were fully functional, the project was not in operation. The village had been supplied with UPCL's grid connections and, though not dissolved, the Samiti was no longer functional. There seemed to be a difference of opinion between the people who ran and

---

[5] Electricity Management Committee (EMC) and Samiti are synonymous words in the context of this thesis.

managed the project (operators and EMC members) and other non-participating villagers. The villagers alleged that the EMC was inefficient in running the project, whereas the EMC members said that the villagers did not cooperate, did not pay bills on time, and that that had caused financial troubles. The stream diversion to the canal also broke almost every rainy season (Figure 17) and had been repaired by the villagers several times. At the time of the research, UREDA was planning to lease the project to a private contractor for generation and feeding the grid. According to the village EMC head:

> *After grid electricity came we were not able to operate our project as my health deteriorated and no one from the village took the initiative to come forward and there are other problems such as lack of UREDA's support. Moreover, the line is very long, we have 4 villages/hamlets connected to our project that are 7-8 kms from the powerhouse. The maintenance and repair can be difficult, Rs. 50 per household was not sufficient for the salaries of 2 operators and the repair work. We had to work on the diversion canal almost every day as it was a temporary arrangement made by us after the original one washed away. Rs. 200-300 was the labour cost for each person for the repair and each time we had to hire 4 people for the repair work. We used only one machine, there are about 300 families in total, but not all paid bills on time, we even tried cutting the lines of some households, but they verbally fought with us and there were many problems like this, so we requested the local MLA to hand the project back to the government and connect us to hydel (UPCL's connection), give us hydel.*

Figure 17: Broken Canal Diversion, Lamabagar (Source: Gurmeet Singh Ghera)

4.3.2.3 Toli

Toli is a village spread on multiple mountain slopes in the district of Bhageshwar (see map, Figure 14). One has to climb uphill for about 2 kms to reach the starting point of the village. There is a drivable unsurfaced road highly prone to landslides that passes near the power house. Interview data showed that although UPCL grid electricity has reached the area, the village still uses electricity from its own project. Labour work, cattle rearing and farming are the prevalent occupations. Most of the youth go to cities such as Dehradun and New Delhi to work. People have cows and goats and the sale of milk is local and for self-use only.

Project overview

The 50 X 2 kW project at Toli has been functioning for the last 18 years. There are three operators that run the project, and each works for 10 days in a month and is paid a salary of Rs. 3000 per month. The general hours of operation are 5:00 pm to 7:30 am. The operators are paid extra in cases of repair and maintenance of wires and connections outside the power house. The Toli EMC consists of 3 members – the EMC head, treasurer and secretary. Village-level democratic elections are held for the EMC every 5 years. All EMC members are male and there is no history of any female members. The EMC is active and the villagers are cooperative. During the research, it was found that neither the EMC nor the villagers had any complaints against each other. Every household has a meter installed by the EMC and bills are charged as per the meter readings.

Issues

The EMC of the Toli project at one time had more than Rs. 7 lakh (14,000 CAD) as savings. This had gone down to Rs. 2.5 lakhs in the 2017-2018 financial year. The Toli project used to provide electricity to 4 villages, namely Toli, Karmi, Bhagar and Chirabagar. As per the village interviews, the project was nonfunctional for a few months in 2017 due to damage to the penstock after some boulders fell on it from the upslope road cutting of a private contractor. By that time, the grid lines had reached the area, and two of the villages, Karmi and Bhagar, decided to switch electricity connections to the UPCL grid. The penstock repair work was done by the EMC at an approximate cost of Rs. 50,000 (1000 CAD). Presently, the Toli project caters to the electricity needs of the villages of Toli and Chirabagar. One of the 50 kw turbines has a technical fault and was non-functional. The operator indicated that the turbine they are using for the project is not produced anymore as the manufacturing company has closed, and resultantly new parts are expensive and hard to get. Funds to do the necessary repair work are not available from UREDA, and the EMC does not want to spend much out of their savings. There have been talks of diverting the project's electricity to the grid and supplying the villages with power from the UPCL grid , but there seems to be some disagreement between the villagers and government officials about the per unit rate of sale and purchase of electricity. The main challenge for the project is to generate more finances. The villagers simply do not use enough electricity, and resultantly the revenue is low and repair and maintenance is hard to finance. Some villagers desire 24 hours a day, 7 days a week electricity, but they say that the operators will have to be paid more and the villagers cannot afford higher bills.

4.3.2.4 Malari

Malari is a small village on the Indo-China border in the Niti valley of the Chamoli district of the state of UK (see map, Figure 14). The village has road access but it is limited during the rainy season as the area is prone to landslides and is closed in the winter. It is a migratory village and all the villagers move to lower altitudes in the winter season (November-April). Men mainly practice agriculture and the women take care of the households. Goats and sheep are raised for meat and shearing. Carpet making and sweater knitting are also practiced by women. The area produces high-quality Kidney Beans that are relatively expensive compared to other varieties on the market. Moreover, the villagers also produce an annual crop of apricots, potatoes, millets and lentils.

Project Overview

Malari is a 50 kW project that was funded by SPWD, a British NGO. The villagers contributed in the form of labour and participated in every stage of the project. In an interview, Mr. Srivastava, an engineer with SPWD who worked on the project, said:

> *This project came out after a lot of policy analysis, we studied the electricity production and coverage scenario in Uttarakhand and then we looked at the mountain perspective for designing interventions and based on that we moved forward, so the project was the product of almost 2 years of research*.

Malari was selected because it was a working project until recently and was a model of successful public participation at all stages of the project – from conceptualization and design through to construction and operation. Moreover, Malari had been in operation for more than 15 years and so it was a good case to analyze whether the villagers had derived or are deriving any benefits from the project. In terms of the main benefit, lighting, I found that Rs. 20 were charged per bulb per month. Bachan Singh Rana (Village Head, Malari) noted that "*People paid 60 Rs. if they use 3 bulbs. We used the money for repair and maintenance and to pay for the salary of the person looking after the project.*"

There were two operators who ran the project, each with a salary of Rs. 2800 per month. The hours of operation of the project were 6:00 pm to 6:00 am and the electricity was mainly used for lighting purposes. The tailrace of the project fed and still feeds a channel used for household water and field irrigation in the village (Figure 18). Literature on the project (Sinclair, Diduck, & McCandless, 2015) also indicated that the villagers had planned to install a berry processing plant, perfume distillation unit and other projects to help the local economy.

Figure 18: Tailrace feeding the irrigation canal, Malari (Source: Gurmeet Singh Ghera)

Issues

Malari village was connected to UPCL grid electricity in the past three years and the local micro-hydro project has been nonfunctional for the last three and a half years. The village head, Mr. Bachan Singh Rana (Figure 19) noted that, *''Up to the border till Niti, which is the last civilian habitable village, UPCL electrification has reached. Since then the maintenance of our project has become loose. Villagers, in general, have become disinterested in the project.''*

Figure 19: Village Head at the Powerhouse, Malari (Source: Gurmeet Singh Ghera)

No economic activity or initiative as noted above has emerged so far from the project. The only use of electricity was for lighting and television. The village head indicated that the villagers are planning to start the project again and sell all the generated electricity to UPCL and generate income for local development through that. But whether Malari residents or UPCL will pay for the jumper/transformer and other expenses, e.g., technical support, is not yet clear.

4.4 Local Projects vs Centralized Supply

To further the objective of total electrification throughout the country, the Government of India is continuing to extend centralized connections to unelectrified remote areas, but the success of this initiative is doubtful for very remote communities in the north, for example, in areas like Ladakh where population density is low, the mountainous terrain is rugged and the villages are separated by 100's of kilometers. One has to ask whether it would even be economically possible to extend the grid to these locations, and even if the government provides these remote communities with electricity from long-running power lines, the issues related to repair and maintenance that already plague hydro in high mountain areas create further doubt about the potential of efficient and regular power supply. Many of the case study sites in this research now have access to grid power provided by state utilities.

Upon inquiring how the grid power differed from their own project and whether participants prefer grid power over their own project, I found that villagers had mixed feelings. Many were against the new grid connections, some neutral to the situation and a few happy to get grid electricity. An interviewee at Lamabagar said, *"The electricity connection is good now because we get electricity day and night. If I get the service, I do not mind paying the bills"*. However, The EMC head in Lamabagar, Mr. Mohan Singh, indicated there were some issues now.

> *We were happy with our project, we could use it to our own comfort, for marriage and other celebrations as well. Now we have to go to Kapkot (closest town) to submit the bill, it takes a whole day to go, deposit, come back. Now the villagers understand the importance of our project. Now they scold us again that it is your/EMC's fault that you gave up the project administration to UREDA, earlier as well, when we administered the project, the villagers used to scold us for not providing good service. We (EMC) were troubled, no villager wanted to contribute or join the Samiti. We made the project ourselves, that is why we took the responsibility to run it despite the issues with villagers, had we not made it we would have not taken the responsibility for this long. If people took responsibility for the project, there was no chance that we would have opted for UPCL connection.*

Earlier villagers paid Rs.50 for unlimited usage, now they are getting troubled with Rs.300-400 bill per month. But people took advantage earlier; they used 10-15 bulbs, sometimes heaters, geysers, etc. People even kept bulbs lit in daylight. So, we got frustrated and asked for a new Samiti, but no one came forward.

Pad Singh Padma (Yangthang) said, *"My son is getting married in 10 days, I cannot say for sure if there would be electricity for the functions, grid power is unreliable. Had our project been working, we could have diverted the project electricity for the celebrations and paid a little extra for it."* In a group interview at one of the hamlets that is part of the Lamabagar project, an interviewee replied in response to a discussion about people being unhappy with grid power:

Yes, many people don't have meters and get random amount of bills. Even people with meters get bills that are way higher corresponding to their usage, this should not happen. Also, we deposited the security money for meter installation but the officials say that the money has lapsed, we have to pay again as the contract of the previous contractor has been canceled/terminated and a new one has been allotted. There is no one accountable.

Ms. Kamla Devi at Jakh village (Ramgaad) commented on some benefits of local hydro production:

We had the option of getting grid electricity, but we chose our own project as maintenance and complaint resolution is very easy here. When we have a problem in our meters, operators come in a day or two to resolve the issue. Had it been the grid line, we might have to wait for months. The reason being that, the people who work in our project are from our villages whereas UPCL employees might be from distant places.

She added, *"UPCL mein sunvai bhi kam hoti hai aur utna door hum jaa bhi nahi paate hain.* (Translation: *Our grievances won't be heard at UPCL's office and it is hard for us to travel that far away from our village.*)

In a group interview at Toli, talking about the villages that were under the local project but have now shifted to UPCL connections, a participant villager said:

They (the other villages) are troubled, because if we have any issue in our connections, *our operator repairs it the same day, but they (the other villages) have long lines now and finding the fault and repairing it takes time, sometimes many days. But the other villages get electricity during the day as well, so that is the only benefit. We have Rs.600 security for a new connection under our project, it was 300 earlier, UPCL consumers pay 1600 for a connection and per unit rate is also higher there.*

Nassir Hussain (school teacher, Bartoo) indicated further:

Some villages have electricity connections from the bigger projects, but at times the production capacity of those projects is low and thus the villagers don't get the supply. These sorts of small projects are good and can be managed easily. Bigger projects have bigger problems. You have to call the govt. employs for repairs; they sometimes come, sometimes don't. So, the more limited the area the better managed the project.

Many of these issues are related to the remote and mountainous nature of this area of India, which is illustrated in a quotation from the UREDA website that promotes small hydro as a solution:

> Most of the area in Uttarakhand is hilly and forest coverage is about 66%. Villages are in scattered manner and household coverage in a village is short. In this situation, either it is not possible to lay grid lines due to forest laws or due to high cost of coverage. Operation and maintenance is also an issue in this pattern. As a solution of this problem- Decentralized Distributed Generation (DDG) Micro & Mini Hydro Projects are suitable and best way to provide electricity facility to the forest fringe and scattered villages. Operation and maintenance of Standalone MHPs can be done in easy manner by local community after a formal training. (Uttarakhand Renewable Energy Development Agency, n.d., p.1)

The experiences these remote villagers described and reservations they have about the grid connections reflect my experience as well. As noted in the interviews and quotation from UREDA above, the repair and maintenance work for the grid connections is difficult because these areas are very remote, have rugged road accessibility, and are prone to floods, landslides and heavy snow. According to respondents and based on my observations in the field as well, the grid power goes out often and can take a long time to repair, especially in winter. Further, long transmission lines do not seem to be a practicable option in this mountainous region for the reasons I have established above. However, with local micro-hydro projects, the villagers have autonomy regarding how to operate their projects and can control the tariffs as per the paying capacity of the villagers. The villagers in these remote locations acknowledged these issues and thus are more inclined towards running their own projects as opposed to getting grid electricity. People that I spoke to said that only those who are relatively comfortable economically compared to the other villagers tend to be neutral or positive towards grid supply.

4.5 Chapter Summary

The focus of this chapter was on providing details of the region and the micro-hydro projects considered in this study. I also presented the results related to the mode of small hydropower generation in these Himalayan states and the viewpoints of the villagers related to their projects. Hydropower generation in the form of small, run-of-the-river projects is on the rise in the northern Himalayan states of India, although the mode of development varies from state to state and depending on the category under which the project falls. In some cases the government acts as a proponent of the project, whereas in others it is left to NGOs. Similarly, sometimes the private sector is responsible for project construction and sometimes it is a collaborative effort of an NGO and the villagers.

In Ladakh, most of the present community-based projects were made with the help of LEDeG, and as mentioned earlier in chapter 4, many of them are no longer functional with low chances of repair. Meanwhile, the new projects that are being developed in the area have no involvement of the locals in any stage of the project. During my consideration of potential case study sites in HP, I found that projects did not have significant or any community involvement. The state has a privatized growth model in the small-hydro sector that requires a big investment that is not possible for local villagers. Overall, UK is the state with the most projects having local community involvement and the most projects providing local electricity, although a boost to privatized growth in the small-hydro sector has been seen in recent years vis-à-vis the community-based projects. Some case studies in this research now have access to grid electricity, and although some villagers might find it better, a majority of the village interviewees preferred having power from their own local project. While grid electricity should be available at all times, it has been seen that these villages get an unreliable supply, repairs are slow and there is a lack of accountability in the overall service.

The practical unfolding of the new policy on small hydro up to 2 MW by the UK government should be interesting to watch. It remains to be seen whether private entrepreneurs will make their way into the new small-hydro sector or if the local villagers be able to take advantage of this government initiative.

Chapter 5 – Exploring the Sustainability Benefits and Learning Outcomes associated with Micro-Hydro Development

5.1 Introduction

This chapter presents results related to the sustainability benefits and learning outcomes identified in my case study projects. Sustainability was analyzed under socio-cultural, environmental, economic and health considerations. Each category had various parameters associated with it that were established through my literature review and embedded in the interview questions, and data related to these were used to tease out the sustainability benefits associated with the projects. Results were found related to new economic activities, home lighting, social changes, environmental compliance, land acquisition and compensation, changes in wood use, etc., and are discussed in this chapter.

Learning outcomes from participation in micro-hydro development and use were also identified in the interviews and through personal observation in the field. Apart from the general villagers, focus was given to understanding the learning outcomes of people directly involved in micro hydro, such as project operators, EMC members and participating NGO officials. Learning was analyzed as part of social sustainability.

5.2 Sustainability benefits

In order to gather data on the sustainability parameters established, I used documents, on-site observation and interaction and interviews with villagers and people relevant to the study. Region-specific considerations, such as social settings and local economics as established in documents and through discussions with locals, were also kept in mind while drafting and modifying the parameters.

5.2.1 Economic Sustainability

A number of indicators of economic sustainability were identified in the data and are used in organizing the presentation of results below. The economic sustainability of the projects considered was analysed with the help of these indicators, these are, i. Issues of land compensation, ii. Job creation, iii. Power plant load factor, iv. Increased economic activity and, v. Project economics, which are also outlined in Appendix C. The projects that were studied in this research had varying levels of economic sustainability associated with them. Some of the projects were non-functional in part due to economic reasons. The details of the findings under these indicators include**:**

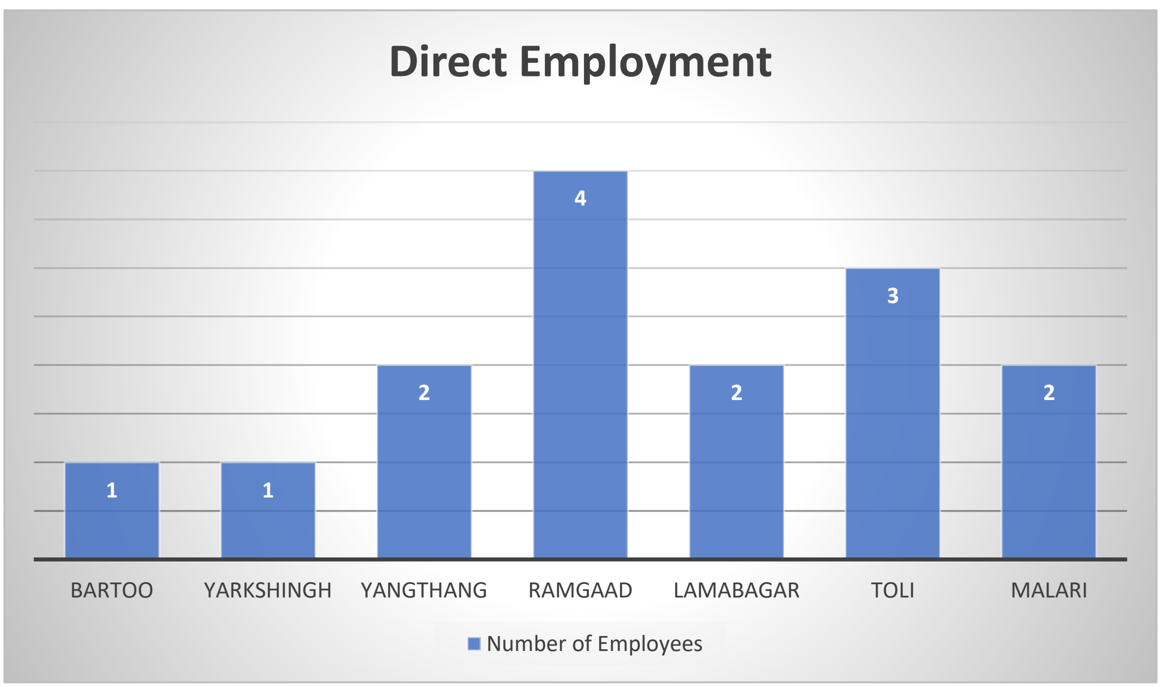
i. Issues of land compensation (satisfaction of people with compensation)

None of my participants at any of the case study sites seemed dissatisfied with the compensation they had received for their land being used for the power house or the penstock. At Bartoo and Yarkashing (the projects developed by LEDeG), the land was not officially bought from the owner, but rather they donated the land for the project, and in return the landowner or an adult male from his family were trained and appointed as the operator with a fixed, regular salary. According to respondents, this arrangement has been fruitful. The operators sometimes demand an increase in their salary, but apart from that there was no resentment or complaint regarding inadequate compensation for land. At Yangthang, Toli, Lamabagar and Malari, the land for the projects was village land and so not subject to compensation. At Ramgaad, one family had to stop practicing agriculture on a patch of land as that land was chosen for the powerhouse. The land was the property of the forest department so there were no issues in its acquisition or with compensation.

ii. Job creation

Although not high in number, the projects did create permanent employment at all case study sites, as shown in Table 4. Apart from this direct employment, some projects also created indirect employment. For instance, at Ramgaad, two mobile towers get electricity from the project, which employ four local men as security and maintenance personnel. Each of the milk committees of the villages involved in the Ramgaad project has a secretary that is trained to measure the fat content and other such indicators that help to determine the per unit price of the milk and milk products. Electricity from the project is needed to carry out these tasks. The secretary has a fixed monthly salary that is paid by the milk committee. At Lamabagar, Mr. Madan Lal (former operator) had set up a small tire repair and welding shop that used to get its electricity supply from the local project.

Table 4: Direct Employment at Case Study Sites



iii. Power plant load factor

A big economic drawback was that, except for Ramgaad, the projects were not being used to their optimum capacity. The plant load factor was very low at all the projects (except Ramgaad), irrespective of whether they are independent or supported by UREDA or some other agency. According to UREDA's Project Officer, Hydro, Mr. L. D. Sharma,

> *There is no economic activity in the villages that use electricity and that is a major problem. Due to this, the PLF (plant load factor) of the plants is also going down. People use electricity at night for lighting and occasionally in the morning, that's it. There is no other use of the projects.*

At Yarkashing, there is an electric Chakki (flour mill) owned by the operator, which replaced a traditional water-powered mill (Figures 20 and 21). He charges Rs. 50 per quintal for cereal grinding. The old mill took a whole day for the work that can now be done in an hour, as an EMC member, Mr. Ghulam Mohammad, described: *"We have a local water run chakki (flour machine) in our village. There is a huge difference between the two chakkis. At the water run chakki, one bag of grains used to take an entire day to grind but now with the electric chakki it takes only a few minutes."* Villagers from Broke, a nearby village, also come to grind their grains at the village flour mill. Yarkashing also has a community water heater that is used in the local mosque for drinking and bathing purposes in winters (Figures 22 and 23). The project operator indicated a desire to buy a washing machine and charge a fixed sum per load, but he thinks the current power generation is not sufficient to support this.

Figure 20: Traditional Grinding Machine (Source: Gurmeet Singh Ghera)

Figure 21: Electric Flour Machine (Source: Gurmeet Singh Ghera)

Figure 22: Community Water Heater (Source: Gurmeet Singh Ghera)

Figure 23: Community Bathing House (Source: Gurmeet Singh Ghera)

The primary reason respondents gave for not using electricity for activities other than lighting and television was to keep from putting the project under any sort of risk and/or overloading the system. For example, Md. Isacc at Bartoo observed that *"LEDeG said that you can use chakki and other machines, but we decided not to use it for anything else apart from lighting and television, because in case the project machinery burns or stops working, where will the money to repair it come from?"*

On the other hand, at projects like Lamabagar there has been a surplus of power since the project started. According to some interviewees, it is a lack of interest and/or awareness and motivation that are the major reasons for the lack of economic activity or electricity use. For example, Mohan Singh from Lamabagar felt that *"if people in our village were educated and* *trained, they might have done something, but here they are uneducated, nobody took any interest in utilizing the project. The potential is there if people wanted to do something."*

iv. Increased economic activity (new activities/already existing activities)

Although new economic activity from the available power was negligible, the time available for people to carry out their existing activities has increased since they got power, as illustrated in the quote below.

> *We can now process the wool of Bhedu (fur goats) at night. In the daytime, we can do outdoor work and work indoor at night. Earlier we had to knit everything in the day along with other work, resultantly we barely met our requirement. But now we can work at night as well, now we have enough time to knit enough woolen wear for everyone in the family. All villagers who invest their time in such activities have been benefited (Mrs. Banu, Bartoo).*

It was also noted that looking for missing cattle, night time irrigation and working in the field has been made easier with lighting. Milk production and selling is a traditional activity in rural India, and at Ramgaad, with the help of electricity, the villagers have shifted to automated machines for testing the fat content and weight of milk (Figure 24). As opposed to before, villagers now get paid according to regularized standards. According to Kamla Devi (village head, Jakh),

> *Now there is minimum wastage with electrical machines, earlier with manual measurement of fat and weight we used to lose 100-200 grams of milk every time and we didn't really get the price based on our fat content.*
> *We have fruit orchards here, if we pluck the fruits in the daytime, we can pack it up in the night and it gets ready to be transported the next morning. This was hard to do earlier.*

Figure 24: Equipment Used for Standardized Milk Selling
(Source: Gurmeet Singh Ghera)

At Yangthang, the villagers extract almond oil, which is considered an expensive commodity, and also sell dried apricots. According to the head hydro project operator, Mr. Tashi, *"Mr. Yogeshwar asked us to use the electricity for carpentry tools, use oil expellers. We can use* *our project for many things. Alchi Power project's electricity is meter based, this was our own electricity, we can use it day and night. But the villagers don't take any interest."*

At Toli, it was noted that aging machinery, loss of customers and minimal electricity usage are negatively affecting the EMC's finances. Commenting on the EMC's inability to make a profit and its depleting savings, operator Diwan Singh said:

> *Earlier the machines were new, they did not need any repair, lines were new, thus fewer transmission losses, fewer repairs of poles, wires, etc. The line is 48 km. in length, so now it needs repair at one place or the other. Also, two villages have taken direct UPCL electricity and disconnected from our project, so Rs. 6000-7000 has reduced in billing. All the billing that we get now goes into repair and maintenance and salary. That 7000 would have been EMC's savings.*

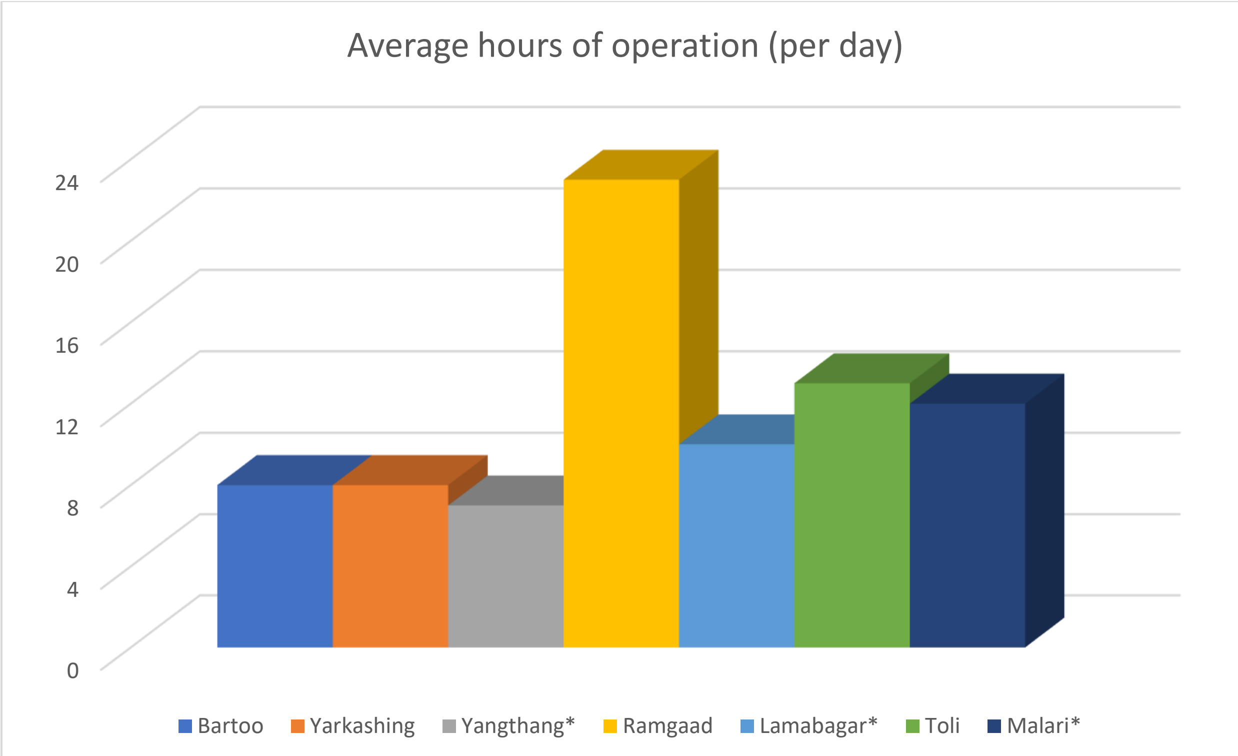
The Toli project also has a coal making plant (Figure 25) provided by UREDA. The idea behind the plant installation was to generate charcoal from locally available wood and sell it. However, the plant has been lying idle since the village got it. There were some initial glitches while running it and it seems that an effort to run it again has been lacking.

> *I thought that we could have an electric flour machine and pond for fishery at the powerhouse so that operators could be paid for the whole day and there will be some income generation, but nobody comes forward. If people want to do, there can be a lot of things done. There's a 5-6 lakh coal making machine, I told them to use it otherwise sell it and use the money for the Samiti. They invested 40-50K in making the shed for the coal machine and it is standing just like that.* (Kashmiri Lal, Ex. EMC President, Toli)

Figure 25: Coal Making Plant, Toli (Source: Gurmeet Singh Ghera)

As shown in Table 5, with the exception of Ramgaad, most of the projects operate 12 hours or less a day. Ramgaad is able to operate almost 24 hours a day because it provides electricity for home lighting at night and sells electricity to the grid during the daytime. The other projects use electricity only for home lighting, which is mostly needed during night time. Plants would have to operate close to 24 hours a day to generate new economic opportunities and surplus finances.

Table 5: Average Hours of Operation



v. Project economics (financial self-sufficiency and repair capacity of EMC)

A difficulty that many community-managed projects face is the constant generation of money to keep the project running. At many of the case study sites, including Bartoo, Yarkashing, Toli and Malari, there are no avenues for employment apart from agriculture, which is usually subsistence in nature, and occasional labour work, thus resulting in villagers having low financial capacity. At a group interview in Toli, one of the participants commented:

> *People don't use much electricity, so the income is not much for the EMC. Also, there are many poor people in the village who can't even afford food properly, if we use electricity for 24 hours a day, the salary of the operator will go up and we'll have to pay higher bills and that is not feasible.*

Others noted the desire for around-the-clock electricity, but at the same time acknowledge that it might be difficult for them to pay for. They felt that due to the poverty of the villagers there are few businesses that would require electricity unless they can export the goods outside the village. As a result, after collecting usage bills, paying the operators and buying regular operation and maintenance parts, the projects do not generate net savings. In cases when there is a major breakdown that requires extensive repair, the money required is likely not available and the plants simply shut down.

Presently, the Ramgaad project generates sufficient funds for the salaries of the operators and minor repair and maintenance work only. Until a few years back, when the river flow remained sufficient throughout the year for maximum electricity generation, the EMC was able to accumulate regular savings. The head operator mentioned, however, that low river flow over the last few years has led to a depletion of the EMC's account, as they were sometimes unable to generate the power required even for home lighting and had to buy electricity from the grid. With respect to the difficulty in maintaining EMC savings, Ghulam Mohammad (EMC member, Bartoo) noted:

> *The bill collection is not that much. Even If we save something, it will be Rs. 1500-2000 per year. Even the person who comes from Kargil to fix the armature takes Rs. 4000 for one visit, so there is no real savings. Carbon brushes get worn out fast, 3-4 per month, so there are expenses like these and there is no net savings.*

Table 6 provides details about the financial state of the projects at the time of the research. Both the Bartoo and Yarkashing projects are managed exclusively by the villagers. Bartoo, being the home of the local councilor of the area, sometimes gets financial help from the councilor in the form of monies from the constituency development fund. During the fieldwork, Yarkashing's EMC was repairing the project with their own finances, and they often take an extra contribution from the villagers for repair and maintenance. The Toli and Lamabagar projects have also had problems related to finance. Toli has a nonfunctional turbine that the EMC is not willing to spend the money to repair, and Lamabagar struggled with monthly bill collection and did not have sufficient finances to remake a concrete diversion for the canal. Malari, until the time it closed, occasionally had difficulty in collecting the money for the salary of the operators and for repair and maintenance.

Table 6: Project EMC Accounts

Project	EMC Savings	Source of Information	Comments
Bartoo	Unaccounted	Villager Interview	No bank account. Apart from bill collection, villagers contribute money when needed.
Yarkashing	None, at the time of data collection	Operator and EMC member	EMC does not have a bank account. Most of the collection is used for maintenance. If EMC has money, it pays for repair, else villagers contribute.
Yangthang	Unaccounted	Pad Singh Padma (EMC member)	Since the EMC has been dissolved for a number of years, there is no record or information if there is/was any savings.
Ramgaad	Rs. 1.5 - 2 lakh	Head Operator	The savings are under a bank account in the nearby town of Garampani.
Lamabagar	NIL/Unaccounted	EMC head	Since the project has been nonfunctional for a few years there is no record of EMC accounts.
Toli	Rs. 2-3 lakh	EMC head	The project has a bank fixed deposit of Rs. 2 lakh and a running account for regular expense.
Malari	Nil	Village head	The project was not able to accumulate any money as EMC savings.

Some respondents said that even if the villagers can spare some extra contribution for the project, it is hard to get them to do it. For instance, at Yangthang almost every household has someone working in the army and so are able to earn money to comfortably support themselves, and some households have cars as well. Thus, generating village-level finances to make the project functional again should not be a big issue, but some felt that a lack of motivation and leadership are hindrances – *"There is no leadership in the village. No one listens to the sarpanch (village headman)"* (Mr. Tashi, Yangthang).

Table 7 shows a summary of the findings regarding economic sustainability in each of the projects considered in this research.

Table 7: Economic Sustainability of the Projects

ECONOMIC SUSTAINABILITY					
Project	**Issues of land compensation**	**Job creation**	**Power plant load factor**	**Increased economic activity**	**Financial self-sufficiency**
Bartoo	No	Low	Low	Low	Low
Yarkashing	No	Low	Low	Low	Low
Yangthang	No	Low	Low	Low	Low
Ramgaad	No	Low	High	Low	Medium
Lamabagar	No	Low	Low	Low	Low
Toli	No	Low	Low	Low	Medium
Malari	No	Low	Low	Low	Low

5.2.2 Environmental Sustainability

The environmental sustainability of a project plays a vital role in its overall long-term sustainability. A number of environmental indicators were identified in the data, around which the presentation of the results below is organized. These included, i. Adequate/inadequate flow in the stream from diversion to the tailrace, ii. Immediate and long term construction impacts, iii. Project safety and other climate related concerns and, iv. Change in wood use. These indicators are explained in details below**:**

i. Adequate/inadequate flow in the stream from diversion to the tailrace

In terms of the flow of associated rivers, all projects seemed to have adequate river flow from the diversion to the tailrace. None of the participants of the focus groups or interviews had any complaints regarding a lack of irrigation water or water availability for other uses. Rather, at places such as Bartoo and Ramgaad the developing organization made provisions for community taps and small irrigation canals. As Mr. Lakshman Singh (Former Treasurer, Ramgaad) said, *"People who were irrigating their fields from this rivulet were assured of continued irrigation and that has been given to them without any problems."*

ii. Immediate and long term construction impacts (debris, damage to crops, fields, deforestation, impact on fisheries, water quality)

In terms of the immediate impacts from construction, there was no significant damage reported or observed to the fields or crops in the villages. Mr. Nassir Hussian at Bartoo said:

> *I don't think there is any negative effect of this project, there are only benefits. Had there been a diesel generator set instead of this project, there would have been a negative effect on the environment. This is a pollution free project, it comes under sustainable energy. There's no big danger and congestion due to this project, there are no life-threatening dangers.*

There were no visible piles of debris or construction residue seen at any of the case study sites. Commenting on whether the project had any effects on the quality of river water, Mr. Bisht at Ramgaad observed: *"I think the quality has reduced over time in general, not because of the turbine and the project."* Regarding impacts of the project on fisheries, the erstwhile President of Ramgaad EMC claimed that, *"This project does not have any negative environmental effects, fishes in the nallah died because of insecticide use in the fields and the catchment area of the nallah, moreover the water level is so low nowadays, the fishes won't be able to survive."*

Some tree cutting was done on personal land at some of the case study sites to make way for the penstock and power house, but as the following quotations illustrate, the owners considered it as a step necessary for gaining something better for the community.

> *Trees had to be cut, sand and stones were dug and thrown away, but the benefit is more than the harm.* (Md. Ibrahim, Yarkashing)

> *I don't think there is any negative effect, instead there is a positive effect. Trees and vegetation have grown naturally along the project canal.* (Mr. Bisht, Former EMC member, Ramgaad).

iii. Project safety and other climate-related concerns

Many of the interviewees in the villages complained about the problems they face in the rainy season. At some places it was a minor issue, for example in Toli, where the penstock sometime gets silt and debris in the water and operators have to close the project for 10-15 days due to strong rains and winds –*"In rainy season, wood debris and sand come in the stream and the project remains closed for 10-15 days sometimes. Apart from the rainy season, our project works reasonably well"* (group interview, Toli). In other places, heavy rains and the resultant excessive stream flow are a big issue, for example in Lamabagar, where the diversion for the project canal has broken almost every rainy season since the project started and the villagers had to repair it or reconstruct a new one every time. At Lamabagar, UREDA could not support the project after the diversion broke for the first time and the villagers had to repair it with their own finances. It seems that the diversion was not designed in a suitable place to begin with. Mr. Mohan Singh (EMC head, Lamabagar) described this issue: *"The diversion head is not there, it broke off 2 times and then we did not get money for it, we have made a temporary arrangement. In the rainy season, wood and sand come with immense water pressure, so it breaks. This was the main problem for the project."*

On the other hand, the Ramgaad project is at a good location that in terms of technical and public safety. It did not suffer any major damage even in the 2013 pan-UK floods, apart from some minor canal and forebay cracks and breaks. Rather, the environmental challenge that Ramgaad has been facing is the consistently low river flows in the summer months. As the Ramgaad nallah is rain rather than glacier-fed, its electricity production is directly proportional to the annual rainfall patterns. Due to consistently low rainfalls in the past few years, Ramgaad's production in the summer season has been correspondingly low, in the range of 20-30 kW (as reported by the head operator), and the villagers have had to rely on electricity supply from the grid. Mr. Rawat (Operator, Ramgaad) noted:

> *Right now (Nov. 2017) the water level is low but sufficient for producing 100 kW of power. In summers, as the water level goes very low, we often run only one turbine out of the two. If the rainfall is timely and normal, we can run two turbines even until May, but irregular/low rainfall doesn't allow water to seep in and the river water level goes down.*

Malari lies in a region that is prone to landslides and avalanches, but the location of the project is safe and there has not been any major damage to the power house or other parts of the project.

The Yangthang project is not functioning anymore due to a technical fault in the turbine. The project's powerhouse was recently damaged as a big rock fell on it, breaking one of the walls but doing no harm to the machinery (see Figure 26). There are many big boulders on the slope of the mountain above the powerhouse. This presents a concern for the safety of the powerhouse and the penstock. Some villagers and an operator were also unhappy with the current location of the powerhouse as it is far from the houses and hard for them to operate on a daily basis. Moreover, with the construction of a new canal up the mountain, villagers say that relocating the powerhouse could result in the continuous operation of the project.

Figure 26: Damage to the Power House due to Rock Fall, Yangthang (Source: Gurmeet Singh Ghera)

iv. Change in wood use

At all the case study sites in J&K, wood consumption has undergone little change as a result of the availability of power, perhaps because the use of electricity is restricted as per the EMC guidelines. Forest wood is still the main fuel for cooking and heating purposes. In the J&K case studies, especially Bartoo and Yarkashing, the availability of 'free wood' is the main reasons for using wood for cooking and heating rather than electricity. The availability of liquefied petroleum gas (LPG) cylinders at some of the case study sites in UK, and in other mountain areas, has lowered the use of wood for cooking purposes, but electricity has played no role in this. Still, many households prefer the use of wood over LPG because they cannot afford the LPG cylinders, some are afraid to use it and, most importantly, wood is viewed as a free commodity. People still predominantly rely on forest wood for heating purposes. The opinion of an interviewee at a group interview at Toli, to which other participants nodded in agreement was that, *"Electric heating and cooking equipment are expensive and we'll have to pay larger hydro bills. We have free, dead wood all around us, why would we not use that?"* Further, Dev Kishan Budlakoti (EMC head, Ramgaad) and Subedar Major Bargali (Former EMC head, Ramgaad) said, respectively:

> *People still use wood for cooking, as LPG cylinders are not readily available and we have to carry them to the town, many people use the cylinders for emergency and use wood for regular use, the poorer people cannot afford LPG, so they use only wood.*
>
> *People don't use heaters for warmth in winters, wood is still used for that purpose, maybe in big cities they use heaters, but not in the villages. Making coal and taking heat from it is better than using heaters.*

The DPR of the Lamabagar project says that electricity will help the villagers in their domestic household areas. It was also noted in the DPR that the use of electricity for heating and cooking will reduce dependence on forest wood. However, contrary to what the DPR predicted, the use of electricity for heating and cooking is highly uncommon throughout the village and most continue to burn wood (e.g., Figure 27).

Figure 27: Wood Stove in a Household Kitchen at Lamabagar
(Source: Gurmeet Singh Ghera)

Table 8 shows a summary of the findings regarding environmental sustainability in each of the projects considered in this research.

Table 8: Environmental Sustainability of the Projects

ENVIRONMENTAL SUSTAINABILITY					
Project	**Diversion to tailrace flow**	**Construction impacts**	**Project safety**	**Climate change concerns**	**Change in wood use for heating and cooking**
Bartoo	Adequate	Low	High	Low	Low
Yarkashing	Adequate	Low	High	Low	Low
Yangthang	Adequate	Low	Low	Low	Low
Ramgaad	Adequate	Low	High	High	Low
Lamabagar	Adequate	Low	Low	Medium	Low
Toli	Adequate	Low	High	Low	Low
Malari	Adequate	Low	High	Low	Low

5.2.3 Social Sustainability

Social sustainability promotes the wellbeing of locals and creates healthy communities. I was able to identify a number of social indicators of sustainability in the data, which are used to organize the presentation of the results below. These include, i. Local acceptance of the project, ii. Equitable distribution of electricity, iii. Gender involvement in project management, iv. Long term benefits and, v. Democratic decision making. These indicators are explained in details below:

i. Local acceptance of the projects

A major benefit argued to be associated with community-based micro-hydro development is that it is for the people, of the people and by the people. I found that the projects where community involvement is meaningful generally tend to inculcate a “we” feeling among the people towards the project, as the group of people/villagers regard the project as their own.

Problems that have been observed between villagers and private developers, such as the lack of adequate compensation and harm to local ecology observed by Sinclair (2003), Baker (2014) and Kumar & Katoch (2014), were largely absent in these community-based projects.

Although local acceptance and the feeling of it being ‘our project’ should be an inherent part of community-based projects, it is not always the case. At Bartoo and Yarkashing, this feeling was prominent, as was evident from the efforts the villagers make to keep the project running. However, at Yangthang the shared feeling of the project being their own was largely absent. The continuous stress and bickering amongst the villagers and the operators also showed the lack of a united effort to run the facility. Project Operator, Mr. Tashi commented:

> *If there was no light, villagers used to yell at us without understanding the reason behind it. Sometimes in the lean season, there is not enough water to run the project throughout the night, even so, the villagers blamed us that we are not doing our duty, so we won’t get paid either, there were issues like these*.

At the projects made by UREDA, considering the project as their own was mostly limited to the EMC members. Although Lamabagar was developed with extensive involvement of the community, it failed to unite the villagers in the management of the project. The Toli project had a good degree of village acceptance and cooperation. The understanding amongst the villagers, operators and EMC members has been good since the project started. Malari displayed a high level of public acceptance for the project as the villagers even paid extra money in addition to their bills to keep the project running, and according to the village head there were no problems among the villagers, EMC members and operators.

ii. Equitable distribution of electricity

My data indicate that the distribution of electricity and benefits was equitable at all the case study sites. Everyone had access to power, if they could pay for it. In the state of UK there is a caste divide in society (as opposed to Bartoo and Yarkashing where all are Shia Muslims and Yangthang where all are Buddhists), yet there was no discrimination seen in the distribution of electricity or electrical connections. Only people who did not pay their bills over a prolonged period of time were denied electricity from the project. Two households at Ramgaad did not have an electricity connection due to non-payment of bills. At Malari this could not be directly observed, as most of the villagers had already migrated down the mountains, but in an interview Mr. Bachan Singh (Village Head) commented that there were households where power had to be shut off due to lack of bill payment. At many sites the penstock passed through crop fields and personal land, but land acquisition was not an issue in any of the cases in this study, as opposed to what has been noted in many private hydro developments in the state of HP (Sinclair & Diduck, 2000).

iii. Gender involvement in the management, role of women and other benefits

From a gender perspective, Bartoo and Yarkashing had women as active EMC members. Since the inception of the EMCs at both sites, at least two members of the EMC have always been women. In the UK case studies, I found there was low involvement of women as well as the lower castes in project EMCs. The only female EMC member observed was the first-time elected Kamla Devi at Ramgaad. She observed that *"Since the project started, meetings were arranged but we women did not used to go, but now when we women are getting empowered, we go to meetings and take part in village affairs".*

Lamabagar's EMC had a member from the Scheduled Caste (i.e., lowest caste) and a former army member out of a total of seven, but no female members. Participants said that the lack of female involvement in the management of these projects may be the result of the lack of interest of the women in the villages towards the projects. However, the women I spoke to were interested and felt that, in general, electricity has helped them distribute their workload throughout the day. Now they do not feel they have to rush things and complete all their household tasks before sunset. On asking what the main benefits of the project are, Ms. Nargis Banu at Bartoo said:

> *There are numerous benefits, light has made us go far away from darkness, old people can walk easily at night without the fear of stumbling and injuring themselves. Earlier whenever there was a function/celebration there was no light and it was very troubling; candles and lanterns were not sufficient. Now functions are celebrated nicely and freely, walking at night is way easier. I am being benefitted a lot, my children can study at night and whenever they want. I don't have trouble anymore while cooking in the evening; I can cook later in the night as well.*

There was some psychological empowerment noted from being associated with the micro-hydro projects as well, as illustrated in the following quotations from interviewees.

> *A few years back it was like we were on the moon, after Joshimath there was no electricity in any area till the China border, but Malari was lit with electricity at that time, we were in heaven back then.* (Bachan Singh Rana, Village Head, Malari)

> *We feel like our home has become the abode of gods since electricity came.* (Bhuvan Chand Joshi, EMC member, Ramgaad)

> *It is our own project, run by our own people. People at other places crave for such projects and we have one in our village.* (Laxman Singh, Former Treasurer, EMC Ramgaad)

On asking “Did you face problems in the rainy season?”, Mr. Bachan Singh Rana at Malari replied, “*No, not in the rainy season but in winters, but we had trained linemen to take care of it. Sometimes the canal broke but we were so proud of our project that we managed to repair things by one way or another.”*

To me, the empowerment experienced seemed proportional to the individual’s level of engagement in the project. At projects like Bartoo, where all the villagers were involved from the construction stage of the project and were consulted before that as well (although in a limited fashion), a sense of community pride in the project was present, whereas in projects where only a handful villagers are involved, such as Ramgaad, this feeling is largely absent. Only a few EMC members and handful of villagers in Ramgaad indicated a sense of pride or similar positive feelings towards the project.

I felt that in villages where social cohesion and the level of cooperation among the villagers on various issues was relatively low, the hydro plants were not running and functioning properly. Social cohesion in this context means not only cohesion among the villagers but between the villagers and involved NGOs and government as well. For instance, at Ramgaad intra-village cohesion was low, but EMC-government cooperation was high and so the project was working. At Bartoo, intra-village cohesion was high but village-government cohesion was low and the project was still working. At Yangthang, both intra-village and village-NGO/government cohesion was low, and resultantly the project was not working, although the presence of grid electricity was also a significant reason for the lack of repair and operation of the project.

iv. Long term benefits

During the daytime light is not required in these villages but it is important at nighttime, especially for study purposes. For example, in Bartoo where girls of 10th standard (i.e., grade 10) live in a temporary hostel and study at night time (Figure 28), lighting has had a multifaceted impact on their lives. In these rural communities girls are more likely than boys to drop out of school due to the established societal norms that emphasize women's role is to take care of the household. The chances of dropping out of school become higher if they do not perform satisfactorily on their exams. Thus, having access to light to study in the evenings, in addition to the educational benefit, adds support to a social change regarding women's roles. It was seen that many women in the case study areas were in their early 20's and already had children aged four to five years old. But some girls presently in the 11th and 12th standards want to continue higher education, thus highlighting the potential change in the present generation of teenage girls. A local school teacher at Bartoo highlighted that the results of the students are getting better every year, and he credited home lighting for this change.

Figure 28: A Night Class for Girls at Hostel, Bartoo (Source: Gurmeet Singh Ghera)

It is also clear that people have become more aware of the outer world with the help of radio and television. The quotes below demonstrate the importance of this to local villagers.

> *We get to know a lot about the world from TV, like our Prime Minister, Mr. Modi went to Canada, what happened there on his visit.* (Mr. Bisht, Former EMC member, Ramgaad)

> *Watching TV is beneficial, children who study these days get help from TV, get to know more things.* (Md. Yusuf, Bartoo)

> *Children benefit in their studies, kitchen work has become easier, we watch TV and get to know what is happening in our country and around the world.* (Prem Singh Rawat, Operator, Ramgaad)

When we watch television, we usually watch it together, children study till 11-12pm in the night. News helps us to learn a lot about the outer world. So there are a lot of benefits. (Md. Ibrahim, Operator, Yarkashing)

v. Democratic decision making

Governance of the micro-hydro project since its inception serves as an important indicator of social sustainability. Although the community-managed micro hydros have local villagers involved in the decision-making process, in the context of sustainability these decisions should be democratic and deliberative in nature. In this research it was found that the involvement of the communities in governing their respective projects did not follow the same pattern in every case. At some sites the community members beyond the EMC were involved in maintaining the project, whereas at others the non-EMC community members had never participated in any project-related activity. The projects that were in running condition had a more active micro-hydro-oriented community compared to the non-working projects.

Table 9 shows a summary of the findings regarding community involvement in each of the projects considered in this research.

Table 9: Community Involvement in the Projects

COMMUNITY INVOLVEMENT				
Project	**Planning**	**Procurement**	**Construction**	**Operation & Maintenance**
Bartoo	No	No	Yes	Yes
Yarkashing	No	No	Yes	Yes
Yangthang	No	No	Yes	Yes
Ramgaad	No	No	No	Yes
Lamabagar	No	Yes	Yes	Yes
Toli	No	No	No	Yes
Malari	Yes	Yes	Yes	Yes

Bartoo

The residents of Bartoo village, with their local councilor as their representative, approached LEDeG to build a hydro project in their village. Project planning was mainly done by LEDeG. Respondents indicated in interviews that the villagers were not involved in the designing and planning phases of the project, although suggestions and views were taken from the villagers regarding potential sites and water availability and annual flow patterns at those sites. LEDeG provided the technical support and the large components of the project, such as the turbine and the penstock. All poles (Figure 29) for transmission lines were made locally with wood available in the area. Villagers had to arrange sand, cement and stones at their own expense and carry the machinery and penstock for several kilometers as there was no road to the village when this project was being constructed. All the labour work was done by the villagers for free under the supervision of LEDeG officials. As per various interviewees, the construction days on the project ranged from 40-60. Mrs. Banu (villager), simply stated that "*We kept on working on the project till there was light in the houses.*"

Figure 29: Locally Fabricated Wooden Pole, Bartoo (Source: Gurmeet Singh Ghera)

Some skilled labour work was also done by the villagers, e.g., Md. Yusuf, a local villager worked as a mason. There was no exclusive division of labour between men and women, but the work that required heavy lifting was generally done by men. At least one person from every household contributed to the work, as Ms. Hamida (villager) indicated, *"Work was allotted* *randomly; everyone did all sorts of work. Only heavy lifting and carrying was exclusively done by men."*

Documents reviewed and comments from respondents indicate that the villagers were involved in most of the project building process and have been entirely responsible for the operation and maintenance of the project since its commissioning. In winters, five to ten people (usually one from each household) take turns maintaining the project. This maintenance mainly includes clearing out accumulated snow in the canal, breaking the ice, and removing leaves, wood and other debris. The operator tells the committee when help is required and the committee spreads the message to the villagers. Committee members also take part in the physical maintenance of the project. In addition to their electricity consumption charges, whenever there is a fault that is beyond the monetary capacity of the committee's savings the villagers contribute cash and physical help, for example, taking a part from the turbine to Kargil city for welding. Moreover, the area councilor of Ladakh Autonomous Hill Development Council (LAHDC) is a resident of the village, and he also personally contributes a little extra towards the project as well as from his Constituency Development Fund when possible.

Yarkashing & Pangbar

Since the project at Yarkashing was made by LEDeG as well, it was based on the same principles of community involvement as in Bartoo. The planning phase was carried out by LEDeG. The sand and stones for the powerhouse, forebay and other construction were excavated locally. The area councilor (the same as for Bartoo) gave monetary support that helped in procuring wires and other relevant material for the project. The village itself is even more remote than Bartoo, so greater effort was put in by the villagers to bring the machinery and penstock to the project site. As one of the EMC members, Mr. Ghulam Md. indicated:

There was no road connectivity to our village at that time. Approximately 10 kilometers before our village the road stopped. We carried all the machinery, wires and penstock on our shoulders and backs. We made a wooden stretcher and 8 people carried the generator on it. Some people even developed a chronic back problem due to that. After that, we brought stones to make the powerhouse and did other labour work. We did all this because ours is the most backward area in this region, there was no light and till date, there is no chance of getting electricity from Kargil. In winters we get cut off, there is four to five feet of snow everywhere. That is why electricity was important for us.

The project is operated and maintained by the villagers, and the operator is a local villager on whose land the power house was built. An extra monetary contribution, when required, is collected from the villagers for operation and maintenance.

Yangthang

The villagers at Yangthang did not know anything about the project until Jansamarth came and briefed the villagers about a grant for the proposed project. All the project planning was done by Jansamarth, and all the material was made available with state funding and no contribution in cash was required from the villagers. The early contribution of the villagers was mainly in the form of work as unskilled labourers. All the technical personal and skilled labour were arranged by Jansamarth from outside the village. The villagers were paid, but not for the entire duration of the work. Jansamarth trained two volunteers from the village in the operation and maintenance of the project at a workshop in New Delhi for two weeks, and these two individuals then ran the project (Mr. Tashi, Operator; Yogeshwar Kumar, Jansamarth). After the funding stopped, the villagers were wholly responsible for the operation and maintenance of the project. Mr. Tashi, one of the operators, described the process:

Mr. Yogeshwar (Jansamarth) brought two or three trucks from New Delhi loaded with machine, cement, iron rods, etc., he brought two or three masons with him as well. The villagers built the canal, carried sand, gravels and did labour work.

Yogeshwar asked for two people from the village to run the project. He said that their salary will come from the villagers. Nobody from the village came forward, then I volunteered for the work. I asked the villagers to decide on the salary. Then I asked Nurbu (second operator) to come along, we went to Delhi for training for a month in how to repair, operate, open and close the machinery.

Ramgaad and Toli

Both the projects at Ramgaad and Toli were built by UREDA. The projects were planned and designed by UREDA and the villagers were not consulted in the design or procurement phases. During interviews with them it seemed that they were not bothered by the fact that they were not consulted. Ramgaad was commissioned in 1990 and Toli in 1999. According to Mr. L.D. Sharma (Project Officer, UREDA), at that time UREDA's approach to micro hydro focused on constructing the project themselves and handing it over to the village EMC for day-to-day operation and maintenance. At both projects, any significant participation of the villagers started only after the construction was completed and project operation had started. Some villagers who wanted to work as labors were able to get temporary employment with the contractor who built the project –*"Villagers that wanted to do the labour work got it"* (Operator, Toli). Both projects are managed by the village Urja Samiti (EMC). The operators are residents of the village and are responsible for the day-to-day operation and maintenance.

Lamabagar

The planning for this project was done by UREDA with the help of AHEC, IIT Roorkee. A committee of nine villagers was formed to procure the machinery and construct and operate the project. As noted in chapter 4, UREDA did most of the work prior to construction. Ordering the machinery and penstock and securing administrative approvals were all mainly done by UREDA. The Samiti authorized UREDA in writing to do these tasks on the village's behalf. However, the committee was informed of procurement and the Samiti head accompanied the UREDA officials for the procurement of the turbine. At Lamabagar, the villagers contributed in the form of labour work and were paid as per the existing daily labour wage at that time. UREDA provided the villagers with a Junior Engineer who administered and guided the construction work. Some labourers such as welders and heavy lifters were brought in from outside, mostly from Nepal, hired on a contract basis. All the other work, including building the diversion canal, powerhouse and forebay was done by the villagers. A technician from Nepal was hired to do all the fittings and four men from the village assisted and learned from him. Two of these men were later appointed as the operators who ran and maintained the project until the time it closed.

Preparing the DPR involves asking the stakeholders some area-specific questions regarding local agricultural practices and livelihood opportunities. Based on such inputs from the villagers, the Lamabagar project DPR noted that there were sustainability benefits predicted for the micro-hydro project. However, it was seen that many of these benefits were not realized in practice. The DPR mentions that the electrification of the area would bring numerous development activities, noting that the working hours of rural folks during early morning and late evening would increase with the availability of electricity. As well, modern commercial and entertainment facilities like radio and television were predicted to bring the entire population of the area into the mainstream of development. The availability of dependable power would create avenues for cottage or mini industries, thus giving a boost to the economic development of the area. Further, with the creation of modern facilities for living, the migration of locals was also expected to be reduced (AHEC, 2005).

As opposed to what was predicted in the DPR, there has been little new development in the village since micro-hydro electrification. Electricity has not replaced wood for cooking and heating purposes, no modern facilities as noted in the DPR were created in the village and, apart from the operators, limited sources of employment have been generated. Facilities such as radio and television have made the people more aware of the outside world, as noted above under social sustainability, but this has also facilitated an increase in migration of youth to the cities. Although Lamabagar always had surplus electricity, as they mostly operated only one out of the two 100 kW turbines and that too was only partially loaded, no cottage or mini industry or enterprise was established in the area and no visible infrastructure development was seen. Only a small tire repair shop was set up by one of the operators. Avenues such as potato and wool processing are present in the village, but have been untapped to date.

Malari

The micro-hydro power plant at Malari was planned by the villagers in collaboration with SPWD. Information was shared between both parties since the inception of the project. Villagers gave input to discussions regarding issues such as the potential power house location and river flow patterns, among other things (Mr. Shrivastava, Engineer SPWD). This process is described in the literature:

> *Information flowed in two directions: between the village (with many of the ideas coming from the late village headman) and the SPWD project officers. The village was responsible mainly for local arrangements, while SPWD handled the business end of the project, negotiated deals with suppliers and obtained necessary regulatory approvals. Information was shared between village leadership and SPWD regularly, and village*

meetings were held where the village population was updated on progress. (McCandless, 2007, p. 94)

After decisions were made, the villagers were informed through meetings of the actions to be taken. The total project cost for Malari was approximately Rs. 19 lakhs (38,000 CAD) and out of that approximately Rs. 10 lakhs (20,000 CAD) was contributed by the community in the form of labour and materials. A village purchasing committee was established who were responsible for machinery procurement. According to Mr. Shrivastava, an engineer with SPWD who worked on Malari project:

> *We gave rights to the village committee, the villagers decided on the purchase of turbines, cables and other equipment. There was a purchasing committee that went from plant to plant and our people went with them for technical support but the final decision of procurement was entirely left to the villagers. Our intention was that the villagers should know what is being used in the project and where can it be found, so that, if in the future they are in the need they can get it and don't have to depend on anyone.*

All the construction work, including canal and power house construction and arranging sand and cement, was done by the villagers. The village head said that their project operators were trained well for running the project, they were taken to Nepal for training and to observe other projects. After the project's commissioning, the EMC did face trouble in paying the salaries to the operators (Rs. 2800 per month each) but they took money from the gram sabha funds and sometimes the villagers contributed extra money in addition to their bills.

5.2.3.1 Learning Outcomes

Learning can be an important outcome of community development and help to foster sustainability, as outlined in my literature review (Chapter 2). Individual and collective actions, for instance, collective effort in maintaining the micro-hydro facility, highlight the role learning played in shaping sustainability behavior in relation to micro-hydro. Learning that occurred resulted in actions that seem to satisfy some basic aspects of micro-hydro sustainability, although, deeper and diverse actions were absent at many case studies. The learning outcomes that I was able to document through my transformative learning lens were associated most clearly with instrumental and communicative learning, as outlined below.

i. Instrumental Learning

Learning that stimulates people to think and apply logical reasoning to solve problems by interacting with their surroundings or environment is an essential component of instrumental learning. In my study, most of this learning was displayed in the form of technical know-how, mainly by EMC members and operators that I interacted with, some of whom had been trained in some way to do their job. Plant operators at all the sites learned skills related to how to run and maintain a small-scale hydro power plant, how to make minor repairs to the plant machinery and how to complete home connections. At Bartoo and Yarkashing, in addition to the operators, the EMC members also learned some technical skills associated with the project operation. This instrumental learning is evidenced in the following quotes.

> *Yes, we have learned a lot. I got to learn about different parts of the machinery, armature, penstock etc. How and when to change a carbon brush, what to do when there is a fault. Moreover, people also get to know how to generate electricity.* (Mr. Ghulam Mohammad, EMC member, Yarkashing)

> *Earlier we did not know how to operate the plant. By being in the committee, I learned how to start the electricity/turbine and close it as well. I learned a little repair work as well, e.g. replacing the fuse. (Md. Isaac, Bartoo)*

> *When people ask us about our project, we direct them to our operators, the operators show them the mechanism of producing electricity, how it is connected to the grid and other relevant information. Children from various schools come here to see this project.*

If the government lays emphasis on such projects, they can be very helpful to people. (Lakshman Singh, Ramgaad)

At both the functional and non-functional case study sites, there were also many other common instrumental learning outcomes. For example, participation in the project at Bartoo and Yarkashing helped the villagers learn that they themselves have to manage the project. At nonfunctional projects, for instance Yangthang, villagers learned that a collective effort is required to keep the project running. At some UREDA projects, e.g., Ramgaad and Toli, the operators and EMC members also indicated that they learned how to carry out official communication with government departments and to record maintenance work. Another instrumental learning outcome observed at places such as Bartoo and Yarkashing, was that the villagers have learned to regulate their use of electricity on the reasoning that otherwise the project will get overloaded and be prone to malfunction. However, I could not find any evidence in the I data on which to base this reasoning.

Although the Malari project is not working anymore, one important outcome from the project was that the villagers never faced any difficulties in procuring parts and this resulted in the smooth functioning of the project for its entire duration. They learned where to buy spare parts and relevant person to contact for different issues, which allowed them to keep to the maintenance schedule, as noted by Mr. Bachan Singh Rana (Malari): *"Yes, we get most of the things from Dehradun, we have addresses of the places where we can get the parts and repairing material from, we don't face problems in procuring and repairing our project."* Thus, local procurement and buy-in to a project can be key to its success. Knowing how important such information was in the Malari case could be helpful for other communities that manage their own projects and could substantially reduce the breakdown time and potential for project failure.

In UK, the government has formulated a new policy on small hydro up to 2 MW in size. This policy was implemented because many projects made under the previous policy were not performing well and were even shutting down. Issues such as a low plant load factor, lack of maintenance and improper plant management were identified as the main reasons. The new policy aims to make the villagers more responsible for the projects, at least in theory. The need to take such action was a learning outcome for government, as issues with project continuance revealed the shortcomings of the previous policy that had resulted in community members assuming the projects would be cared for by government without their input or participation.

NGOs involved in the micro-hydro developments in my cases, such as LEDeG, SPWD and the People's Science Institute (PSI), also demonstrated instrumental learning outcomes, based in part on their years of practical experience. Officials from PSI indicated that they learned that although the model and concept of micro hydro in UK villages was good, the implementation was not carried out properly. Based on their experience they concluded that greater effort needs to be put into what they termed the 'social aspect' of micro-hydro development, which is illustrated in the quotes below.

> *The model and the concept that the Uttarakhand government followed was a good one. The use of local resources to satisfy local need, local consumption and local supply. But the idea that they would hand it over to the local people without adequate preparation/social mobilization and understanding the social dynamics made it a non-starter. The fault was that it was all done through the government department.* (Mr. Ravi Chopra, PSI)

> *So my hypothesis after seeing micro-hydro development in this region is that, an enterprise associated with the project in the village will keep the villagers motivated as they'll have a vested interest in running the project*. (Mr. Srivastava, Engineer, SPWD)

We did extensive research for the micro-hydro projects and community involvement. If everyone used the approach that we do, then micro hydro would have been in a different state right now. MNRE, Government of India and other state agencies focus on machinery and installation, nobody cares about the social aspects. Causes of failure of micro hydro are largely social, if the communities are not interested/motivated, it is hard to run the project. Increase in load/more demands is a different issue, but social mobilization should be there. (Sonam Jorgesh, LEDeG)

Today the major problem with these micro hydro is with the operation and maintenance, strong institution building process has to be there for them to be successful. (Mr. Debashish Sen, PSI)

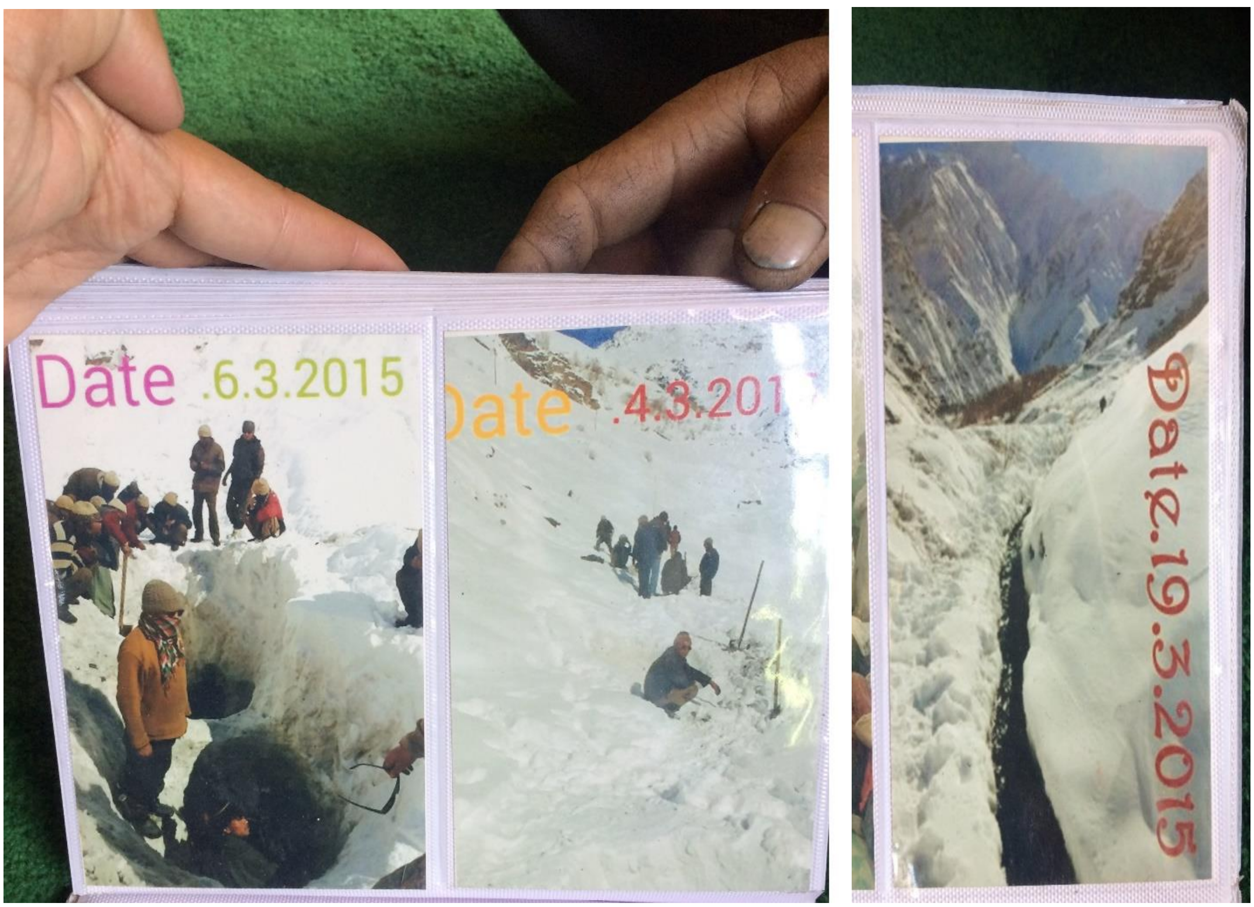
My data also showed that villages with strong leadership have villagers that put time into keeping the project running and that these projects have higher operational success rates. For instance, the former EMC head of Ramgaad spearheaded the process of project synchronization with the grid. In the context of learning about the need for project motivation in the community, Mr. Sonam Jorgesh (LEDeG), said:

In many communities, there are some people who get the concept and if he is the leader/lambardar of the village, 50% of the work is already done. Then he motivates the rest of the villagers. If there isn't a leader like that, then it is troublesome. For example, in a Kargil village there was an educated Shaikh (priest) and he helped us motivate the people and our job became very easy. At Udmaroo, in Nubra valley, there was a retired honorary Captain from the army, he got the concept and resultantly made our work in the village very easy."

ii. Communicative Learning

As mentioned in Chapter 2, communicative learning comes through mobilization within the community, information circulation and interacting as a group. Communicative learning was documented in the operational projects more than the non-operational ones. Bartoo, Yarkashing, Toli and Malari all showed more communicative learning compared to the other cases. Villagers in these communities learned the importance of the involvement of the whole community and sharing responsibility for running their micro-hydro facilities. This was reflected in their collective efforts to maintain and run their facilities, including cleaning the project canal and forebay, snow and ice removal, making extra monetary contribution for repairs and maintenance and helping out the operator whenever required. Figure 30 depicts an example of such a collective effort at Bartoo.

Figure 30: Snow Removal by Villagers at Bartoo (Source: Gurmeet Singh Ghera)



Villagers also expressed this learning and reflected on why some of their projects had failed, as demonstrated in the quotations below

We thought about it and concluded that if people don't work for free and there is no unity in the village and there is no support for the project, the project won't run. That is why we made it clear that if you are in the committee you have to work for free whenever needed. You cannot say that everyone gets light so why should only we work, we'll relax and sleep. This attitude will not be accepted. We talked in public and said that from the day when the project faces any problem and we are not willing to work for free, this project will fail. We realized that a lot of money was spent on Pulkitchrey and Tikat (failed projects) as well. Tikat has higher capacity than our project, J&K Science and Technology Department sponsored that project. That project was better than ours, the operator also got paid higher but still the project failed because people were not united. (Md. Issac, EMC member, Bartoo)

There is a great demand for these micro-hydro projects and many have been made but only those are successful where people are united and there is leadership in the village. (Md. Ismail, LAHDC Councilor, Bartoo)

Some wires and poles in our project needed repair, maintenance money was not sufficient and it seemed that light from the UPCL grid was going to come soon as poles were being installed and sometimes test runs were done. So, people lost interest in maintaining and running our project. (Bachan Singh Rana, Village Head, Malari)

In addition to the villagers, government organizations, such as UREDA, also drew lessons from the poor performance and closure of many projects. For example, Mr. Kachoo Ahmad Khan (Director, KREDA) noted:

Most of the unsuccessful projects in Ladakh are now getting electricity from diesel generators (DG sets) or hydroelectricity from the government. You see, most of the community-based projects are at places where there is no alternate source of electricity. In these villages people feel this is the basic need and when even for one or two days there is no electricity they do everything in their capacity to get it rectified, but if they have an alternate source of electricity the commitment towards their own community based project becomes less.

Mr. L.D. Sharma (Project Officer, UREDA) added further:

> *I think the main challenge is to make the society and community aware. If villagers fight amongst themselves, that is the biggest issue. If the villagers have some awareness level and people are motivated there is no problem and where the village has inside problems that is a big challenge for us.*

Building upon their reflections as to why projects had failed, there was learning drawn for the improvement of future projects. For example, Mr. L. D. Sharma (Project Officer, UREDA) said:

> *There is another angle to micro hydro, now this scheme is seen from the commercial sector/angle. Earlier it was a social sector undertaking, we had to provide electricity to the villagers at any cost. Now we want them to produce and sell to the grid and our distribution company (DISCOM) is ready for it. To date the projects/villagers did not generate any income, that is because they used electricity for four to eight hours and the rest of the time, 16-20 hours, the plant was non-operating and that too not to the full potential of the project, that's why they don't know anything about the project economics and resultantly had no interest. Their interest was only that they are getting electricity and they were paying for it. Now they can run the project for 24 hours for grid feeding and they'll generate revenue, with this idea they might develop an interest in the project. … Things will improve now, after the implementation of the new policy on micro hydro 2015, things will change.*

The data revealed that there was also learning among temporary residents of the villages who were in no way associated with the village micro-hydro projects. For instance, Mr. Nassir Hussain (School Teacher, Bartoo) spoke of how having electric lights greatly helped students with their studies, and further noted what he had learned of the importance of community involvement and the development of social norms:

> *There are 2-3 projects on this stream (nallah). Due to the lack of unity amongst people these projects don't work. Bartoo has a system that people follow and they have a penalty*

system and everyone uses electricity according to the set norms. If there is any problem in the generator or wiring, the community gets involved to repair it. So there is a system, otherwise I don't think this project would have sustained till now.

There were village-level learning outcomes from the closure of projects as well. After the project closure at Lamabagar and Yangthang, many villagers came to the realization that having a local source of electricity was better than grid electricity (as highlighted in section 4.4) as the rates were lower, supply was regular and accountability was higher. According to the Lamabagar EMC head, project appreciation and acknowledgement among the villagers was seen to be higher after the closure of the projects. Some villages were even thinking of restarting their project again, as they now see it as an economic opportunity laying idle: *"We are thinking about generating power from our project and selling it to the UPCL grid. We are waiting for some financial arrears, when it will be available we'll undertake this initiative"* (Bachan Singh Rana, Malari).

Many villagers also highlighted the importance of the project for children, the elderly and other villagers. They acknowledged the importance of having hydropower to them as a society, and took pride in it. Having their own hydro power helped to enhance their sense of community. Relationship building and an increase in community interaction was also observed, especially between common villagers and the EMC members and project operators who had more knowledge about the project and its functioning. These learning outcomes are demonstrated in the quotes below.

People understand the importance of this project, that is why they work as a community and even contribute out of their pocket whenever there is a problem and work really hard to get the repair done. Last time when the shaft broke, they took it to Kargil because the expert did not come to the village, then got it welded, still it was not fitting properly and *then finally bought a new shaft from Jammu. I think all this was done wholly by the villagers, the expense of the shaft, transportation, etc. No government agency and not even the area councilor was involved. Sometime in summers, a lot of silt comes with the extra flow of water and the canal breaks as it is a mud canal. The villagers go with all the tools and repair the canal as soon as possible. … Definitely there has been learning and there has been increased awareness. Children now study to secondary, higher secondary levels. They themselves think that we'll study even further, become engineers, do something more for the village. Awareness definitely has increased.* (Mr. Nassir Hussain, Bartoo)

Whatever I can I will do. If someone will give Rs.50 for repair, I will give Rs.100. I work as a labourer, but if need be, I will not work as a paid labour but work here in the project for free. In winters, two to four people from every household go whenever snow piles up and freezes. People get their turn in every 10-15 days but we EMC members go more than others as we take on the responsibility. (Md Issac, Bartoo)

We did face some trouble to pay the operator salaries. Supposedly the total bill collection came to Rs. 3000 and the salary of the operators was 5600, so the deficit of 2600 was filled in by the village collection. … We were so proud of our project that we kept the project working one way or another" (Bachan Singh Rana, Malari)

Table 10 shows a summary of the findings regarding social sustainability in each of the projects considered in this research.

Table 10: Social Sustainability of the Projects

SOCIAL SUSTAINABILITY						
Project	Local acceptance of project	Gender involvement in management	Long term benefits	Equitable distribution of electricity	Instrumental learning	Communicative learning
Bartoo	High	Medium	Yes	Yes	Medium	Medium
Yarkashing	High	Medium	Yes	Yes	Medium	Medium
Yangthang	Low	Low	Yes	Yes	Medium	Low
Ramgaad	Medium	Low	Yes	Yes	Medium	Low
Lamabagar	Low	Low	Yes	Yes	Medium	Low
Toli	High	Low	Yes	Yes	Medium	Medium
Malari	High	Medium	Yes	Yes	Medium	Medium

5.2.4 Health

All case studies under this research had health related benefits due to a shift to their local project from other sources of lighting and energy. Some health-related sustainability indicators were found in the data included i. Reduction in indoor pollution and ii. Noise pollution, these are described below:

i. Reduction in indoor pollution and Kerosene use

In all the case study sites, before electricity kerosene lamps and pine bark were the main sources of light for cooking, studying, reading and other purposes after dark. The villagers in general, and women in particular, were unanimous in their negative views about these lighting sources. They complained about mild to severe irritation of the eyes, development of chronic coughs and other lung problems. They have noted an improvement in relation to these problems ever since they shifted to hydroelectricity. Lack of interest of children in studying after dark, dim lighting, excessive smoke, black carbon deposition on interior walls and roof, degradation of the aesthetic look of the house from inside and lack of house hygiene, especially in the kitchen, were the main problems that have disappeared with the coming of hydroelectricity. The quotations below illustrate these health issues.

> *Kerosene lamps used to emit smoke everywhere. We used it for maximum of one hour. Earlier we had very tiny windows in the rooms and resultantly we inhaled a lot of smoke. And the aim always was to use it as fast as we can and then go to sleep. Nobody wanted to study under the kerosene lamp. When we used to make food, it took one to two hours and in that time there was dhuan hi dhuan (smoke all around).* (Md. Issac, Bartoo)

> *Light has also helped in improving our health. Earlier we used to have chest problems due to kerosene lamp smoke. Eye irritation was a common thing due to the smoke. Chest congestion and irritation were frequent.* (Ms. Banu, Bartoo)

> *There is now cleanliness in the villages. When we used to visit these villages for project building when there was no electricity, we used to see a lot of dirty things. The kitchens were not clean, but after electricity came everything became visible even at night and this increases cleanliness, so this is the benefit from health point of view for these projects.* (Kachoo Ahmad Khan, Director, KREDA)

> *Earlier due to kerosene lamps there was smoke everywhere. When we coughed smoke used to come out.* (Md. Ibrahim, Operator, Yarkashing)

> *We used to use the bark of pine trees for lighting, it illuminates nicely but causes a lot of smoke. All the carbon used to go inside our lungs, nose, eyes. A lot has changed positively since our project started.* (Mr. Bisht, Former EMC member, Ramgaad)

The traditional use of biomass and wood in poorly ventilated kitchens in rural areas causes various illnesses related to vision and respiration (Katuwal & Bohara, 2009). In the remote areas of Ladakh LPG cylinders and electric stoves are still not available, so the use of electricity for cooking is very limited. People mainly use wood and cow dung cakes as fuel to cook food. Compared to Ladakh, the UK case studies had a better supply of LPG cylinders and some households have switched to gas from wood and cow dung cakes.

Electric heaters and stoves are still a luxury in these areas that most people cannot afford, moreover, due to the low generation capacity of many projects, the use of electric cooking equipment is prohibited by village EMCs, such as in Bartoo, Yarkashing and Malari. Some households, especially in the UK case study sites, have shifted to LPG cylinders for cooking purposes, but many still use wood for cooking because they cannot afford the LPG, have poor access to cylinders or are too afraid to use gas and are comfortable in their traditional ways. As Bhuvan Chand Joshi at Ramgaad said, *"People use gas cylinders with extreme caution, they are afraid of it. Only the knowledgeable person uses it."* Thus, micro-hydroelectricity has not significantly mitigated the problem of indoor air pollution due to cooking; however, it has had a big role in reducing the indoor pollution from the use of kerosene lamps and pine bark for lighting purposes.

ii. Noise pollution from the turbine

At all the case study sites, the power houses were located at a sufficient distance from the houses so that none of the villagers had any issues regarding the noise from the project turbine. During participant observation at each of the sites it was confirmed that the houses located nearest to the power house were at a distance where the noise of the turbine was hardly audible during the day and did not trouble the residents. For example, Bachan Singh Rana (Malari) said that, *"Our project was not very noisy, did not trouble anyone from a noise perspective. It was harmless to the wild animals too."*

Table 11 shows a summary of the findings regarding health sustainability in each of the projects considered in this research.

Table 11: Health Sustainability of the Projects

HEALTH SUSTAINABILITY		
Project	**Reduction in indoor pollution and kerosene use**	**Project noise pollution**
Bartoo	High	Low
Yarkashing	High	Low
Yangthang	High	Low
Ramgaad	High	Low
Lamabagar	High	Low
Toli	High	Low
Malari	High	Low

5.4 Summary

In terms of sustainability benefits (Hansmann, Mieg, & Frischknecht, 2012; Kumar & Katoch, 2014), there were many upsides to these projects. They have been beneficial from health, social and environmental perspectives, such as through the reduction of indoor air pollution due to switching from kerosene lamps and tree bark to electric bulbs for lighting, the achievement of higher levels of involvement of women in project management, technical learning by project operators , the maintenance of adequate stream flows and the regular availability of water for irrigation and household needs. Such benefits are also noted in the literature (e.g., Carrera & Mack, 2010; Kumar & Katoch, 2014; Bruce, Perez, & Albalak, 2000). Some actions from learnings resulted in collective efforts by villagers to maintain their micro-hydro facility that can be essential for the long term project success. It was seen that actions as a result of learning help projects operate for long term. From an economic angle, the data show though that these projects have had limited benefits for the local villagers in terms of the creation of new economic activities. Although these micro-hydro projects have proven beneficial to the local communities in terms of providing lighting and power for small appliances that others elsewhere take for granted, the economic self-sufficiency of these projects in the long run is still in doubt, and as seen in this study, many projects close down after only a few years of operation.

Based on the findings in this research, the sustainability of these micro-hydro projects can be assessed on the basis of certain indicators of success. Key indicators relevant to the context of my research emerged as themes and sub-themes in the analysis of the research data, and are captured in Table 12 below.

Table 12: Key Sustainability Indicators of Success

1.	Project financial capacity
2.	Ability to access an alternate power source
3.	Environmental factors
4.	Learning, attitude and support of the villagers
5.	Proactive village leadership
6.	Efficient EMC
7.	Optimum use of the project
8.	Government’s policy approach to micro hydro
9.	Initial project success

Technical issues related to repair and maintenance of the projects can affect the project’s long term operations. In cases of serious technical faults, such as at Yangthang, these projects generally face long downtimes as they have to get external expertise to help and the EMCs sometimes lack money or the motivation to hire such services. Toli provides another example from the research, where one of the two 50 kW turbines has been nonfunctional for the last year and the village EMC is struggling to get it repaired due to the lack of available finances. Many of these projects do not generate sufficient savings (see Table 5) to maintain the micro-hydro facility in good running shape and provide for timely servicing.

Many of these projects are located in remote communities that have no access to any other source of electricity, which acts as a motivating factor for the villagers to keep their project running, for example, as seen in Yarkashing and Bartoo. In the past few years electricity from other state utilities has reached many remote villages under programs such as Deendayal Upadhyaya Gram Jyoti Yojana and Pradhan Mantri Sahaj Bijli Har Ghar Yojana, which aim at 'last mile' electricity connections in these remote areas, and resultantly some villages are losing interest in maintaining their micro-hydro projects. Others, however, quickly recognized some of the difficulties associated with relying on grid power, including things like long breakdown times and higher costs, and some also see the economic potential of feeding the grid, and so some villages are motivated to keep their local projects in operation.

Environmental factors, including seasonal changes or other natural events, can have effects on the projects that can contribute to their limiting their success, for example, the frequent breakage of the diversion canal that was seen in the case of Lamabagar, or low stream flows and seasonal changes that reduce the amount of electricity that can be generated.

People at some of the villages have low motivation and unity to run and manage their projects, such as was seen in Yangthang where this contributed to the project closure, whereas Bartoo, where villagers learned to contribute as a group in maintaining their project, provides a positive example of social cohesion and commitment in relation to the local micro hydro.

Proactive leadership in the village also helps in the functioning and sustenance of the micro hydro, as seen in Ramgaad.

An efficient EMC can contribute to the long-term success of the project, for example, at Toli the EMC has been running the project efficiently for the past 25 years, managing the tariffs and asking for extra contributions if needed, while keeping their finances transparent so that their credibility remains intact. Optimizing the project use, such as by using the project to facilitate income-generating activities or selling surplus electricity to the grid, can also help in the long-term success of the project.

Having spare parts for the turbines and other project equipment accessible in a defined geographical range if not locally available would help to ensure project success. For example, parts should be available in Dehradun, New Delhi or Saharanpur for the projects located in UK. This would lead to easier and better maintenance, thus reducing downtime and enhancing customer satisfaction.

All of the case study community-based micro-hydro projects in the states of J&K and UK have had mixed results in terms of success and sustainability. As discussed in this chapter, the success of community-based micro-hydro projects relies on multiple variables and is highly affected by the social and economic conditions of the village where the project is based. The financial conditions of the project, support of the villagers and their level of commitment towards the project all play important roles in the project running successfully for the long term. However, keeping focus on the key indicators of project success can help in ensuring better functioning existing and future projects.

Chapter 6 – Conclusions

6.1 Introduction

Micro-hydro development has been playing an important role in Northern India by providing electricity for villagers in many of the remote communities. As noted in chapter 4, there still are a lot of villages in the Himalayan states that are unelectrified. Presently, many villages in the remote regions of J&K and UK where regular grid supply is a challenge, such as Bartoo, Yarkashing and Toli, are running their own micro-hydro projects and using the electricity for local use, supplying most of the village households (chapter 5). The purpose of this research was to understand the sustainability benefits of community-based, micro-hydro power projects for local communities in the Himalayan region of India. The research objectives were:

1) To examine the role of community members in the planning, construction and implementation of community-based micro hydro;
2) To understand the ways that any negative impacts of development and operation are minimized, while positive impacts amplified;
3) To document the ways that the instillation of these projects has produced sustainability benefits to individuals and communities as a whole; and
4) To explore the ways that communities and associated government agencies are sharing their learning about community-based micro hydro.

Seven projects were selected as case studies for this research. Out of the seven, three were operational, one was under repair and three were non-functional at the time of the study. Data were gathered through semi-structured interviews, focus groups, participant observation and a review of relevant literature and documents, including government policy. Interviews were conducted with villagers, project operators, EMC members, NGO officials from LEDeG, Jansamarth and SPWD, government officials from UREDA, KREDA, LREDA and HIMURJA. Follow up interviews were done with the government officials from UREDA and KREDA. Interview questions were developed according to the study objectives, and some questions were added and omitted as appropriate to the context of case study sites (see chapter 3). Focus group discussions were held to validate the results obtained from other data collection methods and to gain additional insight. As many of the case studies were in remote areas that do not have frequent outside visitors, extended time was spent in the villages to build rapport with the locals. Based on the data collected and the results presented in the chapters above, the following key conclusions are drawn.

6.2 Conclusions

Role of Locals in Micro Hydro

My findings show that a project can really only be called community-based in the true sense when the community is involved in every stage of the project development. The literature also supports this contention (e.g., Mansuri & Rao, 2004; Sinclair, Diduck, & McCandless, 2015). For most of the projects in my study, community involvement was limited to the later stages of construction and operation and was not a feature of the planning stages. The micro-hydro project at Malari was the only case that provided a benchmark for community involvement in all stages of development, from concept and design through to operation. The project was found to have had effective community involvement, underscored by the fact that the project ran successfully for several years before grid electricity reached the village.

The efforts so far by the UK state government to provide electricity and generate a sense of local ownership for power projects in villages are laudable, but my data show that communities often still lack the capacity to be engaged, especially in terms of resources and training. Successful community-managed micro hydro requires overall institution building in the community as opposed to the government just coming in building a project and handing it over to the community, especially if the hope is the community will be able to run the facility and utilize the maximum amount of power available. The data show that local people need to understand how the system works and what power potential is present for them to fully exploit it. For example, even after generating surplus electricity, the villagers at Lamabagar were unable to tap the full potential of their project and mainly used the power only for home lighting. Better understanding of the system and the potential to produce maximum power output will also reduce plant breakdown times, which seems to be a big issue for these projects. Unless the villagers are prepared properly and mobilized for contributing to the project, community-based projects will not yield the desired results.

Community EMCs should maintain accurate financial and technical records, especially at projects that are self-dependent (e.g., Bartoo and Yarkashing). This can help in better project management, as project history proves useful when future repair and technical analysis needs to be done. Development agencies like UREDA should take steps to ensure that the composition of EMCs is representative of all the sections of society.

The future trend, according to the officials I spoke to, suggests there will be increased micro-hydro development by the public sector, with a consequent reduction in the contribution of NGOs in the Ladakh area of the state of J&K. This stands in contrast to the new UK policy on micro hydro that will most likely limit the role of UREDA to site allotment, DPR preparation and acting as a general facilitator of development. How this new policy will take shape is yet to be seen, but it is projected that increased private sector growth in the micro-hydro sector could be a likely possibility as the gram panchayats will not have the financial capacity to undertake projects themselves and private entrepreneurs will be keen to take advantage of the benefits the government is providing under the new scheme, such as no court fees for documentation and no royalty and water use charges to the government – as has been seen to have occurred in states like HP. It is yet to be seen whether or not the provision that project ownership remain with the village will result in the realization of actual benefits to all the villagers. Regardless, local people need to be engaged in the development process to ensure the minimization of impacts, enhance project success and facilitate the sharing of benefits locally.

Minimizing Negative and Amplifying Positive Impacts

The community-managed micro-hydro facilities I studied have all had many positive impacts. Most of the negative impacts of privatized micro hydro documented in various parts of India (e.g., Kumar & Katoch, 2014; Baker, 2014; Sinclair 2003), such as dry riverbeds with 100% stream water diversion, were nowhere to be found in this study. The negative feelings and animosity of the locals towards privatized micro hydro noted in the literature (e.g., Kumar & Katoch, 2015), was also not evident in most of my case studies, rather people had an overall positive attitude towards their micro-hydro facility. In the community-managed approach there was permanent employment, even if few in number, temporary paid employment at projects that had sufficient funds, such as Yangthang and Lamabagar, and the electricity needs of the villagers were met before providing electricity for other uses. Since the villagers are using their own water resources for these projects, they are aware that overexploitation of the water resource will prove harmful to themselves, and resultantly all projects diverted the river water at levels not higher than the permissible limit. Thus, village involvement acted as a natural check and balance for regulatory compliance.

My research data also show that these projects generally minimize the negative effects that have been observed in other micro-hydro developments in the region. There are many positives to these projects, but they do not seem to be amplified at the village level. Building village-level capacity to better understand the system can help amplify the observed positive impacts, as discussed above.

In addition to the above-mentioned impacts, community-based micro hydro also saves these remote communities from the negative impacts of long-distance grid connections. Some prominent problems of remote grid connectivity were already documented in the case of Lamabagar and Yangthang. As highlighted by Mr. Pad Singh Padma (Yangthang) in section 4.4, the unreliability of grid power leaves the locals unprepared for celebrations and important events as well as simply satisfying basic electricity needs. If this is the situation in the initial stages of grid power supply, it could worsen when more villages are connected to the grid.

Sustainability Benefits, including Learning

Despite some shortcomings, community-based micro hydro did provide some sustainability benefits to local communities. As suggested in the literature (e.g., Carrera & Mack, 2010; Diduck & Sinclair, 2016; Vera & Langlois, 2007; Kumar & Katoch, 2015), the sustainability of these projects can be measured based on various indicators. To achieve sustainability and long-term success, these projects need to perform well on certain key indicators, as identified in chapter 5. For instance, the ‘efficient EMC’ at Toli has helped the project run for over 25 years and to accumulate considerable savings over the years, and ‘optimum use of the project’, as seen at Ramgaad, helps them generate extra finances by selling surplus power to the grid during the daytime when local household electricity demand is low.

The data presented in previous chapters show that these projects have proven beneficial in terms of health, environmental and social parameters. As outlined in chapter 5, the overall living conditions of the villagers rose with access to electricity, such as enabling better opportunities for education. The villagers have not been able to exploit the full economic potential of these projects, but nonetheless a few people in every village have permanent employment as a result of their project. It was suggested by participants that access to television and computers broadens the mental capacity and awareness levels of villagers to the outside world, which is especially important for children. Electricity from the projects has also given a sense of comfort and relief from the darkness of night, helped maintain household cleanliness and allowed locals to celebrate village gatherings and festivities in a better way. Villagers also observed psychological benefits, for example, they no longer feel confined within their houses by the darkness and some villagers even felt proud about their projects, as described in chapter 5. Some villagers also feel happy that they do not have to look to the government for basic lighting needs. The Malari project, although not working anymore, still provides a sense of pride for residents.

As established in the literature (e.g., Bruce, Perez, & Albalak, 2000), and as predicted in the Lamabagar DPR, an anticipated benefit of small-scale hydro projects is the reduction of indoor pollution and greenhouse gas emissions by replacing wood, coal and kerosene with hydroelectricity. Many villagers still use wood for cooking and heating purposes, but the use of kerosene lanterns and pine bark for lighting has been totally discontinued at all the case study sites, which has greatly improved indoor air quality. So, although not complete, benefits in regard to indoor pollution and greenhouse gas emissions reduction have been partially realized.

More projects need to replicate the Malari model, but with better economic outcomes. If the local projects only act as a source of lighting, as soon as an alternate source is available, i.e. grid power, the need for the local project diminishes and unless the villagers have some vested interest in running their project, for example an income-generating enterprise, they tend to lose interest in running their project. Since all the villages in this study were involved in agriculture and horticulture practices, the installation of agro-processing units could be a potential income-generating activity, for example, since sea buckthorn berry and aromatic flowers grow naturally in the Malari region, berry processing and flower and perfume distillation could be done locally. People at Malari also grow kidney beans that are considered high quality, and women weave rugs and sweaters. By processing the products within the village, the villagers could increase their profits greatly. Wool and potato processing, making papad (wafers) in the Lamabagar area and wool processing in Bartoo and Yarkashing where they rear fur goats (Bhedus) are some other potential local economic activities that could be carried out with the use of locally produced electricity. As well, since agriculture is done mostly on slopes in these mountainous areas, lift irrigation practices could be helpful to increase crop yields and reduce farmers' irrigation efforts.

The case of Toli also shows us that the larger the customer base the better the financial condition of the EMC and consequently the salaries of the operators. It demonstrates that sometimes if the home lighting customer base is adequate, these projects can be sustained for the long term even without other economic, income-generating activities. Thus, wherever possible, projects in the mini hydro category (100kW-2MW) and covering three to four adjacent villages should be preferred over projects covering only one small village, as this would provide greater assurance of long-term viability.

If the villagers do not want to use the electricity for any economic activity, an alternative is to sell the surplus to the grid and earn revenue that way, as observed in Ramgaad. They could use the electricity from their own project for lighting and other purposes in the evening and sell it to the grid during the day, instead of selling the entire generation to the grid and relying on the government grid for the village's own electricity supply.

Being involved in micro-hydro development also provided learning opportunities for community members. However, as the level of village involvement varied from project to project, so did the learning opportunities and outcomes. Successful community-based projects showed more learning outcomes among participants compared to the projects that were government led. In the case of UREDA projects, learning was mostly limited to the EMC members and operators, as other villagers had no direct involvement in the projects. In Ladakh, the majority of the projects presently under construction are based on the policy and funding of the central government (i.e. MNRE), and it is likely that village involvement will not be significant at any stage of project development, so in those cases the scope for future learning at the village level seems limited. After seeing the projects at other villages and working on their own, the villagers at Bartoo and Yarkashing seem to have learned that no community-based project can run unless the villagers are unified and put forward a combined effort. In UK, based on their experience of micro hydro so far the state government and UREDA also seem to have drawn some lessons regarding the importance of meaningful local involvement, and this has influenced the new policy on projects up to 2 MW.

6.3 Concluding Comments

I was struck during my research by the potential for micro hydro to improve the harsh conditions in many of these communities and by the true sense of achievement many felt about their micro-hydro projects. I think that these projects should have a very positive future due to their sustainability benefits, but success can be assured by taking various steps, some of them simple. For example, awareness about local resources and coordination with small-scale cottage industries should be made part of the DPR and the project in general.

Another approach towards micro hydro that can draw active participation of the villages is to promote them as small-enterprise development programs that provide home electricity as well, instead of projects focused on generating energy for home consumption and with other energy uses being secondary. Unemployment and lack of economic opportunities is a big concern in much of rural India and, if approached in the appropriate manner, micro hydro could act as a means of self-employment and increase the number of self-sustaining projects. This could also help address the problem of operation and maintenance associated with these projects.

The whole idea of community-driven micro hydro is to put the development and operation of the facility in the hands of those who will benefit the most to ensure they do actually benefit. However, this study found that the implementation phase of such projects often lacks local involvement and, most importantly, local buy-in. I found that, for the most part, the projects I considered did not become self-sustaining mostly due to low tariff rates being charged and the inability to use all the available power being generated. Greater self-reliance could be achieved by using local resources for income generating activities, as suggested above, and by selling surplus electricity to the grid.

Although these issues are challenging, the current and potential benefits of these projects offer optimism. For most small-hydro projects developed by private entrepreneurs, the power is wheeled out of the hills along with the local benefits, and villagers are left to deal with the negative effects of the development. Since many of these communities do not even have proper road access, reliable light acts as a catalyst for social change, exposure to the outer world and creates a sense of pride.

Future research could be done on the implementation of new policies like the one in UK to explore whether the new approaches benefit the local villagers or not. Future researchers should seek to identify projects that have better economic effects associated with them and examine their sustainability, as well as looking more closely at the learning outcomes resulting from having electrical power and participating in community-based small hydro.

References

*24*7 Power for all Uttarakhand*, (2015). Retrieved from https://powermin.nic.in/sites/default/files/uploads/Uttarakhand_24x7-PFA_Final_Doc_14_Sep_15.pdf

Adaptive Capacity and Sustainable Development. (n.d.). Retrieved from http://www.ipcc.ch/ipccreports/tar/wg2/index.php?idp=653

Agarwal, S. S., & Kansal, M. L. (2017). Issues of Hydropower Development in Uttarakhand Region of Indian Himalaya. *Water and Energy International*, *59*(11), 52-64.

Agrawal, D. K., Lodhi, M. S., & Panwar, S. (2010). Are EIA studies sufficient for projected hydropower development in the Indian Himalayan region? *Current Science*, *98*(2), 154–161.

Ahad, U. (2017). *Hydro Power Projects in J&K State-Potential Scenario*. Retrieved from https://www.ijraset.com/fileserve.php?FID=10946

Alternate Hydro Energy Centre. (2005). Detailed Project Report, Lamabagar.

Alternate Hydro Energy Center. (2012). Standards/Manuals/Guidelines for Small Hydro Development.

Alternate Hydro Energy Centre. (2016). *Projects Under Operation in Uttarakhand State*. Retrieved from https://www.iitr.ac.in/wfw/pdf/Projects_Under_Operation_in_Uttarakhand_State.pdf

Armitage, D. (2005). Adaptive capacity and community-based natural resource management. *Environmental management*, *35*(6), 703-715.

Baker, J. M. (2014). Small hydropower development in Himachal Pradesh: an analysis of socioecological effects. *Economic & Political Weekly*, *49*(21), 77-86.

Bakker, K. (2007). The "commons" versus the "commodity": Alter-globalization, anti-privatization and the human right to water in the global south. *Antipode*, *39*(3), 430-455.

Baxter, P., & Jack, S. (2008). Qualitative Case Study Methodology: Study Design and Implementation for Novice Researchers. *The Qualitative Report. 13*(4); 544-559.

Baxter, R. M. (1977). Environmental Effects of Dams and Impoundments. *Annual Review of Ecology and Systematics*, *8*(1), 255–283. https://doi.org/10.1146/annurev.es.08.110177.001351

Becker, H., & Geer, B. (1957). Participant Observation and Interviewing: A Comparison. *Human Organization*, *16*(3), 28–32. https://doi.org/10.17730/humo.16.3.k687822132323013

Bhattacharya, S. C., & Jana, C. (2009). Renewable energy in India: Historical developments and prospects. *Energy*, *34*(8), 981–991. https://doi.org/10.1016/j.energy.2008.10.017

Bruce, N., Perez-Padilla, R., & Albalak, R. (2000). Indoor air pollution in developing countries: a major environmental and public health challenge. *Bulletin of the world health organization*, *78*(9), 1078-1092.

Canadian Environmental Assessment Agency. (2017). *Building Common Ground: A New Vision for Impact Assessment in Canada*. The Final Report of the Expert Panel for the Review of Environmental Assessment Processes. Retrieved from https://www.canada.ca/en/services/environment/conservation/assessments/environmental-reviews/environmental-assessment-processes/building-common-ground.html.

Carrera, D. G., & Mack, A. (2010). Sustainability assessment of energy technologies via social indicators: Results of a survey among European energy experts. *Energy policy*, *38*(2), 1030-1039.

Competitive bidding process for development of micro/mini hydro power projects in the state of Jammu & Kashmir, phase – 5th . (2015). Retrieved from http://jakeda.jk.gov.in/sector/RFQ%20NIT%20Phase%205.pdf

Cranton, P. (2006). *Understanding and promoting transformative learning: a guide for educators of adults*. Jossey-Bass, San Francisco

Creswell, J.W. (2003). *Research Design- Quantitative, Qualitative and Mixed Methods Approaches.* Second Edition. Sage Publication, Thousand Oaks, CA.

Creswell, J. W. (2014). Research Design: Qualitative, Quantitative, and Mixed Methods Approaches. 4th ed. Sage Publications: Los Angeles.

Creswell, J. W. (2007). Qualitative enquiry & research design: Choosing among five approaches. 2nd ed. Sage Publications: Los Angeles.https://doi.org/10.1016/j.aenj.2008.02.005

Crowe, S., Cresswell, K., Robertson, A., Huby, G., Avery, A., & Sheikh, A. (2011). The case study approach. *BMC Medical Research Methodology, 11*. https://doi.org/10.1186/1471-2288-11-100

Definition of electrified village. (n.d.). Retrieved from http://www.ddugjy.gov.in/portal/definition_electrified_village.jsp

Details of Allotted and Under Construction Projects of Private Developers. (n.d.). Retrieved from https://www.iitr.ac.in/wfw/hp_sites.htm

DeWalt, K. M., & DeWalt, B. R. (2011). *Participant observation: A guide for fieldworkers*. 2nd ed. Altamira Press: Lanham, MD.

Diduck, A., Sinclair, A. J., Hostetler, G., & Fitzpatrick, P. (2012). Transformative learning theory, public involvement, and natural resource and environmental management. *Journal of Environmental Planning and Management*, *55*(10), 1311–1330. https://doi.org/10.1080/09640568.2011.645718

Doelle, M., & Sinclair, A. J. (2006). Time for a new approach to public participation in EA: Promoting cooperation and consensus for sustainability. *Environmental Impact Assessment Review*, *26*(2), 185-205.

Dongier, P., Van Domelen, J., Ostrom, E., Ryan, A., Wakeman, W., Bebbington, A., ... & Polski, M. (2003). Community driven development. *World Bank Poverty Reduction Strategy Paper*.

Doraisamy, K. V. R., & Pai, N. (2016). Transmission and Distribution Losses (Power). Volume 2 Issue 1 (2016). doi: 10.16962/EAPJECT/issn. 2394-935X/2016.

Dutt, A. K., Noble, A. G., Costa, F. J., Thakur, S. K., Thakur, R., & Sharma, H. S. (Eds.). (2015). *Spatial Diversity and Dynamics in Resources and Urban Development*. Volume 1: Regional Resources. Springer: Netherlands.

Erlewein, A. (2013). Disappearing rivers—the limits of environmental assessment for hydropower in India. *Environmental Impact Assessment Review*, *43*, 135-143.

Friedl, G., & Wüest, A. (2002). Disrupting biogeochemical cycles: Consequences of damming. *Aquatic Sciences*. Volume 64 Issue 1. https://doi.org/10.1007/s00027-002-8054-0

Gibson, R. B., Doelle, M., & Sinclair, A. J. (2015). Fulfilling the promise: Basic components of next generation environmental assessment. *Journal of Environmental Law & Practice. (29)*, 257-283.

Goodland, R. (1994). Environmental sustainability and the power sector. *Impact assessment*, *12*(4), 409-470.

Government of India, Planning Commission. (2013). *Twelfth Five Year Plan*. Retrieved from http://planningcommission.gov.in/plans/planrel/12thplan/pdf/12fyp_vol1.pdf.

Government Of Uttarakhand. (2015). *Policy For Development of Micro & Mini Hydro Power Projects up to 2 MW*. Retrieved from https://www.iitr.ac.in/wfw/pdf/MHP_POLICY.pdf

Hansmann, R., Mieg, H. A., & Frischknecht, P. (2012). Principal sustainability components: empirical analysis of synergies between the three pillars of sustainability. *International Journal of Sustainable Development & World Ecology*, *19*(5), 451-459.

HIMURJA. (2018). List/Status of 655 Projects up to 5.00 MW Capacity As On Today. Retrieved from http://himurja.hp.gov.in/wp-content/uploads/2018/09/Details-of-Projects-Alloted.pdf

Jammu and Kashmir Energy Development Agency. (2017). *Policy for Development of Small Hydro Energy for Power Generation (Up to 10 MW)*. Retrieved from http://www.cbip.org/Policies2019/PD_07_Dec_2018_Policies/Jammu%20&%20Kashmir/2-%20Small%20Hydro/2%20Order%20J&K%20SHP%20(Draft)%20Policy%20.pdf

Joshi, M. C. (2007). Hydro Power Potential in Uttarakhand. In: *International Conference on Small Hydropower*. Kandy, Sri Lanka: International Centre for Hydropower, Norway.

Kasl, E., Yorks, L. (2012). Learning to be what we know: The pivotal role of presentational knowing in transformative learning. In: Taylor, E.W., Cranton, P. (eds) *The handbook of transformative learning: Theory, research, and practice*. Jossey-Bass, San Francisco, pp 503–519.

Katuwal, H., & Bohara, A. K. (2009). Biogas: A promising renewable technology and its impact on rural households in Nepal. *Renewable and Sustainable Energy Reviews*. https://doi.org/10.1016/j.rser.2009.05.002

Kellert, S. R., Mehta, J. N., Ebbin, S. A., & Lichtenfeld, L. L. (2000). Community natural resource management: Promise, rhetoric, and reality. *Society & Natural Resources*, *13*(8), 705-715.

Kitzinger, J. (1995). Qualitative Research: Introducing focus groups. BMJ, 311(7000), 299-302. https://doi.org/10.1136/bmj.311.7000.299

Koirala, B. (2007). A community based micro hydro: a promising technology for rural development in Nepal. https://digitalrepository.unm.edu/nsc_research/55

Kumar, A., & Singhal, M. K. Small Hydropower Development.

Kumar, D., & Katoch, S. S. (2015). Sustainability suspense of small hydropower projects: A study from western Himalayan region of India. *Renewable Energy*, *76*, 220-233.

Kumar, D., & Katoch, S. S. (2014). Sustainability indicators for run of the river (RoR) hydropower projects in hydro rich regions of India. In: *Renewable and Sustainable Energy Reviews*, Volume 35, 101-108. https://doi.org/10.1016/j.rser.2014.03.048

Mansuri, G., & Rao, V. (2004). Community-based and -driven development: A critical review. *World Bank Research Observer*. Volume 19, Issue1. https://doi.org/10.1093/wbro/lkh012

McCandless, M. (2007). *Community Involvement in the Development of Small Hydro in Uttaranchal, India*. Unpublished Masters Thesis, Natural Resources Institute, University of Manitoba, Canada.

Mezirow, J. (2003). Transformative Learning as Discourse. *Journal of Transformative Education*, *1*(1), 58–63.

Mezirow, J. (2000). An Overview of Transformative Learning. In: P. Sutherland & J. Crowther (Eds.), *Lifelong Learning: Concepts and Contexts*. Chapter 3, 25-37. Routledge: London.

Mezirow, J. (1991). *Transformative dimensions of adult learning*. Jossey-Bass: San Francisco.

Moyer, J. M., Sinclair, A. J., & Diduck, A. P. (2014). Learning for sustainability among faith-based organizations in Kenya. *Environmental management*, *54*(2), 360-372.

Ministry of New and Renewable Energy. (2015). National Mission on Small Hydro. Retrieved from https://mnre.gov.in/file-manager/UserFiles/Draft-national-mission-on-SHP.pdf.

Ministry of New and Renewable Energy. (n.d.). Scheme. Retrieved from http://www.mnre.gov.in/solar-mission/jnnsm/introduction-2/.

Ministry of New and Renewable Energy. (n.d.). Small Hydro Power Programme. Retrieved from http://mnre.gov.in/schemes/grid-connected/small-hydro/

Ministry of New and Renewable Energy. (2014). Small Hydro Power Programme. Retrieved from https://mnre.gov.in/file-manager/grid-small-hydro/SHP-Scheme.pdf

Ministry of New and Renewable Energy. (n.d.). State Nodal Agencies. Retrieved from https://mnre.gov.in/state-nodel-agencies

Natural Resources Defense Council. (2017). India's Progress Towards its Climate Pledge. Retrieved from https://www.nrdc.org/sites/default/files/paris-climate-conference-India-IB.pdf.

Nautiyal, H., Singal, S. K., Varun, & Sharma, A. (2011). Small hydropower for sustainable energy development in India. *Renewable & Sustainable Energy Reviews*, *15*(4), 2021–2027. https://doi.org/10.1016/j.rser.2011.01.006

National Institution for Transforming India Aayog. (2015). *Towards Accelerated Renewable Electricity Deployment*. Retrieved from http://niti.gov.in/writereaddata/files/document_publication/Report_on_India%27s_RE_Roadmap_2030-full_report-web.pdf.

National Institution for Transforming India Aayog. (2019). Localizing SDGs. Retrieved from https://niti.gov.in/writereaddata/files/LSDGs_July_8_Web.pdf

Noble, I.R., S. Huq, Y .A. Anokhin, J. Carmin, D. Goudou, F .P . Lansigan, B. Osman-Elasha, and A. Villamizar, 2014: Adaptation needs and options. In: Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Field, C.B., V.R. Barros, D.J. Dokken, K.J. Mach, M.D. Mastrandrea, T.E. Bilir, M. Chatterjee, K.L. Ebi, Y .O. Estrada, R.C. Genova, B. Girma, E.S. Kissel, A.N. Levy, S. MacCracken, P .R. Mastrandrea, and L.L.

White (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY , USA, pp. 833-868.

Noor, K. (2008). Case Study : A Strategic Research Methodology. *American Journal of Applied Sciences, 5*(11), 1602–1604. https://doi.org/10.3844/ajassp.2008.1602.1604

Open Government Data Platform India. (2015). Un-electrified Villages as on 31-5-2015. Retrieved from https://community.data.gov.in/un-electrified-villages-as-on-31-05-2015/

Paish, O. (2002). Small hydro power: Technology and current status. *Renewable and Sustainable Energy Reviews*, *6*(6), 537–556. https://doi.org/10.1016/S1364-0321(02)00006-0

Pareek, L., Kelawal, M., Kapoor, R., & Tsephel, S. (2007). A Study on Micro Hydro Units in Ladakh. Dehra Dun: Bishen Singh Mahendra Pal Singh.

Planning Commission, India. (2011). *Faster, sustainable and more inclusive growth: An approach to the 12th five year plan* (No. id: 4452).

Premalatha, M., Tabassum-Abbasi, Abbasi, T., & Abbasi, S. A. (2014). A critical view on the eco-friendliness of small hydroelectric installations. *Science of the Total Environment, 481(1),* 638–643. https://doi.org/10.1016/j.scitotenv.2013.11.047

Qu, S. Q., & Dumay, J. (2011). The qualitative research interview. *Qualitative Research in Accounting & Management, 8*(3), 238–264. https://doi.org/10.1108/11766091111162070

Rowley, J. (2002). Using case studies in research. *Management Research News, 25*(1), 16–27. https://doi.org/10.1180/01409170210782990

Rural Electrification Corporation Limited (2017). Deen Dayal Upadhaya Gramin Jyoti Yojana: Status of Rural Electrification in Jammu & Kashmir. Retrieved from http://garv.gov.in/assets/uploads/reports/statesnaps/Jammu%20&%20Kashmir.pdf

Sarkar, A. U., & Karagöz, S. (1995). Sustainable development of hydroelectric power. *Energy, 20*(10), 977-981.

Sathaye, J., Shukla, P. R., & Ravindranath, N. H. (2006). Climate change, sustainable development and India: Global and national concerns. *Current Science – Bangalore, 90*(3), 314.

Saxena, P. (2007, October). Small hydro development in India. In: *International Conference on Small Hydropower, Hydro Sri Lanka* (pp. 1-6).

Schell, C. (1992). The value of the case study as a research strategy. *Manchester Business School, 2*, 1-15.

Sinclair, A. J. (2003). Assessing the impacts of micro-hydro development in the Kullu District, Himachal Pradesh, India. *Mountain Research and Development*, *23*(1), 11-13.

Sinclair, A. J., & Diduck, A. P. (2000). Public involvement in environmental impact assessment: A case study of hydro development in Kullu District, Himachal Pradesh, India. *Impact assessment and project appraisal*, *18*(1), 63-75.

Sinclair, A. J., Diduck, A. P., & McCandless, M. (2015). A comparative case study of small hydro development in the Indian Himalaya. In: *Spatial Diversity and Dynamics in Resources and Urban Development* (pp. 361-378). Springer: Netherlands.

The Indus Waters Treaty, India, Pakistan and International Bank for Reconstruction and Development., 19 Sept. 1960. Retrieved from https://treaties.un.org/doc/Publication/UNTs/Volume%20419/volume-419-I-6032-English.pdf

Uttarakhand Renewable Energy Development Agency. (n.d). Small Hydro Programme in Uttarakhand. Retrieved from http://ureda.uk.gov.in/pages/display/131-micro-hydro-projects

Van Teijlingen, E. (2014, December). Semi-structured interviews. In PGR Workshop. Retrieved from https://www.scribd.com/document/348410957/PGR-Workshop-Interviews-Dec-2014.

Vancleef, A. (2016). Hydropower Development and Involuntary Displacement: Toward a Global Solution. *Indiana Journal of Global Legal Studies 23*(1), 349-376. Indiana University Press. Retrieved October 30, 2016, from Project MUSE database

Vera, I., & Langlois, L. (2007). Energy indicators for sustainable development. *Energy, 32*(6), 875-882.

Yin, R. K. (2003). Case Study Research: Design and methods. Sage Publications: Thousand Oaks, CA.

Yin, R. (2014). *Case study research : design and methods* (5 edition.). Los Angeles: SAGE.

Zeigler, D. J., Brunn, S. D., & Johnson Jr., J. H. (1996). Focusing on Hurricane Andrew through the eyes of the victims. *Area*, *28*(2), 124–129. Retrieved from http://www.scopus.com/inward/record.url?eid=2-s2.0-0030302216&partnerID=40&md5=647084fa5f1062832258a73f04d8400d

Appendix A: Semi-Structured Interview Guides

Questions for villagers:

- Did you propose the project to the developers/funding agencies or they came to you?
- In what ways do you think the villagers were/are involved in the upcoming and management of the project?
- What has been your role in the micro hydro development?
- What do you see as the main benefits of the micro hydro project?
- What are the socio-cultural benefits of the project?
    - Probe: more time for family, local jobs, less drudgery, access to television.
- Can you tell me some environmental and health benefits?
    - Probe: Power in winter to stay warm, less use of firewood.
- Can you tell me some of the economic benefits?
    - Probe: new economic/ business activities, use of machines at work.
- What are some of the things/ key lessons you have learned through being involved in micro hydro activities/development/management.
- Were you able to participate as much as you wanted in the development and now operation of the community micro-hydro development?
    - Probe: do you think you wanted to do more but were not allowed to or there was no scope of anymore participation?
- Do you see any negative effects related to the upcoming and running of the micro-hydro facility?
    - Probe: environmental damage, tree cutting, soil erosion, shifting of houses.
- Do you think the micro-hydro has affected/benefited your daily lives?
- Do you have any comments or questions related to micro-hydro and this interview?

Additional Questions for women and women's groups:

- Was your role in the micro-hydro development different from that of your husband's and other men from the community?
- Have you seen that you/your group has influenced the decision made regarding the micro-hydro project? If yes, in what sort of ways?
- What changes has the micro-hydro brought in your individual life and as a group?
    - Probe: more time with family, increased economic opportunities, more respect within the family and village.
- Do you have any comments or questions related to micro-hydro and this interview?

Questions for development agencies:

- What was your motivation for involving the communities to develop the micro-hydro?
- How long have you been involved in community-based development? How many projects have you built?
- If you came up with the project, how did you provide information about the project to the local people?
- Did the villagers proposed to get involved in the project or you asked them to do so? In case you did, was it hard to convince them to get involved? How did you convince them?
- Is it easier to work with communities or without their involvement? Do you face any problems when local communities are involved in the project development?
- Do you think community involvement in the project helped the community gain something more than just electricity?
- Are there better ways to enhance or facilitate local people's participation in the projects?
- Do you have the documentation of environmental clearance and detailed project report (DPR) with you? If yes, can I please look at them.
- Do you have any comments or questions related to micro-hydro and this interview?

Appendix B: Focus Group Schedule

- What has been your experience with the involvement in micro hydro development? Does it play a large role in your day to day life and in the community?
- As per you, what are the various health, social, economic, cultural and environmental benefits associated with the micro-hydro?
- Are there any negative effects and challenges associated with micro hydro development? How did/do you tackle these?
- Do you think the level of community involvement in the project was adequate? If not, what more could be done?

Appendix C: Sustainability Indicators

Economic Indicators:

i. Land Compensation (satisfaction of people with the compensation).
ii. Job creation.
iii. Increase in economic activity (new activities/already existing activities).
iv. Small/local industry.
v. Project economics (net loss/profit).
vi. Who did the repair, monetary angle.
vii. Sustainability/Reliability of Public Finance (e.g. regular supply of funding or fixed funding for renovation/repair).
viii. Financial self-sufficiency.
ix. Plant load factor.

Environmental indicators:

i. River health and vitality (water quality, change/bad effects on river due to the project).
ii. Immediate Construction impacts (debris, damage to crops, fields, deforestation).
iii. Long term damage (slope destabilization, increased landslide, impact on fisheries)
iv. Afforestation.
v. Adequate/inadequate flow in the stream from diversion to tailrace.
vi. Wood use change.
vii. Irrigation stress/freshwater availability
viii. Climate change concerns such as low water level as compared to a few years back in Ramgaad.

Social indicators:

i. Local acceptance of the Project (+ive, -ive, or neutral).
ii. Equal distribution of electricity.
iii. Equal gender involvement in the management.
iv. Role for women.
v. Long term, slow effect showing benefits (better educated next generation)
vi. Quality of life (satisfaction of the villagers with the project and electricity)
vii. Democratic decision making.

Health Indicators:

i. Reduction in indoor pollution.

ii. Kerosene usage reduction and effects.

iii. Noise pollution from the turbine.

Appendix D: LEDeG Projects

LEDeG

Status report of MHPU established by LEDeG in Kargil

S. No.	Name of Village/Beneficiary	Unit Established	Scheme/Project under which established	Year of installment of Unit	Present Status	Remarks
1	Bartoo	30 kW	BORDA	2009	Functional	Community is planning to use secondary machine like Flour mill, knitting machine
2	Stiyangkong	5 kW	DCA	1995	Non-functional	
3	Purkitchey	12.5 kw	DCA	1993	Washed away by flood	
4	Pangbar/Yarkashing	5kW	BORDA	2006	Functional	This unit is attached with flour mill, community water heater and butter churner.
5	Shargandi	15 kW	BORDA	2004	Non-functional due to some social and Technical problem	Recently the community has approached LEDeG for estimate the damaged parts. Now they want to make it functional.
6	Purkitchey	10 kW	BORDA	2005	It was functional till year 2009, Non-functional due to technical problem	The operator has approached to LEDeG for repairing but the community is not taking interest.
7	Amaltik	5.5 Kw	BORDA	2002	Functional	Community has approached LEDeG for upgradetion of 5.5 Kw unit. It has also attached with flour mill.
8	Yokma Tangole	10 kW	BORDA	2006	Functional	
9	Gongma Tangole	5.5 Kw	BORDA	2002	Functional	
10	Tringuchey	5.5 Kw	BORDA	2002	Non-functional due to social problem	There is conflict among the community, therefore it is not functional.
11	Rigil Sapi	1.5 kW	BORDA	2003	Functional	There is some leakage in the pipe, it will have to repair/replace.
12	Sapi	3.70 kW	BORDA	2003	Functional	Attached with flour mill

Note: - Any other information relevant to the units may also be attached with the above format like if a unit is non functional what is the problem (on account of breakage of some parts etc) and how the unit can be made functional (suggestions).

Prepared By:-
LEDeG Kargil
October 2011

STATEMENT SHOWING STATUS REPORT OF MICRO HYDRO POWER UNIT (MHPU) INSTALLED BY LEDeG, ENDING DECEMBER 2011

S.No.	Name of Site/Villge	Block	Year	No.of HHs	Capacity	Funded By	Status	serviceable/ unserviceable	End use	End Use Status	Remarks
	Nubra Region										
1	Digar	Nubra	2006	64	10 KVA	BORDA	Not in Function	Serviceable	1.floor mill 2.Oil Expeller	functinal but but not being used since it was intalled.	It was in operation till August 2011, thereafter it occurred problem with ELC
3	Rongdo	Nubra	2008		5 KVA	IREP	Functional	-	1. floor mill	functinal but but not being used	-
5	Bogdang	Nubra	1996	36	10 KVA	DCA	Functional	-	-	-	Not being used, as the power requirement is more than the power output.
7	Udmaroo	Nubra			30 KVA		Functional	-	1. Floor mill 2. Oil expeller 3. Wood planer 4. Wood bandsaw 5. Pulpier machine	Not in function Not in function Functional Not in function Functional	The unit is in good condition but few end use machine is not working i.e Lower grinding stone is broken in floor mill. New expeller is not yet installed Band saw has a problem in blade etc
9	Khalsar	Nubra	2001	28	12 KVA	DCA	Not in Function	Serviceable	-	-	Damage at various part of canal in flash flood.
	Sham Region										
1	Achinathang	Khalsi	1989	55	10KVA	DCA	Defunct	unserviceable	-	-	The unit was not in function since 2000, later all the components were found missing. In the Flash Flood of August 2010 the structure was also washed away.
2	Shiela Wanla	Khalsi	1989	18	6KVA	DCA	Defunct	unserviceable	-	-	Hardware was collected back by LEDeG.
3	Ullaytokpo	Khalsi	1989	Private	6KVA	DCA	-				Maintained by owner himself.
4	Wanla	Khalsi	1990	49	10KVA	DCA	Defunct	unserviceable			Washed away in Flash Flood.
5	Domkhar Burma	Khalsi	1991	24	10KVA	DCA	-	-			New unit is installed inplace (refer row 21).
6	Dha	Khalsi	1992	32	10KVA	DCA	Defunct	serviceable			During Kargil war power house and canal was destroyed while constructing a road by the Army. The present status is, everything including structure is missing only the forbay tank is visible.
7	Hemishukpachen	Khalsi	1993	37	10 KVA	DCA	Defunct	-			The villagers are using the DG set provided by the Government at a later date. The unit is recovered back by LEDeG
8	Hanuthang	Khalsi	1994	33	6 KVA	DCA	out of order		-	-	The power house was partially damaged by flood. Now the villagers are interested to revive the unit.
9	Yangthang	Khalsi	1994	20	3 KVA	DCA	Defunct				The unit was functional till year 1996. The villagers dicontinued operation of unit on the excuse that operator found it inconvinient to go to the site due to steep climb.
10	Bemma	Khalsi	1996	67	5x2 KVA	MNES &DCA	out of order				The two portable set were made available by MNES. The present status is, penstock is demaged at various section and power house is in ruined shape and need to selvage.
11	Ullaytokpo	Khalsi	2000	5	1.5 kv	BORDA	Defunct	-			villagers dismentled the unit and kept the tools for new propose site which they think is more reliabe than the earlier one.
12	Ursi	Khalsi	2001	15	3KVA	BORDA	Defunct				Whole unit inclding the penstock was washed away in the flashflood of Aug 2010. Now the Villegers showing keen interest to re-establish the unit at another suitable site.
13	Urbis Rongdo (individual)	Khalsi	2002	1	0.37 KVA	BORDA	Not in function.				Alternator stops producing electricity
14	Fangila	Khalsi	2002	17	3.7 KVA	BORDA	-	-	-	-	The set is being removed and shifted to Hammer at Tagmachik, now that a new 5kw unit(refer to S/No19 below) has been installed
15	Sumdo	Khalsi	2002	5	1.5 KVA	BORDA	Defunct	-			The unit was stopped by villagers as it interfared with irragation need. Now they want to relocate the unit at another suitable site.
16	Hanupatta	Khalsi	2003	15	1.5 KVA	BORDA	Defunct	unserviceable	-	-	The structure was damaged in flood, all other hardware was kept in one of the villagers house and need to salvage.
17	Sumdachun	Khalsi	2003	6	1.5 KVA	BORDA					
18	Sumda do	Khalsi	2003	7	1.5 KVA	BORDA					
19	Fangila	Khalsi	2005	12	5 KVA	BORDA	silt up	serviceable	1.flour mill 2.Wood Planer	functional functional	The power house was silt up in the flashflood of Aug 2010. Now they are interested to revive the unit for income generation.
20	Mangyu	Khalsi	2006	39	10KVA	BORDA	functional	-	1.flour mill	functional	The damaged forbay tank is re-constructed this year and they hope to run the unit in the upcoming season.
21	Dhomkar Burma	Khalsi	2006	24	5KVA	BORDA	functional	-	1.flour mill 2.Band saw 3.Nut cracker 4.Pulper	Not in function functional functional functional	Fully damaged in flashflood of 2010, but villagers revived the unit this year and also run the unit on new year occasion. ELC and Dummy load is yet to install.
22	Hinju	Khalsi	2006		10KVA	BORDA	functional	-	1.Flour mill	Not in function	The Unit is not in use after the village was connected to grid. The flour mill is not functioning properly since it was installed.

Appendix E: Consent Forms

UNIVERSITY OF MANITOBA

Natural Resources Institute
Clayton H. Riddell Faculty of
Environment, Earth, and Resources

303 Sinnott Building
70 Dysart Road
Winnipeg, Manitoba
Canada, R3T 2N2
Telephone (204) 474-8373
Fax (204) 261-0038

<u>Interview and Focus Group Consent Form</u>

Research Project Title: Considering the Sustainability Benefits of Community-Based Micro-Hydro Development in Northern India.

Researcher: Gurmeet Singh Ghera.

Sponsors: Social Sciences and Humanities Research Council (SSHRC) and Graduate Enhancement of Tri-Council Stipends (GETS).

The text of this consent form will be translated and printed in the local language if necessary and will be read if I engage illiterate participants.

This consent form, a copy of which will be left with you for your records and reference, is only part of the process of informed consent. It should give you the basic idea of what the research is about and what your participation will involve. If you would like more detail about something mentioned here, or information not included here, please feel free to ask. Please take the time to read this carefully and to understand any accompanying information.

Project Description

The purpose of this research is to examine the sustainability benefits of community-based micro-hydro in the Himalayan region of Northern India. As such, the research pays attention to various parameters (social, environmental, health, economic and cultural) that combine and result in sustainability outcomes of a project. This research aims to shed light on people's perceptions about community-based micro-hydro and associated sustainability benefits. This research will add to the growing body of literature pertaining our understanding of how community-based management of natural resources can contribute to long-term sustainability.

Participant Involvement

You are invited to participate in an interview that will last between 30 to 60 minutes and a focus group discussion lasting between 1 to 2 hours. The interview will explore your experience with micro-hydro and related activities in your community, your perception of sustainability and learning experiences that have arisen by your involvement with micro-hydro. The focus group will aim at getting your inputs on the ideas and finding that I have gathered through my study. Written notes will be taken during the interview and focus group, and they will also be audio-recorded if you agree.

Anticipated Risk

I do not anticipate that your participation in this research should expose you to any risks beyond those you experience in the course of your work and daily life.

Confidentiality

To protect your identity, you will be given the opportunity to choose a pseudonym for the interview. This name will be used in all research reports, presentations and publications. Your true identity and raw research materials (such as interview tapes, transcripts and my research notes) will only be available to me and my thesis supervisor. You may, however, choose to have your real name used if you prefer. Confidentiality will not be possible in the focus groups as participants will know and hear one another. All participants will be asked to keep what is shared in the workshops confidential, but as this cannot be guaranteed the risk of confidentiality breaches will be fully explained before the start of the discussion.

Feedback

The type of research I am undertaking is an interactive process. I plan to share my ongoing analyses and conclusions with you, by sharing copies of interview transcripts with you and notes taken during the interviews for your comment, and through a final focus group in which I will present my ideas to you for comment. A briefing note summarizing the research results and providing recommendations will be produced for you.

Your signature on this form indicates that you have understood to your satisfaction the information regarding participation in the research project and agree to participate as a subject. In no way does this waive your legal rights nor release the researchers, sponsors, or involved institutions from their legal and professional responsibilities. You are free to withdraw from the study at any time, and/or refrain from answering any questions you prefer to omit, without

prejudice or consequence. Your continued participation should be as informed as your initial consent, so you should feel free to ask for clarification or new information throughout your participation.
Questions or concerns can be directed to:

Gurmeet Singh Ghera (principal researcher):
gherag@myumanitoba.ca

Dr. John Sinclair (thesis supervisor): 1-204-474-8374
John.sinclair@umanitoba.ca

The University of Manitoba may look at your research records to see that the research is being done in a safe and proper way. This research has been approved by the Joint-Faculty Research Ethics Board of the University of Manitoba. If you have any concerns or complaints about this project, you may contact any of the above-named persons or the Human Ethics Coordinator at 1-204-474-7122 or e-mail humanethics@umanitoba.ca. A copy of this consent form will be given to you to keep for your records and reference.

I, ____, consent to participate in this research:
Participant's Name (printed)

____

Participant's Signature Date

Or

Verbal consent sought and received: □

I consent to be audio recorded:

____

Participant's Signature Date

Please check one of the following:

□ I consent to the use of the following pseudonym in the thesis report, publications and presentations:

____

Pseudonym Signature Date

OR

□ I consent to the use of my real name in the thesis report, publications and presentations:

Participant's Signature Date

Witnessed by:

Researcher and/or Delegate's Signature Date

परिशिष्ट सी: सहमति फॉर्म

प्राकृतिक संसाधन संस्थान
क्लेटन एच। रिदम की संकाय
पर्यावरण, पृथ्वी और संसाधन

303 सिनोट बिल्डिंग
70 डायसर्ट रोड
विन्निपेग, मैनिटोबा
कनाडा, आर 3 टी 2 एन 2

UNIVERSITY OF MANITOBA

साक्षात्कार और फोकस समूह सहमति फॉर्म

अनुसंधान परियोजना शीर्षक: उत्तर भारत में सामुदायिक आधार पर माइक्रो-हाइड्रो विकास के स्थिरता लाभों को ध्यान में रखते हुए।

शोधकर्ता: गुरुमीत सिंह घड़े

प्रायोजक: सामाजिक विज्ञान और मानविकी अनुसंधान परिषद (एसएसएचआरसी) और त्रि-परिषद स्टिपेंड (जीईटीएस) के स्नातक संवर्धन।

इस सहमति फॉर्म का पाठ अनुवादित और स्थानीय भाषा में मुद्रित किया जाएगा यदि आवश्यक हो और पढ़ा जाएगा अगर मैं निरक्षर प्रतिभागियों को शामिल करता हूं।

यह सहमति फार्म, जिसमें से एक प्रति आपके साथ आपके रिकॉर्ड और संदर्भ के लिए छोड़ेगा, केवल सूचित सहमति की प्रक्रिया का एक हिस्सा है। यह आपको अनुसंधान के बारे में मूल विचार देना चाहिए और आपकी भागीदारी में क्या शामिल होगा। यदि आप यहां वर्णित कुछ चीज़ों के बारे में अधिक जानकारी चाहते हैं, या यहां शामिल जानकारी शामिल नहीं है, तो कृपया पूछने में संकोच न करें। कृपया इसे ध्यान से पढ़ने और किसी भी साथ की जानकारी को समझने के लिए समय निकालें।

परियोजना विवरण

इस शोध का उद्देश्य उत्तरी भारत के हिमालयी क्षेत्र में सामुदायिक आधारित माइक्रो-हाइड्रो के स्थिरता लाभों की जांच करना है। जैसे, शोध विभिन्न मापदंडों (सामाजिक, पर्यावरण, स्वास्थ्य, आर्थिक और सांस्कृतिक) पर ध्यान देता है जो कि एक परियोजना के स्थिरता के परिणामों को मिलाते हैं और नतीजे करते हैं। इस शोध का उद्देश्य समुदाय आधारित माइक्रो हाइड्रो और संबद्ध स्थिरता लाभों के बारे में लोगों की धारणाओं पर प्रकाश डालना है। यह शोध हमारी समझ से संबंधित साहित्य के बढ़ते शरीर को जोड़

देगा कि कैसे प्राकृतिक संसाधनों के समुदाय-आधारित प्रबंधन दीर्घकालिक स्थिरता में योगदान कर सकता है।

प्रतिभागियों की भागीदारी

आपको एक साक्षात्कार में भाग लेने के लिए आमंत्रित किया जाता है जो कि 30 से 60 मिनट के बीच रह जाएगा और 1 से 2 घंटों के बीच एक फ़ोकस समूह चर्चा चलेगी। साक्षात्कार आपके समुदाय में माइक्रो-हाइड्रो और संबंधित गतिविधियों के साथ अपने अनुभव का पता लगाएगा, आपकी स्थिरता और सीखने के अनुभवों की धारणा जो माइक्रो हाइड्रो के साथ आपकी भागीदारी से पैदा हुई है। फोकस ग्रुप का उद्देश्य अपने विचारों को अपने विचारों को प्राप्त करने और यह जानने के लिए है कि मैंने अपने अध्ययन के माध्यम से इकट्ठा किया है। लिखित नोट साक्षात्कार और फोकस समूह के दौरान लिया जाएगा, और यदि आप सहमति देते हैं तो उन्हें ऑडियो-रिकॉर्ड भी किया जाएगा।

अनुमानित जोखिम

मुझे यह आशा नहीं है कि इस शोध में आपकी भागीदारी से आपको अपने काम और दैनिक जीवन के दौरान अनुभव किए जाने वाले लोगों के अलावा किसी भी जोखिम का पर्दाफाश होना चाहिए।

लाभ

इस शोध का एक मुख्य लक्ष्य समुदाय आधारित माइक्रो-हाइड्रो के फायदे के बारे में अधिक स्पष्टता लाने के लिए है। भारत में अभी भी कुछ समुदाय-आधारित सूक्ष्म जल विकास है, फिर भी अवसर बहुत अच्छा लगता है। दूसरों को अपने अनुभवों से सीखना होगा बेशक मुझे भी उम्मीद है कि इस शोध से आपके समुदाय में लाभ आते हैं, और मुझे उम्मीद है कि ये उपलब्ध ऊर्जा के कुशल उपयोग से संबंधित होंगे, सकारात्मक तरीके से बढ़ेगा और माइक्रो-हाइड्रो ऑपरेशन के किसी भी चल रहे नकारात्मक प्रभावों को कम करना।

गोपनीयता

आपकी पहचान को सुरक्षित रखने के लिए, आपको साक्षात्कार के लिए छद्म नाम का चयन करने का अवसर दिया जाएगा। यह नाम सभी शोध रिपोर्टों, प्रस्तुतियों और प्रकाशनों में उपयोग किया जाएगा। आपकी असली पहचान और कच्ची अनुसंधान सामग्री (जैसे साक्षात्कार टेप, टेप और मेरे शोध नोट्स) केवल मेरे और मेरे थीसिस पर्यवेक्षक के लिए उपलब्ध होंगे हालांकि, यदि आप चाहें तो अपना असली नाम इस्तेमाल करना चुन सकते हैं। फोकस समूहों में गोपनीयता संभव नहीं होगी क्योंकि प्रतिभागियों को एक दूसरे के बारे में पता होगा और सुनेंगे। सभी प्रतिभागियों को कार्यशालाओं में जो कुछ साझा किया गया है, उन्हें गोपनीय रखने के लिए कहा जाएगा, लेकिन इस बात की गारंटी नहीं दी जा सकती कि गोपनीयता की उल्लंघनों के जोखिम पूरी तरह से चर्चा की शुरुआत से पहले समझाए जाएंगे। जैसा कि मेरे अनुवादक (मेहरु ठाकुर) साक्षात्कार और फोकस समूह में होंगे, उनके पास डेटा तक पहुंच होगी। उन्होंने एक गोपनीय शपथ लेने पर सहमति जताई है, जो अध्ययन के प्रतिभागियों द्वारा प्रकट की गई किसी भी

जानकारी का खुलासा न करें या उस पर चर्चा न करें। उन्होंने मैनिटोबा और कनाडा की विश्वविद्यालयों से शोधकर्ताओं के साथ बड़े पैमाने पर काम किया है। 15 फरवरी 2018 के बाद अनुसंधान से वापसी संभव नहीं होगी, क्योंकि मैं उस बिंदु पर डेटा का विस्तृत विश्लेषण प्रारंभ करूँगा। संपर्क जानकारी डेटाबेस, पहचान संख्या, फ़ील्ड नोट्स और लॉग्स के साथ-साथ ऑडियो फ़ाइलों को 26 सितंबर, 2021 तक नष्ट कर दिया जाएगा। साक्षात्कार के प्रतिलेख अज्ञात होंगे और शोधकर्ता द्वारा आगे के संदर्भों के लिए रखा जाएगा।

प्रसार

इस अध्ययन के माध्यम से एकत्र किए गए डाटा को मास्टर की थीसिस के माध्यम से प्रसारित किया जाएगा, जिससे मैं यह सुनिश्चित कर सकूं कि आपका समुदाय स्थानीय स्कूल या लाइब्रेरी, काम का एक संक्षिप्त विवरण सारांश, पत्रिका लेख और अन्य पोस्टर के लिए हो। इस प्रक्रिया का उद्देश्य यह सुनिश्चित करना है कि लोग मेरे अध्ययन के परिणाम और मुख्य निष्कर्ष देखें। ग्रामीणों, गैर सरकारी संगठनों और सरकारी अधिकारी सहित अनुसंधान में शामिल सभी प्रतिभागियों को उनके ईमेल पते पर आमंत्रित किया जाएगा यदि वे अनुसंधान परिणामों की एक प्रति प्राप्त करना चाहते हैं।

प्रतिक्रिया

मैं जो उपक्रम चला रहा हूं, वह प्रकार एक इंटरैक्टिव प्रक्रिया है। मैं आपके साथ अपने साक्षात्कार प्रतिलिपियों की प्रतियों को साझा करके और आपकी टिप्पणी के साक्षात्कार के दौरान लिया गया नोट्स, और एक अंतिम फोकस समूह के माध्यम से, जिसमें मैं अपने विचारों को टिप्पणी के लिए पेश करता हूं, मेरे साथ अपने चल रहे विश्लेषण और निष्कर्षों को साझा करने की योजना बना रहा हूं। अनुसंधान परिणामों के सारांश में एक ब्रीफिंग नोट और सिफारिशें प्रदान करने के लिए आपके लिए उत्पादित किया जाएगा।

इस फार्म पर आपका हस्ताक्षर इंगित करता है कि आप अनुसंधान परियोजना में भागीदारी के संबंध में आपकी संतुष्टि को समझ चुके हैं और एक विषय के रूप में भाग लेने के लिए सहमत हैं। इससे कोई फायदा नहीं है कि यह आपके कानूनी अधिकारों को माफ़ कर सकता है और न ही शोधकर्ताओं, प्रायोजकों या संस्थाओं को उनकी कानूनी और व्यावसायिक जिम्मेदारियों से रिहाई नहीं करता है। आप किसी भी समय मौखिक रूप से कहकर, और / या पूर्वाग्रह या परिणाम के बिना किसी भी ऐसे सवालों के जवाब देने से बच सकते हैं, जो आप को छोड़ना पसंद करते हैं। आपकी लगातार भागीदारी एक होना चाहिए जैसा कि आपकी प्रारंभिक सहमति के रूप में सूचित किया गया है, इसलिए आपको अपनी भागीदारी के दौरान स्पष्टीकरण या नई जानकारी मांगने के लिए स्वतंत्र महसूस करना चाहिए।
प्रश्न या चिंताओं को निर्देशित किया जा सकता है:

गुरुमीत सिंह घोरा (प्रमुख शोधकर्ता): [illegible]
gherag@myumanitoba.ca

डॉ। जॉन सिंक्लेयर (थीसिस पर्यवेक्षक): 1-204-474-8374
John.sinclair@umanitoba.ca

मैनिटोबा विश्वविद्यालय मेरी शोध के रिकॉर्डों को देख सकता है कि यह शोध एक सुरक्षित और उचित तरीके से किया जा रहा है। इस शोध को मनिटोबा विश्वविद्यालय के संयुक्त-फैकल्टी रिसर्च एथिक्स बोर्ड ने मंजूरी दे दी है। यदि आप इस परियोजना के बारे में कोई चिंताओं और शिकायतें हैं, तो आप ऊपर दिए गए किसी भी व्यक्ति या मानव एथिक्स समन्वयक से 1-204-474-7122 पर ईमेल कर सकते हैं या ई-मेल humanethics@umanitoba.ca पर संपर्क कर सकते हैं। इस सहमति फॉर्म की एक प्रति आपके रिकॉर्ड और संदर्भ के लिए रखने के लिए आपको दी जाएगी।

मैं, ___________________________________, इस शोध में भाग लेने के लिए सहमति देता हूं:
प्रतिभागी का नाम (मुद्रित)

____

प्रतिभागी की हस्ताक्षर तिथि

या
मौखिक सहमति की मांग की और प्राप्त: □

मैं ऑडियो रिकॉर्ड करने की सहमति देता हूं:

____

प्रतिभागी की हस्ताक्षर तिथि

या
मौखिक सहमति की मांग की और प्राप्त: □

कृपया निम्न में से एक को देखें:

1. □ मैं थीसिस रिपोर्ट, प्रकाशन और प्रस्तुतियों में निम्नलिखित छद्म नाम के उपयोग की सहमति देता हूं:

____

छद्म नाम हस्ताक्षर तारीख

या

छद्म नाम का उपयोग करने के लिए मौखिक सहमति मांगी गई और प्राप्त की गई: □

2. □ मैं थीसिस रिपोर्ट, प्रकाशन और प्रस्तुतियों में अपने असली नाम के उपयोग की सहमति देता हूं:

____

प्रतिभागी की हस्ताक्षर तिथि

गवाह ने देखा:

____
शोधकर्ता और / या प्रतिनिधि के हस्ताक्षर   दिनांक

या

वास्तविक नाम का उपयोग करने के लिए मौखिक सहमति मांगी गई और प्राप्त की गई: □