

# Assessing Impacts of Climate Change and Water Induced Disasters from Gendered Perspective in Darchula, Nepal

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**Abstract:** Climate change induced natural disasters are predicted to be increasing and its impacts are predominantly floods, rainfall variation and temperature rise with melting water towers and low water during rainy season. Especially the water induced disasters have impacted on involuntarily displacement which is likely to increase vulnerability of human communities, their livelihoods and ecosystems. Among the flood disasters linking to climate change is also seen in 2013 in Darchula in Mid-June with unprecedented rainfall in Uttarakhand and Far West of Nepal. The Gendered perspective of impacts on climate change and coping with disasters so far have not been assessed in detail. Thus, this study was designed to understand and assess Impacts of Climate Change and Water Induced Disaster with Coping Strategies from Gendered Perspective in Darchula District, Nepal. The research findings based on focus group discussion and key informant interview indicates that the families living in Shree Bagad, Khalanga, Dhap, Ukku and Galfaiarea were affected severely and lost their fertile land and houses. According to the respondents both men and women highlighted that the poorest of the poor in the village were displaced and the richer communities migrated to Mahendra Nagar. 90% of the respondents mentioned the major hazards mapped in the regions are directly and indirectly linked to climate change. The impacts observed since BS 2050 onwards are floods and landslides, which has made the whole Darchula more vulnerable than the last 30 years. Finally, both the respondents felt that sufficient coping strategies by people themselves and government are inadequate and climate change awareness for adaptation and building resilience capacity is needed.

**Key words:** vulnerability, climate change, adaptation, floods and landslides

## 1. Introduction

Climate change refers to a statistically significant variation in the mean state of the climate for an extended period. Climate change induced natural disasters are predicted to alarmingly increase the number of involuntarily displaced even though it is particularly difficult to segregate regular natural disaster induced

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displacement cycles and climate change induced extreme natural disaster stimulated displacements. It has been predicted that climate change is likely to increase vulnerability of human communities and ecosystems as the occurrence and severity of extreme weather events, especially water related disasters as drought, floods, mudslides and cyclones increases (IPCC 2007 a). IDMC, 2010, and IPCC, 2007 a, says that most of the disaster displacement within countries was caused by climate-related hazards, primarily floods and storms not just destruction of life and property but also changes in water availability and as a result other natural resources, threatening livelihoods and fuelling mass migrations. According to Disaster Prevention Network report 2009 it ranks Nepal 4<sup>th</sup> in the list of vulnerable countries to climate change and is one of the most disaster prone countries in the world, ranking 23<sup>rd</sup> in the world in terms of natural hazard related deaths with the major natural disasters as floods, landslides, earthquakes, droughts and wildfires. It is believed climate change induced disasters especially water induced vulnerability mapping being inadequate has failed to address the adaptation process and this new form of human movement yet has to be accepted by the international agencies to address the impact (USAID, 2007; Christian Aid, 2007; Oxfam, 2009). Smith et al., 2001; Corfee-Morlot and Höhne, 2003; Hare, 2003; Oppenheimer and Petsonk, 2005; ECF, 2004; Hitz and Smith, 2004; Leemans and Eickhout, 2004; Schellnhuber et al., 2006 have studied the key impacts that may be associated with key vulnerabilities are found in many social, economic, biological and geophysical systems, and various tabulations of risks, impacts and vulnerabilities. There are several consequences such as forced migration not being addressed, conflict in resources, threatening the livelihoods and ecosystems in coming years are being studied by Berringer, 2012; Brown, 2008; and El-Hinnawi, 1985; IOM, 2008; Bates et al., 2003.

Addressing water related climate change disasters will be vital not just for Nepal, but for the region, since Nepal lies at the head of the Ganges basin on which 500 million people reside. Among the natural disasters, flood and droughts are chronic problems in most parts of Nepal and the climate change driven changes in patterns of precipitation is exacerbating the water induced hazards. About 26 major events of floods, cloudbursts, Glacial Lake Outburst Floods (GLOFs), Infrastructure Failure Outburst Flood (IFOF), landslides have been recorded between the year 1958-2013 (June). The major events of floods were found in the rivers Koshi, Bagmati, Narayani (Sapta Gandaki) and Karnali (Paudel, et. al. 2013). Mahakali river basin is one of the watersheds of precedence in Nepal in terms of its biological and natural resources especially after the floods from past years 2013 in Darchula has become more vulnerable and is important to conduct this study. Melting of Ice caps and water induced disasters related studies by DWIDP, 2008; DpNet, 2009; Paudel, et. al, 2013 indicates the loss of life and property loss having a forced migration of the people.

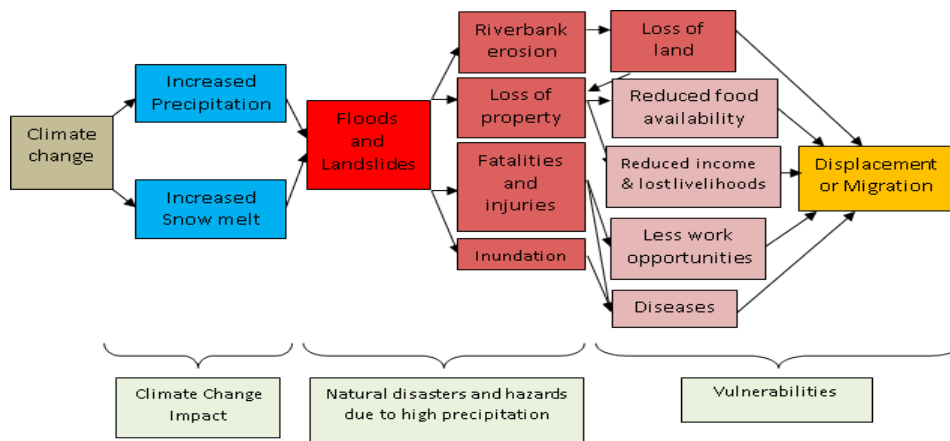
Several studies attest that women and girls are more vulnerable to disasters such as drought, floods, and

hurricanes. For instance, it has been reported that women and girls made up 90 per cent of deaths during the 1991 cyclone in Bangladesh and 75 per cent of deaths during the 2004 Indian Ocean Tsunami. In Sri Lanka, swimming and tree climbing are taught mainly to boys; this helped males cope better than females when the tsunami hit. In times of disaster and environmental stress, women become less mobile because they are the primary care givers (UNECA, 2009). Women are very vulnerable, and are most likely to be disproportionately affected by the adverse impacts of climate change because they constitute the majority of poor people. Women's traditional roles as the primary users and managers of natural resources, primary caregivers, and laborers engaged in unpaid labor mean they are involved in, and dependent on livelihoods and resources that are put most at risk by climate change. Khosla and Pearl 2003; Brody, et.al, 2008; WEDO 2008; Karlsson, 2007; Oxfam, 2007, have strongly pointed out that gender dimensions in climate change and its relation to water, energy, natural resources, health and having significant impact directly affects the women and girls and making them vulnerable.

## **2. Materials and Methods**

There is growing interest in the issue of climate change and displacement of people, there doesn't seem to be much consensus about the 'entry point' into the debate of how to categorize and support such displaced communities in the lack of an international law on climate refugees and Internally Displaced Persons (IDPs) and the inabilities of states most vulnerable to provide timely reliefs and basic human rights and to the displaced. Looking at the climate change induced impacts, there aren't studies based on gendered perspective that limits the women and vulnerable groups to have the access to the services and benefit sharing. This study here tries to link the impacts of climate change with vulnerabilities and livelihood strategies among the displaced.

The research design for this study was mixed with use of both qualitative and quantitative research methods. Quantitative methods were used in socio-economic and vulnerabilities assessments and perception studies, while qualitative methods were used for analysis of gender dimensions of vulnerabilities, and coping/adaptation strategies existing and needed in the study area. Both primary and secondary data has been used for this research. The research has employed an interdisciplinary approach to be understood in terms of process rather than representation. Therefore, Climate change related vulnerability, consequences and adaptation model has been modified based on IPCC 4<sup>th</sup> Assessment Report 2007 bas below figure 1. The main objective of this study is **“To Assess the Impacts of Climate Change and Water Induced Disaster from Gendered Perspective in Darchula, Nepal”**.



**Figure 1 Climate change, natural disasters and hazards related to high precipitation and related vulnerabilities**

### 2.1. Primary Data Collection

The sample sizes and selection procedures varied with the information and data collection tool. The primary data was collected from field through key informants interviews, in-depth interview, questionnaire survey, direct measurements or observations, along with community discussions using different participatory tools. For the primary information, participatory community meeting or focus group discussion and key informant interviews were conducted for wellbeing ranking, participatory resource and vulnerability mapping at VDC level, then for preparation of seasonal calendar and timeline and noted perceptions climate change and coping strategies. The focus group discussion information gathering method has been adopted from World Bank, 2005 which specifies that, it's very important to have age groups specified from age 25 to 60 to hazard mapping during the focus group discussion (FGD) and mapping the event calendar drawn for 30 years. To ensure the gender disaggregated information, both men and women groups were separately interviewed.

Gender, Environment and Development is a sub approach of Gender and Development Approach which involves gender analysis of sex-disaggregated information on experience, knowledge, and needs of men and women specifically in regards to environment, natural resources and development. It has been used in this research since it is best suited for analysis of climate change impacts and adaptations from gendered perspectives as it provides sex disaggregate data on intra community environmental inputs and outputs along with external interventions as development.

The historical timeline specifically focused on the major disasters and hazards, environmental, social, political and cultural events during the last 30 years or more will be observed in different intensity, intervals and seasons were discussed in the community group discussions and presented in graphical to tabular form.

The changes in cropping patterns, changes in land use, land tenure, changes in food security and nutrition, as well as the beginning of different services, networks and facilities will be discussed and documented. Both hard copies and digital copies of topographical maps (scale: 1:50,000 Map sheets – 2883 12 and 2884 09) of 1996 (prepared based on aerial photographs of 1996) published by the Survey Department of Government of Nepal in 1998 was acquired for analysis.

## **2.2. Data Analysis**

Finally the data was analyzed using time scales and comparative maps, photographs, as well as descriptive statistics with help of Microsoft Excel 2010. Ladder of Life for wellbeing ranking is done to analyze the vulnerable groups of the community and number of household so far vulnerable. Besides this, the gendered perceptions and observations of hazard mapping is measured based on ranking the hazards and compared in a scale using Likert scale Very high to do not know in 1-5 format. The overall vulnerabilities is determined using matrices/multi criterion analysis and participatory ratings calculations. Department of Hydrology and Meteorology Department temperature and rainfall data from 1988 and 1985 upto 2015 has been analyzed to verify with the people's perception.

## **2.3. Study area**

The Mahakali, a river between Nepal and India (forming the western international border between Nepal and India), originates from the Greater Himalayas at Kalapaani (there is a long lingering dispute over territory with Nepal) at an altitude of 3600 m, in the Pithoragarh District of Uttarakhand, India, joins with the Gori Ganga at Jauljibi, which in turn joins the Saryu River at Pancheshwar. (The area around Pancheshwar is called 'Kali Kumaon'). Kalapani is situated on Kailash Lake Mansarovar trek and it is said that at this place the Great Sage Vyasa meditated and the valley is called Vyasa valley. The river is named after the Goddess Kali whose temple is situated in Kalapaani near the Lipu-Lekh pass at the border between India and Tibet (China). The river borders the Nepalese Mahakali Zone and the Indian state of Uttarakhand.

The study area Darchula District of Mahakali Zone (Figure 1 and Google earth map) covering an area of 2,322 km<sup>2</sup> and has a population (CBS, 2011) of 133,464. The town has an Indian counterpart to its northwest, named Dharchula. The split between the two towns is just virtual as the traditions, culture, and lifestyle of the people living across both the regions are quite similar. About 89.90% of the total population depends upon agriculture. Substance agriculture, lack of basic infrastructure, difficult geophysical condition, traditional agricultural practice, and low literacy rate and population growth are the root causes for deep rooted poverty. The district has three physiographic zones with three types of climate namely a) Cool Temperate, b) Mild

Temperature and c) Sub-tropical. Main areas of the district on the climatic zones. The Average maximum temperature in Darchula district is 33°C in summer season while in winter season 3.8°C. The average rainfall of Darchula district is 204.92 mm.



Source: Google Map and Google Earth map downloaded in 2016.

**Figure 2.** Study Area Darchula District in Far West of Nepal and June 2013 Flood Occurrence area

The study area after the preliminary field visit and GIS map study, the study was focusing crucial areas downstream VDC allocated of Nepal area covering Shree Bagad, Bange Bagad, Khalanga, Galfai, Dattu, Dhap and Ukkuhaving a direct impact from the water induced disaster flood in June 2013. Climate Change impact in causing water induced disaster may not be limited only to these areas, but were found vulnerable more than the other sites.

### 3. Results

The total respondents were from Api Municipality which has been merged having Shree Bagad, Bange Bagad, Khalanga, Galfai, and Dhap, and two other areas Dattu and Ukku. Most of the respondents were either directly affected by the flood or vulnerable towards the disasters. In the focus group discussion around 152 men and women participated, out of which 70 men and 82 women. It was also found out that the female headed household ranged from 1 to 50% that is Bange Bagad is the only village where both men and women said that there were 50% of the household headed by women compared to other villages. Gendered perception of climate change and disasters induced varies based on understanding and having knowledge about the issues. Perception varies here in knowing climate change, vulnerability and coping strategies.

**a. Vulnerability mapping:** National Adaptation Plans of Action (NAPA) project in 2010 carried out the climate change vulnerability index mapping and showed that Darchula is moderately vulnerable (0.356-0.600)

(MOE, 2010). The initial phase of the analysis is to know about the general household information from the severely to moderately vulnerable areas by the flood in June 2013 and are vulnerable in coming years as well. These information were gathered from separate male and female groups via focus group discussion and shows that among the seven sites chosen the household today is more in Dattu, Dhap and Khalanga area ranging from 400 to 520metre. Comparing the household 10 years ago, it was said the households were almost 50% less than what it is today, meaning the household in these area are increasing mostly in the bazaar area. The causes of being vulnerable to flood in the area were identified by all the groups. The causes were deforestation, having houses along the river bank and built not having proper housing codes, increasing urbanization and soil being very fragile. Now before mapping the vulnerability, ladder of life was mapped to know which villages or the groups vulnerable due to flood. Table 1.below indicates the ladder of life having 4 categories of group showed that 10 years ago none of the residents were in category 4 or rich and most of them belonged to group 1 to 3. Now mapping the vulnerable groups accordingly the first the group 1 belongs to below poverty level and they are the ones who are more vulnerable than the others. The Figure 2.taken from Google map was shared to identify the vulnerable areas. In the vulnerability mapping we also tried to focus on food shortage season and duration of it.

**Table 1.** Ladder of Life Scenario of study area

Categories	Area FGD group	Shree Bagad		Bange Bagad		Dattu		Dhap		Ukku		Galfai		Khalanga	
		M	F	M	F	M	F	M	F	M	F	M	F	M	F
-Having income sources -Businessman	Ladder of life 4 Now	0	0	0	0	1	4	0	0	0	0	0	0	0	0
Having high fertile land -Well educated -Having decision making power -Having vehicles -Having connection with political power	10 yrs ago	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-Having income sources -Businessman	Ladder of life 3 Now	2	4	3	6	7	10	5	6	5	6	3	5	5	7
-Having high fertile land	10 yrs ago	3	2	3	3	5	6	2	2	5	5	2	4	3	5

-Educated -Having decision making power															
-Children in government school -Governmental officer	<b>Ladder of life 2 Now</b>	13	10	12	10	6	7	11	10	10	4	12	10	3	3
-Food sufficient for 3-6 month	<b>10 yrs ago</b>	9	10	9	8	12	4	5	6	12	2	6	5	8	7
-Food insecure HH -Illiterate -wage labors -Landless	<b>Ladder of life 1 bottom Now</b>	5	6	5	4	7	3	4	4	5	10	5	5	12	10
-Unable to fulfill basic needs -Having mud houses -Large family size -Higher dependency ratio	<b>10 yrs ago</b>	8	8	8	9	3	10	13	12	3	13	12	11	9	8
Vulnerable areas based in Likert Scale (Very high 5- Very low 1)		5	5	5	4	4	4	3	3	4	4	5	5	5	5

As per the discussion the time of year that they have food shortage is mostly in rainy season for 3-12 months respectively in Shree Bagad, Bange Bagad, Dattu and Ukku area, where as there is food deficiency in Galfai, Khalanga and Dhap area maybe these area belonging to the Bazaar and no area to grow crops. It means the people along these areas mostly depend on Indian market and buy food the whole year round. Now after the analyzing the ladder of life and vulnerable areas mapped, it was indicated the poorest of the poor are the ones who were displaced from the flood of 2013 and risk factor is high of displacement in the Bazaar area in coming days. There is also a migration trend found among the male in the area that is there is a displacement due to disaster such as flood and landslide in the region and most of the men migrate temporarily to India or to the District Headquarters for work and children's education. The vulnerable groups from the floods has not been compensated with land and only some cash was given which was not enough. These groups are still leaving in a poor shelter or a rented apartments.





Source: Google Map April 2016

**Figure 3.** Vulnerable areas of Darchula due to Flood and Landslide

**b. Trends of climate change, disaster mapping based on gendered knowledge**

IPCC, 2007 c, defines that Climate change (CC) refers "to the variation of earth's global or regional climate over a long period of time, whether due to natural variability as normal changes or it is the result of human induced activities". The report also says that CC has been alarming in the world by global warming which is caused by increasing concentration of greenhouse gases (GHGs) Physical impacts of climate change & Deforestation. People's perception of climate change from their knowledge could be the most important factor determining their willingness to accept the scientific conclusion that humans are causing global warming and verify it.

Table 2. here documents the seasonal climate variation from the last 30 years to last year based on the understanding of male and females knowledge on climate change. Both male and female here perceived that winters would be cold, with winter rain and sometime intense cold, which has changed now and has become colder in some places with no winter rain but more fogs and dry winters. The shift in monsoon is also

observed indicating that the rainfall pattern was regular through June to September and now it's not like that. The monsoon now does not have regular rain and there is more erratic and irregular pattern causing more floods and landslides and even impacting the agricultural production.

**Table 2.** Seasonal Climate Variation from 30 Years to Last year

Month	30 Years ago	Last year	Respondent groups	
<b>Jan</b>	Cold, winter rain	More cold than 30 years ago, drought	F	M
	Dew, fog, winter rain	Dew, Fog ( More cold than 30 years ago), drought	F	M
	Intense cold	Decrease cold	F	M
<b>Feb</b>	Cold, winter rain	more cold than 30 years ago, decreasing rainfall	F	M
	Dew, Fog	Dew, Fog ( More cold than 30 years ago), drought	F	M
	Intense cold, Cold Wind, Snow in mountain	Decreasing cold, less snow in mountain	F	M
<b>March</b>	Dew in morning, hail storms. Affected the wheat harvest	Decreased in rain, drought, less agricultural production, affected the wheat harvest	F	M
<b>April</b>	dry and humid	Very humid and hot	F	M
<b>May</b>	Calm climate	Increased warm	F	M
<b>June</b>	Start rainfall but not high	Increased warm, increased pest and diseases, less vegetable production	F	M
<b>July</b>	Continuous and high Rainfall	Sometimes high erratic, cloud burst and intense rainfall and sometimes drought	F	M
	High rainfall, water level high in river, high water sources	Decreased rain, increased drought, decreased in water level in river	F	M
<b>Aug</b>	Continuous rainfall and high	Decreased rainfall, unpredictable rainfall, storm, loss of agricultural production	F	M
<b>Sept</b>	Medium rainfall	High intensity rainfall, warm	F	M

<b>Oct</b>	Calm climate, dew in morning and cold at night and morning	Not so cold in morning, loss in paddy production	F	M
<b>Nov</b>	Cold	More cold, storm	F	M
<b>Dec</b>	Cold, winter rain	More cold, drought, loss of vegetables due to drought	F	M

Source: Field Study, Darchula 2016

The other indicator that was discussed among men and women were what were the disaster trends they have observed during their life time. Most of the female respondents said that events of flood was recorded in 2028 BS (1971) which created flat land along the river bank and had caused less damage especially in the Khalanga Bazaar area. Again it was the female respondents who said there were earthquake happening in 2023 B.S (1966) and 2052 B.S. (1995) which had caused landslides and food insecurity. Some major disasters observed in recent years by both men and women were floods, landslides, hailstorm and drought in most of the area along these study area impacting agricultural fields, villages and leading to food insecurity (Table 3).

**Table 3.** Disaster Trend Mapping of the study area

<b>Year</b>	<b>Responses</b>	<b>Disaster event</b>	<b>Adverse impact and effect</b>	<b>FGD area</b>	<b>Remarks</b>
2028	Female	Flood	Created some flat land along the river side and then less damage Landslide	Khalanga-5	
2023	Female	Earthquake	HH and school collapse, landslides, food insecurity	Khalanga-5	Landslides due to earthquake
2037	Female	Earthquake	Damage of HH	Dattu	Landslides
2052	Female	Earthquake	HH and school collapse, landslides	All FGD areas	Landslides due to earthquake
2058	Both	Landslide, flood	Swept out house and land	All FGD areas	
2059	Both	Snowfall	Loss of agriculture production	Dattu	
2060	Both	Flood	Swept out wooden bridge	Dattu	

2068	Both	Hailstorm	Damaged Agricultural production	Uku	
2070	Both	Flood	Swept out agricultural land and market	All FGD areas	-
2071	Both	Forest fire	Damage forest	All FGD areas	-
2071	Both	Landslides	Damage of land, increase risk in road	All FGD areas	-

Source: Field Study, Darchula 2016

During the focus group discussion, the respondents both men and women were requested to rank the current hazards, its frequency, adverse impacts, its vulnerabilities and impacted areas. Both the respondents ranked flood as the 1<sup>st</sup> hazard and landslide 2<sup>nd</sup> with increase in pests and insects as the 6<sup>th</sup> event respectively having an adverse impacts on physical, natural and economic prospects of livelihoods and making poor farmers more vulnerable. That is in terms of agriculture, transportation and loss of life is more vulnerable in most of the river banks of Mahakali ridge (Table 4).

**Table 4.** Hazard ranking and mapping adverse impacts, vulnerabilities and impacted areas

S.N	Hazards	Frequency	Adverse impacts	Vulnerabilities	Vulnerable groups	Impacted areas
1	Flood	Regular (larger 3 times)	Loss of agricultural land, loss of property, difficulties in transportation, loss of market	Agriculture, food security, transportation, market	Poor people, remote area residents, businessman, house owner	All the Mahakali river belt
2	Landslides	Regular	Loss of soil, difficulties in transportation, increased risk	Risk in transportation, loss of grazing land, loss of livestock	Remote of residents, farmers, wage labor	Along the Mahakali ridges and inner hills
3	Earthquake	Regular (small magnitude), 2 times major	Not so harm full,	Risk in households, increased risk of small scale landslides	Poor people	Whole Darchula

4	Hailstorm	Regular in winter seasons (in small scale)	Loss of agricultural production (potato, wheat, and others cash crops), damage of household roof	food insecurity,	Farmers, poor people	All Darchula
5	Fire	Sometimes forest fires	Loss of forest	Loss of biodiversity	Forest consumers groups	Hills of Darchula
6	Pest and diseases	Regular (mostly in drought seasons)	Loss of agricultural production, increased in diseases like diarrhea, typhoid etc.	Risk in agricultural production and personal health	Poor, farmers, children	All Darchula

Source: Field Study, Darchula 2016

**c. Adaptation Knowledge and Coping Strategies**

If we look at the definition, **adaptation to climate change or global warming** is a response to global warming that seeks to reduce the vulnerability of social and biological systems to current climate change and thus offset the effects of global warming. Faber, 2007 and Schneider *et al.*, 2007 highlights that adaptation is especially important in developing countries since those countries are predicted to bear the brunt of the effects of global warming. IPCC, 2007 strongly emphasizes that while doing adaptation it is closely linked with social and economic development. But while doing adaptation and coping strategies also depends on the knowledge of men and women. Here the perception of knowledge and coping strategies are analyzed. That is, the capacity and potential for men and women to adapt can be unevenly distributed especially in Nepal not having sufficient knowledge in climate change and its impact.

Table 5 below gathers the information on various coping strategies and both men and women mentioned that in most of the cases they do not have the knowledge to adapt based on climate change, because there has not been any organization that supports them. Now if we look at the services provided in the region, men being more migrant have the access to the services but sharing among the household is less. No doubt there is no adaptation or coping practices done for building resilient capacity based on National Adaptation Plan of Action (NAPA) or Local Adaptation Plan of Action (LAPA), because they do not know about the policy exists. Some men and women in the study area doing coping practices like using composting, plantation, minimizing the use of pesticides and participating in community activities are increasing.

**Table 5.** Practice documented for Coping Strategies

Coping Strategy	Number of villages adopting	Remarks
Changing crop species/variety and using improved seeds/varieties	None	No knowledge
Multi cropping and crop rotation with increase in diversity of crops (vegetables/fruits)	None	No support and knowledge
Changing time of plantation and other farm inputs	Shree Bagad, Dhap, &Dattu	River banks only
Increasing irrigation with improvement of irrigation systems (canal/drip irrigation)	None	Fully rain fed
Using farmyard or compost manure	All villages	
Use of plastic tunnels, drip irrigation, and improved farming technologies	Shree Bagad	Traditional farming
Use of scientific farming with minimum tillage, terrace farming with use IPM	None	
Use of chemical fertilizers and pesticides	All the villages	Buy from India
Construction of water tanks/reservoirs, conservation ponds and rain water harvesting systems and maintenance of water distribution systems	None	Pumps water directly from river
Reducing water use, conservation of water sources by plantation around water sources and participation in water users group	None	No awareness
Conservation of forests, plantation and live check dams	Few villages	Government support
Livelihood diversification	None	Depends on livestock
Participation in saving and credit/farmers/mothers or any other community groups	All villages	
Temporary migration	All villages	To Mahendra Nagar

Finally, the study tried to find out the coping and adapting strategies to water induced hazard in Darchula. Both men and women groups identified that floods, land mass movement, hailstorm, drought and water scarcity as water induced disasters in the area. All these hazards had an impact on agriculture production,

property, human life and physical assets and livelihood of the community. Adaptation options such as Gabion wall, drainage improvement, plantation along the river banks, construction of reservoir water tanks and change in agriculture production tools and techniques were mostly executed externally than locally. Even if the government has some program for displaced persons, besides 35,000 rupees and some support from the Red Cross, significant support were not found in the area. There is an institution set up to deal with flood victims, but as per their view no compensation has been provided to them for their betterment of the livelihood. Government is involved in building the dams but taking too long that more disaster in future can damage the structures if they are not completed in time.

**Table 7.** Coping and adapting to water induced hazard

Hazard	Vulnerabilities	Adaptation Option	Executed by		New Option	
			Locals	External	Locals	External
Floods	Loss of agriculture field, crop produce, property and even life, reduced livelihood options	Gabion wall check dam along the river bank and land slide area		√		√
		Improvement of drainage through construction of diversion canal and gully reclamation	√			√
		Plantation along river bank, landslide area, barren slopes, trails, etc.		√	√	
Mass movement	Loss of life and property, reduced natural resource availability, reduced livelihood options, decreased access to public services and development	Gabion wall check dam along the river banks and land slide hazard prone area		√		√
		Plantation along river bank, landslide hazard prone zone, barren slopes and trails	√		√	
Drought	Acute water scarcity for all purposes, limited livelihood options, food deficits, poverty	Construction of water tanks, reservoirs and conservation activities for conservation of water sources				√
		Improvement in agriculture via training, improved species/seeds/breeds, improved techniques, tools and technologies.				√



Water scarcity	Greater time and labor inputs for water collection, Decline in living standard and increased poverty	Construction of water reservoirs and conservation of water sources		√		√
		Improvement in agriculture via training, improved species/seeds/breeds, improved techniques, tools and technologies.				√
Hail	Food deficit and reduced returns from farming as livelihood options	Improvement in agriculture via training, improved techniques, tools and technologies.	√	√	√	√

#### 4. Discussions

MOE, 2010 indicates that Nepal having low level of development and complex topography increases the vulnerability and impacts are seen in the sectors of agriculture, forestry, water and energy, health and overall livelihoods and economy. It also says that 1.9 million people are highly climate vulnerable and 10 million are increasingly at risk, where mid and far western region are one of the most vulnerable due to its poverty rates, heavy reliance on small scale agriculture and erratic rainfall patterns and the lack of basic services and alternative livelihood options (MOE, 2010).

Regmi et al., 2009 studied that poor people are more vulnerable to loss of livelihood assets and they lack access to information and basic services relatively to richer people, which we have also observed in the study area. In Most of the cases it is the men who has the access to the information and have decision making power than women. But in the case of Darchula though having mostly men in the Flood Victim Rehabilitation Committee, they seem to lack information and basic services. Women in developing countries are particularly vulnerable to climate change because they are highly dependent on local natural resources for their livelihood. Women charged with securing water, food and fuel for cooking and heating face the greatest challenges. Women experience unequal access to resources and decision-making processes, with limited mobility in rural areas. It is thus important to identify gender-sensitive strategies that respond to these crises for women.

In the Global Gender and Climate Change Alliance Report by UNDP, 2013 highlights that “a number of factors account for the discrepancy between women’s and men’s differentiated exposure and vulnerability to climate change risks and there are gender based differences in time use, access to assets and credit and treatment by markets and formal institutions (including the legal and regulatory framework) constrain

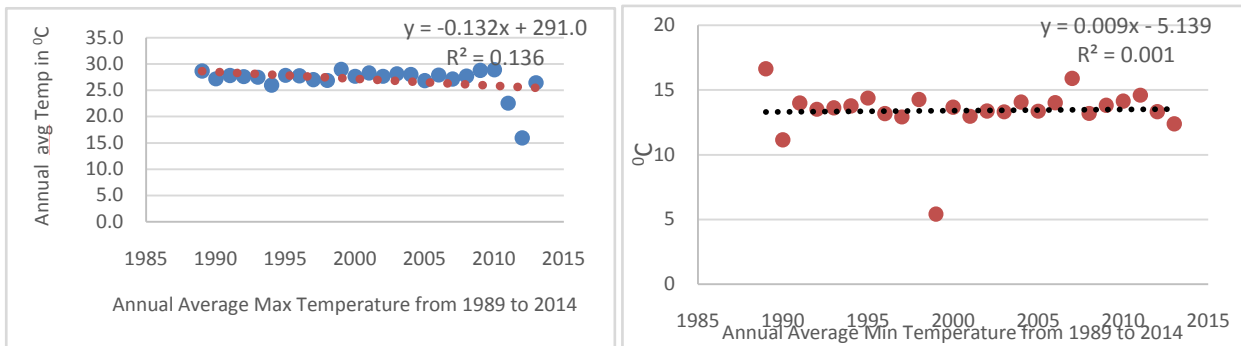


women's opportunities. Thus the adaptation strategies and coping with climate change factors needs to overcome the gender inequalities and ensure their knowledge to combat climate change.

Neumayer and Plumber (2007) studied natural disasters adopting gender discrimination vulnerability approach and stated that natural disasters do not affect people equally but differences in exposure, sensitivity to risks as well as inequalities in access to resources, capabilities and opportunities systematically disadvantage certain groups of people making them more vulnerable to the impact of climate change and natural disasters. They studied natural disasters in 141 countries in between 1981 A.D. to 2002 A.D. and found that women's life expectancy decreased significantly with increased frequency of disasters with the decrease being increasingly dramatic with increasing intensity/magnitude of the disaster.

UNFCC climate change glossary defines adaptation as a process through which societies make themselves better able to cope with an uncertain future with a changing environment. Adaptive capacity is the ability to understand climate changes and hazards, to evaluate their consequences for vulnerable peoples, place and economies and to moderate potential damages to take advantage of opportunities, or to cope with the consequences. Organization for Economic Cooperation and Development (OECD) (2009) has categorized all adaptation strategies into 9 types. Smith *et al.* (2010) has mentioned that individuals and communities respond directly to threats through adopting appropriate and rational adaptation actions and most adaptation literature makes the assumption that accepting the need to adapt follows from identifying and demonstrating the harm that will result from failing to act. However, this approach there overlooks the wide range of social factors that may influence how adaptation actions are shaped. Social barriers to adaptation, most often related to social and cultural processes may exist governing how individuals respond to climatic stimuli and these social barriers may play a large role in encouraging individuals to avoid fully or partially accepting the possibility of unpleasant futures and the need to act immediately.

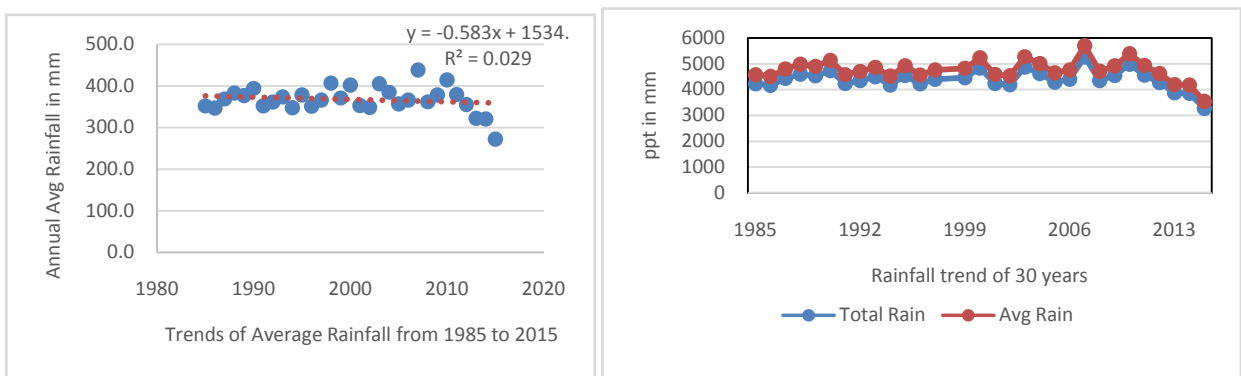
**Verifying the climate change:** It was necessary for the researcher to understand and verify if the climate change was occurring, that is the finding from figures 4 below shows that both the average maximum and minimum temperature were not changing till 2010 and its started declining.



Source: DHM, 2016

**Figure 4.** Trends of Annual Average Max and Min Temperature of Darchula

Now as the temperature change are very low, maybe we are not able to see or predict climate change is happening at this moment and have to wait another 15 years to visualize the climate change impacts.



Source: DHM, 2016

**Figure 4.** Trends of Annual Average Max and Min Temperature of Darchula

The data from Department of Hydrology and Meteorology 2016 also gives the researcher to know that the rainfall pattern is also changing and compared to previous years, its also decreasing but rainfall pattern changed from regular and timely rainfall to erratic and unprecedented rain in the region.

Temperature observations in Nepal from 1977 to 1994 showed a general warming trend and increased in average annual temperature was  $0.06\text{ }^{\circ}\text{C}$  (Shrestha et. al., 1999). Climate change scenarios for Nepal showed considerable convergence on continued warming, with country averaged mean temperature increases of  $1.2\text{ }^{\circ}\text{C}$  and  $3\text{ }^{\circ}\text{C}$  projected by 2050 and 2100 (Shrestha et. al., 1999). Past emissions are estimated to involve some unavoidable warming (about a further  $0.6\text{ }^{\circ}\text{C}$  by the end of the century relative to 1980-1999) even if atmospheric greenhouse gas concentrations remain at 2000 levels (IPCC, 2007).

## **5. Conclusion**

Looking at the disaster caused in Mahakali, Paudel, et.al 2013 highlighted that the disaster impact was due to human activities were blamed based on their response, not having preparedness and response plans and not having water induced disaster risk mitigation action plans both in Nepal or Indian side. Some adaptation to current climate variability is taking place, however, this may be insufficient for future changes in climate and lack of awareness in policy change for climate resilient development needs to pursue a sustainable development path that can reduce vulnerability to climate change by enhancing adaptive capacities and increasing resilience. Women and gender experts should ensure that they are well informed about the gendered dimensions of climate sensitive sectors, particularly the existing inequalities between men and women and how climate change can exacerbate these inequalities.

This study is highly of use to benefit the expected environmental impacts, because Nepal still has not developed a warning system, nor we have any plans to upon negative effects. Other thing is human awareness in climate change and its impact especially water disasters linking to threaten the livelihoods are not addressed. Darchula area itself has 80% of the area as hills and they are vulnerable to landslides as well and deforestation has been a problem stopping environmental degradation and combat climate change impacts. Once the vulnerability mapping is done this could be useful to develop adaptation and mitigation practices to secure the livelihoods and existing ecosystems.

The overall adaptation and coping strategies do not only rely on social construction of the people, however the practices vary based on temporal and spatial scales which is yet to be measured in case of Darchula. That is the predication of climate change cannot be done through the trends that has been observed and may take another 10 years before climate change predication can be done.

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