Vol 7 Issue 5 June 2017

ISSN No : 2230-7850

International Multidisciplinary Research Journal

Indian Streams Research Journal

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RNI MAHMUL/2011/38595 **ISSN No.2230-7850**

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ISSN: 2230-7850 IMPACT FACTOR : 5.1651(UIF)

INDIAN STREAMS RESEARCH JOURNAL

VOLUME - 7 | ISSUE - 5 | JUNE - 2017

CLIMATE CHANGE IMPACTS ON MOUNTAIN COMMUNITIES, PERCEPTION AND ADAPTATION IN 'DABKA WATERSHED' OF UTTARAKHAND

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ABSTRACT

Mountain communities are at the forefront of the battle against climate change with increased exposure and vulnerability of Mountains Ecosystem to extreme weather events. People from hills are migrating atan increasing rate tonearby urban centers due to limited options of livelihood. Local resources, both natural and socio-cultural, are lessening drastically. It is becoming increasingly important to understand local knowledge, the perception of hill people to climate change and how these relate to resilience inmanaging the impacts of climate change (adaptation methods). This paper is based on these aspects; identifying natural constraints in terms of changing weather conditions, its impact on local livelihood and local perceptions about climate change. Three villages of Debka Watershed in Nainital district have been selected for this study which is considered to be very sensitive in terms of climate change.

KEYWORDS: *Climate Change, Community Perception, Livelihood, Dabka Watershed, Uttarakhand.*

INTRODUCTION :

The Uttarakhand Himalaya is well known for its diverse natural bio-resources and fine fettle Climate. However, in the recent past, due to changes in climatic conditions and socio-economic setup, there has seen rapid depletions in natural resources and an increase in natural disasters which is affecting state's economy. Studies in the Himalayas, a global biodiversity hotspot (Myers et al. 2002), have shown that the mean temperatures in the Himalayan alpine zones have increased by 0.6 to 1.3 ° C between 1975 and 2006 (ICIMOD2011; Dimri and Dash 2011). However, scientific climate change studies, rely on the modelling of long term metrological data assessment, but local indigenous knowledge and perceived impacts based studies have very important role in impact assessment. The impact of climate change can be much greater on indigenous communities living in more remote and ecologically fragile zones whoreliesdirectly on their immediate environments for their subsistence and livelihood (UNFCCC, 2004). Piya et al., (2012) stated that the perception of local people about the climate change can be entirely different from what science says about climate change.

Natural Hazards in Himalaya may be defined as extreme geophysical events immensely exaggerated according to normal occurrences in both magnitude and frequency. Uttarakhand has been experiencing flooding, landslide, GLOF, Cloud burst and roadside erosion events frequently within past 10 years. Flooding of Alaknanda River and Mandakini River has displaced thousands of people in Uttarakhand and swept away many lives, number of people are still missing. Researchers and academicians are still working on the post-disaster risk assessment and livelihood restoration options in affected areas. There are several sensitive zones located in remote areas of Uttarakhand where cloudburst and landslides have damaged local village economies severely.

These areas are undiscovered and far from the mainstream management and assessment activities. In order to improve the ability of communities and households to adapt to ongoing and future climate change, an in-depth study with improved understanding of the risk they are facing is essential. Therefore, assessing potential climate change impacts on livelihood is urgently needed for the survival of these rural communities.

OBJECTIVE:

The objectives of the study are as follows,

1. To assess the perceived impact of climate change on local livelihood.
2. To understand local adaption and mitigation methods to cope with changing climatic conditions in 'Dabka Watershed'.

RESEARCH METHODOLOGY

The study was conducted at 'Dabka Watershed' area of Nainital district (Uttarakhand). The case study on assessment of people's perception and adaptation methods are specifically conducted in three village namely Bausi, Baghni and Saur villages. The present study applied participatory methods in order to generate qualitative and quantitative information about climate change impacts and community based adaptation strategies. The qualitative information has been collected by Focused Group Discussion and interview method. Metrological data of 40 years has been assessed to show the temporal changes in climatic conditions. A total of 120 samples have been taken for study from Dabka Watershed area, which consists of 40 samples from each village. Group meetings were also organised, each meeting was attended by over 15 participants. These meetings and interviews were held in the village temple where local people gathered, they shared their views and experiences in an informal environment. Participatory tools like matrix ranking (disaster impact on livelihood assets), timeline (for identifying major events and frequency of occurrence) were used. In addition, climate change impacts on different sectors especially agriculture, were collected through interview. The secondary data was collected through IMD, local weather station and websites.

The Study Area

The Dabka Watershed (Figure1) is located in the district of Nainital, it consider to be the starting points of Kosi Basin of Shiwalik range. The watershed is extended in-between29°24'09"N to 29°30'19"N and 79°17'53"E-79°25'38"E in the North-West of Nainital District. It has an area of 69.06 km2. The altitudinal height of the watershed is varies in between700 mt. and 2623 mt. altitude above mean sea level.

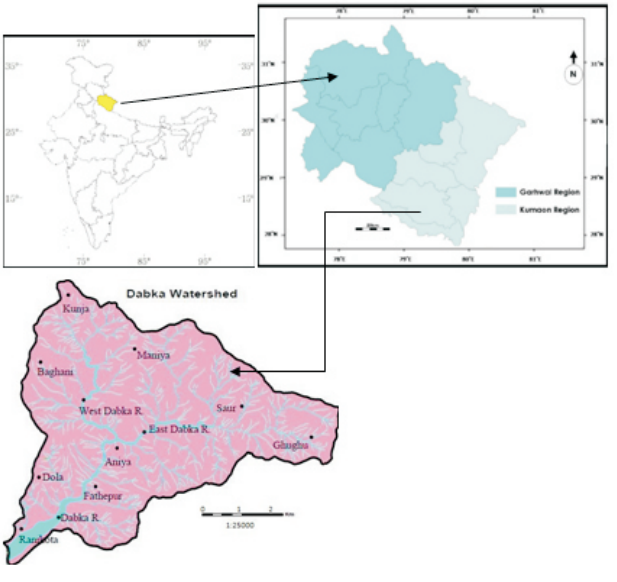

Figure1: Location Map of the Study Area

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In most of the mountainous part of the watershed, the surface gradient is steep and uneven. Badanthaly (2475 mt.) and Ghanyal Devi-Ghughukhan (2334 mt.) are the two highest peak points of the area. Dabka Watershed is surrounded by Ghughukhan, and Tit ka Danda ridges (South), Devidhunga ridge, Devidhunga, Malla Jalna and Dola and Ranikota (west). The DabkaRiver flows towards south-west and south of the Ranikot village. The area can be approached from Nainital (Nainital - Kunjakharad road) and Kotabagh (Kaladhungi-Ramnagar). Out of the total geographical area of the watersheds 53.24 percent is under different types of forests that include a variety of trees, shrubs, herbs, grasses and other vegetation types.

Geographical Conditions of Dabka Watershed

Geology

The rocks of The Dabka Watershed are divisible into Blaini and Krol groups (Pant, and Goswami, 1998). The oldest rocks exposed in the watershed comprise quartzarenite, diamictite, siltstone and shale.The degree and intensity of deformation varies throughout the watershed resulted overturned isoclinal and reclined folds near thrusts and faults. The tectonic deformations have made area topographically unstable, even a small changes in the relief and bedding order can leads to heavy mass wasting and slope sliding. The watershed lies in zone IV of the Seismic hazard zone map of India. The area is very much sensitive in terms of rock falling, slope sliding and landslides that adversely affecting the local people and their livelihood. The main soils found in the watershed is sandy, salty, Loumous and stony and humus contents extend over an area of 10 percent of the catchment.

Climate

The region has subtropical climate, the valley remains hot in summers but the high altitudinal areas remains cold with other climatic variations to the valley areas. The average height of the surveyed village is in between 2300- 2400 mt. The areas above 1500 mts. receive snowfall during winters. The annual average temperature of the area is 18 °C. The maximum temperature of the area varies from 38 °C (Valley) to 10 °C (High altitude) in summers and 24° (Valley)to -2° (High altitude) during winters. The average annual rainfall in the watershed is 250 cm, it is unevenly distributed within the watershed. The average annual humidity of the basin is 72.14 percent, which varies between 62.00 percent in the barren land and 79.84 percent in the forested areas (Rawat, P, 2014).

Drainage

The Dabka Watershed is located in Main active boundary thrust that separates the Lesser Himalaya from Siwaliks. The DabkaRiver has two main streams - one running in the east –west direction from Ghughukhan to Aniya and the other from north to south originating from northwest slopes of Baghni and flowing up to Aniya. These streams are Western-Dabkaand Eastern-Dabkawhich meet to the south of Aniya village and form Dabka River. Dabka then flows further to southwest, and finally meets Kosi River at Chhoi village after travelling a distance of 18 km.

Population

According to Census 2011 total 960 households resides in the Debka watershed comprises total 4,966 population which was 5,250 in 2001. Among sixteen villages total population of the three selected villages namely Bausi, Baghni and Saur is 2,366, that includes 1,210 male population and 1,156 female population. The study found that population has declined inalmost all the villages during 2001-11. Total male population of the Dabka Watershed is 2,558 and female population is 2,408. The study found that People migrating from the top located villages and settling down towards valley areas. The main reason of migration is lack of livelihood options and infrastructural facilities in these remote villages. There are 25 villages which comes under this watershed among them 16 are main villages (Figure 2).

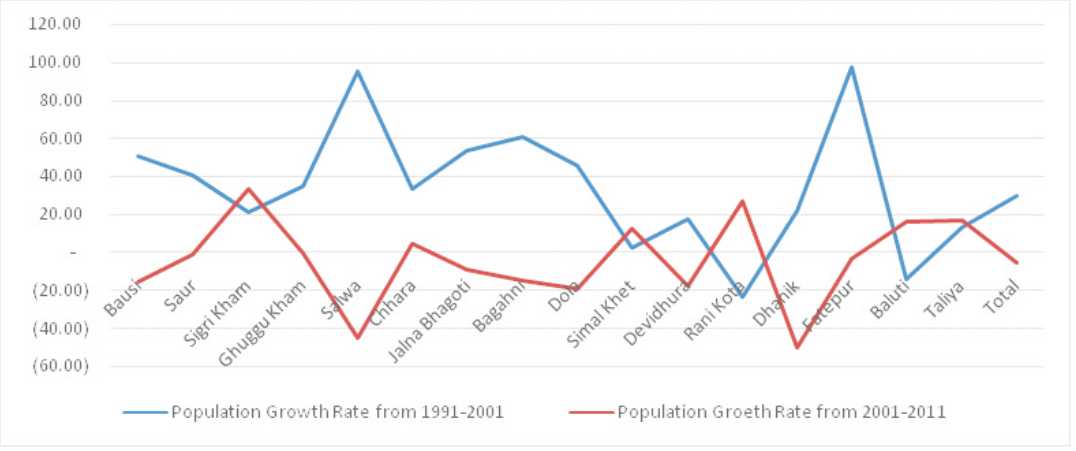

Figure 2: Village-wise Population growth of Dabka Watershed from 1991 to 2011

OCCUPATIONAL STRUCTURE

The study found that village Saur has highest main and marginal working population followed by village Bausi and Baghni. Total working population is found to be highest in village Baghni on the basis of its total population (Figure 3). The study found that in the three selected villages most of the people were engaged in farming, construction work and agriculture labour work, people who engaged in these activities were more than 500.

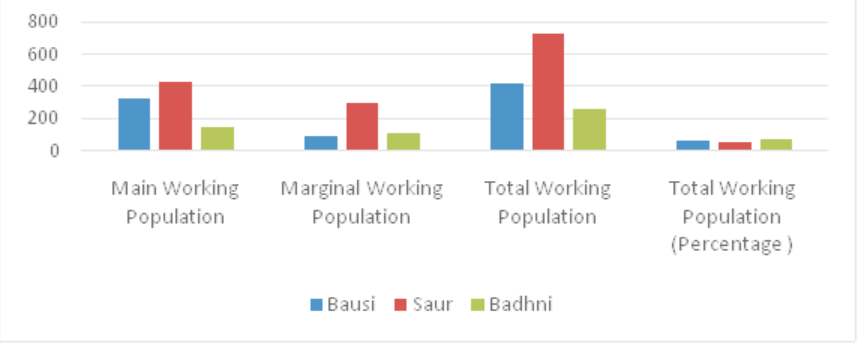

Figure 3 Main and Marginal Working Population in the Selected Villages.
Source: Primary Survey

PERCEIVED CHANGES IN TEMPERATURE

The Metrological data as well as locals people confirmed that the temperature has been increased drastically within past 30-40 years, there can be seen an increasing trend in temperature in all four seasons December/January (Poush) and (January/ February (Magh); June/July (Ashad) and July/August (Shrawan). The data also shows that the average temperature of the area was below 16°Cbefore 1970 but presently it is 18 °C, a slight change of 2°C can also be make huge impacts on weather conditions. During summer the average temperature of the watershed rises to 24°C, that varies between 10°C (high altitude areas)and 38°C (in the foothill region). During winter the average temperature of the watershed is 11°C, which varies between 24°C (in the foothill region) and -2°C (high altitude areas). The study found that the temperature of the area has been increased 1.5 °C to 2°C in both of the season. The perceived differences in temperature gradient at valley and top were found to be high. According to locals due to increased temperature local vegetation, soil moisture, agriculture production have severely affected that leads to pest attacks on tree roots and crops, water scarcity, low quality soil, health issues in humans as well as animals, frequent disaster occurrences and changes in crop and vegetation species.

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Perceived Changes in Rainfall

The watershed receives maximum rainfall in July, August and September which accounts for 68 percent of the total annual rainfall. The watershed also gets some rainfall during winters that accounts for only 6 percent of the total annual rainfall. The pre- monsoon period rainfall accounts (April, May and June) 25 percent of the total amount of rainfall. The water level of Dabka water falls down during summers because of low influx of water streams. The average annual rainfall in the watershed is 250 cm. which was more than 400 cm. during 1960. The study found high variability in total rainfall received amount in Kotabagh Valley and the high altitude areas within the watershed. The rainfall data reveals fall in the number of rain days in the region, it was also confirmed by the local people. The geology of the Dabka Watershed comprises loose bedding plane with sandy soils, which easily allowed the erosional and denudation process, number of erosional activities making many sensitive fault zones due to intense and heavy rainfall. The present average annual humidity of the basin is72.14 percent, which varies between 62.00 percent (in the barren land) and 79.84 percent (in the forested areas).

Perceived impact on Agriculture

The village economy of the Dabka Watershed is based on the agriculture and horticulture. People believe that earlier they use to grow variety of traditional crops like Ginger, soya beans, potatoes, Apple, Bhatt, Gauhat etc. But now a days their crop species and cropping methods both have changed due to changing climatic conditions. Earlier they used to sell tonnes of ginger in the nearby markets and cities, but presently they are growing garlic, coriander, mangoes, potato, beans, and peas in place of their traditional crops. During village survey it was found that most of the people in the village individually have 20 to 50 Nali of land despite thatper/acre crop production from their fields comparatively low, they earn very less from their farms. Including changing climatic conditions there are other reasons for low productivity; these are high soil erosion, lack ofsoil moisture, fall in fertile land, wild animals attacks(monkey, wild bear, pigs and gibbon etc.) and pest infection. People felt increasing cases of forest fire force wild animals to move towardssettlement areas. They harm their agri-products and sometimes attack the villagers, especially children. Earlier mangoes and jackfruits production was only limited to the some part of Kotabagh but now these species can be seen in high altitude areas. People have also started using hybrid seeds to enhance their agricultural production.

Plate 1 Mix vegetation Farming in village Bausi
Plate 2: Fodder collection by local women in village Baghni

Group discussions revealed that they have changed their cropping methods and crop species as well. The changing temperatures have brought several new crop species in the area like Jackfruits, litchi and mango, earlier these species were limited to the low altitude areas(<1000 mts) but now these species can be seen in 1500 mts. area. The study also found that the emergences of new pest are causing decrasement in crop production. They think that this is primarily because of high temperature and disorder in occurrences of rainfall.

This has compelled the farmers to increase use of chemical fertilizers and pesticides. Various studies has shown that there is direct co-relation between increase in temperature with the increases in the risks of pests, incursion of new wild plant and other crop related maladies (Malla, 2003 and Ziska et al., 2011).

PERCEIVED IMPACT ON WATER RESOURCES

The Dabka watershed is drained by many water streams which come from villages located in high altitude. Most of these water streams have dried-up during summers and these become functional only during the rainy season. The agriculture based economy of the village is very much dependent on rain, traditional water resources like Gadhera, Naulas are drying due to low ground water table. The Dola Nyay Panchayat have 8 Gram Sabha, villages comes under Dola NP have more than 60 water streams locally known as Gadheras. The main river of the watershed is Dabka River located along with Kotabagh valley. The study found that piped water and water tankers are the main sources of drinking water. These water tankers have been constructed in the vicinity of these clusters of villages, presently more than 4 tankers supplying water to these villages. Drinking water supply connections get hampered during intense rainfall and cloud burst events, these lead to leakages, breakages of water pipes.

PERCEIVED IMPACTS OF HAZARDS

Local environments are made up different geo-system with specific resilience and inertia, well adopted to the local conditions thus change in bio-physical configurations of an area directly affected its geo-system (Pandey, 2002). The hydro-metrological disasters like rock slides, soil erosion, fault and fracturing etc. not only hampering the water supply but also affecting the agricultural production, livestock options, forest products, infrastructure etc. The Hazard Impact Assessment Table (Table 1) shows that occurrences of roadside disasters are frequent in the study area, following with forest fire cloudburst and floods.

Table 1: Level of perception of hazards impacts on different Sectors in Dabka Watershed

Hazards	Agriculture	livestock	forest	Human Causalities	infrastructures	Water sources	Total	rank
Flood	5	2	1	3	3	3	17	4th
Road side landslide	3	3	4	5	4	2	21	1st
Intense rainfall	4	2	3	2	3	4	18	3rd
Rainstorm/cloudburst	4	2	2	2	4	4	18	3rd
Forest fire	4	4	5	3	2	1	19	2nd
Total	20	13	15	15	16	14		
Rank	1st	5th	3rd	3rd	2nd	4th		

*1st Severe 2nd Very High 3rd Very High 4th Medium 5th Severe
Source: Primary Survey, 2015.

Perceived Impact on Vegetation and Forest Cover

The watershed is rich in variety of trees (Tropical Sal forests, Sub-Tropical Moist Deciduous, Temperate Pines, Moist Temperate and Temperate Coniferous Forest), shrubs, herbs, grasses that covers 53.24 percent area of this watershed. Most of the villages of Debka watershed are located more than 1800 mts height. Main species found in the watershed areBanj (Quercus leucotrichophora); Surai (Cupressus torulosa), Chir (Pinus roxburghii); Burans(Rhododendron), Mehal (Pyrus pashia), Toon (Cedrela toona),Rianj (Quercus incana); and Sal (Shorea robusta), Sheesam (Dalbergia sissoo), Sagwaun (Tectona grandis), Khair (careachi var.catechi) and Kharsu (Quercussemecarpifolia). The study found that percentage of Pines trees in total tree cover has increased more than 25 percent in the past 20 years. Local people felt that pines trees hamper the growth of other beneficial plant species and a leading cause of forest fires; dry leaves of Pines catches fire easily and spread in the large area

within 2-3 hours. Forest fires are diminishing biodiversity of the area. According to the locals the main reasons behind vegetation losses are loss of inherent species, new invasive species and low rainfall.. Locals especially old people felt that earlier the region was covered with full of Oak trees, which is helpful in containing soil moisture, benefitting soil health and maintaining ground water level. Earlier Oak trees were easily found at an altitude of 1600 to 1700 mts. altitude but now it can hardly be seen at this altitude. Many new species of trees vis. Pines, Sals, Burans etc. and shrubs vis. Cactus and Nagfani (Plate 5) and Mushrooms, truffle (plate 4) are increasingly growing in the area.

Plate 3: Tree Route Infected by Pest Attack **Plate 4: New Species of Wild Mushroom**

Plate 5: Cactus Plants in Bausi village **Plate 6: Stone wall near forest area in village Baghni**

Perception Regarding Local Issues

Climate change and climate induced disasters fetters the availability of infrastructural facilities in the region. During study it was found that no means of transportation were available in the remote villages. Half of the way leads to the village was metallic and remaining was earthen track. The metallic roads were heavily broken and it becomes very dangerous during rainy season's roadside rock falls. The whole watershed is very vulnerable in terms of geological and metrological disasters. People have shown their concern regarding hybrid seeds and fertilizers uses that is diminishing the natural soil fertility. It was also found that the whole area is suffers from poor infrastructure facilities.

Few vehicles pass from the area as the public transportation facilities are poor, only few vehicles travels in the village, especially in the morning and evening time. People bring groceries and rashan from Kotabagh market and load them on Horses and Mules. Locals wants good accessibility and communication sources with other facilities like Health centres, Kisan training centres, Banking and Educational Institutions, to keep youth migration in check. They also believe that increasein agricultural production methods should be prioritized and implemented at village level. Some people were also worried for the poor health of their animals. Per animal milk production was also very poor, on an average it was 4-5 litres per day/cattle. Farmers percieved that new breeds

and new diseases outbreak, livestock injuries, decreasing pasture lands are some main reasons which are responsible for poor health of livestock's. They also narrated how within past 3 years, many of the animals' especially milch and domestic cattle have died due to poor vision and other diseases. Locals were also demanding a veterinary Hospital in the area. It was also found that people were using questionable methods (chemicals and injections) to increase milk production of milch and domesticate animals. All facilities like schools, banks, post offices and health centers are only limited to Kotabagh which is 10-15 and sometimes more than 20 km far from the surrounding villages. Kotabagh block has one Polytechnic, 1 Degree college, 1 Government Inter college, 1 Government Girls Inter College, 3 Banks (SBI, PNB, BoB), one Hydel power station and 1 Community Health Centre. It was also found that schools and Health centers of village Bausi and Baghni were not functional. People are helpless and compelled to visit Kotabagh for minor health problems and purchasing daily necessities.

Plate 7: Primary School at village Bausi

Plate 8: Roadside rock erosion on the way of Village Saur

PERCEIVED IMPACT OF CLIMATE CHANGE

Study participants indicated that they perceived changes in temperature and rainfall, expressed mainly in terms of patterns of weather experienced; higher temperatures, below normal rainfalls, short rainy seasons, higher frequency and intensity of extreme weather events. During the study it was found that among total 120 samples, 90 per cent of the respondents perceived changes in climatic conditions within past 2-3 decades, 8 percent respondents perceived no changes in climate within this time period and the remaining 2 percent were not sure of changes in weather conditions. In the category of Causes of Climate Changewhen asked about primary causes of climate change, 39 percent felt that it is because of God's wrath, 58 percent referred to natural and human actions and 3 percent of respondents were unsure about why climatic conditions are changing (Figure 5). In the category of Climate Impacts on Agriculture it was found that 69 percent felt that climate change is not favourable for agricultural production, on the other hand 22 percent believe that climate change is favourable for agriculture and 3 percent were not sure about the favourability or in-favourability of climate change on agriculture (Figure 4).

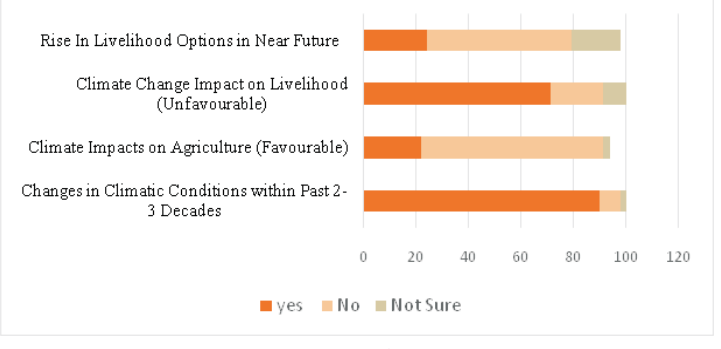

Figure 4: Perceived Impact of Climate Change

Source: Primary Survey, 2015

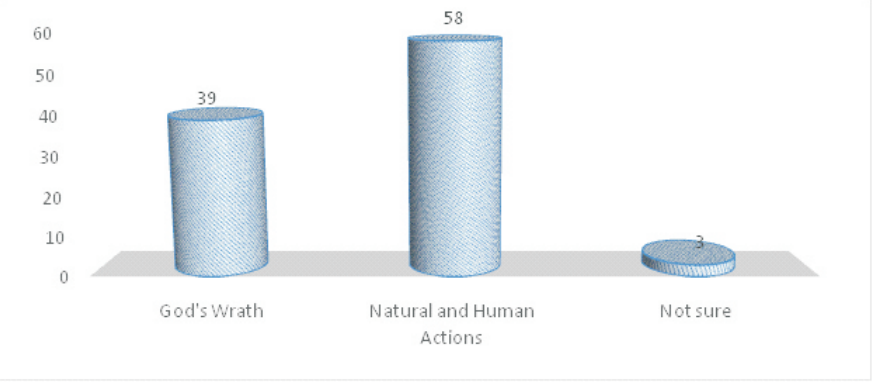

Figure 4: Perceived Causes of Climate Change
Source: Primary Survey, 2015

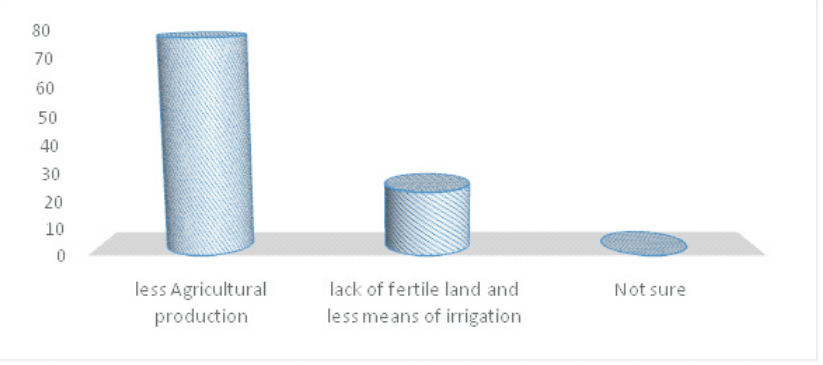

Figure 5: Magnitude of Changes in Agriculture Production
Source: Primary Survey, 2015

Among sampled respondents, 77 percent were concerned about the Magnitude of Changes leading to less agricultural production, 23 percent respondents have given preferences to low soil quality and less means of irrigation for low production. When asked about the Climate Change Impacts on Livelihood71 percent of respondents believe that changes in climatic conditions have limited their livelihood options. In the category of Future Livelihood Options 55 percent of respondents said that their present livelihood options like agriculture, agribusiness, livestock and forest products will be shrunk in the near future, 24 percent believed that future options of livelihood will be growing with the new production techniques and 19 percent were not sure about the future because of the uncertainty of climatic conditions.

CONCLUSION

The results of the study shows that the majority of the respondents at the three surveyed villages felt changes in climatic conditions. They also narrated many examples how their traditional water resources, plant species, medicinal plants shrubs and other local resources are on the verge of extinctions. These perceptions built up the understanding of climatic change impacts and were also the basis for adaptive decisions to cope-up with climate change extremes. However the perceptions were influenced by the existing situations, primarily increasing resource scarcity. The study found that proper adaptation strategies are being applied by the local communities to restore their livelihood options. In the end it can be stated that understanding local knowledge on climate change is very essential in upgrading findings of scientific analysis. Further, the study found that their (remotely located communities) vulnerabilities should be identified with proper solution rather than leaving them in isolation. Climatic perceptions could be a relevant guide in structuring adaptive actions on climate change through validation with scientific studies.

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