



Climate Change and Local Impacts- Synergy between Adaptation and Renewable Energy Development for Nepal

Preliminary Understanding to Issues of Climate
Change, Adaptation and Linkages with renewable
energy

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CLIMATE CHANGE IS NOT A SECTOR BUT NEED TO BE FACTOR FOR ALL SECTORS

Few Words

Climate change though broadly have impact on livelihood, natural resources and environment, it is also imperative to deal with-how it has implications on energy resources, energy demand and supply chain. This is necessary because energy consumption pattern has a close relation with human development index. Among different supporting themes to build adaptive capacities to the climate change, energy access also has an important value. This can be correlated and rationalized by analyzing importance of synergizing energy access for productive and basic needs for the livelihood enhancement. In the same context, in developing countries like Nepal, renewable energy has crucial role to increase access to information, opportunity to improve their normal livings through different income generation and entrepreneurship activities. All these are the pre-requisite to build resilient capacities to adapt with the changes.

This paper has been designed with an effort to make a basic understanding on how climate change has impacts in livelihood and to the sustainable development. An attempt has been made to portray importance of energy linkages with climate change adaptation process. It has also attempted to advocate that energy acts as a cross cutting tools to address the vulnerabilities on livelihood, health and environment. Furthermore, development and promotion of renewable energy can be found more crucial, when we analyse how and in what way it can contribute in upgrading physical quality of rural population and for sustainable development.

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All the ideas mentioned here are purely author's personal views and not of the organization that he belongs.

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Energy for All



Abstract

The level of Carbon dioxide (CO₂), which is regarded as a principal greenhouse gas have risen more than ten-fold since the start of the industrial revolution. With the current trend of CO₂ emissions it has been expected that its concentration could reach twice than the pre-industrial level by the mid of this century. The result of which, is the commonly known terminology- **global warming** and **climate change**. Climate change will exacerbate impacts such as droughts, floods and extreme weather events, which may contribute to food shortages, infrastructure damage and the degradation of natural resources upon which livelihoods are based. It is not just an environmental issue but also issues of degradation of the economic and social dimensions of sustainable development and millennium development goals.

To address the issues generated due to climate change at different levels a number of efforts have been initiated, one of which is the mandate of Kyoto Protocol of United Nations Framework Conventions on Climate Change. As per the Kyoto mechanism carbon mitigation efforts have been initiated through Emission trading, Clean Development Mechanisms and Joint Implementation, which are entirely, based on the promotion of clean energy technologies and energy efficiency improvement measures for mitigating the level of CO₂ equivalent. In the same context even though liberation of GHGs is low from developing countries than that of the developed/industrialized country, impact of climate change are more susceptible in developing world. Conference of Parties (COP-7) had put forwarded - necessity of raising funds and supporting to vulnerable communities and countries as per the need in the name of adaptation. Adaptation can be regarded as how people continue on doing what they are pursuing regardless there is adverse impact of climate change. Adaptation can be directly linked with building resilience capacity of vulnerable people, where economic and livelihood enhancements have a core values. Regardless, on the adaptation process- energy linkages are not explicitly defined but energy acts as a cross cutting tools in every social and economic development. Role of energy hence should be identified for the adaptation process and building resilient capacity.

It has been identified that climate change has impacts on different areas including natural resources. On the broad impact areas, vulnerabilities to energy resources can also be observed, for e.g. to the supply potential of biomass energy resources (due to degradation in land use pattern, agriculture productivity, migration, loss of lives etc). It means that climate change has implications to the current and future energy demand and supply chain of the country as well. Energy since act as a cross cutting tools to every economic development; livelihood enhancement is also expected to get affected due to these changes, because basic and productive use of energy are minimized with poor and low access of energy. At the mean time, improving access to energy and its management can also compliment in improving adaptive capacity of rural and urban population by creating opportunity to undertake different economic activities. Hence, energy linkages with climate change adaptation should be discussed and outlined in two ways- one *how climate change has impact to energy resource and technology and how the associated threats can be managed and maintained for normal living*; secondly *how energy access can compliment in millennium development goals and sustainable development to support in the adaptive processes*. The paper also highlights on the possible role of renewable energy for socio-economic development, which is complimentary part to the MDG as well. It has discussed potential avenues and activities for synergizing the local impacts and minimizing it by supporting the pre agreed targets of Millennium Development Goals.

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1. Background:

Carbon dioxide (CO₂), the principal greenhouse gas is reported to have risen more than ten-fold since the start of the industrial revolution. More than 30 percent concentration of CO₂ is raised and if the present emission rates are continued its concentration could reach twice than the pre-industrial level by the mid of this century. On this concentration developed countries accounts for over half of the global Green House Gas (GHG) emissions. In order to reduce the level of GHG emissions, historically the Kyoto Protocol has been conceptualized in the Conference of Parties-3 (COP-3) in 1997, which was further entered into force in 2003. The protocol establishes targets for developed countries only and aims to reduce their collective emissions by 5.2 percent from the 1990 levels. However, the actual reduction is likely be substantially less because of compromise negotiated by the parties and the withdrawal of the United States of America. Due to rising population, income levels and energy usage developing countries are also leading to rapid increase in GHG emissions. Brazil, China, India, Mexico, South Africa and Turkey are the major new GHG emitters apart from the Annex-1 countries [1 and 2].

On dealing with climate change and to address the consequences developed from it, globally it has been treated broadly in two aspects, Climate Change Mitigation (reducing GHGs-CO₂ equivalent through promotion of clean energy technologies, energy efficiency measures etc and also ensuring sustainable development in developing countries as per the pre-determined criteria of Kyoto protocol) and adaptation (building resilient capacity to cope with the consequences of climate change impacts).

2. Major Events on Climate Change

UNFCCC since entered into the force, the parties (representation to climate change from the different countries) have been meeting annually in COP to assess progress in dealing with climate change and beginning in the mid -1990s to negotiate the Kyoto Protocol to establish legally binding obligations for developed countries to reduce their emissions [2]. Some of the major achievements in different COPs as retrieved from the UNFCCC webpage and Wikipedia on UNFCCC were;

COP-1, 1995, The Berlin Mandate

It voiced concerns about the adequacy of countries' abilities to meet commitments under the convention. These were expressed in a UN ministerial declaration known as "Berlin Mandate", which also established a 2 -year Analytical and Assessment Phase (AAP), to negotiate a "comprehensive menu of actions" for individually, made the best economic and environment sense. The Berlin Mandate exempted non-Annex I countries from additional binding obligations, in keeping with the principle of "Common but differentiated responsibilities" established in the UNFCCC even though, collectively , the larger newly industrializing countries were expected to be the world's largest emitters of GHG emissions 15 years after. In order to monitor the implementation of the Convention, COP1 also established two permanent subsidiary bodies: the Subsidiary Body for Scientific and Technological Advice (SBSTA) and the Subsidiary Body for Implementation (SBI) [2 and 3].

COP-2, 1996

It took place in Geneva, Switzerland. However its ministerial declaration was noted, it was further not adopted. Some of the key features presented in this convention were; Accepted the scientific findings on climate change proffered by the Intergovernmental Panel on Climate Change (IPCC) in its second assessment (1995); rejected uniform 'harmonized policy' in favor of the flexibility; and 'called for legally binding mid-term targets' [2 and 3].

COP-3, 1997, The Kyoto Protocol

The COP-3 was organized in Kyoto- Japan, which was further termed as *Kyoto Protocol*, one of the major steps in the Climate Change. This Convention outlined the GHG emissions obligations for Annex I countries, along with what came to be known as Kyoto Mechanism such as Emission Trading, Clean Development Mechanism (CDM) and Joint Implementation (JI). Most industrialized countries and some central European economies in transition were defined as non Annex-I countries, agreed to legally binding reductions in GHG emissions of an average of 6-8 percent below the 1990's level between the years 2008-2012, which was defined as the *First Emissions Budget Period* [2 and 3].

COP 4, 1998; COP 5, 1999; and COP-6, 2000

COP 4 took place in November 1998 in Buenos Aires. However, expected that the remaining issues unresolved in Kyoto would be finalized at this meeting, the complexity and difficulty of finding agreement on these issues proved insoluble, and instead the parties adopted a 2-year "Plan of Action" to advance efforts and to devise mechanisms for implementing the Kyoto Protocol, to be completed by 2000. During COP4, Argentina and Kazakhstan expressed their commitment to take on the greenhouse gas emissions reduction obligation, the first two non-Annex countries to do so [2 and 3].

COP 5 took place in 1999, in Bonn, Germany and was primarily a technical meeting, and did not reach major conclusions. COP 6 took place in 2000, in The Hague, Netherlands. The discussions evolved over the major political issues like major controversy over the United States' proposal to allow credit for carbon "sinks" in forests and agricultural lands, satisfying a major proportion of the U.S. emissions reductions in this way; disagreements over consequences for non-compliance by countries that did not meet their emission reduction targets; and difficulties in resolving how developing countries could obtain financial assistance to deal with adverse effects of climate change and meet their obligations to plan for measuring and possibly reducing greenhouse gas emissions. In the final hours of COP 6, despite some compromises agreed between the United States and some EU countries, notably the United Kingdom, the EU countries as a whole, led by Denmark and Germany, rejected the compromise positions, and the talks in The Hague collapsed [2 and 3].

COP 6, 2001

COP 6 negotiations resumed on 2001, in Bonn, Germany, with little progress in resolving the differences that had been produced in the Hague convention. George W. Bush the then President of the United States rejected the Kyoto Protocol in March 2001; as a result the United States delegation to this meeting declined to participate in the negotiations related to the Protocol and chose to take the role of observer at the meeting. As the other parties negotiated the key issues, agreement was reached on most of the major political issues, to the surprise of most observers, given the low expectations that preceded the meeting. The agreements included:

1. **Flexible Mechanisms:** The "flexibility" mechanisms which the United States had strongly favored when the Protocol was initially put together, including emissions trading; Joint Implementation (JI); and the Clean Development Mechanism (CDM) which allow industrialized countries to fund emissions reduction activities in developing countries as an alternative to domestic emission reductions. One of the key elements of this agreement was that there would be no quantitative limit on the credit a country could claim from use of these mechanisms provided domestic action constituted a significant element of the efforts of each non Annex I country to meet their targets.
2. **Carbon sinks:** It was agreed that credit would be granted for broad activities that absorb carbon from the atmosphere or store it, including forest and cropland management, and re-vegetation, with no over-all cap on the amount of credit that a country could claim for sinks activities. In the case of forest management, an Appendix Z establishes country-specific caps for each Annex I country. Thus, a cap of 13 million tons could be credited to Japan (which represents

about 4% of its base-year emissions). For cropland management, countries could receive credit only for carbon sequestration increases above 1990 levels.

3. **Compliance:** Final action on compliance procedures and mechanisms that would address non-compliance with Protocol provisions was deferred to COP 7, but included broad outlines of consequences for failing to meet emissions targets that would include a requirement to "make up" shortfalls at 1.3 tons to 1, suspension of the right to sell credits for surplus emissions reductions, and a required compliance action plan for those not meeting their targets.

4. **Financing:** There was agreement on the establishment of three new funds to provide assistance for needs associated with climate change: a fund for climate change that supports a series of climate measures; a least-developed-country *fund to support National Adaptation Programs of Action*; and a Kyoto Protocol adaptation fund supported by a CDM levy and voluntary contributions [2 and 3].

COP 7, 2001, Marrakech Accord

COP 7 meeting was organized in Marrakech, Morocco on 2001. The United States delegation maintained its observer role, declining to participate actively in the negotiations. Other parties continued to express hope that the United States would re-engage in the process at some point and worked to achieve ratification of the Kyoto Protocol by the requisite number of countries to bring it into force (55 countries needed to ratify it, including those accounting for 55% of developed-country emissions of carbon dioxide in 1990). The date of the World Summit on Sustainable Development (August–September 2002) was put forward as a target to bring the Kyoto Protocol into force. The World Summit on Sustainable Development (WSSD) was to be held in Johannesburg, South Africa [2 and 3].

The main decisions at COP 7 included:

- Operational rules for international emissions trading among parties to the Protocol and for the CDM and joint implementation;
- A compliance regime that outlined consequences for failure to meet emissions targets but deferred to the parties to the Protocol, once it came into force, the decision on whether those consequences would be legally binding;
- Accounting procedures for the flexibility mechanisms;
- A decision to consider at COP 8 how to achieve a review of the adequacy of commitments that might lead to discussions on future commitments by developing countries.

COP 8, 2002 and COP-9, 2003

In 2002, COP8 organized in New Delhi- India, adopted the Delhi Ministerial Declaration-*amongst others, called for efforts by developed countries to transfer technology and minimize the impact of climate change on developing countries*. In 2003 as in COP-9, the parties agreed to use the Adaptation Fund established at COP7 in 2001 primarily in supporting developing countries better adapt to climate change. The fund would also be used for capacity-building through technology transfer. At COP9, the parties also agreed to review the first national reports submitted by 110 non-Annex I countries [2 and 3].

COP 10, 2004

COP10 held on Buenos Aires, Argentina discussed the progress made since the first Conference of the Parties 10 years ago and its future challenges, with special emphasis on climate change mitigation and adaptation. To promote developing countries better adapt to climate change, the Buenos Aires Plan of Action was adopted. The parties also began discussing the post-Kyoto mechanism, on how to allocate emission reduction obligation following 2012, when the first commitment period ends [2 and 3].

COP 11/MOP 1, 2005

COP 11 or Meeting of Parties-1 (MOP-1) took place on 2005, in Montreal, Quebec, Canada. COP 11 was also the first MOP to the Kyoto Protocol since their initial meeting in Kyoto in 1997. It was therefore one of the largest intergovernmental conferences on climate change ever. The Montreal Action Plan is an agreement hammered out at the end of the conference to "extend the life of the Kyoto Protocol beyond its 2012 expiration date and negotiate deeper cuts in greenhouse-gas emissions" [2 and 3].

COP 12/MOP 2, 2006

COP 12/MOP 2 took place on 2006 in Nairobi, Kenya. At the meeting, certain strides were made, including in the areas of support for developing countries and clean development mechanism. The parties adopted a five-year plan of work to support climate change adaptation by developing countries, and agreed on the procedures and modalities for the Adaptation Fund. They also agreed to improve the projects for clean development mechanism [2 and 3].

COP 13/MOP 3, 2007

COP 13/MOP 3 took place on, 2007, at Nusa Dua, in Bali, Indonesia. Agreement on a timeline and structured negotiation on the post-2012 framework (the end of the first commitment period of the Kyoto Protocol) was achieved with the adoption of the Bali Action Plan (Decision 1/CP.13). The Ad Hoc Working Group on Long-term Cooperative Action under the Convention (AWG-LCA) was established as a new subsidiary body to conduct the negotiations aimed at urgently enhancing the implementation of the Convention up to and beyond 2012 [2 and 3].

COP 14/MOP 4, 2008

Delegates agreed on principles for the financing of a fund to help the poorest nations cope with the effects of climate change and they approved a mechanism to incorporate forest protection into the efforts of the international community to combat climate change [2 and 3].

COP 15/MOP 5, 2009

The overall goal for the COP 15/MOP 5 held in Denmark was to establish an ambitious global climate agreement for the period from 2012 when the first commitment period under the Kyoto Protocol expires. However, on November 14, 2009, the *New York Times* announced that "President Obama and other world leaders have decided to put off the difficult task of reaching a climate change agreement... agreeing instead to make it the mission of the Copenhagen conference to reach a less specific "politically binding" agreement that would punt the most difficult issues into the future." Ministers and officials from 192 countries took part in the Copenhagen meeting and in addition there were participants from a large number of civil society organizations. As many Annex 1 industrialized countries are now reluctant to fulfill commitments under the Kyoto Protocol, a large part of the diplomatic work that lays the foundation for a post-Kyoto agreement was undertaken up to the COP15.

The conference did not achieve a binding agreement for long-term action. A 13-paragraph 'political accord' was negotiated by approximately 25 parties including US and China, but it was only 'noted' by the COP as it is considered an external document, not negotiated within the UNFCCC process. The accord was notable in that it referred to a collective commitment by developed countries for new and additional resources, including forestry and investments through international institutions, which will approach USD 30 billion for the period 2010 – 2012. Longer-term options on climate financing mentioned in the accord are being discussed within the UN Secretary General's High Level Advisory Group on Climate Financing, which is due to report in November 2010. The negotiations on extending the Kyoto Protocol had unresolved issues as did the negotiations on a framework for long-term cooperative action [2 and 3].

3. Voice for Climate Change Adaptations

UNFCCC has explicitly stated that in order to increase resilience capacity to the now and future's impact of climate change, adaptation measures are vital to undertake and internalize. Some of the major considerations forwarded through UNFCCC Parties on different conventions are;

- Enhanced action on adaptation as part of the Bali Action Plan under the Ad-hoc Working Group on Long-Term Cooperative Action under the Convention (AWG-LCA)
- Nairobi work programme on impacts, vulnerability and adaptation to climate change, development and transfer of technologies, research and systematic observation under the Subsidiary Body for Scientific and Technological Advice (SBSTA)
- Issues related to implementing, including national adaptation programmes of action (NAPAs), and supporting adaptation through finance, technology and capacity-building under the Subsidiary Body for Implementation (SBI) [2,4,5 and 6].

It has been realized that to ensure successful adaptation to the threats of climate change, essentially government should take the leading role for the sustained engagement of stakeholders- national, regional and international organizations, private sectors and civil societies. The Convention specifies that developed countries are committed to helping "particularly vulnerable" developing countries meet the costs of adaptation. The seventh session of the Conference of the Parties to the UNFCCC (COP7) held at Marrakech in 2001 established new funds relevant for adaptation, including the Least Developed Countries Fund (LDCF) under the Convention to support the 49 Least Developed Countries (LDCs) to adapt to climate change. The LDCF has been used initially to support the preparation of National Adaptation Programmes of Action (NAPA). The NAPA provides a process for LDCs to identify, communicate and respond to their most "urgent and immediate" adaptation needs, and prioritise those needs. The NAPA preparation is a pre-requisite for accessing funding from the LDC Fund.

Organization for Economic Cooperation and Economic Development (OECD) has also recognized that meeting the challenges of climate change will require action at many levels and through many channels. OECD has also forwarded its commitments, based on the 2006 *OECD Declaration on Integrating Climate Change Adaptation into Development Co-operation* by laying out specific priorities on how we can support our developing country partners in their efforts to reduce their vulnerability to climate variability and climate change and to identify and prioritise adaptation responses [6].

4. Defining Adaptation

Institute of Development Studies (IDS) in one of its publications have pronounced that Climate change has generated its own glossary of terms and definitions. The natural sciences have had particularly strong influences in its development. Hence, before entering into the concept of adaptation it is necessary to understand on some specific terminologies like; Vulnerabilities- a combination of exposure to external shocks (e.g. a flood) and stresses (e.g. a gradual temperature increase), and the ability to cope with the resulting impacts. It is dependent on a wide variety of institutional, economic and environmental factors, not all of which are linked directly with the climate; climate shocks- effects on the general human livings, ecology and ecosystem due to imbalance in the concentration of atmosphere thereby leading to different natural stress.

Hence reducing vulnerability to climate change is -understanding and preparing on how individuals, groups and natural systems can practice for and respond to changes in climate – known in climate change terminology as **adaptation**.

Formally, the leading international scientific body on climate change, the 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' [6].

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' [6].

The potential to adjust in order to minimise negative impacts and maximise any benefits from changes in climate is known as adaptive capacity. Adaptation is a broad concept covering actions by individuals, communities, private companies and public bodies such as governments. Successful adaptation can reduce vulnerability by building on and strengthening existing coping mechanisms and assets, targeting climate change vulnerability with specific measures, and integrating vulnerability reduction into wider policies [2 and 3].

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.

5. Global Support for Adaptation

Articles 4.4, 4.8 and 4.9 have elaborated that the developing countries need international assistance for supporting adaptation activities primarily through funding, technology transfer and capacity building [1]

Financial mechanism developed by UNFCCC has also stated some of the funding opportunities, which is currently operated by the Global Environment Facility (GEF) and the Adaptation Fund Board (AFB). Some of the stated funding opportunities include:

- The GEF Trust Fund, including support for vulnerability and adaptation assessments as part of national communications;
- The Least Developed Countries Fund (LDCF) under the Convention;
- The Special Climate Change Fund (SCCF) under the Convention;
- The Adaptation Fund (AF) under the Kyoto Protocol and managed by the AFB.

Similarly there are number of trusts, and charities announced globally as for the climate change and energy access.

6. Climate Change Impacts in Nepal

It is well known fact that impact of climate change has adverse impact on general livelihood and resources. In this context Nepal the country with varied topographical and climatic composition has been reported to be adversely affected in its natural resources, socio-cultural environment, bio-diversity and livelihood. The following section elaborates impacts of climate change broadly in resources and capitals. Even though elaboration has been distinctly made, both broad areas have interrelation to one another.

6.1 Impacts on Resources

Agriculture Resources

Majority of the people of the country are pursuing their economic activity primarily based on agriculture, which is expected to be adversely affected due to changes in physiochemical properties of soil like loss of the top humus/fertile soil because of erosion, landslides and floods. Agricultural production since is directly affected by the quality of soil, degradation in

the soil properties eventually decline the productivity of the country. In addition to this, it has also been found that crop yield reduces with every 4 degree rise in temperature, which will affect the low thermo resistant crops (for e.g. Maize) of the country [7,8,9 and 10].

Decrease in grain filling period due to increase in respiration process, fertilizer use efficiencies, shift in agricultural zone, increase in insect pest population, desertification, increase in soil erosion, evapo-transpiration and cause malnutrition in a world overflowing with food due to reduction of protein and decrease in mineral nutrients content in different crops are negative effects [2 and 11].

Evidences of Climate Change and Impacts in Nepal

Intergovernmental Panel on Climate change (IPCC) provides a comprehensive review of climate models with a projection on temperature and precipitation trend [OECD, 2003]. In this context, the Atmosphere Ocean Coupled General circulation Models (AOGCM) shows greater than the average warming in the South Asian Region in summer. Different studies on the global temperature rise shows that the mean temperature increase for the period 2071 to 2100 relative to the period 1961 to 1990 is in the range of 3⁰- 4°C. Organization for Economic Co-operation and Development (OECD) performed assessment of 12 recent general circulation models (GCM) [9].

The best 7 GCMs results pronounced that there is significant and consistent increase in temperature projected for Nepal for the years 2030, 2050 and 2100 in various models adopted by OECD. This analysis also shows somewhat larger warming in winter months than the summer months. It also agrees with the study on climate change assessment conducted with US country studies programme [9]. The projected change above the baseline average is 1.2°C for 2030, 1.7°C for 2050 and 3.0°C for 2100. This analysis also agrees with the IPCC analysis in the projection of precipitation change, i.e. less significant change and high standard deviation among the model results.

In addition to this some of the facts that support the affects of climate change in Nepal are as follows [9]

- Twelve warmest years since 1975 to 2007 (eg. 2006 was the warmest year)
- Late or pre-monsoon, unusual precipitation, decreased rainy days and intense rainfall events caused more runoff and low groundwater recharge.
- Extreme fog conditions have recently been observed in the terai regions.
- Traditional rainfalls of Jestha and Ashar (mid July) have been shifted in Shrawan and Bhadra in Kathmandu. It has affected negatively in the paddy production.
- Receding snowfall and retreating of the glaciers (small glacier mountain shrinking at alarming rate) due to increase in atmospheric temperature in mountain environment
- Kathmandu valley frost day decreasing, winter cold shifted to a month later than regular and snowfall in Kathmandu (Feb 2007, after 60 years).
- Recently Darchula district of the country faced unusual snow fall affecting collection of precious medicinal herbs Yarsa gumba *IKantipur news may 2008*
- Mosquito from Terai and Mid-hill being able to survive in high- hills (Ilam, Mustang and Helambu area)

Lower agricultural productivity not only creates threats of food insecurity but also lowers the potentiality to harness biomass energy resources, which are generated from different agri-products like paddy, maize etc and their by products. Similarly, it has implication to the livestock population which can potentially lower down the potentiality of biogas.

Water Resources

The changes in temperature and precipitation are expected to alter the hydrological cycle and water resources. The total water reserve capacity of the country is 200 billion m³, and runoff provides 72% of water reserve (144 billion m³) while snow provides 12% (24 billion m³). The monthly variability of runoff is quite high, for example, with the Sapta Koshi varying from 400 m³/sec in February to 4300 m³/sec in August. Mean monthly discharges

show that global warming would shift the peak discharge month from August to July, due to the fact that the snow cover on mountain tops would melt earlier. This could lead to increased flooding and variations in water availability throughout the year. In some areas, drought could become a problem [8,9 and 12]. Furthermore, depletion of water resources hence is one of the consequences that have been felt in the country due to unbelievable changes in the hydrological cycles, which can be regarded as a pinnacle in environmental cycle due to global warming.

Impact to water resources not only has threats to big hydro power plants, but also to the present micro/mini hydro energy technologies. Possibilities of having different runoff pattern, land slides etc can affect the present power plants and also future potentialities.

Forest Resources

Forest and vegetations are potential carbon absorbing source in the nature, but forest of Nepal has been depleting due to different human interventions. Vulnerabilities like changes in the forest composition, annihilation of different wild species etc are some of the examples that we can feel at the moment. Other potential vulnerabilities in the forestry sector are; Tropical wet forest and warm temperate rain forest would disappear, and cool temperate vegetation would turn to warm temperate vegetation. It has been predicted that the vegetation patterns would be different under the incremental scenario (at 2°C rise of temperature and 20% rise of rainfall) than the existing types. Furthermore, migration of vegetation and decline in biodiversity will have further adverse impact on wildlife. One study has found that 2.4% of biodiversity may be lost with climate change [8,9 and 10].

In the context of energy supply base of Nepal, where fuel wood contributes large amount, impact in forest resources has definite impact to supply potential of sustainable and accessible forest areas for energy purposes.

Livelihood and Socio-culture

Some of the other potential impacts due to climate change are impact on livelihood and socio-cultural environment of Nepal. This could be because of degradation in agricultural productivity, poor livestock management, floods and hazards, risks of diseases (Malaria, Kalazaar, Japanese Encephalitis, primarily in subtropical and temperate region) etc [8,9 and 10].

6.2 Impacts on Capitals

Human Capital

It refers to qualities and skills for economic production (and re-production), market exchange, level of education and productive skills of the people. It is vital to every society and enhances human capabilities. Indirectly, it does enlarge individuals' opportunity sets giving them new possibilities to enrich their life [13]. A good level of education will increase available livelihood options and enhance adaptive capacity. It includes knowledge, skills, competencies and attributes embodied in people that facilitate creation of personal, social and economic well-being; as well as motivation, behaviour, physical and emotional attributes and mental health. Along with range of other things such as the availability and distribution of resources across the population; the structure of critical institutions; decision-makers' ability to manage information; the public's perception of the significance of exposure, implementation of effective adaptation options also depends on the stock of human and social capital [14].

The Third Assessment Report of the Intergovernmental Panel on Climate Change concluded that climate change would cause:

- increased heat-related mortality and morbidity
- decreased cold-related mortality in temperate countries
- greater frequency of infectious disease epidemics following floods and storms

Natural Capital

Natural capital refers to natural resources such as soil, water, air, fish, forest and environmental services, like the hydrological cycle, pollution sinks from which resources flow and the services used for livelihoods are developed [13]. The ability of any natural base to maintain its productivity -even after an impact from a climate 'shock' - is important. In Nepal, in particular, a significant percentage of the population depends on firewood collected from the forest and farmlands for fuel, soil fertility for agricultural cultivation, water from the surroundings for irrigation and fishing for food and funds.

Physical Capital

In order to engage in effective productivity, people need physical capital, namely assets such as land, other forms of infrastructure, livestock, cash/savings and machinery used in production [13]. A society, family, group or person with limited or no physical capital, is at risk of non-productiveness which is likely to affect their livelihood. For the people of Nepal to develop a livelihood strategy that would enhance their adaptive capacity, they need physical capital. The farmers need farmland for agricultural production, grazing of livestock and energy sources/technologies for residential and other productive purposes, along with cash and savings to be able to fall back on after a disaster, enabling them to replace what has been lost. Physical capital allows people to develop livelihood strategies that improve their resilience. [13].

Social Capital

In pursuing different livelihood strategies, people, groups, communities and families draw necessary requisites from the resources available to them, through their association with others, clubs, networks and affiliations. Through association and relationships, communities could learn from each other and review past and present strategies and adaptation processes that could lead to better resilience [13].

Financial Capital

Financial capital plays a very important role in determining livelihood options and strategies available to the people. It also pulls together other forms of capital assets (human capital, natural capital, social capital) needed for a successful livelihood strategy in climate high risk areas of developing countries. Therefore, access to formal financial services from banks, and microfinance industry (microcredit, micro insurance and micro savings) improve adaptive capacity, and reduce the vulnerability of the poor to climate induced extreme events [13]. Government reserves, commercial and non-commercial insurance, contingent credit and catastrophe bonds that will ensure capital availability for relief and recovery after climate events impact are necessary requirement for better livelihood options and adaptation to climate change.

6.3 Impacts on MDG

Climate change will exacerbate impacts such as droughts, floods and extreme weather events, which may contribute to food shortages, infrastructure damage and the degradation of natural resources upon which livelihoods are based. This may also jeopardise development gains achieved through development co-operation and make it more difficult to reach our development objectives including those agreed at the Millennium Summit that are described as the Millennium Development Goals. Adapting to the impacts of climate change is therefore critical. It is not just an environmental issue but also affects the economic and social dimensions of sustainable development. All these overwhelming effects have adverse impact on the target set by the Millennium Development Goals (MDG) [6].

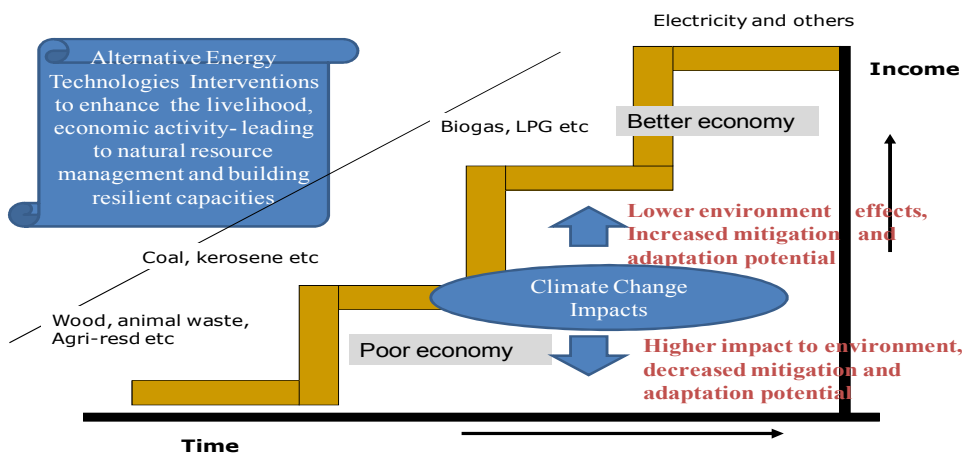
Table 1: Potential Impact of Climate Change on MDG. Source: [6 and edited by author for Nepalese context]

Millennium Development Goals	Examples of Link with Climate Change
Eradicate extreme poverty and hunger (Goal 1)	<ul style="list-style-type: none"> Climate change is projected to reduce the assets and livelihoods of many poor people, for example health, access to water, homes, and infrastructure. Climate change is expected to alter the path and rate of economic growth because of changes in natural systems and resources, infrastructure, and labour productivity. A reduction in economic growth directly affects poverty through reduced income opportunities. Climate change is projected to alter regional food security. Adverse impacts on food security could be seen due to land degradation
Promote gender equality and empower women (Goal 3)	<ul style="list-style-type: none"> Natural resource-dependent activities, such as agriculture, which are particularly vulnerable to climate change. Women's traditional roles as primary users and managers of natural resources, primary caregivers and labourers engaged in unpaid labour (<i>i.e.</i> subsistence farming) mean they are involved in and dependent on livelihood and resources that are put most at risk by climate change. Land degradation and vulnerabilities along the chain of energy flow will create a additional burden to women and socially excluded people to depend on inconvenient and unreliable source of energy, where access of clean energy is very poor to disadvantaged and so called-socially excluded groups.
<u>Health-related goals:</u>	
Combat major diseases (Goal 6)	<ul style="list-style-type: none"> Illnesses associated with heat waves (although fewer winter cold-related deaths may occur in some regions). Illness due to indoor air-pollution and adverse polluted of the atmosphere
Reduce child mortality (Goal 4)	<ul style="list-style-type: none"> Climate change may increase the prevalence of some vector-borne diseases (for example malaria and dengue fever), and vulnerability to water, food, or contagious diseases (for example cholera and dysentery).
Improve maternal health(Goal 5)	<ul style="list-style-type: none"> Children and pregnant women are particularly susceptible to vector and waterborne diseases. Anaemia – resulting from malaria – is responsible for a quarter of maternal mortality. Climate change will likely result in declining quantity and quality of drinking water in many locations, which is a prerequisite for good health, and exacerbate malnutrition—an important source of ill health among children—by reducing natural resource productivity and threatening food security, particularly in many low latitude areas.
Ensure environmental sustainability (Goal 7)	<ul style="list-style-type: none"> Climate change is likely to alter the quality and productivity of natural resources and ecosystems, some of which may be irreversibly damaged, and these changes may also decrease biological diversity and compound existing environmental degradation
Global partnerships (Goal 8)	<ul style="list-style-type: none"> Climate change is a global issue and response requires global co-operation, especially to help developing countries adapt to the adverse impacts of climate change.

7. Identifying Role of Energy in Adaptation

However role of energy in adaptation is not explicitly defined and practices for this are on initial stages, energy promotion can definitely have good opportunity and scope to build resilience capacity. When we look after the typical energy ladder of the developing world, we can see that poor economic group relies on traditional/inconvenient and non – environment friendly energy sources. This eventually has higher impacts to environment, more vulnerable and minimum mitigation potentiality. In the same context, if we look on the energy usage of higher economic group, the energy sources and technologies that they are dependent are friendlier to environment and have high mitigation potentiality as shown in Figure-1. Hence, switching towards the clean energy technologies demonstrate high potentiality for adaptation and mitigation aspects. But until and unless other livelihood enhancement activities are integrated, switching towards clean energy technologies, efficiency improvements are difficult to adopt by poor people.

Figure 1: Typical Energy Ladder- Links between Energy, Environment and Climate



Poverty alleviation and livelihood development needs to be integrated in every development aspect so that adaptive capacity can be increased to cope with impacts due to change in climate.

Energy and Poverty

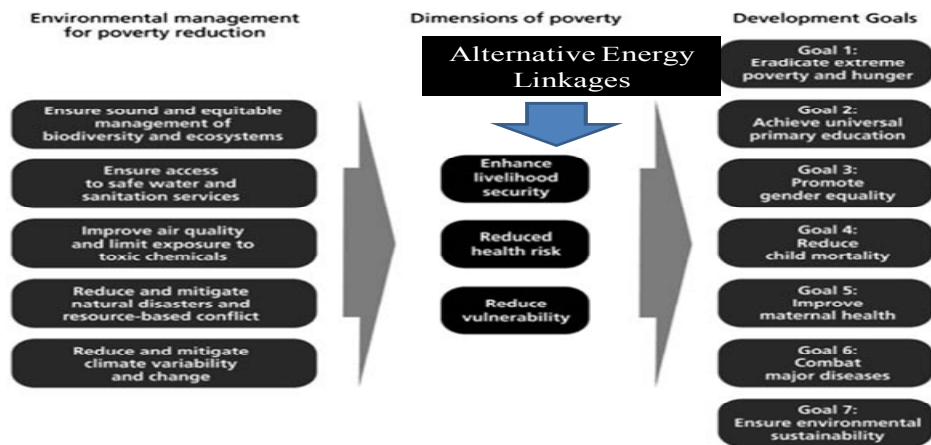
The International Energy Agency released a chapter of their influential World Energy Outlook (WEO) at the WSSD entitled "Energy and Poverty." This IEA contribution was essentially a synthesis of the aforementioned reports, and reiterated many of the key energy-poverty linkages; among their key assertions were that:

- Access to electricity and other modern energy sources is a necessary, but not sufficient, requirement for economic and social development...modern energy services enhance the life of the poor in countless ways [15] and
- The extensive use of biomass in traditional and inefficient ways and the limited availability of modern fuels are manifestations of poverty [13].

7.1 Synergizing impact of Climate Change on MDG with energy

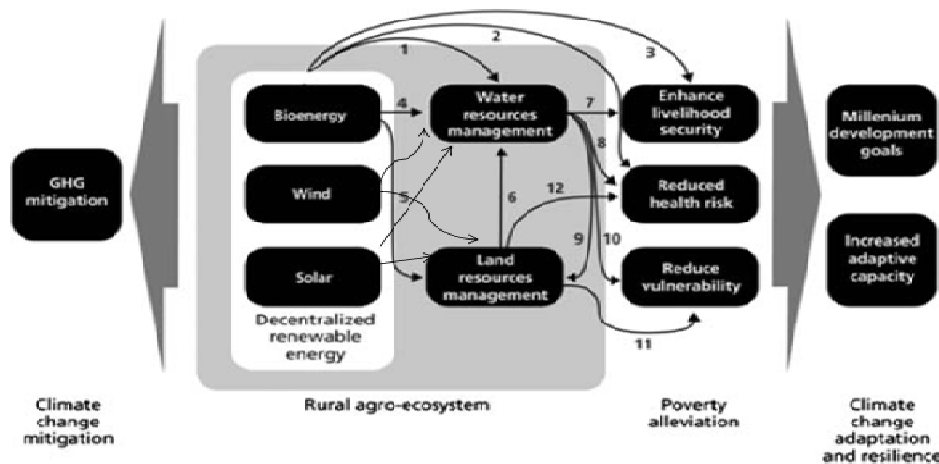
As mentioned in the earlier section –MDG targets can be affected because of the climate change. In this context, one of the publications of the World Bank has also spelled on potential linkages with environmental management for poverty reduction as shown in Figure-2. It shows a conceptual schematic of the relationship between environmental management, the dimensions of poverty, and the Millennium Development Goals. The Figure-2 intends to convey the main pathways between environmental conditions and dimensions of poverty, and necessary linkages of energy (for e.g. alternative energy) as shown in Figure-3 [16].

Figure 2: Relationship between Environment management and MDG



Source: 16

Figure 3: The decentralized renewable energy mitigation-adaptation nexus,



Source: 17

Furthermore, the interrelation among MDG scopes, climate change impacts and necessary linkages with energy as a cross cutting tools is shown in Table-2.

Table 2: MDG Scopes, Climate Change Impacts and Energy Linkages

MDG Scopes	Climate Change Impacts	Linking Energy as a cross cutting tool
Eradicate Extreme Poverty and Hunger:	Loss of bio-diversity, land degradation, food insecurity, loss in soil moisture, food degradation, low accessibility and availability of food, labor force availability and opportunity	<ul style="list-style-type: none"> • Energy is pre-requisite for the production, harvesting and processing of food commodities. • Income generation and employment creation on the chain of demand and supply side of energy, where it can considerably support in land and water management (etc. irrigation, pumping, soil managements); food conservation (solar dryers) • Development and proliferation of energy projects with employment generation and local development • Relying on largely indigenous renewable sources of energy can protect local economies from the massive economic disruptions caused by speculation-driven swings on global commodities markets • Energy Supply and demand management, energy efficiency measures can contribute to the optimum energy usage.
Achieve Universal Primary Education	Loss of lives, infrastructures, migration due to less availability and accessibility to basis needs	<ul style="list-style-type: none"> • Universal education requires integration of Information, Education and Communication materials for which energy is essentially required. • Improved accessibility of bioenergy reduces a major labour burden on women and children—particularly girl children—and improves their opportunities for education • household electrification improves the quantity and quality of lighting, the provision of which is very important for encouraging home study and education
Promote Gender Equality and Empower Women	<p>Exposures to traditional and unsafe energy sources, vulnerabilities in the chain of energy supply, women spending more time on energy management.</p> <p>Women spend much time on grinding, hulling, pressing for food grains. They usually walk long distance to collect fuelwood and inhale fumes and CO, CO₂ and other toxic gases from fuelwood burning</p>	<ul style="list-style-type: none"> • Promotion of different productive enduses and improved source of residential enduses can support in the Gender Equality and empowerment. • Women and children are the primary gatherers and user of traditional bioenergy (fuelwood, crop residue, animal dung). • Women are most severely affected by environmental degradation and bioenergy shortages, and are the primary beneficiaries of increased bioenergy accessibility and improved quality and quantity of household energy services

Reduce Child Mortality	<ul style="list-style-type: none"> Impacts on clean and safe water source, mal nutrition, food insecurity, exposure to unsafe energy source Air pollution from the transport and power sectors has made our cities hazardous to our health, particularly to our children's; 	Country's greatest child killer, acute respiratory infection, will not be tackled without dealing smoke of fuelwood in the rural hamlets.
Improve Maternal Health	Impacts on clean and safe water source, mal nutrition, food insecurity, exposure to unsafe energy source	<ul style="list-style-type: none"> Improving health and reducing death rates will not happen without energy. Need of refrigeration in clinics, hospitals, health posts etc for vaccination and other medicinal purposes require energy
Combat HIV/AIDS and malaria and other diseases	Infrastructure damages, low access to medical facilities, structures and equipments and motive power to operate medical end-uses	<ul style="list-style-type: none"> Improving health and reducing death rates will not happen without energy. Need of refrigeration in clinics, hospitals, health posts etc for vaccination and other medicinal purposes require energy.
Environment Sustainability	<ul style="list-style-type: none"> Degradation to ecosystem and ecology and deterioration to environment dynamics Degradation to the energy carrier resources/sources due to deforestation and landslides 	<ul style="list-style-type: none"> Deforestation will not be reduced without efficient technology and clean energy. Clean water will not be pumped or treated without energy. A dispersed system of renewable generating systems is much more physically secure from attack contribute to the sound and equitable management of biodiversity and ecosystems by lessening pressure on natural forests Improve agricultural productivity by providing energy for irrigation pumping and postharvest processing. These productivity improvements can in turn reduce pressure to convert forest to agricultural land otherwise required to maintain of increase productivity bioenergy can reduce and mitigate natural disasters such as droughts and floods. If bioenergy feedstock is also produced by afforestation in degraded watersheds, floods and droughts can be attenuated by improved watershed function through reduced run-off and increased deep percolation

<p>Develop a global partnership for development</p>		<ul style="list-style-type: none"> • Effective communication among the different stakeholders is difficult and more or less impossible without energy • Growing renewable energy industry has demonstrated, the sector is a fast-growing, supplier of high quality jobs, much more so than the capital-intensive conventional energy sector, but necessary collaboration with national/international/bilateral and multilateral associations is necessary to upscale the energy projects in developing countries like Nepal.
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7.2 Identifying Energy Linkages with Climate Change Adaptation

As mentioned earlier in Section-2, the Cop-7 of the UNFCCC had developed an implementation framework around five main themes like; technology assessment, technology information, enabling environment, and capacity building [2 and 4]. Being inline with this themes role of energy interventions can be identified for adapting to the impacts due to change in climatic conditions, such as;

UNFCCC Themes	Possible rationalities	Activities Needed
Technology Assessment	To identify and analyse region/country-specific technology needs, energy mix options (basis for assessment on technology mix	Assessment of local/regional and national impacts due to climate change, vulnerable mapping and potential areas, scale of vulnerabilities and affected population , nature of degradation to natural resources so that energy mix option can be prioritized as per the purchasing power of vulnerable people and communities. This will also lead to mitigation opportunities.
Technology Information	to enhance the flow of information on environmentally sound technologies and current R&D	Necessary information dissemination and awareness campaign is necessary from respective energy sectors as well as other cross cutting sectors, where energy interventions can be linked with disaster risk reduction and mitigation.
Enabling Environment	to create and maintain a macro/meso/micro economic environment to support development of clean energy technologies	Institutional strengthening and backstopping to local/regional/national stakeholders for preparing to local/national adaptation plan of actions, implementation,, monitoring and evaluation from respective levels
Capacity Building	to strengthen and develop existing scientific and technical skills, capabilities and institutions	Strengthening and capacity development of stakeholders involved in poverty alleviation, disaster risk reductions and energy development/promotions
Mechanism to technology transfer	to facilitate and promote credit flow and support financial, institutional and methodological activities to enhance coordination between stakeholders	Awareness and capacity development of micro finance institutions, cooperatives, development banks, commercial banks and encourage for investing in clean energy development

7.3 Building Resilience Capacity through different Adaptive channels and Energy Inputs

7.3.1 Anticipatory and Reactive Adaptation

Anticipatory adaptation refers to the necessary efforts to deal with possible impacts that can be foreseen. For e.g. awareness on the incidence of flood through early warning system, river water gauge measurements etc and preparation to adapt from the loss of lives and economy. Likewise for the local impacts associated with energy resources, it refers to the clear observations and incidence of natural resources degradation, forest depletion, low productivity of cereal grains resulting to low productivity of agri-residues and biomass energy sources, migration and associated depletion on livestock population resulting to inadequate inputs as a energy carrier, water resources depletion affecting power production and also high flood resulting to land slides, erosion thereby possibilities to demolish power plants etc.

For this kind of anticipatory impacts adaptive process should be prioritized and channelized to ensure the sustainable supply of energy resources to meet the growing demand. At the same time, other integrated adaptation measures also need to be ensured where energy can only act as a cross cutting tools.

Similarly, to react with the change immediately after the happening of any incidence can be referred as reactive adaptation. This depends on how and what resources are available at the time of incidence.

7.3.2 Private and Public Adaptation

Adaptation actions initiated by individuals and public entity can be categorized in the private and public adaptation process. Involvement of private institutions, development organizations in the chain of energy supply and demand for necessary adaptive efforts not only guarantee the increasing access to energy technologies but also towards employment generation and livelihood enhancements, which support in building adaptive capacities of poor and resilient communities.

Community-based adaptation has evolved alongside the UNFCCC negotiations. So while there is considerable overlap with other sectors and approaches, it has developed a distinctive set of terminology and its own research community. The focus should therefore be on empowering communities to take action on vulnerability to climate change, based on their own decision-making processes. The 'bottom-up' aspects of community-based adaptation are in part a reaction to many 'top-down' energy-based interventions, which commonly dominate climate negotiations [18].

The goal of community-based adaptation projects is to increase the climate resilience of communities by enhancing their capacity to cope with different anticipated impacts. The livelihoods and vulnerability focus of much climate adaptation research and practice will help forge stronger links between the communities. *It has also been found that to reduce the vulnerability of livelihoods to climate change risks, community-based development projects must:*

- Begin with a thorough understanding of local livelihoods, so protecting assets vulnerable to current and future climate risks can be a core project activity.
- Help communities develop an understanding of the main climate risks and how they impact on livelihoods (through a learning-by-doing approach).
- Emphasise active participation of community members in all stages of the project (design, implementation, monitoring).
- Build on existing social institutions to carry out activities.
- Encourage the strong participation of women, recognising their role as community resource managers, while also acknowledging their specific vulnerability to climate risks.

- Enhance local technical, financial and managerial skills.
- Invest in long-term resilience-building efforts, which also meet immediate development needs.
- Advocate a policy framework that decentralises natural resource management and recognise that current coping strategies may not be sustainable [18].

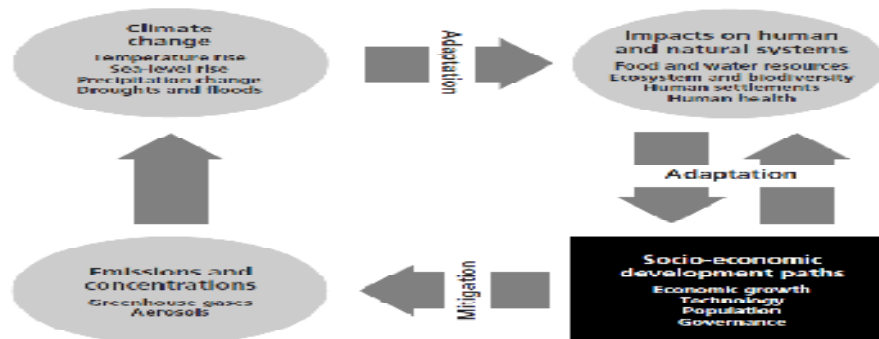
7.3.3 Autonomous and Planned Adaptation

Autonomous adaptation process can be referred to those activities that are generally occurring or taking into action knowingly/unknowingly in different communities. For e.g. shifting towards clean energy devices will contribute towards improving the physical quality of living and simultaneously on adaptation process. Whereas planned adaptation may refer to the activities that are prioritized as per the anticipated and expected vulnerabilities. Assessment of susceptibilities due to climate change and thereby planning for necessary interventions at different level can be categorized in this aspect. For e.g. to address the impact on power sector due to landslides and floods necessary insurance policy and activities can be planned. Similarly local adaptation and national adaptation plan of actions can be characterized and harmonized for this purpose where necessary energy linkages can be established for sustainable development and livelihood enhancement.

8. Integrated Approach to Deal with Climate Change

For integrated and coordinated approach to deal with impacts of climate change, firstly we need to improve our understanding of how climate change affects people's vulnerability, challenges of adapting with the change, which is crucial not only for sustaining poverty reduction, but also for necessary advocacy and lobbying efforts to get more urgent actions to reduce GHG emissions and also required support for developing resilience to deal with changes. As discussed earlier, till date no any explicit relation has been practiced for linking energy access and adaptation, but working on climate change adaptation can open avenues for considering energy to poor communities to promote sustain growth and poverty reduction. It has also been found that *larger and less efficient grid-based power systems currently favoured internationally often bypass the needs of poorer and more remote communities. Hence, promoting decentralised energy can help combine the goals of cutting emissions through efficiency savings and of pro-poor energy provision and consumer empowerment. It also prompts debate on how the use of renewable energy to deliver power locally can be scaled up to the national and continental levels, even potentially to create net exports of clean energy* [6]. For necessary integration on approaches and efforts for contributing towards adaptation to climate change, firstly assessment of impacts at different socio-economic and political regime is necessary, thereby identifying integrated mechanism to adapt and mitigate the consequences should be prioritized in every development activities. IPPCC has also pronounced on this aspect as depicted in Figure-4.

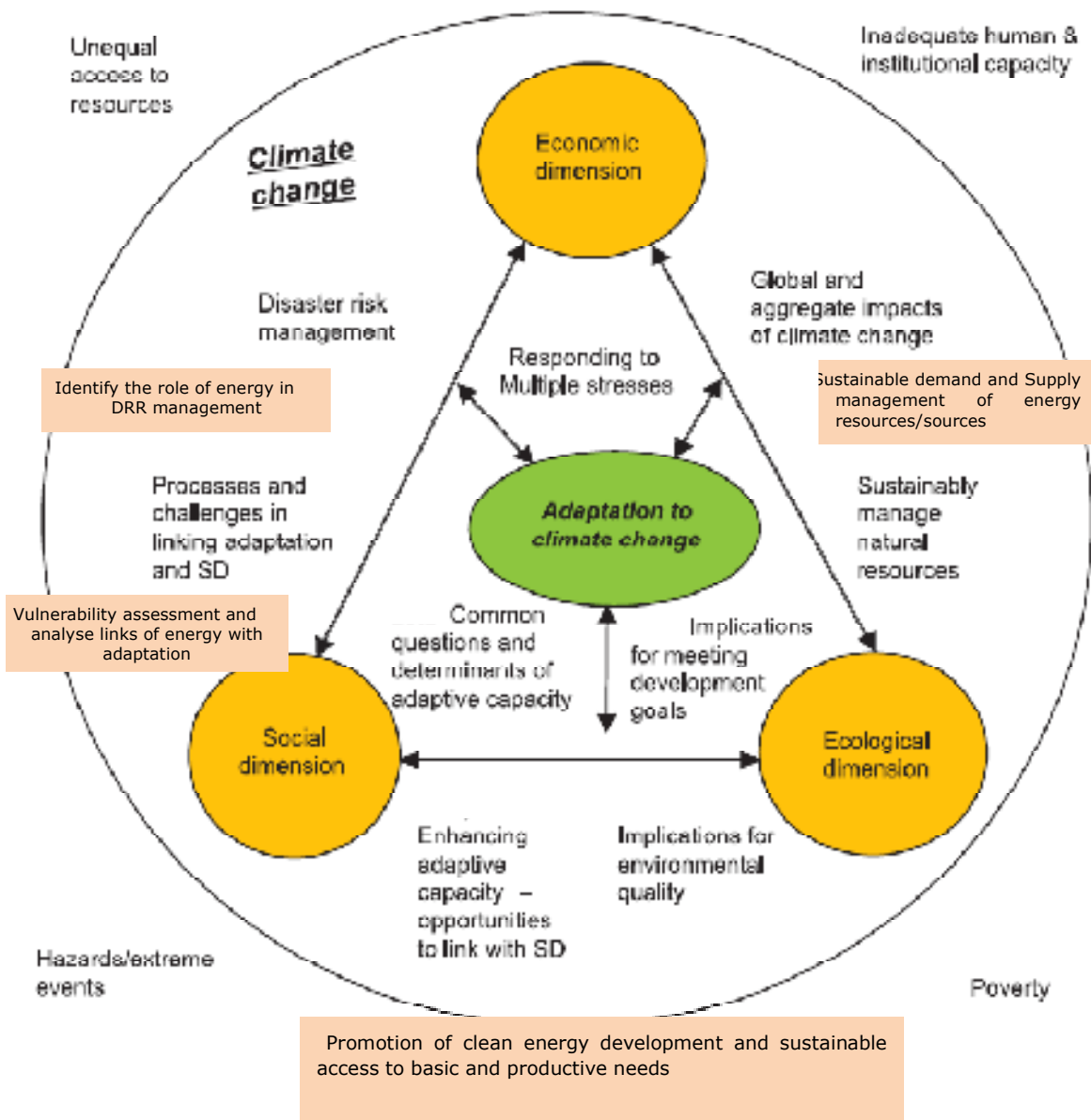
Figure 2: Integrated Assessment Framework for Anthropogenic Climate Change



Source: [8]

Adaptation to climate change basically requires efforts to deliver and upgrade- Economic dimensions (labor force, employment, entrepreneurship development, financial security and access); Social dimensions (health and hygiene, food security, access to basic needs, social and gender inclusions etc) and Ecological dimensions (natural resource management, ecology and ecosystem sustainability, technology transfer for coping with change in ecology and environment). Figure-5 tries to link basic parameters to address the climate change impacts and its adaptation, for which identification of role of energy to sustain all the above mentioned dimensions in the physical economy.

Figure-5: Climate Change Adaptation, Sustainable Development and Energy



Source- [19 and further edited for energy linkages]

Integrated approach is necessary for harmonizing different efforts to meet the impact at scale to address the effects of climate change, which will also smooth effectiveness of adaptation efforts at local and project level as well as to ensure the sustainable development [20]. Likewise it will also ensure the likelihood of scaled-up financial resources

for adaptation, offered a window of opportunity to invest in a coherent to adaptation planning and implementation. Integrated strategic (short, medium and long term) development plans, poverty reduction strategies, sectoral policies needs to be formulated and implemented considering energy as a cross cutting tools for relevant adaptive process. Hence for necessary actions to be taken under the domain of integrated approach, interventions at the country level can be taken primarily in two different level; Local and national level. This requires harmonization of the top-down and bottom-up approaches of inputs followed by outputs to address according to given inputs to address needs of adaptive actions. Here, local level acts as pinpoint with all related stakeholders and actions to assess the vulnerabilities, scale of vulnerabilities, adaptive capacity and interventions required to address the consequences. Local level is thus important to mainstream climate change adaptation because impacts are observed at the local level where livelihood, economic and entrepreneurship, health activities are affected and are at risk. Similarly, vulnerability and adaptive capacity are determined by local conditions. Likewise, adaptation activities and measuring impact at scale of adaptive needs interventions are often best observed at the local level. Local people should be placed at a key position to have decisions on providing inputs on what kind of livelihood strategies and investments can help in mitigating their poverty level, what kind of energy interventions can help them to improve their basic and productive needs. Local level inputs also provide ample of spaces to overview monitoring and evaluation of how policies, programmes and projects are supporting adaptation- *provide a basis for scaling up, revising and learning [20]*.

All these require some specific enabling environment, which obviously varies as per the ecology, geography and settlements. There needs to be broad and sustained engagement with and participation of local stakeholders, including local governments, communities, civil society and businesses from the inception, design, planning, implementation of adaptive strategies and actions. Local authorities like District Development Committee, relevant line agencies, local development organizations, political leaders should need to involve in the collaborative approach where they can be formalized and organized to contribute as a legitimate decision-making agents. On all these nationally adaptive plan and prioritization can be carried out to address the local needs [20].

Integrated Approach

In generalized issues of Climate Change and adaptation process at the local level, appropriate information needs to be gathered and used to inform local-level adaptation decisions. Responses to short-term climatic shocks and those called for by projected long-term climate change impacts need to be reconciled. Four entry points are identified to facilitate the integration of climate change adaptation into local development planning processes [1]:

- i. consideration of the implications of climate change in development planning processes of local governments (village action plans and rural or district development plans, as well as city development plans or strategies);
- ii. adjustment of local regulatory and service provision frameworks, to include provision of information based on likely local impacts of climate change;
- iii. adjustment of local government accountability mechanisms; and
- iv. engagement of private-sector and civil society organizations and processes, which can support adaptation at the local level by internalizing and institutionalizing climate risk management into their own decision-making processes and operations.

To facilitate the integration of adaptation at the local level, a number of priority actions is required to take at higher levels of government, like:

- Collect information on climate change adaptation and make it available.
- Obtaining this information will require a combination of drawing from the knowledge and experience at the local level and having access to information sources housed at higher levels.
- Provide human, financial and technical resources and services to support local adaptation.
- Provide social protection for the poorest and most vulnerable.
- Ensure a supportive policy and institutional framework [1].

Necessary awareness building on climate change, role of energy and other cross cutting tools towards climate change impacts to local actors are necessary. It is required so that they know why they need to take different decisions or call on different additional resources in shaping their livelihoods. Awareness should be raised among a number of different local stakeholders, such as households, local organisations, opinion leaders and educators [20].

9. Efforts in Nepal on Climate Change Adaptation

National Adaptation Plan of Actions (NAPA) established under the Ministry of Environment (MoEnv), Government of Nepal (GoN) has been working to strategically create a sustainable framework for national climate change action. At the same time, the Government of Nepal has initiated a number of concurrent activities on climate change. The Government of Nepal is therefore using the NAPA to provide a basis for the development of a multi-stakeholder Framework on Climate Change Action, ensuring that the NAPA-related stakeholder processes are institutionalised and backed up by dedicated knowledge management and learning platform. In this way, the NAPA will 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.

The NAPA Project has been conceptualized to promote a wider process, which combines the NAPA with broader support and knowledge infrastructure to ensure its sustainability and related climate change activities. This wider programme of work is supported with co-financing from DFID and DANIDA. Currently, The NAPA with its three components- Preparation and dissemination of a NAPA document; Development and maintenance of a Climate Change Knowledge Management and Learning Platform for Nepal; and Development of a multi-stakeholder Framework of Action for Climate Change in Nepal is identifying well defined short-term and long-term priorities for climate change action in Nepal. It will create and enhance awareness of climate change adaptation issues at different scales and build long-term capacity through cross-sectoral and multi-stakeholder coordination. The Project will also form the basis of a critical pathway for climate change action in Nepal, opening avenues for mainstreaming climate change adaptation into development planning [21].

Similarly, recently, Alternative Energy Promotion Centre (AEPC), semi-autonomous body working in the promotion of rural (renewable/alternative) energy technologies, under the MoEnv, GoN has established a Climate and Carbon Unit (CCU) with the technical assistance including organizations like SNV Netherlands Development Organisation and financial support from the UK's Department for International Development (DFID). CCU has been prioritized to deliver its expertise in the carbon mitigation and district climate and energy plans. CCU is now proceeding in the piloting of 3 District Climate and Energy Plans (DCEPs). The goal of DCEPs is to both expand coordination and service provision of renewable energy at district level but also to mapout opportunities that energy can contribute to climate change mitigation and adaptation intending to mainstream gender and social inclusion into energy planning and processes [22].

10. Conclusion

Linking adaptation with energy access is a complex process, since outputs of energy interventions on adaptation depends on the level of resilience needs and cannot be achieved immediately. As discussed earlier that among the different factors to support in building adaptive capacities in the developing world- income growth, social harmonization, sustaining of different capitals (human, natural, social, physical etc) are necessarily strengthened so that people continue on doing what they owe for their existence and normal livings.

Adaptation approach should be treated both from top-down and bottom-up perspectives, with considerable overlaps between the two. Bottom-up approaches assess vulnerability and adaptive capacity to current climate variations and future climate trends at the local

level. Climate variability is a reality that humans have always been exposed to and have developed different ways of dealing with. Similarly top-down approaches could provide avenues of necessary technical and institutional support to address the potential vulnerable areas (along the chain of energy supply as well) to build resilience capacity.

According to the decision 28/CP.7 of the UNFCCC, NAPAs has been given a broad guidance to identify priority activities on the basis of selection criteria on the areas, which includes;

1. Loss of Life and Livelihood
2. Human Health
3. Food Security
4. Water Availability, quality and accessibility
5. Essential infrastructure
6. Cultural heritage
7. Biological diversity
8. Land-use management and forestry
9. Other environmental amenities

On these areas, none of the single activities can be deal in isolation to adapt from the consequences of climate change. Hence, for every area, assessment of energy inputs is necessary. For e.g. to ensure water availability, quality and accessibility- integration of energy inputs is necessary so that water can be reached to taps and purified. Similarly, for human health, energy is pre-requisite tools for necessary preservation and utility.

Thus, for all these it is necessary to ensure better linkages with energy access with adaptive process, for which the crucial things that needs to better understood is the flow of energy supply from source to the consumer, vulnerability on these, adaptation to the flow itself and finally also guarantying improved resilient capacity through the promotion of convenient/reliable/safe/clean energy sources and technologies. But until and unless proper mechanisms of energy delivery services are ensured, intervention of adaptive measures could not be successfully implemented. On doing so necessary things that need to be brought into considerations are;

Assessment of Vulnerabilities on Energy Supply-Demand Chain

More than 80 percent of population of Nepal relies on biomass energy sources, the energy supply system of this sources itself could be vulnerable, for e.g. due to land degradation, forest degradation access to sustainable forest resources to supply sustainable fuel wood (basically for pro poor) could be in threat. These have a number of implications on social, economic and environment concerns. It requires development and promotion of clean and efficient energy technologies to cope the basic needs and improving livelihood. This is also not easy to analyse in a linear way, firstly affordability context should be understood, and availability of sources for particular technology should be brought into consideration.

Identify roles of energy in addressing to minimize threats due to climate change

Threats to resources- agriculture, water, forest since have been reported in an alarming rate in different studies. This means that possible threats on these resources have direct and indirect impact on human, social, financial and environmental capitals. Necessary analysis should be carried out how necessary adaptation measures can be adopted to cope with these threats on human and ecological systems also identifying roles of energy on them.

Decentralized Energy Management and Planning

Decentralized renewable energy offers a constructive climate policy direction that provides simultaneous adaptation and mitigation benefits. The mitigation benefits are clear; decentralized energy promotions (renewable energy) that have low/absence of emission factors. Energy planning hence needs to be linked with ecosystem services – poverty alleviation, relation between energy services and poverty, relation between energy services and gender and social inclusions etc. Decentralized renewable energy (bio –mass energy, wind, hydro, geothermal and/or solar), provides energy for irrigation pumping and post-

harvest processing, which in turn provides new water resource management options and livelihood opportunities, Better lighting expands educational opportunities and livelihood options.

Energy planning process needs to consider the climate change-local impacts to identify the threats to resources, livelihood, health, food security and cultural heritages. Decentralised energy management through minute energy planning procedures are hence necessary to speculate the technology needs, information transfer, capacity development needs and flow of funds for necessary adaptation action to ensure the energy security and building resilient capacity.

Technology Transfer and Capacity Development

Transfer of energy technologies and other appropriate technologies is crucial for building resilience capacity to address the impact of climate change. Necessary research and development is also necessary to optimize the cost of clean and reliable energy technologies, accessibility of energy sources so that pro- poor can also be in the domain of supports achiever.

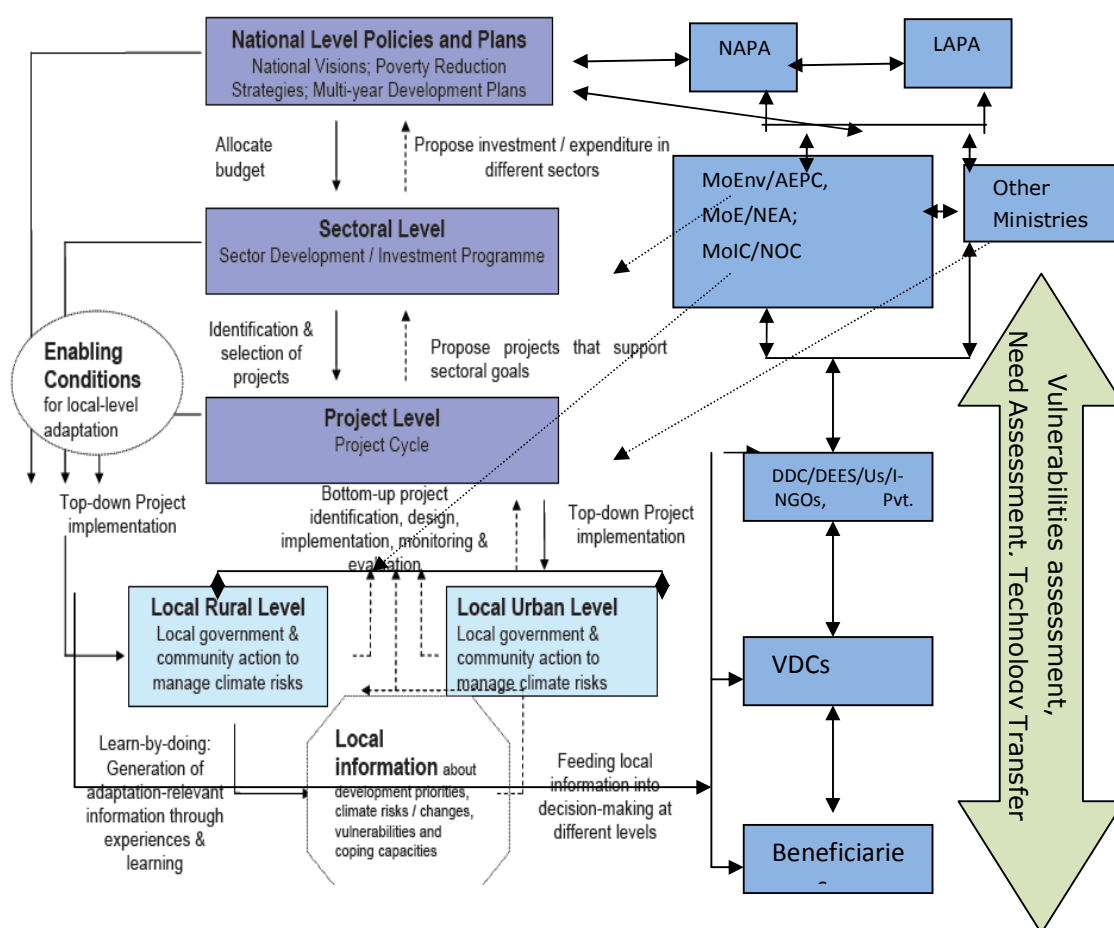
Institutional Support and Harmonization

A number of organizations and institutions are involved in research and development, policy formulations, service provisions in the sector of energy. However, necessary capacity development and institutional strengthening is necessary to ensure decentralized service provisions.

Figure 6 shows a tentative integration and flow of necessary supports to and fro for assessment of vulnerabilities, scoping, designing, planning, implementation and monitoring of activities for addressing climate change with necessary energy interventions and other sectoral collaborations.

In the context of Nepal donors and international communities are supporting on different economic and livelihood activities which are also directly/indirectly enhancing adaptive capacity within rural and urban settings in a number of ways. For more concrete and reasonable investment necessary reviews on sectoral priorities of different donor communities needs to be carried out to mainstream the adaptive process in on going and future programs and projects. For e.g. on the long-term projects on support for agriculture and rural development, as well as for sustainable land and water management, necessary intersectoral coordination can be facilitated. Let's say how post harvest aspects and agro-processing can support in food security and how energy can be linked with it. For this necessary integration of activities, available funds and channelization is necessary to build local adaptive capacity and reduce duplication and maintain accountability and transparency. Local resource mobilization (e.g. municipal infrastructure funds, village development funds, district development funds etc) can be supported in the process. Decentralization mechanism and strengthening of such mechanism from regional and national level can enhance the flow of support (either for technology transfer, information dissemination, and capacity development).

Figure-3: Integrated Approach for addressing the climate change impacts



Source: [18] and further edited for linking energy access

Advocacy and Lobbying

Different attempts have been made in addressing the issues of climate change across the world as well as in Nepal. Even so there is no any explicit relation made for linking climate change adaptation with energy access. NAPA since is one of the legitimate body to address the needs of adaptive process, necessary coordination and cooperation is required to ensure role of energy in national and local adaptation plan of actions. Similarly, advocacy and lobbying with national, international, bilateral and multilateral organizations is required to mainstream energy linkages in different livelihood and poverty reductions supports, as far as applicable.

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