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Insights from Local Community on Changing Availability of Non-Timber Forest Products Under Climate Change in Panchadeval Binayak Municipality, Achham District, West Nepal

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Abstract

Local people in the hilly area depend upon different varieties of non-timber forest products (NTFPs) such as foods, medicines, spices, etc. for income generation, except timber. This paper highlights the perception of local people over current situation including status of availability of NTFPs under changing climate. Data were collected by using questionnaire survey and key informant interview (KII) in 9 wards of Panchadeval Binayak Municipality during April, 2022. Altogether 225 interviews were taken with the oldest family members of each household. Total 89 species of NTFPs were noted. Majority of species were used for medicinal purpose (53.92%), followed by edible (30.33%) whereas 15.73% species were used for fodder, fuelwood and other purposes. Climate change and availability of NTFPs were analyzed according to people's perception. The study showed that about 96% of respondents agreed to increase in temperature, 84.83% believed in decrease of rainfall, whereas13.33% agreed the rainfall to be unpredictable. Due to those climatic changes, the availability of NTFPs is predicted to decrease and the dependency of people on NTFPs is in critical condition in this municipality. Therefore, it is urged to develop some climate change coping strategies at the local and national level which will assure the NTFPs availability for the local people.

Keywords: Livelihood, Local people, NTFPs, Perception, Temperature

Introduction

Non-timber forest products (NTFPs) are used as integral part by rural livelihoods all over the world. NTFPs are all biological materials other than timber that are extracted from the forest for human use (Cocks & Wiersum, 2003). According to the Food and Agriculture Organization (FAO, 2001), NTFPs can be defined as goods of biological origin rather than wood, derived from forest, other wooded land and trees outside the forests. Local people of the hilly area depend upon different varieties of NTFPs for their sustainable livelihood such as foods, medicines, spices, different rituals and cultural activities as well as income generation.

Nepal is highly diverse in context of geographic and climatic conditions that leads to its rich biodiversity. It is well known that Nepal is rich in NTFPs where there are 11,971 recorded flora, accounting for 3.2% of the total flora of the world (Ministry of Forests and Soil Conservation [MoFSC], 2014). NTFPs have crucially contributed to the economy of Nepal where approximately 800 species of NTFPs are used as foodstuffs, flavoring agents and spices, perfumes and cosmetics, pharmaceuticals and biological agents (The International Tropical Timber Organization [ITTO], 2004). In Nepal, 700 plant species are medicinal, 440 are wild foods, 30 are spices, and other 71 are fibers yielding (Subedi et al., 2014).

The NTFPs can be categorized into two group i.e., consumptive and non-consumptive. Consumptive NTFPs are the kind of products which are utilized at household level and serve as the products that are sold in the market; whereas non-consumptive NTFPs are related to the indirect benefit for forest management and promoting ecotourism (Hammet, 2004). NTFPs are especially important in mountain communities which are home to 12% of the world's population.Around 10% of the world population directly depends on mountain resources including NTFPs for their livelihoods (Schild, 2008). NTFPs are important forest resources that convey great

potential magnifying the local economy, natural resource management and their conservation for consequent sustainable development. In Nepal, the activities related with NTFPs contribute economical support of about 90% to the rural household for their sustainable livelihood (Bista & Webb, 2006). The total annual benefits from forest ecosystem services in three eastern districts (i.e., Taplejung, Panchthar and Ilam) of Nepal was estimated as nearly US$ 125 million and 80% of this was from NTFPs (Pant et al., 2012). NTFPs are harvested in between 10,000-15,000 tons per year in Nepal and traded to international markets including India with an estimated value of US$ 8.6 M (Edwards, 1996). Besides these contributions, NTFPs also provide other several services to the communities who reside nearby the forest or who depend on forest such as promoting their cultural aspects, ecotourism and knowledge.

An estimation offers information that NTFP could provide higher economic benefits in comparison to timber (Peters et al., 1989). Therefore, forest policies in worldwide began to put emphasis on NTFPs since late 1990s shifting away from the earlier narrow focus on timber (Choudhury, 2007; Saxena, 2003). Till NTFPs received intense attention, conservation of species was dealt by the establishment of conservation areas separate from forest (Guha, 1997).

Global climate change is a considerable challenge to human livelihoods and ecosystems. Floods, droughts, storms, spreading of infectious diseases and extinction of species can be seen as the results of changes in climate somehow induced by anthropological activities. Global trend of surface temperature is consistently increasing since about 1950 (Solomon et al., 2007) and in the high mountain areas the changes are likely to increase more (Shrestha et al., 1999). Along with temperature, precipitation is another climatic factor showing changes in amount and pattern.

Despite the broad scientific consensus on climate change, public views about this major environmental change are unambiguous and do not converge with the scientific evidence (Weber, 2010). However, perceptions of local communities over climate change put forward their concerns on the impacts of climate change on their lives. The previous studies show that the local peoples' perception matches with these trends of temperature and precipitation (Devkota, 2014; Timilsina-Parajuli et al., 2014) but still the factors of climate change, its impacts and perception at different regions are remained to be documented (Shrestha et al., 2012). Documentation of perception on climate change are fundamental to identify local and global contexts and for constructing theory about how people response towards changing environment and associated risks (Crona et al., 2013).

Climate change is expected to cause adverse impacts on forest ecosystems. Climate change is currently one of the greatest stressors to plants and other natural resources. Nowadays, the pattern of climate change, such as increasing temperature and irregular rainfall are assumed to have adverse effects on biodiversity. Due to the climate change, the availability of forest products such as fuel, medicine, food and herbs seems to take away the better livelihood of rural people. There are many evidences that climate change is affecting the forest resources and forest ecosystems. However, there is limited information available regarding the communities' perception on shifts in the climate, their vulnerability, and their coping and adaptation practices (Bomuhangi et al., 2016). The main objective of this study is to understand people's perception on availability of NTFPs under climate change in Panchadeval Binayak Municipality of Achham district, west Nepal.

Materials and Methods

Study sites

The study was carried out at Panchadeval Binayek Municipality of Achham district which is situated in the mid-hill of Sudur-Paschim Province of Nepal. Topographically, it is distributed from 28°46' to 29°29' N latitude and 81°32' to 81°35' E longitude. Panchadeval Binayak Municipality of Accham includes nine wards, such as Kuika (1), Binayek (2), Binayek (3), Kalikasthan (4), Layatti (5), Toli (6),

Putletauli (7), Warla (8), and Kalekada (9), having 147.75 sq. km. of total area and 27,485 populations. This Municipality is uneven and elevation ranges from about 728 to 3200m. The climatic condition of this Municipality is distributed from upper tropical to subalpine where forest is also diversely distributed accordingly. Various kind of ethnic groups reside in this place, where Thakuri, Brahmin, Chhetri, and Damai are dominant ones. Figure 1 shows the map of study sites.

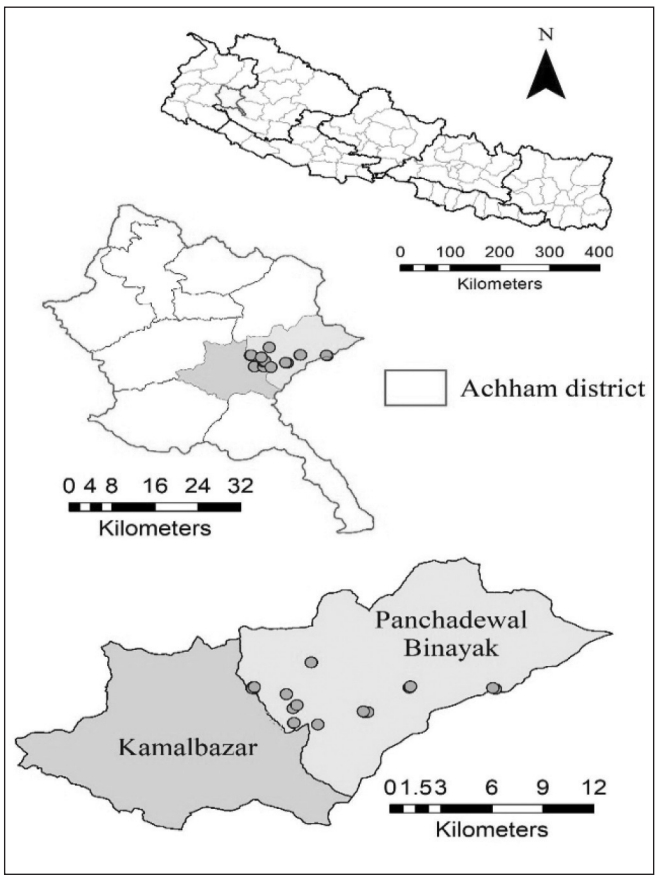

Figure 1: Map of study sites

Sampling strategies and data collection

A purposive sampling method was used to capture experienced local people's knowledge and their views on climate change. Total of 225 households, including 25 households of each ward, were selected randomly for understanding people's perceptions on status and availability of NTFPs and their adaptation under climate change. The survey focused on different area of nine wards of Panchadeval Binayek Municipality, namely Kuika, Binayek, Binayek, Kalikasthan, Layatti, Toli, Putletauli, Warla and Kalekada (Figure 1). The data were collected twice (i.e., during January and June of 2022) by using key informants interview questionnaire at household survey using prepared checklists. Key informant interviews were qualitative in-depth interviews with selected people. The participants were asked to reckon all the information, which they have perceived mainly to identify changes in climate and impacts of such changes particularly on vegetation and status of NTFPs. The questionnaires were structured as well as unstructured.

Before implementing the questionnaire, it was tested through a pilot survey of selected household and modified the questionnaire before actual field survey. The source of data for this study was the review with existing published documents and primary data was collected from the field survey. Both quantitative and qualitative data were collected during the data collection. Each Key Informant Interviews (KIIs) was carried out for about 45 to 60 minutes. The responses from the key informants were recorded. Global Positioning System was used in each ward during the field survey for recording the locations of the households and mapping the resources (e.g., collection locations of NTFPs). Information was collected on different aspects such as status of usage pattern, purposes, availability of NTFPs, strategies for adaptation under impacts of climate variability, emphasized conservation strategies of current situation of NTFPs at local level and its overall impact on socio-ecological system. The meteorological data were recorded from Department of Hydrology and Meteorological (DHM), Ministry of Energy, Water Resources and Irrigation, Babarmahal, Kathmandu Nepal.

Data analysis

Data was analyzed using both quantitative and qualitative methods. The data obtained from the household survey were visualized graphically and analyzed quantitatively using the Statistical Packages for Social Science (SPSS) software and Microsoft Excel to obtain the descriptive and inferential statistics. The data were coded to facilitate data entry and numerical codes were given to responses for systematic organization of data into categories. The qualitative data obtain from the KIIs was analyzed

by using thematic coding analysis. Meteorological data were interpreted to draw trend line that shows the variation on climate over past several years.

Results and Discussion

Trends of changing temperature and rainfall

Meteorological data of annual mean temperature coincided with local perception which showed its increasing pattern from 2008 to 2016 while it was opposite from 2016 to 2018 and again increasing up to 2021 which is shown in Figure 2. On the other hand, observed trend of yearly rainfall of last 29 years was fluctuated over the period that slightly supports to the local perception toward changing rainfall (Figure 3).

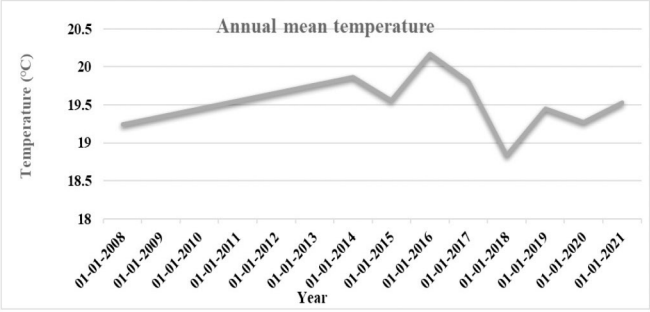

Figure 2: Graphical representation of annual mean temperature

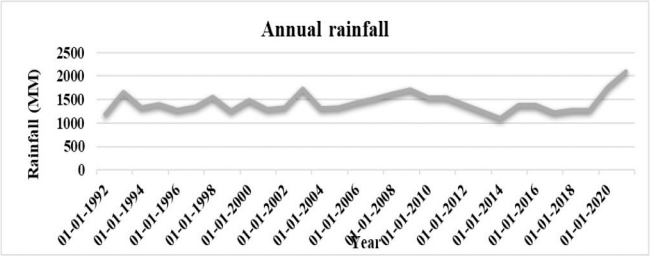

Figure 3: Graphical representation of annual rainfall

Factor affecting perception of local with their demographic characteristics

Perception on climate change was different from one individual to another and to some extent influenced by a number of socioeconomic factors such as gender, age and education. There were about 52% and 48% of male & female respectively, and they both agreed that climate has been changed (Figure 4).

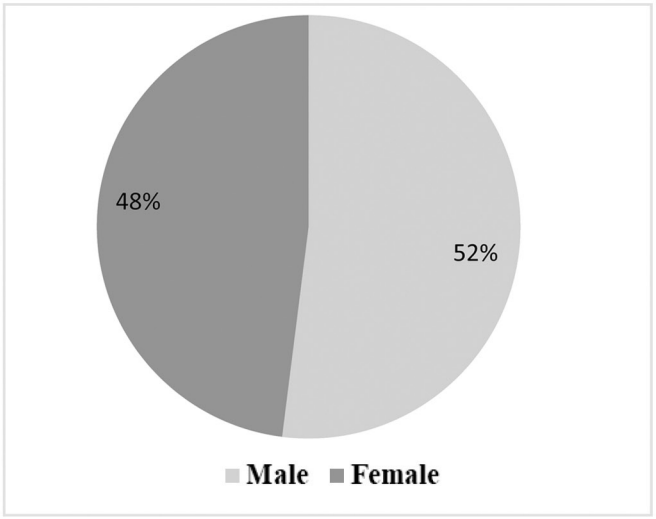

Figure 4: Chart showing respondent's gender

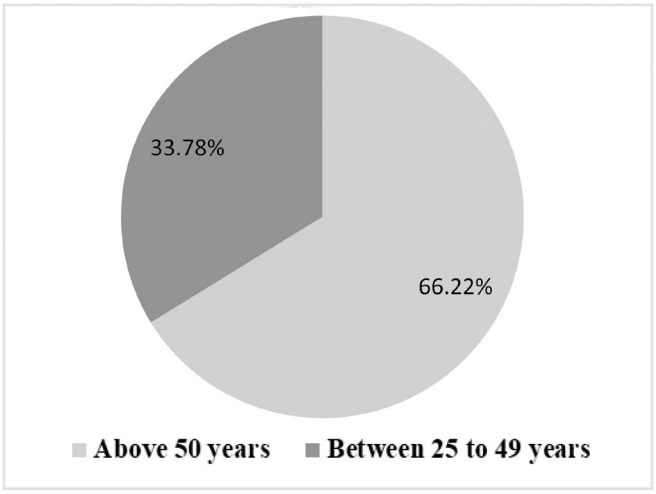

Figure 5: Chart showing respondent's age

It revealed that about 33.78% of people aged above 50 years agreed that there has been climate change in their area and about 66.22% of people aged between 25-49 years agreed that there have been changes in the climate (Figure 5). This implies that the younger people have amassed knowledge on changes in climate and variability in the study area. Although previous studies found the role of age in predicting climate change, and that older age groups were more likely to perceive actual temperature trends (Habtemariam et al., 2016). People living in a same locality for a longer period can predict actual climate more accurately; the greater the number of years' respondents are living in the localities, more accurately they can predict the changes.

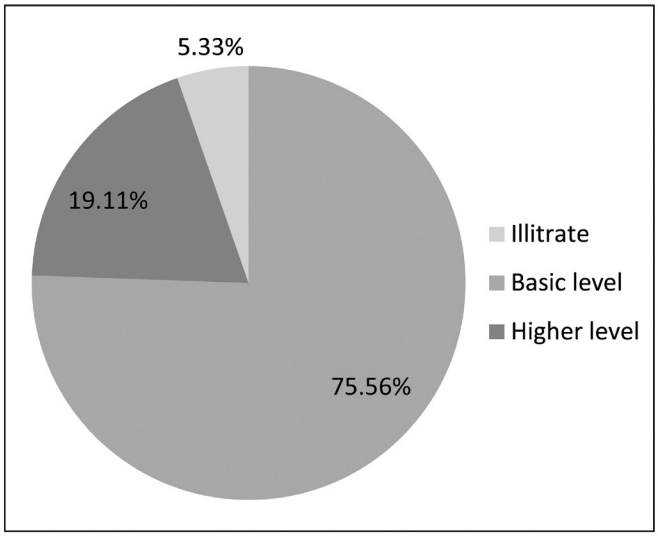

Figure 6: Chart showing respondents education

Among all of the respondents about 75.56% people were illiterate, 19.11% people were literate with basic level education whereas 5.33% people were educated with higher level education. Prior understanding of climate change, household income, and education were not associated with the accuracy of local perceptions of climate change as shown in Figure 6. Gender, age, and caste/ethnicity affect the level of understanding and perception of reality and the urgency of climate change (Macchi et al., 2015; Wolf & Moser 2011). Gender is a widely demonstrated demographic factor related to risk judgments, including the risks of climate change (Sundblad et al., 2007).

Local perception on climate change

Majority of respondents out of total 225 agreed that the climate has been changed gradually in that area. The main climatic changes identified by local people of Panchadeval Binayek Municipality of Achham were increase in the temperature and unpredictable rainfall. Few people were familiar to the climate change but most of respondents knew about climate change from radio, television, newspaper and discussion with neighbors, relatives and family members.

Our study shows that about 96% people agreed to the increase in temperature and 84.89% people agreed with the decrease in rainfall, followed by 13.13% people who believed into unpredictable rainfall as

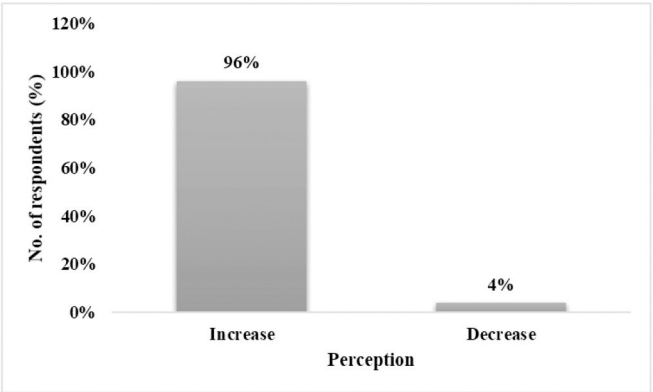

Figure 7: Graphical representation of people perception toward variation in temperature

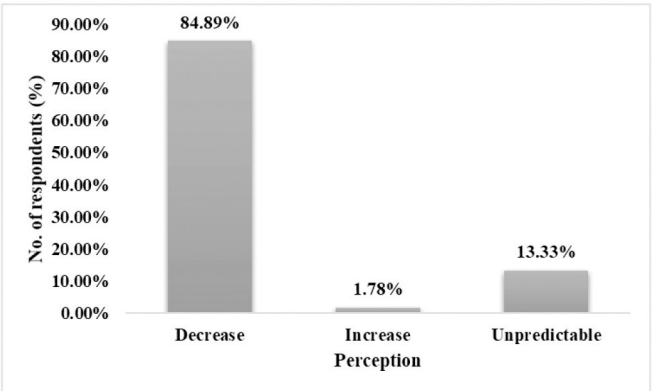

Figure 8: Graphical representation of people perception toward variation in rainfall

shown in Figures 7 & 8. According to the study, most of respondents in the study area have noticed changes in climatic factors in comparison to 5-10 years ago.Similar trends of temperature and rainfall, and perceptions of local people were observed in various districts of Nepal e.g., in Chitwan, Rampur (Paudel, 2014), Banke and Dang (Devkota, 2014), Kaski (Timilsina-Parajuli et al., 2014), Doti and Surkhet (Bhandari, 2013), Rupandehi (Dahal et al., 2015); Shankarpur VDC of Kanchanpur, Gadariya VDC of Kailali (Maharjan et al., 2011). Mean annual temperature of Nepal has increased by 0.03°C/ year, with an increase in maximum temperature by 0.02°C/ year and minimum temperature by 0.04°C/ year and the rate of increase was more pronounced after 2005, making 2016 the hottest year (Shrestha et al., 2019). Peoples' perception and the trend of both temperature and rainfall in Panchadeval Binayek Municipality of Achham indicate that the district is also one of the vulnerable districts of Nepal to climate change.

Local perception on causes behind climate change

During survey, different perception existed as to the causes of climate changes where 16.44% perceived human activities only, 58.67% perceived both human activities and religious beliefs. Only 8.89 % perceived belief and 10.67% perceived uncertain about the causes of climate and variability as shown in Figure 9. This suggests that local people around Panchadeval Binayek Municipality are aware of the causes of climate change and their impacts on their livelihoods.

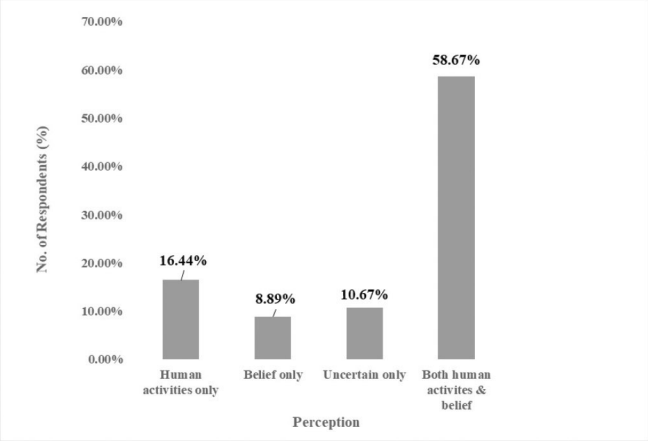

Figure 9: Graphical representation of local perception toward causes behind the climate change

Further study revealed that 54% respondents agreed that climate change started between 5 to 10 years ago where 32% respondents agreed that variability in climate evolved between 10 to 15 years ago, 14% agreed between 15 to 20 years ago and 1% respondent agreed that climate changed before 20 years ago as represented in Figure 10.

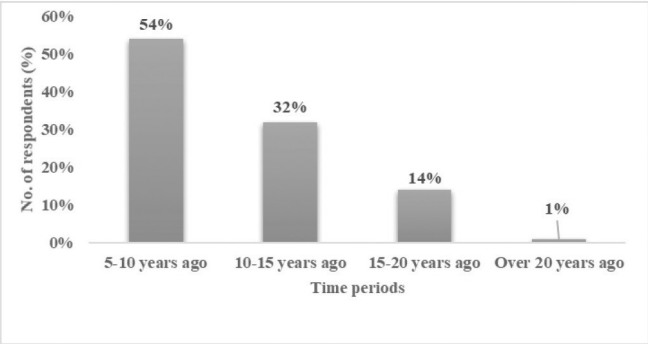

Figure 10: Graphical representation of local perception toward time duration of changes in climate

NTFPs status and use pattern

It revealed that the demand for NTFPs around Panchadeval Binayek Municipality has gone high with use pattern ranging from food, fodder, primary health care, making handicrafts and faith on religious beliefs since many years. Although, the study area was rich in NTFPs there was moderate use of NTFPs such as wild vegetables and mushrooms, wild fruits, bush meat, animal feeds, honey, poles, wood fuel, wild animals and medicinal plants.

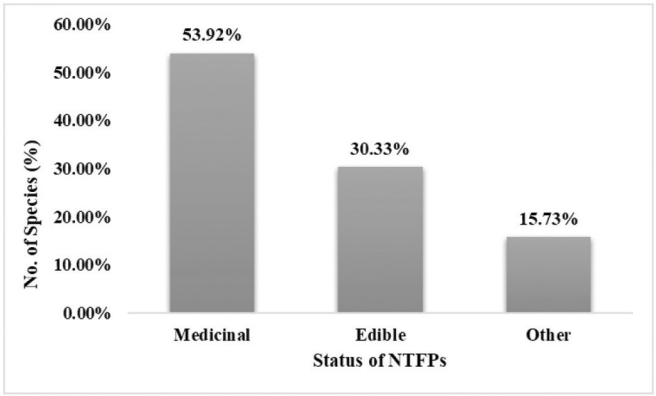

Figure 11: Graphical representation of status and usage pattern of NTFPs

A total 89 species were used from nearby the forest having consumptive and productive use value. Among them 48 species were used as medicinal purpose (Table 1), 27 species were edible and 14 species were used for other values such as spices, fodder, perfumes, fat and detergents. The study shows that about 53.92% of medicinal, 30.33% of edible and 15.73% of other used plant species as NTFPs were found as shown in Figure 11.

The demand of NTFPs has increased possibly due to theincrease in population despite the weak condition of forest. Most of people accepted that the reason behind declining of NTFPs are warming environment year after year, unpredictable rainfall, human activities, dominancy of *Pinus* trees and droughtiness. Extraction of resources from the forest was seasonal dependent. Local people extracted NTFPs primarily for meeting household needs, as well as earning some income to support or supplement their livelihoods. Few of the respondents claimed that they harvested wild species of fruits, medicinal plant and trees used as fodder. Honey

Table 1: List of non-timber forest products plant species used by local people of Panchadeval Binayek Municipality of Achham district

S.N.	Scientific name	Family	Vernacular name	Parts used	Uses
1	*Justicia adhatoda* L.	Acanthaceace	Kaalo Asuro	Leaves, Roots, Stem	Liquid extraction of roots is taken for malaria
2	*Acorus calamus* L.	Acoraceae	Bojho	Roots	Liquid extraction of roots is taken for cold cough
3	*Justicia adhatoda* L.	Amaranthaceae	Amatta	Barks	Extraction of barks is taken for jaundice
4	*Centella asiatica* (L.) Urb.	Apiaceae	Ghodh Tapre	Leaves, Roots	Extracted juice of leaves, roots is taken for burning micturition, stomach pain
5	*Selinum tenuifolium* Wall.	Apiaceae	Bhutkesh	Roots, Fruits	Decoction of roots is taken for abdominal pain and hysteria
6	*Pleurospermum benthamii* C.B. Clarke.	Apiaceae	Gandaino	Roots	Powdered form of roots is used as ingredients of tea for gastritis
7	*Arisaema tortuosum* (Wall.) Schott	Araceae	Baanko	Branches, Leaves	Leaves is consumed as vegetables
8	*Agave cantula* Roxb.	Asparagaceae	Hattibandh	Roots	Extraction of roots is taken for eye infection, bone pain, diarrhoea, dysentery
9	*Asparagus racemosus* Willd.	Asparagaceae	Kurilo	Roots, leaves	Extraction of roots is taken for anticancer, astringent and tonic
10	*Diplazium multicaudatum* (Wall. Ex C.B. Clarke) Z.R.He.	Aspidiaceae	Kuthurke	Twigs of leaves	Twigs of leaves is consumed as vegetables
11	*Tanacetum dolichophyllum (*Kitam). kitam	Asteraceace	Baayojadi	Roots	Decoction of roots is taken for gastritis
12	*Artemesia indica* Willd.	Asteraceace	Tite Paati	Leaves	Paste made from leaves is used in wound and extracted juice is taken for asthma, diarrhoea and abdominal pain
13	*Berberis aristata* DC.	Beberiadaceae	Chotra	Fruits	Fruits are eaten raw
14	*Terminalia chebula* Retz.	Combretaceae	Harro	Fruits	Directly eaten for cold cough
15	*Terminalia bellirica* (Gaertn.) Roxb.	Combretaceae	Barro	Fruits	Directly eaten for cold cough
16	*Ipomoea hederifolia* L.	Convolvulaceae	Jantiful	Roots	Extraction of roots is taken by pregnant woman to gain strength
17	*Dioscorea pentaphylla* L.	Dioscoreaceae	Githaa	Fruits	Fruits are consumed
18	*Dioscorea bulbifera* L.	Dioscoreaceae	Ban Tarul	Fruits	Fruits are consumed
19	*Shorea robusta* C.F. Gaertn.	Dipterocarpaceae	Saal	Leaves	Leaves are used as leaf plate in traditional feasts
20	*Rhododendron arboretum* Smith.	Ericaceae	Laligurans	Flower	Directly flower is eaten for diarrhoea and fever
21	*Senegalia catechu* (L.f.) P.J.H. Hurter &Mabb.	Fabaceae	Khair	Barks	Extraction of barks are taken for headache and body pain
22	*Bauhinia variegata* L.	Fabaceae	Koiralo	Twigs of leaves, Flowers	Extracted flower juice is taken for diarrhoea, dysentry and also leaf twig are eaten as vegetables
23	*Phanera vahlii* (Wight & Arn. Benth.	Fabaceae	Maalu	Leaves	Leaves are used as leaf plate in traditional feasts
24	*Ganoderma lucidium* P. Karst	Ganodermataceae	Raato Chyau	Fruits	Fruits is consumed as vegetable
25	*Swertia angustifolia* Buch. – Ham. ex D. Don	Gentianceae	Chiraito	Whole plant	Extraction of plant is taken for chronic fever, pregnancy nausea, chest pain

S.N.	Scientific name	Family	Vernacular name	Parts used	Uses
26	*Juglans regia* L.	Juglandaceae	Okhar	Fruits	Fruits are eaten raw as well as oil is extracted
27	*Callicarpa macrophylla* Vahl	Lamiaceae	Guheli	Fruits	Fruits are eaten raw
28	*Cinnamomum tamala* T.Nees & Eberm.	Lauraceae	TejPatta	Leaves	Leaves are used as spices ingredient
29	*Persea odoratissima* (Nees) Koesterm.	Lauraceae	Kaulo	Leaves	Leaves is used as toxic substance to kill fish
30	*Fritillaria cirrhosa* D. Don	Liliaceae	Ban Lasun	Fruits	Paste made from fruits is used in molar and red spot of body
31	*Punica granatum* L.	Lythraceae	Daarim	Fruits	Fruits are eaten raw
32	*Paris polyphlla* Smith.	Melanthiaceae	Satuwa	Rhizoids	Mixed milk paste of rhizoid is taken to reduce body pain
33	*Tinospora cordifolia* (Wild.) Miers ex Hook.f & Thomson	Minispermaceae	Gurzo	Stem	Extracted liquid from stem is taken for cold cough and also given to cattle as nutrient riched source
34	*Ficus semicordata* Buch..-Ham. ex Sm.	Moraceae	Khanayo	Roots	Extracted juice from roots are taken for jaundice and liver ailments
35	*Ficus subincisa* Buch..-Ham. ex Sm.	Moraceae	Bedulla	Roots	Extracted drinks from root is taken for foot corn
36	*Ficus auriculata* Lour.	Moraceae	Timila	Fruits	Fruits are eaten raw
37	Morella esculenta (Buch.-Ham. ex D.Don) L.M.Turner	Myricaceae	Kafal	Fruits	Fruits are eaten raw
38	*Syzygium cumini* (L.) Skeels	Myrtaceae	Jaamun	Fruits	Fruits are eaten raw
39	*Dactylorhiza hatagirea* (D. Don) Soo.	Orchidaceae	Paanch Aule	Tubers, Roots	Decoction of rhizoids is taken for diarrhoea, dysentry and chronic fever
40	*Oxalis corniculata* L.	Oxalidaceae	Charimilo	Leaves	Extracted juice of leaves is taken for influenza, fever and snake bites
41	*Papaver somniferum* L.	Papaverceae	Aphim	Fruits, Leaves	Fruits
42	*Pinus wallichiana* A.B. Jacks.	Pinaceae	Salla	Resin	Resin is used to make gums
43	*Neopicrorhiza scrophularii flora* (Pennell) D.Y. Hong	Plantaginaceae	Titekatuko	Roots	Directly roots are sucked for cold cough
44	*Imperata cylindrica* (L.)P.Beauv	Poaceae	Siru	Roots	Liquid extraction of roots is taken for worm disease
45	*Thyasanolaena maxima* (Roxb.) O. Kuntze	Poaceae	Amliso	Flower	Flower is used as sweeper
46	*Drepanostachyum falcatum* (Nees) Keng.f.	Poaceae	Nigalo	Stem	Stem is used to make instrument
47	*Bombusa vulgaris* Schrad.	Poaceae	Baas	Stem	Stem is used to make instrument
48	*Thamnocalamus spathiflorus* subsp. *aristatus* (Gamble) D.C.McClint.	Poaceae	Deulo	Stem	Stem is used to make instrument
49	*Phyllanthus emblica* L.	Phyllanthaceae	Amala	Fruits	Fruits are eaten raw
50	*Persicaria barbata* (L.) H. Hara	Polygonaceae	Pire Jhar	Leaves, Roots	Paste made from leaves and roots is used in scabies wound and swollen parts
51	*Rheum emodi* Wall.	Polygonaceae	Padam Chalna	Roots	Powdered paste of root is used in swollen part, wound and blood clotting

S.N.	Scientific name	Family	Vernacular name	Parts used	Uses
52	*Matteuccia struthiopteris* (L.) Tod.	Polypodiaceae	Daurey	Tender Shoots	Tender shoots are consumed as vegetable
53	*Pontederia crassipes* Mart.	Pontederiaceae	Jaluka/Jalkubhi	Fruits	Fruits are eaten raw
54	*Aconitum spicatum* Donn	Ranunculaceae	Thulookto(bikh)	Roots	Extraction of roots are taken to reduce bone pain
55	*Pyracantha crenulata* (D. Don) M. Roem.	Rosaceae	Ghangharu	Fruits, Leaves, Barks	Decoction of leaves, barks are taken for hypertension, over bleeding of blood during mensturation and used as ingredient of herbal tea
56	*Rubus ellipticus* Sm.	Rosaceae	Raato Aiselu	Fruits	Fruits are eaten raw
57	*Rubus foliolosus* D. Don	Rosaceae	Kaalo Aiselu/ Tirkhula	Fruits	Fruits are eaten raw
58	*Prunus cerasoides* D. Don	Rosaceae	Paiyu	Stem	Stem is used in religious beliefs
59	*Pyrus pashia* Buch.-Ham. ex D. Don	Rosaceae	Mel	Fruits	Fruits are eaten raw
60	*Hedyotis corymbosa* (L.) Lam	Rubiaceae	Majithe Jhar	Leaves	Decoction of leaves is taken for gastric irritability, nervous depression, liver complaints and fever
61	*Russula virescens* (Schaeff) Fr.	Russulaceae	Chyau	Fruits	Fruits are directly consumed as vegetables
62	*Zanthoxylum armatum* DC.	Rutaceae	Timur	Seeds	Seeds are used as spices
63	*Aesculus indica* (Wall. ex Cambess.) Hook.f	Sapindiaceae	Paangar	Seeds	Extraction of seeds is taken for gastric or stomach pain
64	*Sapindus mukorossi* Gaertn.	Sapindiaceae	Rithaa	Fruits	Fruits are used as detergent material
65	*Diploknema butyracea* (Roxb.) H.J. Lam	Sapotaceae	Cheuri	Fruits	Fruits are used to extract oil
66	*Datura metel* L.	Solanaceae	Dhaturo	Leaves, Fruits, Stem	Leaves and Fruits are
67	*Taxus contorta* Griff.	Taxaceae	Lauth Salla	Leaves	Extracted juice of leaves is taken for cough, fever, headache, and gastrointestinal problems
68	*Tectaria macrodonta* (Fee.) C.Chr.	Tectariaceae	Neuro	Tender Shoots	Tender shoots are consumed as vegetable
69	*Daphne bholua* Buch.–Ham. ex D. Don	Thymelaeceae	Setpaudo (lokta)	Roots	Extracted juice from roots are taken for rheumatism and increase blood in body
70	*Typha angustiflolia L.*	Typhaceae	Khar	Roots	Extracted juice of roots is taken for air bubbles in body
71	*Pouzolzia zeylancia* (L.) Benn.	Urticaceae	Paatejhar	Roots	Extracted drinks from roots is taken for stomach pain
72	*Girardinia diversifolia* (Link) Friis	Urticaceae	Allo	Barks	Barks are used to make rope
73	*Urtica dioica* L.	Urticaceae	Sisnoo	Leaves	Leaves are taken as vegetable
74	*Valeriana jatamansi* Jones	Valerianaceae	Sugandawal/ Samayo	Flower, Roots	Extraction of roots are taken for epilepsy, mental illness
75	*Curcuma angustifolia* Roxb.	Zingiberaceae	KaaloKachur	Roots	Extraction of roots is taken for heart attack
76	-	-	Hat Pasaaro	Roots	Decoction of roots is used for bone fracture
77	-	-	Dinge laharo	Roots	Decoction of roots is used for bone fracture
78	-	-	Paanch pate	Roots	Extraction of roots is taken for heart attack

S.N.	Scientific name	Family	Vernacular name	Parts used	Uses
79	-	-	Maubeuro	Whole plant	Decoction of plant material is used for wound and steam is taken for pain
80	-	-	Maikoralo	Leaves, Stem	Extraction of leaves and stem is taken for malaria
81	-	-	Maasuphure	Bulb, Roots	Decoction of roots is used for bone fracture
82	-	-	Gudacheura	Bulb, Roots	Decoction of roots is used for bone fracture
83	-	-	Aakhijaal	Roots	Extraction of roots is taken for heart attack
84	-	-	Batulyatti	Leaves, Roots	Frozen extraction of leaves and stem is taken to increase blood level
85	-	-	Hariyookto	Leaves	Extraction of leaves is taken for headache
86	-	-	Paaney	Twigs of leaves	Directly leaves are eaten
87	-	-	Bhyui jaamun	Fruits	Fruits are eaten raw
88	-	-	Piyaljara	Roots	Extraction of root is taken for seasonal fever of children
89	-	-	Mahajadi	Roots	Roots are chewed directly for Gastritis

and beeswax, weaving grasses, ferns and some medicinal plants were the common traded NTFPs in that area in less amount. The selling of NTFPs were in decline because NTFPswere only used for meeting household needs. About 34% of respondents admitted that they prefer traditional medicine to manufactured medicines. The main diseases cured using traditional medicine included stomachache, chest ache, fever, colds, allergic reaction and various infections. This indicates that respondents have a wide knowledge on a number of useful medicinal plants, which contribute to the primary health care of their families.

Impacts of climate change on NTFPs and their availability

Different categories of NTFPs such as fuelwood, wild vegetables, wild fruit, fodder, bamboo products, agricultural tools, medicinal plants, ornamental plants and traditional plants were found that put up the well-being and better livelihood of people for survival. Somehow, the impact of climate change has been faced by the communities that facilitates the miserable in well settled livelihood due to declining in availability of NTFPs, low crop production, increase of pest and disease, water scarcity and wildfire. Extreme droughtiness which result in a drastic reduction in the availability of grass, fodder, medicinal plants, water for livestock and agriculture and product that can be extracted from forest. The reduction rate in non-timber forest products over the study area can be directly or indirectly linked to climate change in accordance with perception of people. Also it was seen that the vegetation composition of most of the forest was heavily dominated by *Pinus* species which ultimately restrict the growth of other variety of vascular plant in that forest, therefore, it could be the another factor for declining in availability of NTFPs. Local people also claimed that main reason for the reduced availability of NTFPs was overexploitation, overgrazing and disturbances.

This study revealed that 49.78% people perceived that crop production had declined forlast several years, 23.12% of people agreed that the water scarcity had increased. Similarly, about 15.50% of respondents agreed in increment of pest and disease and 11.55% respondents claimed the wildfire to be the burning impact of climate change which has adversely affected growth of forest (Figure 12).

Peoples has been amazed on decreasing natural vegetation, change in vegetation composition with decreasing or increasing certain plant species in their surrounding and natural habitats. In this study, it was revealed that due to change in climate the availability of NTFPs has been in risk so, that people were sustaining livelihood narrowly.

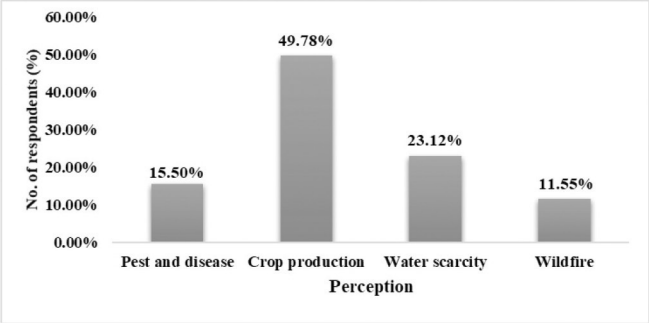

Figure 12: Graphical representation of local perception toward impact of climate change

About 42.67% of people have agreed on highly decrease in the amount of NTFPs, 40.44% of respondents agreed that availability of NTFPs is moderately decreased. Similarly, about 13.33% respondents agreed to slightly decrease in amount of NTFPs whereas 3.56% respondents believed that there has been no change in accessibility of NTFPs in their area (Figure 13).

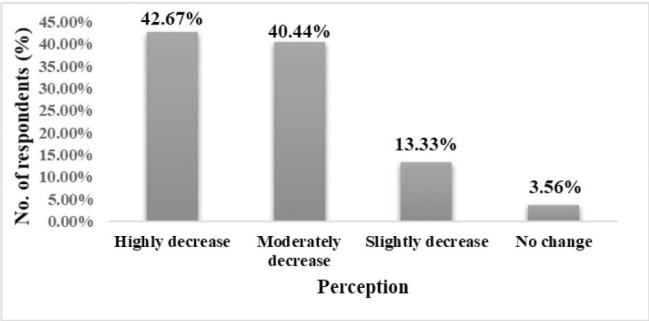

Figure 13: Graphical representation of local perception toward changing availability of NTFPs

Coping strategies toward climate change by local people

Human settlement in hilly and mountain is highly depended upon the weather and seasonal rains but global changes in climate has a negative impact on availability of NTFPs, crop yield and food supply for survival. People experienced and admitted that over last several years there has been irregular rainfall (shift in rainfall, low rainfall or no rainfall) and rising temperature that resulted into lacking in edible fruits and medicinal plant from the forest. Changes in climate has also resulted in the introduction of new pests and diseases in the plants and animals, including highly dominant of invasive species such as *Parthenium hysterophorus, Lantana camara* and *Ageratina adenophora* which directly impact on growth of other useful species and soil fertility. In the study area, the variety of forest composition was found to be lacking due to paramount of *Pinus* and Sal trees which inhibits the growth and sustainability of other species.

Generally, the adaptive capacity of that communities was also somehow low but with response to change in weather and climate, the local habitants have developed their adaptive strategies based on their past experience and local knowledge against the climate change. Water scarcity, unpredictable weather events and increasing crop pests were identified as among the biggest challenges. It was observed that people were practicing all possible strategies to sustain such as practicing alternative income generation activities, application of agroforestry, practicing the forest fire management, removal of invasive species, plantation of different variety of plant species and changing in seasonal calendar for harvesting. Respondents also reported that nowadays different water reservoirs have been built up for storage of water. Many respondents claimed that NTFPs such as some important medicinal herbs, shrubs, fruits and fodder providing species were also cultivated in their agriculture land. It was also unveiled that people have been provided knowledge about well farming, management of pest and some of respondent had studied agriculture and forestry education and implied their gained knowledge. The role of local people should be incorporated more actively in the design of policy and adaptation of strategies at national and global level. Therefore, it is quite important to evaluate the understanding of local people along with their reaction and coping strategies against climate change for their better and sustainable livelihood.

Conclusion

This study provided fundamental information about increasing temperature as well as reduced rainfall which has put adverse effect on status and availability of NTFPs and sustainable livelihood of people in accordance to the local perception on Panchadeval Binayek Municipality of Achham. Different medicinal plants, wild foods, fodder and other such as oils, resin were found to be consumed and utilized by the local people for their survival. Increasing water scarcity and erratic rainfall events, increases in crop pests and disease had negative impact on already existing food, water and income insecurity. The communities' perceptions of change were somehow consistent with the recorded climate data, particularly recent data.

The adaptation practices have not been fully adopted toward climate change by local communities yet. It is needed to exhibit in both form of mitigation and adaptation practices to overcome the challenges thrown by climate change. But the adaptation factor can be the better option to combat the impact and threats provided by climate change whereas mitigation can be lengthy process which is also hard to applicate. People's perception and understanding of climate change can be an important asset to adaptation to climate change. The majority of the research should be carried out for the indigenous knowledge of both adaptation and mitigation mechanisms developed by the local people at the national and international level. Our findings help to fill a research gap in understanding local people's knowledge and perceptions about climate change and adaptation in managing NTFPs ecosystem services which is mostly absent from scientific studies. This new understanding of local climate change adaptation strategies can support policy makers in both government and non-government organizations to improve the sustainability of NTFPs in hilly areas and the benefits that local people gain under future climate change.

Author Contributions

All the authors were involved in concept development, research designing, and literature research. Sabina Shahi collected and analyzed data and prepared manuscript. Shiba Raj Ghimire and Hem Raj Poudel edited and reviewed the manuscript.

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