.

Micro and Mini Hydro Technologies- Vulnerability and Adaptation to Climate Change

Efforts to identify linkages of renewable energy in adaptation to climate change in the context of Nepal.

Ranjan Parajuli
5/10/2011

Abstract:

Micro hydro is one of the most mature decentralised energy technologies used in developing countries like Nepal. Micro hydro as “social infrastructure” supports in development of isolated off-grid electricity through community participation, which increases the capacity of rural communities to understand the dynamics of rural development and needs of social cohesion for expected impact. Similarly, as “physical infrastructure” uses the approaches applied to electric power generation more generally, and to such investments as the provision of rural roads, and irrigation systems. Even more recently micro hydro has been seen in terms of small and medium enterprise development, and the role that such enterprises can play in “securing livelihoods” can support in building adaptive capacity of vulnerable communities, which is expected to occur/occurring due to climate change and natural disaster.

Vulnerability associated with the technology is categorized in two broad way- Physical/Infrastructural vulnerability and Resource vulnerability. The change in runoff in the river flow obviously can damage the intake structure of the power plants, thereby halting the generation of electric power from short to a very long period, depending on the accessibility of market area to rehabilitate and repair the system. Similarly, changes in runoff, degradation of water resources due to climate change may affect the power generation in the long run. This has serious implication to the basic and productive uses, on which the rural livelihood is based.

This paper has tried to highlight- how micro/mini hydro can support in building resilient capacity of vulnerable population; how promotion of Mini/micro hydro can be integrated through local development plan to support the national climate change initiatives. It also discuss on the possible adaptive approaches that can be integrated in the project cycle of the technology promotion.

Ranjan Parajuli

May 12, 2011

Revised version: May 13, 2011

Public Profile: http://np.linkedin.com/pub/ranjan-parajuli/13/694/67 a

For comments E-mail: parajuliranjan@yahoo.com

Contents

History of Development of Micro/Mini Hydro in Nepal

Despite of having enormous potential of hydro power in Nepal, only 40 percent of the country's households have access to electricity and at the meantime disparity in access is stark as well [1]. It covers for over 90 percent of the urban population connected to the grid and only 27 percent of rural households with access to electricity.

Micro and mini hydro technologies are electrical energy generation system from water resources with installed capacity respectively up to 100 kW and 100 kW to 3 MW of electric power. This technology has been successful to extend and expand rural electricity in rural areas.
It has been found that in Sri Lanka, for instance, many micro hydro plants have been initially installed primarily to 'improve the quality of life by providing electric light'. And in Peru the key question for many project developers was 'how long will the plant last, rather than how high is its rate of return or how quickly the capital will be paid back'. Similarly in Nepal after passing the era of testing and assessing the technical viability of the system, after the early 60's the system has been treated to increase access to rural energy services for basic lighting facilities [3].

The history of use of the water resources in the country reveals that people had initiated to harness the available hydraulic energy by trapping by some traditional way and using in the traditional water mills. The harnessed mechanical energy has been used for grinding grains and other agro-processing activities from the time immemorial. Introduction of micro hydro power plants took place in early 60's. Micro hydro is now a mature technology that has been greatly improved by electronic load controllers, low cost turbine designs, the use of electric motors as generators, and the use of plastics (High Density Polyvinyl Plastics) pipe work and penstocks. This experience shows that in certain circumstances micro hydro can be profitable in financial terms, while at others, even unprofitable plant can exhibit such strong positive impacts on the lives of poor people [3].

The emphasis on power development in Nepal followed the adoption of the Hydropower Development Policy in the early 1990s, which combined with changes in electricity legislation and the opening up of the power sector to local and foreign private investments. This was intended to make institutions operating in the power sector efficient and creditworthy, as well as increase the participation of the private sector in the provision of electricity services to the people. Under this policy and regulatory framework, Government of Nepal (GoN) has been able to attract some private (foreign) investments in power generation, yet there is an increased recognition that more needed to be done to attract private capital in the sector and to improve the efficiency and creditworthiness of Nepal Electricity Authority (NEA), the central Government owned grid operator, generator and distributor [2]. Nepal's 10th National Plan aims to increase the electrification rate to 55 percent through both grid extension and non-grid options including micro-hydro and solar. Similarly, the 3 years Interim Plan (2010-13) aims to increase additional electrification coverage of 7 percent of households through the development of Mini/micro hydro power in rural areas.

With the establishment of Alternative Energy Promotion Centre (AEPC) under the Ministry of Environment, Government of Nepal the development of micro/mini hydro has gained new momentum. AEPC is executing body to promote the decentralized energy system through private and public cooperation. Rural Energy Development Programme (REDP) and Energy Sector Assistance

Programme (ESAP) are the major programmes of AEPC to promote micro and mini hydro technologies in Nepal.

The field of micro hydro is "evolving", particularly in relation to the motivation of project developers. In recent times most of the initial installations in developing countries might be said to be the result of "technology push". That is, plants were installed to test their technical viability and their acceptability. This experience has established the technical reliability of the micro hydro systems, reduced their cost, and has resulted in substantial technical improvement. Hence, now the "technology push" approach should be replaced completely by the "Market Pull" approach. This needs to be facilitated through the demand based mechanisms, where optimum utlisation of power is ensured. This has implications on the financial viability of the power plants through the promotion of rural based micro-enterprises and other economic activities.

MHP Services and Contribution to the Society

Contribution of micro hydro to the society can be understood from the aspect - how its intervention is supporting in development and management of rural ecosystem, how it has contributed in building social harmonization and equity to access of energy, how energy services had helped to enhance the livelihood of rural population. Micro hydro as "social infrastructure" and "physical infrastructure" has been found in contributing in social and economic development through bringing energy services and utility in the rural hamlets.

Promotion of this technology has facilitated to improve the social, physical and economic assets in the rural community of Nepal. Now with the increasing threat to ecosystem due to environmental degradation, it is obvious to say that this technology can have substantial contribution to low carbon development path and clean energy promotion that supports in uplifting socio-economic conditions and physical qualities rural population of the country, ensuring the sustainable development.

Decentralized Energy Access

Micro and mini hydro technology being a feasible decentralized and alternative energy technology in Nepal has helped to ease the rural livings by increasing access to energy to carry out basic and productive uses. With the increased access of energy in rural settlements, the technology has promoted rural education services and has facilitated promotion of rural based commercial/industrial activities. Nevertheless, exploitation and optimum utilization of energy is still need to be materialized in a practical manner. In the situation, where there is high investment density due to very low population density in high hills and mountains to promote transmission and distribution of electricity from the national grid, micro and mini hydro has been regarded as one of the viable alternative energy technologies. Also water is plentiful in the rugged hills of Nepal and micro-hydro provides a more practical and cost effective alternative to the National grid.

Poverty Impact

A study commissioned by the UK's Department for International Development, pointed out that it is conceptually and empirically difficult to attribute measurable poverty impacts to relatively small investments, such as micro hydro, when there are so many other circumstances (such as climatic variation, and macroeconomic change) that affect the measurable poverty status of remote communities over any particular time period. However, it has outlined that the effects of micro-hydro on the incomes of the poor through changes in entrepreneurs' incomes, labour incomes,

consumer real incomes and backward and forward linkages. Following this approach the study found:

"in relation to the number of schemes in existence the poverty reduction performance of micro-hydro is impressive, particularly in Nepal and Ethiopia….micro-hydro is indeed a relatively efficient method of poverty reduction, in terms of costs per person moved across the poverty line. The poverty gap measure suggests that micro-hydro is also able to reach a number of the extremely poor….through the channel of wage employment in micro-hydro schemes themselves and linkage activities derived from those schemes. In addition, it has been mentioned that the estimates of poverty reduction from micro-hydro .. systematically understate poverty impact, as they exclude a range of very difficult to measure but important effects such as time savings from no longer having to carry kerosene or other fuel, improved education from the availability of electric light and improved health and agricultural production from drinking and irrigation water made available out of channels originally developed for micro hydro schemes." [4]

Social Harmonization

Promotion of Micro/mini hydro in Nepal has been practiced with active participation of community from the stage of feasibility study, design, construction and operation. This has strong influence on the taking ownership, sharing of cost to be borne by marginalized people. The financial cost is reduced by involving the community in the process of project development.

The participatory way of developing the power plants not only creates a foundation for cost sharing and deployment of labor but also facilitates the group to work and support each other in the case of extreme events and disaster risk minimization. This harmonization effect is thus one of the strong elements that can be potentially utilized autonomously for the disaster risk preparedness and for the post-disaster management.

Climate Change Vulnerability and Adaptation

Intergovernmental Panel on Climate Change (IPCC), defines vulnerability in terms of systems, as 'the degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of the character, magnitude, and rate of climate variation to which a system is exposed, its sensitivity, and its adaptive capacity' [5].

Adaptation is defined as 'adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities' [5].

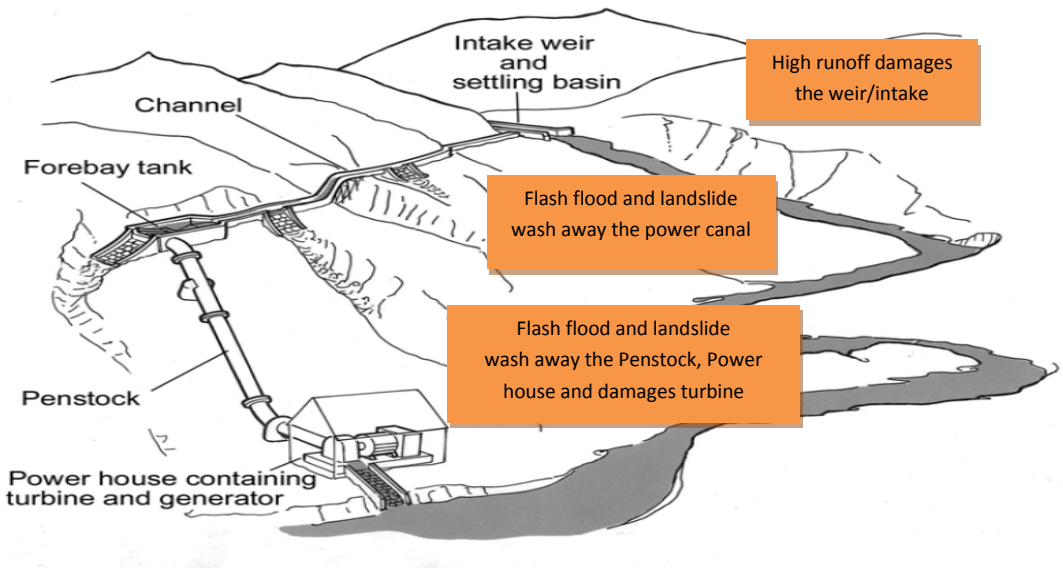
Hence, adaptation is a social process that requires collective action and social capital provides such an opportunity. It enables the society to effectively interact with other capital assets and appropriate institutions, like the state, civil societies and financial institutions that can help formulate livelihood strategies that would enhance their ability to cope with extreme weather conditions [6].

Vulnerabilities Associated with Micro/Mini Hydro Power in Nepal

There have been records of a number of extreme events occurring in Nepal in last few decades; however it is difficult to correlate those events with the climate change. However natural disasters have jeopardized economic development in the country.

Physical Vulnerability

Physical vulnerability refers to the structural damages in the micro hydro power systems due to climate change, extreme events and natural disasters. Nepal's high hills and mid hills topography are prone to natural disasters like floods, landslides and erosion.



Source: ***MHP Layout****- Practical Action, Micro Hydro, Technical Brief*
Risks tabs*-author opinion*

Figure 1: Typical Layout of MHP and Vulnerabilities due to extreme events

These disasters can demolish the power generating system and other elements like Intake, power canal, forbay, penstock, and power house (including the mechanical and electrical accessories in-built in the system). It has been found that almost all Micro/Mini hydro built in Nepal have temporary intake system and consists of trash rack type weirs. The high runoff in the river obviously can damage the intake structure of the power plants, thereby halting the generation of electric power from short to a very long period, depending on the accessibility of market area to rehabilitate and repair the system. The Figure 1 shows the most possible physical vulnerability, which potentially affect the sustainable operation of the technology. This has serious implication to the basic and productive uses, on which the rural livelihood is based.

Resource Vulnerabilities

It is expected that due to the climate change, there will be certain uncertainties associated with the whole hydrologic cycle. Hydrologic cycle itself is a complex system and the climatic and hydrologic changes will add more uncertainties to its complexities. Every component of the cycle, viz., evaporation, transportation, and precipitation and run off, will be affected in different magnitudes and thus, new balance in the cycle will be created, which may not be the same as present [7]. The existing hydropower plants (big/small/micro) may not function with designed capacity, as the variation in flows might vary (may increase for the short time and decrease after a longer period of time).The most critical impacts of climate change in Nepal can be expected to be on its water resources, particularly glacial lakes, and its hydropower generation. Water supply infrastructure and

facilities are at risk from increased flooding, landslides, sedimentation and more intense precipitation events (particularly during the monsoon) expected to result from climate change. This has greater impact to power generation from Micro/Mini hydro, as the structure of this technology is less robust to withstand these risks. Greater unreliability of dry season flows, in particular, poses potentially serious risks to water supplies in the lean season. Micro-hydro plants are highly dependent on the one time measurement of dry season flow. It is expected that the changes in runoff of river discharge due to climate change may affect the power generation in the long run. Therefore, increased climate variability, threatens the potential for power generation

Role of Micro Hydro in the Adaptation to Climate Change

Micro Hydro for ensuring Energy Security

Decentralized energy technology like Micro-hydro is one of the tools to ensure energy security in developing countries like Nepal. Here, energy security can be referred to a situation where there is;

- Access to affordable and convenient energy technologies established through conducive energy policies
- Availability of efficient energy technologies and access to minimum energy required for reducing energy poverty
- Availability of energy services for Productive end-use promotion and operation
- Energy for better health and education services
- Reliability of available forms of energy [8].

But the major challenge on its sustainability is the load factor, which is very low. Hence, demand management is very essential in the promotion of micro/mini hydro technology in Nepal. If the demand assessment is carried out considering the need of power for end-uses (agro-processing, rural cottage industries and other income generating activities) at the core and lighting services as complimentary applications, it has two distinct advantages. Firstly access to lighting services is easily ascertained and secondly end-uses promotion helps in sustainable operation of the system and promotes many opportunities of livelihood, which better enhance the environmental, social and financial assets and the ongoing capability to transform these assets into human well-being. There is wide scope of Micro/mini hydro and other Renewable Energy Technologies (RETs) in ensuring energy security, which supports in productive applications relevant to rural settlements.

Hence, Energy security in rural areas has significant role to- reduce stress and pressure on vulnerable natural resource. Access to reliable off-grid electricity also helps in transferring communication and information to reduce the potential impact and losses that may takes places due to extreme events [8].

Environmental management

Looking from the lens of climate change vulnerability and disaster risk on every development process, the key factor required to be considered are- *they should be able to ensure sound and equitable management of bio-diversity and ecosystem; ensure access to safe water and sanitation services; improve air quality and limit exposure to toxic chemicals; reduce and mitigate natural disasters and resource-based conflict; and reduce and mitigate climate variability and change* [9]

Decentralized energy system like micro/mini hydro and other renewable energy technologies has significant role in social and environmental development, where all the necessary factors as outlined are expected to ensure properly. Equitable use and management of resources, access of energy for basic residential activities from the development of the technology is expected to support in environmental management and poverty alleviation.

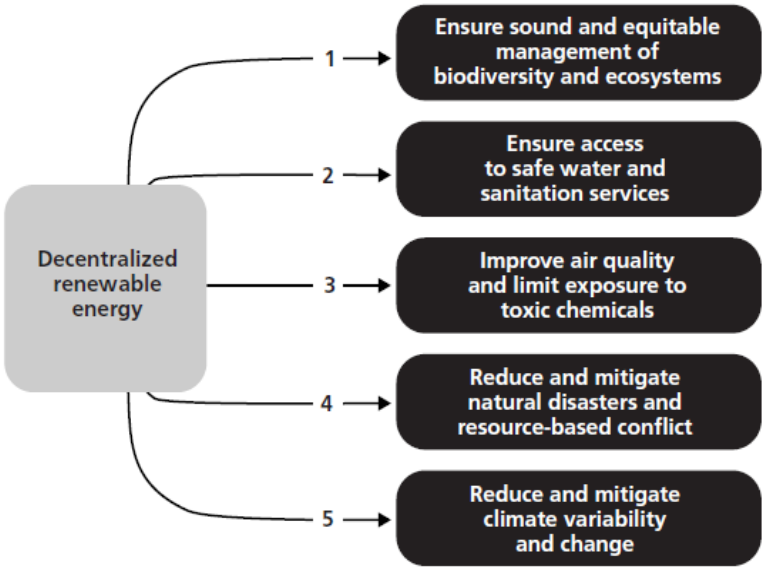


Figure 2: Relationship between decentralized energy services, environmental management and poverty alleviation

Source: IISD (2006).

End-uses for building Resilience Capacity

The most common end-uses, which are found, integrated with micro/mini hydro development in the country, are shown in Table-1. The table further shows possible factors that enhances resilient capacity of vulnerable population against climate change and natural disaster. These end-uses have different direct and indirect contribution to enhance resilient power through tangible and intangible benefits associated with them.

Here, agro-processing end-use (for e.g. operation of huller, oil expeller, grinder etc) supports in processing of agro-products, which are require for maintaining nutrients either during normal or disaster period. Processing of agri products and better storage facilities helps to ensure food security in the long run and also support in providing during the period of scarcity. In addition to this, these interventions also promote rural enterprise development and support in income generation. This has direct impact to the overall livelihood enhancement of the community/family.

Table 1: Most Common End-use for influencing on climate change and DRR Initiatives (direct relation)

S.N	Common Rural Enterprises	Factors for Building Resilience Capacity					
		livelihood support	Support in Food Security	Support in DRR management through information exchange	Employment Generation	Support to Health Services	Agri-Productivity and Income
A	Basic Lighting Services	√	-	√	√	√	-
B	**Productive End-Uses**		-	-	-	-	-
1	Rural Agro-processing Industry	√	√	-	√	-	√
2	Rural Paper Production Industry	√	-	-	√	-	-
3	Energy for Grocery business and operation	√	√	-	√	√	-
4	Electronic and Electrical Repair		-	√	√	-	-
5	Cable TV network	√	-	-	√	-	-
6	Metal Workshop	√	-	-	√	-	-
7	Poultry	√	√	-	√	-	-
8	Rural Bakery	√	√	-	√	-	-
9	Cold Store	√	√	-	√	-	-
10	Rural Communication and Computer center	√		√	√	-	-
11	Diary	√	√	-	√	-	-
12	Medicinal Herbs Processing	√	-	-	√	√	-
13	Rural Carpentry	√	-	-	√	-	-
14	Water Pumping	√	√	-	-	√	√
C	**Other Utility (Tailrace water)**						-
1	Irrigation	√	√	-	-	-	√

Source: Author Opinion

Similarly, rural communication services may help in increasing access to information related to natural disaster, extreme events, and weather forecasting etc. Repair and maintenance centre for electrical parts promoted by MHP helps in maintaining the rural electrical and electronic appliances to sustain reliable availability of information/data required for management of disaster risk reduction and assessment of climate change impacts in rural areas for better planning.

Roles of Micro Hydro Technology in Climate Change Initiatives

Carbon Mitigation

Micro/Mini hydro Technology is the second Carbon project for renewable energy technology promoted by the government of Nepal. AEPC as an executing agencies is able to register the Micro/Mini hydro technologies as CDM project by registering in the UNFCCC. The estimated emission

reduction potential of Micro/Mini hydro as a CDM project is 2.3 tonnes of CO_2 equivalent per kilo watt of generated power per year. [10].

This opportunity of carbon market may support in further development and promotion of the technology in the rural areas of the country, which will not only increase access to decentralized energy but also supports in the sustainable development. This carbon revenue potentially can also be used for adaptation purpose to reduce the vulnerabilities associated with the technology through the development of appropriate policy.

National Adaptation Programme of Action

National Adaptation Plan of Actions (NAPA) is the key strategic tool developed by Ministry of Environment; Government of Nepal which outlines the major thematic areas/sectors that can better address the issues of climate change adaptation in the country. NAPA provides a basis for the development of a multi-stakeholder Framework on Climate Change Action, ensuring that the NAPA-related stakeholder processes are institutionalized and backed up by dedicated knowledge management and learning platform. The NAPA is expected to form the basis of, and support for, a wider strategy for climate resilient, low carbon development, with which other climate change processes in Nepal can be aligned. [11]. The broad framework and Nepal's Development Goals as presented by NAPA is shown in Table-2. The table also shows how MHP supports the development goals and thematic areas as a cross cutting element

Pilot Program for Climate Resilience

The goal of the Pilot Program for Climate Resilience (PPCR) is to help countries transform to a climate resilient development path, consistent with national poverty reduction and sustainable development goals. [12.a; 12.b]

Broadly, linkages and role of decentralized energy development to strengthen PPCR Components is shown in Table-3.

Table 2: Cross Cutting Values of Micro Hydro in the NAPA Framework and Nepal's Development Goals

NAPA Thematic Areas (##)	Summary Highlights of Tenth Plan and Three Years Interim Development Plan (##)	Micro Hydro as a Cross Cutting Elements ($)
Agriculture and Food Security	• The 10th plan envisaged growth in agriculture and reduction in food insecurity and malnutrition. • The Agriculture Perspective Plan (1995) emphasized on the stronger role for private sector development and increased roles of communities, farmers, cooperatives in the management of infrastructure and assets	• Water Resource management at the rural level ensures the convenient way of water applications for irrigation and other applications • Development of rope way (gravity and electrified) in feasible areas supports in increasing access to market • MHP is the decentralized means of promoting rural electrification in the country, which supports in improving market linkages for ensuring better value chain development of the agricultural productions. • User/community group of MHP mostly represent rural farmer. This group can be capacitated for commercial agriculture development.
Water Resource and Energy	The 10th Plan emphasized on • the development of power sector and aimed to expand electricity coverage in a sustainable and environment friendly manner; • the acceleration of rural electrification promotion and develop hydro power as a export commodity • to develop alternative energy, reduce dependency on imported energy and • to strengthen the role of private sector in developing and delivering these priorities The 3 years Interim Plan envisioned for optimal utilization of water resources and to meet the local electricity demand and export the surplus while expanding the development and services in order to contribute to the livelihood of Nepalese people	• MHP is regarded as a sustainable decentralized energy system in Nepal. • Supports in reducing the pressure on the resource base of the energy like forest • Promotion of end-uses like agro-processing activities reduces the dependency on the imported fossil fuel (like diesel used for diesel mills) • MHP as a decentralized energy eliminate the issues of high investment density, compared to big hydro This support in enhancing the pace of rural electrification. • Isolated on-grid system development is potential to make it financially sustainable and export the surplus, while expanding the development and services of rural areas. • Ensures the perfect combination of Public-Private Cooperation. • Creates tremendous opportunities of entrepreneurship and employment generation.
Forest and Bio-diversity	• 10th Plan recognized role of forest in promoting rural livelihoods and promoting environmental services. • The 3 years Interim plan recognized it as contributing to other sectors significantly.	• MHP can act as a cross cutting elements to reduce pressure on forest resources as an energy carrier. • Promotes rural carpentry services for necessary requirements. • Promotion of MHP can integrate plantation activities, nursery

	• Emphasized on proper utilization, conservation, protection, use of forest resources to general public needs to be facilitated in a sustainable manner.	development and other bio-engineering applications, to combat the negative consequences on the environment and promote livelihood of rural people and.
Public Health	The 10th plan envisioned overarching national objective in the health sector as to reduce the magnitude of poverty substantially and make it sustainable by developing and mobilizing healthy human resources. The interim plan envisioned establishing appropriate conditions of quality health services, accessible to all citizen of the country, particularly focusing on low income citizens.	• Access to electricity to rural hospitals and health post promotes qualitative and safe medical services through the use of modern health equipments and accessories. • Vaccination services can be promoted through the access of electricity to operate the refrigeration requirements. • Access to information on health, sanitation and safety can be facilitated by convenient information dissemination systems like TV, radio, rural cyber hubs etc.
Urban Settlements and Infrastructure	The 10th plan focused on the infrastructure development, especially road networks and national communication infrastructure. It has spelled to provide potential support in post- disaster emergency relief in the forms of emergency shelters and housings for disaster affected families.	• Disaster doesn't look for poor/rich and urban/rural, it means that requirement for disaster preparedness and post-disaster management is equally important for the vulnerable areas nation-wide. • Access to electricity will enhance the different disaster preparedness activities, operation of early warning systems, and dissemination of weather forecasting features to the population. • Post-disaster emergency relief might need energy services to carry out relief activities and services, and to carry out basic activities.
Climate Induced Disaster	Disaster Risk Management has been priortised in the 10th Plan. Government has approved the National Strategy for Disaster Risk Management (2009), which aims to establish disaster resilient communities, mainstreams disaster risk reduction into development through sectoral development and poverty alleviation planning. The interim plan set its objectives to promote security of life and property from disaster through sustainable, environmentally friendly and result oriented development by making disaster risk management practices efficient, competent, strengthened and effective.	Energy is a pre-requisite tools for social and economic development. Sectoral development, if is planned in an integrated approach will assure all the basic and productive needs required for the development of society. The need of energy for a number of economic activities will help to enhance the steps moved towards the poverty alleviation of the vulnerable communities/population.

(##) *Sourced from NAPA to Climate Change, Nepal [11];*

($) *Further edited by Author to show the linkages on NAPA thematic areas and Development Goals*

Table 3: Linkages and Role of Decentralized Energy Development to strengthen PPCR Components

PPCR Components (#)	Major Areas for strengthening PPCR Component (##)	How existing approach of decentralized energy (DE) development support them ($)
Component 1: Building Climate Resilience of Watersheds and Water Resources in Mountain Eco-Regions **Component 2:** Building Resilience to Climate-Related Extreme Events **Component 3:** Mainstreaming Climate Risk Management in Development **Component 4:** Building Climate Resilient Communities through Private Sector Participation	• **Watershed Management** o Integrated Watershed Management to ensure ecosystem and community adaptation to climate change o On-farm soil and water conservation and up scaling and implementation of non-conventional irrigation systems in water stressed areas o Flood management to reduce the vulnerability of communities and increase their adaptive capacity • **Disaster Risk Reduction** o Community-based disaster risk reduction strategies and activities o Early warning system development in disaster prone areas o Interlink climate change with DRR and enhancement of institutional capacity at different levels • **Infrastructure Development** o Construction of water retaining structures as sustainable adaptation measures to address the effect of climate Change o Management of existing hydrological and meteorological network at DHM and up-scaling the services o Strengthening forecasting / early warning and surveillance o system on climate change & health in Nepal • **Capacity Building** o Building capacity to enhance community adaptation to climatic hazards o Enabling climate vulnerable communities through ▪ livelihoods by improving access to agricultural services ▪ Increasing community climate adaptive capacity through improved production and marketing systems	• **Sustainable Natural Resource Management** o Natural resource conservation, transformation and utilization o Sustainable use of biomass resources reducing the impact on watershed management practices o Water resources management through construction of improved water mills, micro/mini hydro o Development and promotion of irrigation systems like water pumping and promotion of pressurized irrigation system for cash crops production • **Energy Infrastructure Development** o Micro/mini Hydro installation through productive end-uses promotion for livelihood enhancement of vulnerable communities o Off-grid electricity promotes the intervention and operation of qualitative early warning systems, and collection/management of hydro meteorological information • **Private Sector Development** o Capacity building needs can be identified for the existing active private and public organizations working for increasing energy access o Capacity building to identify/assess the livelihood options that can support in increasing resilience capacity o Capacity building and institutional strengthening of community based organisations to enhance the agriculture productivity and better establish market linkages for the produced commodities

(#) *World Bank et al, 2010, [12.b];* ***(##)*** *World Bank et al, 2010, further edited by author;* ***($)*** *Author Opinion*

Consideration of Climate Change Issues in the Project Cycle

In the context, where climate change adaptation requires to be integrated in every development practices, it is also equally imperative to identify its linkages at the micro level, like project development and operation. The ideal project cycle consists of (i) Project Identification (ii) Project Appraisal (iii) Detail Design (iv) Project Implementation and (v) Monitoring and Evaluation. All these components/cycle of project consists of different activities, where climate change adaptation needs can be identified and prioritized [13 and 14]. The Figure 3 shows different entry points and indicative activities to link climate change adaptation need identification in the project cycle.

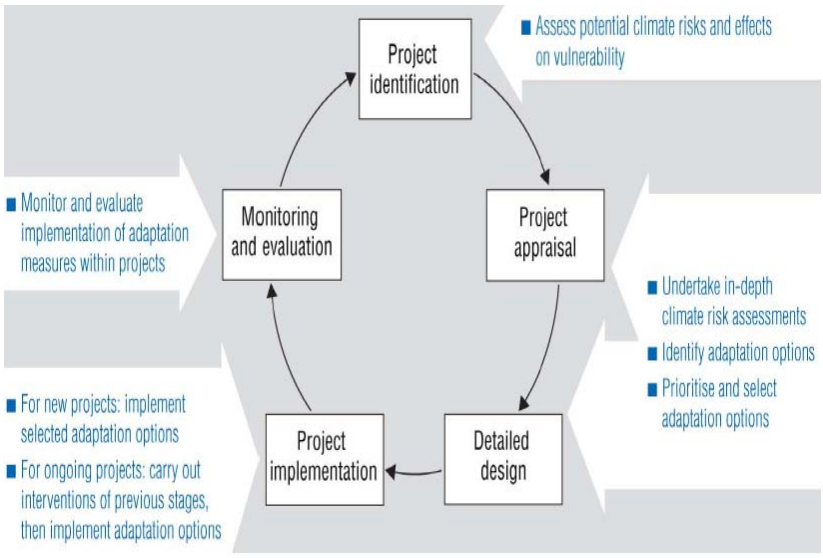


Figure 3: Entry Points for Climate Change consideration in an Ideal Project Cycle

Source: OECD (2009).

Integrating Adaptation Process in Micro/Mini Hydro Project

Consideration in the Project Cycle

Project Identification

- During the pre-feasibility assessment of the micro/mini hydro technologies, assessment of potential climate risks and vulnerabilities is essential. This may comprises of;
  - Assessment of changes in the run-off pattern of the source of river, which will be sourced for power plants (this can be evaluated from past recall of local consumer or by the use of available tools)
  - Assessment on the land degradation (landslides, floods) in the areas to identify potential less vulnerable sites for power generation
  - Assessment of impact observed due climate change and extreme events by the community, which may comprises agriculture production, loss in bio-diversity, health etc.
  - Assessment of potential end-uses that can be integral part of the power development for sustainability of the system

Project Appraisal

- Identification of possible adaptation measures to address the vulnerabilities
- Identification of possible activities that can be integrated for enhancing livelihood opportunities thereby increasing resilience capacity of the vulnerable population

- Identification of structural and non-structural measures to adapt and build resiliency against vulnerabilities associated with the power plants
  - Identification of feasible demand driven end-use promotion that can support livelihood opportunities;
    - Livelihood options and better economy may reduce the cost of adaptation intervention in the technology.
  - Identification of opportunities that the power plants can create to upgrade the education system in the project areas
  - Identification of other adaptive options like health security, management of rural eco-system, drudgery reduction, which can support in increasing resilient capacity of the community with the access of energy
- Financial viability of the project to ensure the sustainability

Detail Design

- Construction of embankments and soil conservation measures to support in the structural adaptation options
- Selection of reliable power house sites and transmission and distribution system, where there is no/minimal risks
- Provision of appropriate design that can mitigate the problems of silting and debris flow, which can deteriorate the mechanical and civil structures of micro/mini hydro
- Estimation of load factor and ensure the demand driven approach (integrated by optimum application of end-uses) to make the project financially sustainable
- Priortise the adaptation options that can be implemented in the following years
- Preparation of periodic action plan to identify the risk and cost to address them. This will be lesson learning to other potential promotion.
- Benefit cost analysis for finalizing the site selection considering the vulnerability associated with climate change and extreme events

Project Implementation

- Construction of power plants/house with qualitative materials
- Capacity building of Users Group on the sustainability of the project
- Capacity building of Users Groups on the autonomous and reactive adaptive actions for the extreme events
- Identification of planed adaptation options from the assessment of associated vulnerabilities carried out in the initial phases of the project
  - Implement the selected adaptive options in the case of new projects
  - For ongoing project, carry out interventions of previous stages and implement the adaptive options

Monitoring and Evaluation

- Monitoring activities and action plan to assess the implementation of the adaptive actions

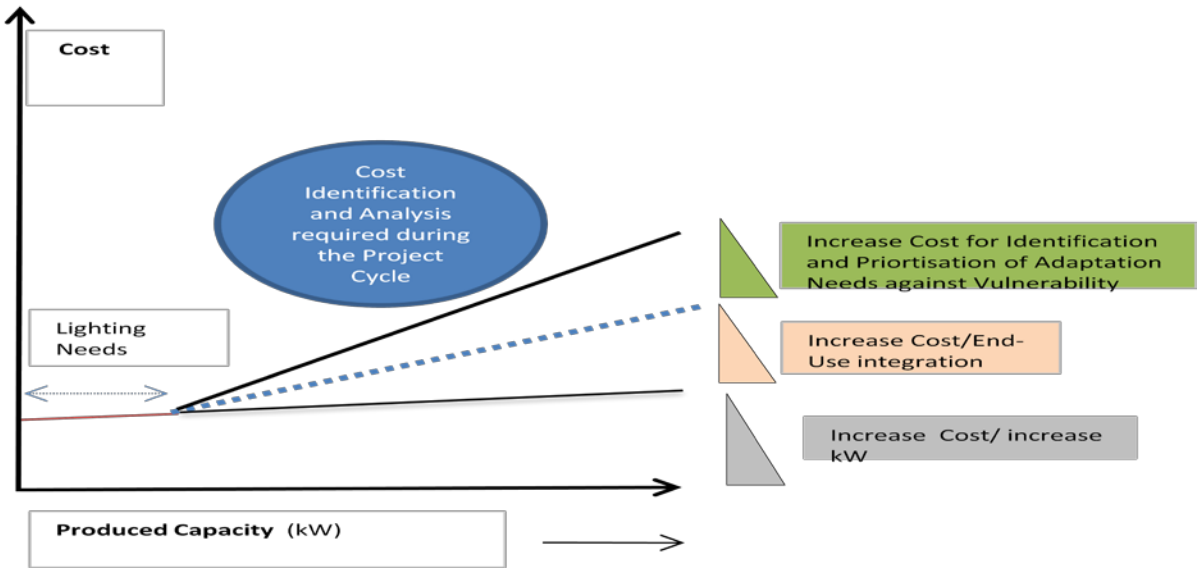
- Monitoring activities for the assessment of advantages of access to energy in building resilience capacity
- Evaluation of the impact of adaptive actions implemented against the vulnerabilities
- Actual Cost Benefit analysis of the adaptation measures adopted in the power system
- Evaluation of relation of livelihood and resilience capacity of vulnerable population, which is expected to be improved through the intervention of energy
  - Evaluation how energy access can play a significant role in enhancing the physical, financial, social, natural assets of the vulnerable communities
  - Evaluation of the limitations of the approaches to address appropriately in future
- Evaluation of the advantages and shortcomings of the adaptation actions, which can be utilized for future projects

Viability of Integrating Adaptation Options in MHP development

Proper assessment of vulnerability is one of the most important aspects for ensuring climate resilient development activities. In this context, resilient micro hydro development needs; identification of susceptibilities in MHP (physical and resources), vulnerability to natural resources on which livelihood is based and vulnerability to basic services of the community.

There is no choice rather than to integrate adaptation aspect to make the power plants sustainable. But in doing so, the viability of such approaches needs to be examined. The rough picture of the cost wedge (gradient), which could exist while integrating climate change adaption options, is shown in the Figure-4.

Figure 4: Cost Wedges to be considered for integrating Adaptive Options in MHP Development



Source: Author Idea

It is obvious that with the increase in generated capacity of power, the cost also increases, which further increases with the integration of end-uses and other adaptation options. The increased in cost depends on what kind of integration is applied in the system. However, viability of such integration can be assured, if it is carried out considering the return on investment, i.e. how such investment in-turn will contribute to enhance the social, physical, economical and natural assets of the community.

The investment for building resilient capacity in the community based infrastructure like MHP should ensure;

- The adaption options should be managed by local resources as far as possible
- The options should be compatible to community to adapt
- Options should be affordable to Community thus should have minimum cost gradient wedge (as shown in Figure 4)
- Proper awareness and capacity building activities should be facilitated from the beginning of the project
- Return on Investment should be justifiable and supportive to enhance economic status of beneficiaries, which will inturn support in autonomous adaptation process
- Adaptive options should respond to multiple effect of climate change and vulnerability of the specified areas/population

Conclusion

Policy Regimes

- Climate change adaptation will have synergistic impacts on developing countries' development policies. To support in the long-term, policy-makers need to integrate them into the non-energy, non-climate and cross-sector related issues through an institutional arrangement which takes in account all sectoral development including development of renewable energy.
- Integrated local development plan and strategies is essential to better address the climate change adaptation needs in more efficient. effective and accountable manner
    - Every cross cutting elements needs to be identified for the local sustainable development and sub-sector planning should be done
    - To meet adaptation needs in developing countries at the local level, policies should focus on a community-oriented approach leading to a well-distributed and diversified renewable energy mix – i.e. through an enhanced off-grid and renewable energy technologies policy, which can support the cross sectoral development as well.
    - Estimation of energy requirement for different local/infrastructure development needs and sub-sector planning formulation should be done accordingly.

Promotional

Development of Micro hydro should be driven by market forces, so that optimum utilization of generated power is ensured, which support in rural agro-ecosystem to enhance the livelihood of vulnerable population.

Identification of adaptation measures should be initiated from the phase of project feasibility, so that adaptation options can be explored and implemented as per the specific locations.

Cost benefit analysis of the integration of the adaptation measures needs to be evaluated and hence appropriate measures should be implemented to make the project financially feasible and sustainable.

Assessment on Vulnerability and Identification of Adaptation Needs

- Assessment of vulnerability and its scale on the resource
- Assessment of vulnerability due to extreme events on the technology itself
  - During the initial phase of the project cycle it is necessary to explore whether structure of MHP are more vulnerable
  - Identify necessary considerations required for building resilience capacity of vulnerable population (in areas served by MHP)
  - It is necessary to identify/assess how energy access helps in building resilience capacity

This will support in adopting adaptive options from the beginning of project cycle. If the assessments recommend that promotion of technology needs to be carried out by considering the optimum intervention of productive end-use at the core, then the policy needs to be mainstreamed accordingly.

Consideration on Adaptations

Adapting to climate change will entail adjustments and changes at every level ranging from community-based to local and eventually to the national level. The range of practices that can be used to adapt the climate change is diverse which includes:

- changes in behavior (e.g. water use or farming practices),
- structural changes (e.g. the design specification of intake, canal, forbay, site selection, power house and transmission systems),
- policy based responses (e.g. integrating risk management and adaptation into project cycle through a conducive micro-hydro development and rehabilitation policies),
- technological responses (e.g. improve forecasting for disaster preparedness, integration of bio-engineering principles for slope stabilization)
- managerial responses (e.g. improve forest management and biodiversity conservation)

To identify the crucial challenges, a comprehensive study on impact of climate change and natural disaster to the micro/mini hydro should be carried out so that it represents practical and behavioral needs and understanding on the issues.

References:

1. CBS (2001). Population Census of Nepal, Government of Nepal
2. WECS (2005). Nepal Country Strategy on Integration of Energy and Rural Development Policies and Programme - Government of Nepal, December 2005
3. Khennas. Smail and Andrew B. Micro-hydro power: an option for socio-economic development, World Renewable Energy Congress VI, Invited Paper
4. David Fulford, Alistair Gill and Paul Mosley, Micro-hydro generation as instrument of poverty reduction: Asian achievement and African potential, Reports to DFID, Reading University.
5. IPCC. (2001) Climate Change 2001
6. Parajuli. R. (2010). Climate Change and Local Impacts-Synergy between Adaptation and Renewable Energy Development for Nepal, http://www.environmental-expert.com/resultEachArticle.aspx?codi=209871, retrieved on 2011-05-06.
7. Pathak. M. (2010). Climate Change: Uncertainty for Hydropower Development in Nepal, Hydro Nepal, Issue no.6, Nepal
8. Parajuli. R. (2011). Highlights on Energy Security for Climate Change Adaptation, published on http://www.environmental-expert.com/resultEachArticle.aspx?codi=235811
9. IISD (2006). Seeing the Light, Adapting to Climate Change, Challenges and Opportunities for the Developing Communities, Institute of Development Studies
10. AEPC (2010) unpublished
11. MoEnv, http://www.napanepal.gov.np/napa2.php, retrieved on 2010-9-08
12. .a MoEnv, 2010, Developing Nepal's Strategic Program for Climate Resilience (SPCR) Prioritisation Planning Process, Climate Investment Fund, http://www.ppcrnepal.gov.np/files-download/PPCR%20Prioritization%20Planning%, retrieved on 2011-05-11.

12.b WORLD BANK / ADB / IFC JOINT MISSION. (2010). NEPAL: PILOT PROGRAM FOR CLIMATE RESILIENCE (PPCR), Aide Memoire, 10 December 2010

13. OECD. (2009) Integrating Climate Change Adaptation into Development Co-operation, POLICY GUIDANCE.
14. OECD (2009). Key Message from the new OECD Guidance on Integrating Climate Change Adaptation into Development Cooperation, International Workshop on Mainstreaming Adaptation to Climate Change-Guidance and Tools, Berlin, 2009