~~Study on causes~~Cause and socio-economic impact of water shortage on thehouseholds of Laptsakha community, Punakha~~.~~

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ABSTRACT

Water is indispensable for life since it is a basic need and is also important for economic activities. Although Bhutan has one of the highest per capita water resource availability in the world with 94,500 m3/capita/annum, the imbalance of geographical and temporal distributions is leading to experience of shortages in local areas.This study determined the shortage of water supply and its socio-economic impacts in Laptsakha community under Punakha,Bhutan.The semi structured questionnaires were distributed to the household of 74 following census method sampling.The result showed that ~~showed that~~ the climate change had significant effect on water scarcity (R^2=.208, p<.05). There was a moderate positive correlation between total income and total spent on buying food items (r=304, p<.05); however, there was no significant between total annual incomes and annual expenditure on materials to cope up water shortage (r=.209, p >.05). Ability to maintain hygiene was significantly affected by numbers of days the water was available in the tap per week H(2)=7.030, p<.05). The findings from the study also shows that due to decrease of water supply, it has adverse impacts on total annual income of the households and on their health.

This study concluded that water shortage has adversely impact on socio economic of the people of Laptsakha chiwog, which requires implementation of new strategies and actions towards allocating new source of water for households.

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Keywords: Economic, Hygiene, income, Impact, Water-shortage, Water-availability

1. INTRODUCTION

Water is an important natural resource and is vital for all life on earth, while other people in someparts of the world maybe enjoying enough supply of water however, some are faced with water shortage (Machethe, 2011). Population growth and urbanization are leading factors to rise in global demand for water for drinking, sanitation, agriculture, energy production, industry, and environmental protection (Food and Agriculture Organization [FAO], 2011). The sustainability of the water supply is seriously threatened because of widespread depletion of groundwater, surface water pollution, and climate change impacts (Intergovernmental Panel on Climate Change [IPCC],2007). Because of declining availability of water in many parts of the world, a global water crisisis possible in the near future if appropriate water conservation and adaptation measures are not undertaken. Poor or no access to safe water supply can result in many diseases where women and children are the most burdened by traditional household function (Nyarko etal. 2006).

Although Bhutan has one of the highest per capita water resource availability in the world with 94,500 m3/capita/annum, its imbalance geographical and temporal distributions is leading to experience of shortages in local areas (National

environmental commission [NEC], 2016). There are increasing reports of drying water sources all over the country. Drying up of water sources over the last two decades, along with incidences of decrease and erratic rainfall patterns including delayed onset of monsoon is reported in Punakha and Wangude Phodrang valley in Bhutan (Norbu & Kusters, 2012).Laptsakha chiwog(consituency) is one of the community facing water shortage for drinking as well as for irrigation of the field.

~~1.1 Problem statement~~

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~~Today, t~~The issue of water shortage that is experienced by the majority of the world (Rijsberman, 2006). In many partsof Bhutan, major rivers and tributaries flow in the valley bottoms while most communities lie on the hills upstream and therefore, mostly depend on smaller streams, springs and lakes for their fresh water supplies. While the increased village population and improved living standard could contribute towards increased water usage; however, drying of water sources itself is major concern(NEC, 2016). In Laptsakha chiwog, pipes are dry without water and no waterruns through the tap. But any how the villagers have resorted to collecting rainwater in jerry cans,artificial ponds, sintexs and wells. However, this method does not look safe and healthy for residents. Ugyen Wangchuck Institute for Conversation and Environment Research [UWICER] states, climate change, in addition to increasing anthropogenic activities, could impact of water availability because climate change in the region is occurring at a greater speed. Currently, Bhutan lacks a comprehensive national study or report on the extent, causes and solutions to the growing water scarcity in Bhutan (Gyelmo, 2015).Findings of the study will help to fill the gaps by providing information on the impacts of water shortage for proper decision making on water management to ensure regular supply.

1.2 Objectives

To determine the causes of erratic water supply and evaluate the socio-economic impacts of intermittent water supply in Laptsakha community

2. MATERIAL AND METHODS

2.1 Study Area

Laptsakha Chiwog is located under Talo gewog which falls under Punakha Dzongkhag (fig.1). The chiwogconsists of three vilages; Laptsakha, Gungthramo and Sewdrangsa with 81 households. The study area covers an area of 82 hectare enclosed within latitudes of 27°31'44" N to 27°32'17" N and longitudes of 89°50'51" E and 89°50'1" E and the elevation ranges from 1428m to 1783m (Tshedup, 2017).The study involved households, environment officer and head of the community, the study followed descriptive survey.

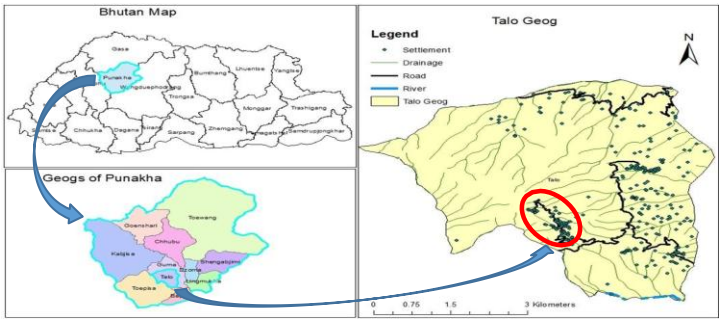

Figure1. Study map

2.2 Sampling and data collection procedures

There were 81 households in Laptsakha community, data were collected from all the households using census method sampling and only 74 households were surveyed. Both qualitative and quantitative approaches were used for data collection. The data collection methods that to be used are; interviews, observation, audio visual records and photography. The data were collected through semi structured questionnaires and interview on demographic status,types of water sources, and causes of water shortage and socio-economic impact of water shortage on the households. The questionnaire were both open ended and closed ended questions.The data collected covers the full range of issues in linewh the study objectives. Primary data was collected from households, community groups and the district environmentoffice. Secondary data was collected from different literatures from libraries, institutions, previousthesis, the internet, maps and other relevant ~~materials~~sites.

2.3 Data Analysis

Both descriptive and inferential data was analyzed using Statistical Package for the Social Sciences(SPSS) and Microsoft Excel. ArcGIS was used for generating the map of study area.

3. RESULTS AND DISCUSSION

3.1 Demographic Characteristics

Majority of the respondents was aged between 8 to 60 years (85.1%), 1.4% of the respondents below 18 years and 13.5% of the respondents were above 60 years . The education level of the households involved in the study was categorized as primary, secondary, college (diploma/degree), university (masters/PhD), non- formal education, no education and monks/nuns. 51.4% respondent had no education, 16.2% had secondary education, 13.5% had primary education, 10.8% had monastic education and 8.1% had non-formal education. The occupation of respondents varied as 74.3% were farmers, 16.2% were students, 5.4% were business individuals and 4.1% were employed. The average household size of therespondents living in study area was 5 while average household size of country was 4 as found by National Statistics Bureau of Bhutan (2017). About 73% of respondents stayed more than 30 years in their village.

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3.2 **Source of water**

Figure 2. represents the proportions of the respondents who used the different sources of water. About 5% of the respondent got their water from stream, 46% of the respondent obtained the water from spring and remaining respondent 48% collected water from ponds .The percentage of respondents that depended on untapped water was 1.4% compared to those that have tapped/piped water source despite that the water is often not available. 64.9% of respondent indicated that water ~~is~~ was communally shared, 13.5% shared from neighbors and 21.6% own the piped water personally (Fig. 3).Ponds were the main source of water and 64.9% of respondent share their water sources communally and only few households were depended on the untapped water. Similar study by Venkatesh et al., (2016) in the rural areas of a health unit district, Tamil Nadu, India noted that in ~~4~~ four villages, ponds were used by the villagers for drinking without purification in spite of the presence of water supply system.

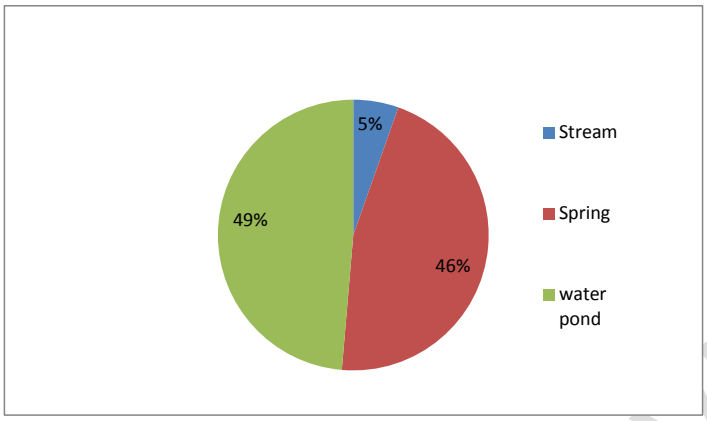

Figure 2.Sources of water

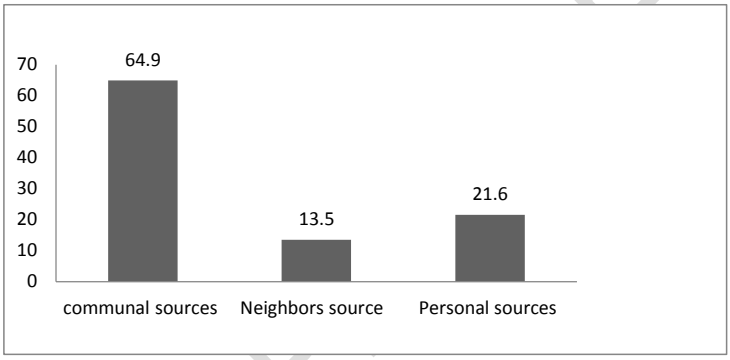

Figure 3. Different sources of water

3.3 Water Connection of Households of the Laptsakha chiwog

About 44 (59.5%) respondents said that they have different water source for drinking and irrigation. However, 40.5 % expressed that they face problem of drinking water shortage. 72 (97.3%) respondents brings drinking water from source to home by pipes, 1.4% through channel and 1.4% respondent used other than pipe and channel to bring water from source to home.

3.4 How do you bring irrigation water from source to field?

About 25.7% of the respondents do not have connection of water for irrigating their fields where as 5.4%,41.9%, 24.3% and 2.7% used pipes, traditional channels, cemented channels and others respectively to irrigate their fields (Fig.~~ure~~ 4.).

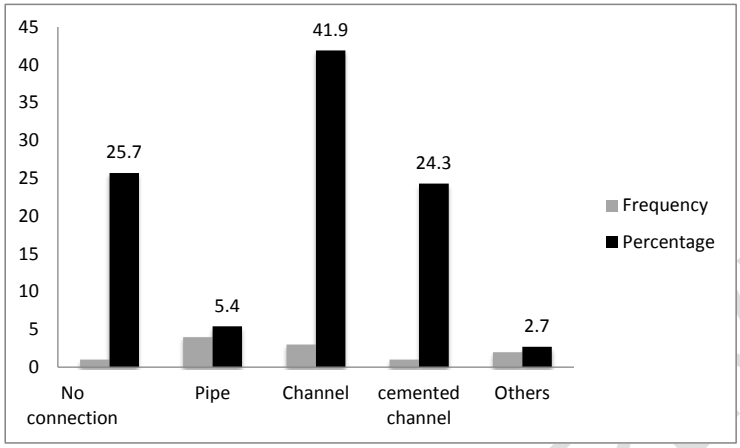

Figure 4. How respondents bring water from source to fields.

3.4 Water Availability

About 17.6% ~~respondent~~respondents were found to be accessing water only 3-4 days (sometimes). 4.1% ~~of~~ respondent received water onlyonce per week (rarely) while 78.4% received water daily but insufficient. About 27% they have daily water supply in their respective field, 24.3% they have sometime only water is available in the field while 8.1% depends on their turns to water their fields for irrigation but 40.5% ~~they~~ don't have access to water for irrigation in their fields.

3.5 Water source management

About 48 (64.9%) people responded source of the water was managed as community services while 26 (35.1%) respondents manage their source of water individually (~~table~~ Table 1). Furthermore, ~~to the question how do you feel about the way the water source is maintained,~~ only 10.8% were satisfiedwith types of water source managed while 89.2% of the respondents said that water source needsto be improve .Cleaning, constructing tank and fencing at the water source were some of the water source management adopted by the residents.

Table1. Water source management

Who manage the water source?	Frequency	Percent(%)
Community	48	64.9
Personally	26	35.1
Total	74	100.0

However, they were not satisfied and they expressed for better management through renovation of tanks, metal fencing and constructing cemented tanks. ~~s~~Similar study was carried out in Awgu local government area of Enugu State, Southeastern Nigeria by Obeta and Nwankwo (2015) based on analysis of the factors responsible for water supply shortage in the study area, they recommended that conserving water to reduce water waste is a first step in water management, thus the communities should adopt various water conservation measures such as installing concrete tanks in springs to avoid the waste of the spring water and to protect it from contamination. Households should install large tank particularly underground tanks for collection of rain water in the wet season which can be used when springs and streams yield small quantity of water in the dry.

3.5 Possible causes of water shortages in Lapsakha chiwog

The second ~~objective~~ research question of the study was to identify the causes of erratic water supply in Laptsakha Chiwog. ~~The second research question sought to find out the causes of erratic water supply in Laptsakha chiwog.~~ The decreased of the water supply from the sources were~~,~~ 20.3% ~~was~~ due to increase in population that hence an increase in demand for the scarce resource, 20.3% was due to exploitation of the water sources, 33.8% was due to climate change and 25.7% still don't know what caused the decreased in water supply to their homes and fields from their respective water sources (Fig. 5.)

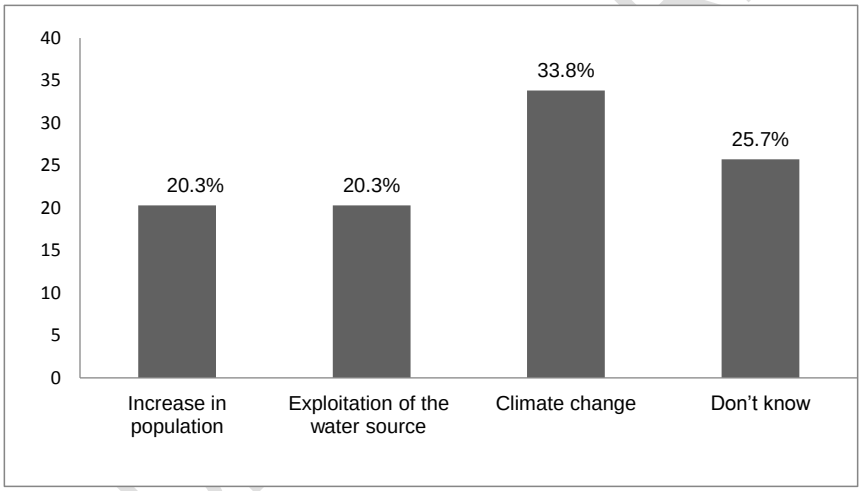

Figure 5. Causes of water shortage in Lapsakha Chiwog.

Regression analyses was conducted to examine the relationship between observed decrease of water supply from the source and various potential predictors. The regression model with all three predictors produced R^2=*.208, and p<.05* .The model predicted that climate change asmain caused for decrease water supply from the water source, p<.05.

Statistically shown that a possible cause of decreased water from the source in ~~study~~ selected area was climate change accompanied with high temperature, low precipitation and loss of vegetation cover~~.~~, ~~it~~ It also supported by availability of water differs with seasons that ~~is~~ was decreased in supply of water during dry season (winter and spring) compared to other seasons and almost all of them stayed more than 30 years in their respective areas~~.~~, ~~so~~ So climate change could

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be the factor that decreased water supply in study area as well as 30 years means. ~~it~~ It fulfilled the minimum standard years to be called data as climate change.

Similarly, the spring survey results confirmed farmers' perceptions and showed that 73.2% of the springs used as water sources had a decreased flow and 12.2% had dried up over the past 10 or more years, as recognized by local residents. In response to the severe decline of precipitation and the drying up of springs, local communities have implemented some climate change adaptation measures (Poudel & Duex, 2016). Study conducted by Kusters and Wangdi (2013) also shows that analysis of rainfall data collected at six stations between 1990 up to 2008 located in the Punakha-Wangduephodrang valley seems to confirm farmers perceptions, showing a decreasing trend which is significant (sig = .00187). According to the large majority of the interviewed farmers this has negatively affected their access to water for the irrigation of paddy fields.

Table 2. Regression table

Model		B	Std. Error	Beta	T	Sig.
1	(Constant)	1.798	.170		10.605	.000
	Pressure from increasing population	-.193	.134	-.175	-1.434	.157
	Exploitation of water source area	-.071	.139	-.064	-.514	.610
	Climate change	-.532	.181	-.366	-2.940	.005

a. Dependent Variable: There is observed decrease of water supply from the source.

3.6 Socio-economic impacts

The second objective of the study was to evaluate socio-economic impacts of intermittent water supply at Laptsakha chiwog. The third research question sought to find out the socio-economic effects of water supply in Laptsakha chiwog.

3.7 Source of Income for the households of Laptsakha chiwaog

About 85.1% of the respondents depends on agriculture as their main source of income with highest category while 60.8% of the respondents depends on dairy products as source of income with highest in moderate category and respondents reported that there was less depending on business as source of income.

Table 3. Total Annual Income earned by respondents

Minimum	Maximum	Mean
3000	200000	43162.2

The total annual income earned by households in Laptsakha chiwog, finding shows that mean of the total annual income was Nu.43162.2 per year.

3.8 Expenditure spent to cope up with water shortages

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About 89.2%of respondent said that they depends on the external source of foods (rations: oil, vegetables, rice etc) and in average annually they spent Nu 75.7% respondents responded " Yes" that they spent to cope upwith the water shortage by building cemented tanks, installing sintex and brought storing containers like jar cans and sintex. 60.8% purchased for storing containers, 25.7% purchased for cemented tank, 24.3% purchased for sintex and 63.5% purchased for ~~So~~ so on average they spent Nu. 6734.26 per year (Table 4.)

Table 4. Annually spent expenses to cope up with water shortages (n=54).

Minimum	Maximum	Mean
500	30000	6734.26

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3.9 Relationship between total annual incomes of the respondents and spent annually on water materials to cope up with water shortage.

Seventy four residents were surveyed between total annual income (*M=43162.16, SD=36704.31)* and spent annually on materials to cope up water shortage *(M=6734.26, SD=5402.81).* A Pearson's *r* data analysis revealed a moderate positive correlation, *r=.209, p >.05* .Residents who spent on buying materials to cope up with water shortage has no effect on their total income. However, water shortages increases their expenditure on food items increases, so it directly effect on the total income of the households. Their main source of income was agriculture and decreased of water has affected their source of income through low production from fields and as alternative they depends on external source of foods. Their income were also affected by spending money on buying materials like containers, sintex, cemented tank and pipes to cop up with decreased of water from the source. Statistically shown that when there is water shortage, ~~they~~ their expenditure on food items increases which has direct effect on the total income of the households but expenditure spent on buying materials to cope up with water shortage has no effect on their total income. A similar study conducted by Kusters andWangdi (2013) in Punakha district also found that out of 125 respondents 89% of the respondentshas reported a change in water availability; this negatively affected their household economy. Most of them (97%) mentioned a negative effect on the production of crops, fruit trees (23%) and livestock (12%). According to 8% of the respondents low yields cause the local market prices of agricultural products to increase in years with insufficient irrigation water. So, may be residents living the study area faced low production from their fields and indirectly they spent market food items but the market price so high that has impact their total annual income. There was no impacts of buying materials (pipes, sintex, cemented tank and storing containers) to cope up water shortages may be that they didn't go expensive things like using water pumps to irrigate their fields because in a similar ~~paper~~ finding was found that the use of a gasoline pump, of which four households had been able to actually purchase one. A strong-enough pump costs somewhere between US$1,000 and US$1,500, which is close to an average annual income (Kusters & Wangdi, 2013). In addition,farmers adopt adaptation measures to deal with changes in water availability, but according to 88%of the adapting households these are insufficient to neutralize the negative effects.

3.10 The impact on health and social relations

Respondents' ability to maintain hygiene were significantly affected by numbers of days in a weekis the water available in the tap, *H(2)=7.030,p<.05* .Mann-Whitney tests were used to follow up this finding .A Bonferroni correction was applied and so all effects are reported at a .03 level of significance. It appeared that ability to maintain hygiene were no different when availability of water in taps is sometimes in a week (*U=353.500, r=-.03*) compared to always but insufficient. However, when water availability is rarely per week ability to maintain hygiene was significantly reduced than when water availability is always but insufficient (*U=25.500, r=-0.21)*. So if water availability in tap is rarely in a week it significantly reduces respondents ability to maintain hygiene compared water availability in tap is always but insufficient. The shortage of water also affected health of people as they are not able to maintain sanitationand cleanliness as supported by Utsev and Aho (2012), found there is short in water supply to meet the water demand of the people; hence, high prevalence of water shortage and associated health and other problems. About 95% of the settlements have no water supply facilities to compliment natural water supply sources like streams and rainwater. The result of the analysis indicated that almost all the streams and well water in the three communities were not safe for drinking as a result of high E-coli and coliform count, thus causing pathogenic diseases.

4. CONCLUSION

The research study shows that majority of the respondents lies in between 18-60 years old, 51.4% had no education, 74.3% were farmers and 73% has stayed more than 30 years in their respective village.The ~~source of water available in the study area were~~sources of water available in the study area were spring, pond, stream and rain water and the water source were mostly communally shared. Though they have different source of water for irrigation and drinking, 25.7% still do not have connection of water for irrigating their fields and 40.5% expressed they face problem of drinking water.Water were connected from source to homes and fields through pipes, traditional channels and cemented channels.The source of the water were managed communally as well as individually such as constructing tanks, fencing and planning trees around the source but 89.2% were not satisfied, theyexpressed that water source needs to be improved. The ~~study~~ finding shows that decrease in water supply from the source was caused due climate change accompanied with the decrease in precipitation and increased in temperature. The decreased in water supply has socio-economic impacts on the households. The total annual income of the households were affected due decrease in water supply from source when they spent money buying food items from the markets however buying water materials like sintex, pipes, cemented tank and storing containers has no significant effect on the total annual income. The water availability in a tap has significant impacts on the residents, when water is available rarely they were not able to maintain hygiene (washing, sanitation, cooking) but the reported cases of the disease has no significant effect with the water availability.

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