Conditional cooperation

for mitigating effects of climate change in rural Nepal.

Abstract

Due to the climate warming effects the glacier lakes of the Khumbu has started to form and grow in size and the natural moraine dams give poor support to the expanding lakes. In order to find out how much the sherpa people wants to contribute to build the safety measures that can protect them from the effects of a glacier lake outburst flood this paper investigates their willingness to contribute with work time. The work time can be used to work on strengthening the dam and settlements along the upper Dudh Kosi river. The willingness to contribute was investigated to see if it is affected by others contribution and if the contribution levels varies with socioeconomic variables such as income, perceived risk level and gender.

The finding of this paper is that the willingness to cooperate amongst the sherpas of the upper Dudh Kosi river basin increases with others contribution.

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Picture 1. Heading up to Chukkung with Nuptse south face partly covered by clouds.

Introduction

The Hindu Kush Himalayas contains the highest concentration of glaciers, snow and permafrost in the world. It is a source of ten major rivers of Asia that supports over 1.3 billion of people down stream with water (International centre for integrated mountain development (ICIMOD), 2016).

The average temperature of Nepal is increasing by 0,06 degrees celsius per year due to climate change but the temperature in the Himalayas is increasing at a faster rate (Prasai, 2010). The glaciers melts and retreats at a high rate and this retreat causes the formation of new glacial lakes and enlargement of existing ones due to accumulation of meltwater. The meltwater lakes are poorly supported by moraine dams that are a potential source of danger for the people of the valleys below. In Nepal there have been several glacier lake outburst (GLOF) events in recent years with Bhote Koshi and Sun Koshi events of 1964 and 1981 and the Dig Tsho event of 1985. The Dig Tsho event destroyed the almost finished Namche Small Hydroelectric Project in addition to causing damage further downstream. (ICIMOD, 2011)

There are several ways of mitigating the impact of GLOFs. One way is to decrease the climate change and the climate warming gases causing it but locally in these high Himalayan valleys it is more a question of adapting to the effects of the GLOF event. Decreasing the volume of the lake can be done by controlling the outlet of the lake by drainage. Structural mitigation measures can be built to river bank settlements, intakes and bridges downstream so that the structures will hold when the flood occurs. There is also a possibility of preventing trigger events such as snow or ice avalanches with structural measures so that displacement waves can not occur. (ICIMOD, 2011)

The expected economic damage of a GLOF event is the combination of the probability of the event and its negative consequences (ICIMOD, 2011). The ICIMOD (2011) assessment does not project a future frequency of GLOF events but it states that the glaciers of Hindu Kush Himalaya melts and retreats at an increasing rate. According to Kaltenborn, Nellemann and Vistnes (2010) the frequency of the GLOF events in the same area are increasing. Hence this paper assumes that the probability of an GLOF event will increase in a future state of the world. Also, if the land use increases the negative consequences of such an event will increase

and hence the expected economic damage in this future state of the world will increase (Nussbaumer, Schaub, Hugger & Walz, 2014).

In order for the local community to adapt to the future effects of a GLOF event it is important to understand how much they are willing to do this and under which circumstances this willingness is formed. This paper aim to test how many working hours the population of the upper Dudh Kosi valley would contribute with in order to adapt to the effects of a GLOF event given their beliefs about others contribution, and whether they would increase their contribution given that they are informed that the other households contribution is twice as high as their contribution. The paper will also try to find the main socio economic causes for this contribution. This study can serve as information for a decision of authorities or local groups so they can see how much the people along the upper Dudh Kosi are willing to contribute with work time to adapt to climate changes and under which conditions this willingness forms.

Literature review

The stated preference method is used to valuate willingness to adapt to future floods. There are several papers of interest about willingness to pay for measures in order to adapt to floods created by climate change. Some investigates the willingness to pay for a whole agricultural program of which the flood risk adaption is a part (Ahmed, Masud, Al-Amin, Yahaya, Rahman & Akhtar, 2015; Masud, Junsheng, Akhtar, Al-Amin & Kari, 2014). Others investigates willingness to pay for adapting to floods by insurance, elevating houses, embankments or building better waste water systems (Botzen & van der Berg, 2012; Botzen, Aerts & van der Berg, 2012; Sharier & Kotani, 2016; Veronesi, Chawla, Maurer & Lienert, 2013). All papers uses the the stated preference method in order to find the willingness to pay for climate change adaption of the investigated populations. Veronesi et al (2013) uses the choice experiment method while the other authors uses the contingent valuation method. The choice experiment gives more information but is harder to answer. In a comparative study Hanley, McMillan, Wright, Bullock, Simpson, Parsisson & Crabtree (1998) finds that the choice experiment method is more effective of evaluating the marginal willingness. Since this paper is investigating the willingness to adapt to the effects a future GLOF event in rural Nepal it uses the contingent valuation method since it evaluates the total willingness to pay for a future policy.

The literature of Ahmed et al (2015); Masud et al (2014); Botzen and van der Berg (2012); Botzen, Aerts and van der Berg (2012); Sharier and Kotani, (2016); Veronesi, Chawla, Maurer and Lienert (2013) are all controlling for socio economic causes of willingness to pay for adapting to floods like education, income and age and it helped this paper to find a sensible selection of socio economic determinants. In addition to this Ahmed et al (2015); Masud et al (2014); Botzen, Aerts and van der Berg (2012); Botzen and van der Berg (2012) investigates the motivating factors that affects the willingness to pay. The authors claims that one motivating factor for willingness to pay for adaption is if the respondent is concerned about the risks of climate change or if the respondent feels responsible for the climate changes. Therefore it is important to investigate how the respondents of this paper perceives the risk of a future GLOF event. Moreover Botzen, Aerts and van der Berg (2012); Botzen and van der Berg (2012) finds that the respondents willing to invest in elevating houses had a higher willingness to pay than the respondents that was willing to pay for an insurance that

decreases the financial risk of a flood. This means that the respondent finds it more interesting to reduce the economic damage of a flood rather than to buy financial security and still be exposed to the risk. Thus it is important to investigate the willingness to pay for safety measures that decreases the economic damage of a GLOF event. Ahmed et al (2015) and Masud et al (2014) states that another motivating factor that affects the willingness to pay is if the respondent thinks that the environment has the right to be protected irrespective of the cost. Masud et al (2014) claims that this factor had low priority amongst the respondents and recognizes that the most important motivating factor is the environmental impact on their own agricultural production. Hence the strongest motivating factors seems to be the factors that affects the respondents private economy (Ahmed et al, 2015; Masud et al, 2014; Botzen, Aerts & van der Berg, 2012; Botzen & van der Berg, 2012). Therefore it is of importance to investigate if the respondents owns land in the research area but also important to report the flood effects on private property in the scenario of the survey.

Is the willingness to pay a limited evaluation tool when the respondents are poor? Sharier and Kotani (2016) finds that poor and less educated people in coastal Bangladesh tends to choose the willingness to donate labor instead of willingness to pay when adapting to cyclone floods. Similarly Rai, Nepal, Shyamsundar and Bhatta (2014) finds that 50 per cent of the respondents are willing to pay with money in order to adapt to water scarcity in the Koshi river basin but this willingness increases to 75 per cent when asked to contribute with work time. The authors argues that the low income level and budget constraint of the respondents makes the willingness to pay a limited way of measuring the willingness to adapt. On the other hand the authors Casiwan-Launio, Shinbo and Morooka (2011) claims that in order to compare the two modes of payments amongst poor people in a valuation framework it is necessary to have knowledge about the respondents alternative cost of time and the local labor market. The difference in willingness levels between monetary- and labor contribution amongst poor people motivates this papers method of evaluating willingness to contribute with work time since the population of this paper is assumed to be equally poor and limited with similar budget constraints.

In addition, when changing payment mode from monetary- to labor payment, it is important to find out if the respondents decision to contribute with work time is affected by information about the other households contribution. This behavior is defined as conditional cooperation

(Frey & Meyer, 2003; Ostrom, 1990). The change of contribution with information about the other players has been investigated using public goods games and these experiments finds that the individual contribution in many cases increases with more information about the others contribution (Fischbacher, Gächter, & Fehr, 2001; Cartwright & Lovett, 2014). Again the conditional contribution can also be investigated in a real life setting (Heldt, 2005) using non student field experiments. The field experiment methods uses questionnaires about willingness to pay to elicit the conditional contributions and the public goods games uses constructed scenarios with a limited amount of tokens to spend amongst the players. The public goods games get the results in a more controlled way and the field experiments have the advantage of resembling the choices of a real life setting. On the other hand the results of the above experiments on conditional behavior contradicts the theory of altruism which according to Croson (2007) and Sugden (1984) predicts less contribution if the respondent is informed of the other households increased contribution. This since the personal utility of the altruistic respondent is fulfilled by the others contribution and the need for a contribution is reduced (Becker, 1974). The conflict between the literature on the theory of altruism (Margolis, 1982; Becker, 1974) that predicts less contribution given information and the literature on theory of reciprocity (Rabin, 1993; Sugden, 1984) or theory conformity (Carpenter, 2004) that predicts more contribution given information can be explained by the different economic behaviors they are trying to explain.

Background

According to ICIMOD (2011) the scenario of a GLOF event includes expected economic damage due to destruction of infrastructure, real estate and conditions for economic valuable activities. Three lakes, of which the possibility of a future GLOF could not be dismissed, was investigated in different perspectives with potential risk in mind. The conclusion was that the local communities needs to become more aware of the GLOF hazard and a new policy needs to be developed so that the awareness, early warning and mitigation issues could be solved. Although ICIMOD (2011) risk assessment study can not predict if the rate of the GLOF events will increase in the future Kaltenborn, Nellemann and Vistnes (2010) claims that the rate of these events will increase in times to come. With the fact that the climate change melts the Hindu Kush glaciers at an increasing rate (Pasai, 2010; Intergovernmental Panel on Climate Change (IPCC), 2014) this paper assumes higher risk of GLOF events in the future state of the world. Nussbaumer et al (2014) have focused on trying to quantify the expected damage of a GLOF event over time and they find that the expected damage of a GLOF event in 2045 increases with different land use. According to Worldbank (2014) a good strategy for the Nepal economy is to focus on its growth sectors which is hydro power and tourism. Both sectors can be expected to increase land use in the flood prone areas and therefore increase the future expected economic damage of a GLOF event even further.

In order to adapt to the risks of future GLOF events in Nepal a three-year project called "Nepal: Community Based Flood and Glacial Lake Outburst Risk Reduction" has been implemented and this project has been focusing on early warning systems, development of GLOF programmes and raising awareness of climate change amongst the local districts. The government of Pakistan and UNDP has implemented a project in the two districts of Gilgit-Baltistan and Chitral in Pakistan. The project is aiming to raise awareness of GLOF events but also to install early warning systems in the projects areas. A five-year project in Bhutan was aiming at creating a practical framework to assess the dangers of GLOFs for the local people of the two valleys which are considered to be the most threatened sites of the country. An early warning system was also implemented in the Punakha-Wangdi valley of Bhutan. (ICIMOD, 2016)

Theoretical background

Different goods can be divided into four groups according to table 1.

	Exclusion	No exclusion
Rivalry	Private good	Open-access common property
No rivalry	Club good	Public good

Table 1. Rivalry and exclusion

It is very hard to exclude anyone from the services of the measures taken to adapt to the effects of a GLOF event. Therefore the services of adapting to a GLOF event is considered a public good and so the problem of free riding will occur. Free riding is when people benefit from the collective work without contributing themselves. The free riders can not be excluded from using the public good because the property rights of the public good can not easily be defined. (Perloff, 2015)

The theory of free riding can be explained by the Nash equilibrium of the prisoners dilemma which is when none of the individuals in a game would gain more utility by changing strategy. The utility outcomes of table 2 can be used to define the supposed behavior of the people in the upper Dudh Kosi valley when deciding to contribute with work time or not.

	Contribute_2	Defect_2
Contribute_1	$(2_1, 2_2)$	$(0_1, 3_2)$
Defect_1	$(3_1, 0_2)$	$(1_1, 1_2)$

Table 2. Prisoners dilemma utilities

The utility of individual one is the first number in the parentheses and the strategies of individual one are described by the left column. The utility of individual two is the second number in the parentheses and the strategies of individual two are described by the top row. Given the strategy of one individual is unchanged it does not matter from which of the positions the other individual change to the defect strategy, this individual will gain utility. Given the defect strategy of one individual is unchanged and one individual changes to the contribute strategy from the lower right position this individual will loose utility. Hence, the dominant strategy for both individuals is to defect since none of the individuals gains more utility by changing from this strategy. This equilibrium is the Nash equilibrium and will cause both individuals choosing the dominant strategy of free riding even if they receive information about the other individuals actions. (Perloff, 2015)

A rational and self-interested individual would maximize her own utility given the others contribution and not contribute with work time to a public good such as building safety measures for a GLOF event. But it is not always that pure economic self interest decides how an individual will act. Sometimes we use norms to decide our actions. The theory of conditional cooperation states that higher contribution rates will occur when information is provided about how much others contribute (Frey & Meyer, 2003). The members of the group makes a comparison with the others and creates a norm that will have large effect on the contribution (ibid). It has also been shown that conditional contributors can contribute before they know the norm only by believing a majority of the members will contribute (Ostrom, 1990). Another way of describing the causality between these beliefs and the contribution is presented by Ross, Green & House (1977) who argues that people might form beliefs as to justify their own behavior. That is, beliefs might not cause contribution but the other way around - contribution causes beliefs.

Fischbacher, Gächter, and Fehr (2001); Cartwright and Lovett (2014) investigates how the contribution changes if information about the others contribution is provided in a public goods game. They find that half of the players of the game do not let their personal gain of utility influence their decision but chooses conditional contribution by comparing themselves to the others. Cartwright and Lovett (2014) finds that the contribution with no information given about the other players contributions is depending on the personal gain of utility the players get of the outcome. This behavior is called unconditional contribution.

Conditional contribution might happen for several reasons. One reason mentioned by Carpenter (2004) is conformity which is when people fear breaking the norm created by the group. Another, described by Rabin (1993), is reciprocity which is a reaction to perceived kindness of other people. Feldt (2005) finds that age has a positive correlation with conditional contribution in one of the first non student field experiments in a public goods context. Feldt (2005) also argues that the group that is informed contributes at a higher rate. This result contrasts with the theory of altruism which implies that an individual would decrease its own contribution if informed of the others contribution since the need for a contribution is reduced (Sugden, 1984). In this case the utility of the individual is not defined only by its own consumption but also by the consumption of the others (ibid).

Empirical question

The empirical question of this paper is how many working hours the population of the upper Dudh Kosi valley would contribute to adapt to the effects of a GLOF event given their beliefs about others contribution, and wether they would increase their contribution given that they are informed that the other households contribution is twice as high as their own contribution. The paper will also try to find the main socio economic causes for this contribution.

The scenario of the investigation is that the expected economic damage of a GLOF event in the Imja Lake is high and increasing and lives and houses within the flood prone area are directly exposed to this risk. The other households in an extended area are indirectly exposed to this expected damage through loss of income. The data is collected along a stretch of 25 km down stream from Imja Lake by making the respondents fill in a survey. The survey can be found in appendix 2. A map of the area is attached as appendix 1.

Experimental design and process

The sample

The choice between potential research sites are singled out by the factors GLOF risk, accessibility, english proficiency amongst the people in the research area and the 2015 earthquake effects in the area. This paper chose to follow the ICIMOD (2011) prioritization of critical lakes since the GLOF risk is very high and the access is good at all three sites. A guide was hired in order to translate the interviews with respondents with low english proficiency. The 2015 earthquake is supposed to have effect on the answers in the way that if the respondent just experienced effects of an earthquake it might be impossible to contribute with work on safety measures to prevent another catastrophe. The choice was between Lake Thulagi, Lake Rolpa and Imja Lake. The language barrier was considered to be higher at Lake Rolpa since there are less tourists there (ICIMOD, 2011). The 2015 earthquake effects were more severe at Lake Thulagi (ICIMOD, 2016) and therefore Lake Imja was chosen. Lake Imja is situated in Sagarmartha national park which attracts many tourists that comes to Nepal. All contributing factors were checked with the contact person of this investigation - Ganesh Sharma - which organizes climbing expeditions to Nepal.

The resident sherpas of the upper Dudh Kosi valley can be expected to be a small group with strong social ties interested in collective action according to the definition of Ostrom (1990) and will make up the sub population of the sampling. The sampling itself was designed with the condition that the investigator would collect the cross section data by foot amongst the resident sherpas. The area of sampling is along the Dudh Kosi river between Namche Bazar and the Imja Lake in both high risk villages and other villages. The resident households was identified by asking the respondents if they were residents. There was a suspicion that it would be more problematic interviewing women since they according to our contact person would be more prone to stay indoors which due to sherpa custom is harder to reach without invitation. The interviewer tried to interview not only one part of the village but distribute the interviews uniformly through out the village. The sample size was limited by the time restriction of the data collection. When leaving the research site the sample size was at the level of 66 due to this time restriction. There were no budget to cover the costs of the guide and translator for more than the 66 answers that were sampled.

Problems with the data collection

The data collection needs to be commented because of several reasons. One is the rough terrain. In the steep and high altitude terrain it takes time and effort to reach the villages of the sub population safely and this gives limited time for data collection. The size of the sample therefore became smaller than initially planned. The second reason for commenting the sample is the translation and the language barrier. The survey had to be filled in by the interviewer and the questions were translated on site by the guide. It was difficult to make sure that the guide fully understood the survey questions and it was hard to know if the translated questions reflected the questions of the survey well. Therefore the meaning of the scenario and the questions can get distorted and create bias to the data. It was also hard to know if the questions were fully understood by the respondents. The respondents misconception of the questions can give bias to the data as well. The third reason to comment on the data collection is that the interview was personal but often other persons of the household or persons of other households were sitting next to the respondent. This kind of non anonymous interview situation can be an explanation to an upwards bias of the contribution level since the respondent can be influenced by the others that are sitting and listening. According to Patel and Davidsson (2003) the interview shall to the largest extent possible be anonymous so the respondents answers can be uninfluenced of the other people attending the interview. But the situation of the interview, often in the kitchens with families or friends, made it hard to ask the remaining individuals to step out after being invited to their home. Therefore it was hard to prevent this bias. One thing that could have improved the anonymity of the interviews would have been if the survey was translated to the nepalese language. Then the respondents could have filled in the survey without any pressure from the other persons in the group. A fourth reason to comment on the data collection is the selection process. Our guide has many sherpa friends in the investigation area and a handful of them were interviewed. Our guide was informed that the selection was supposed to be random and when entering the kitchens of the respondents homes there was no sign of our guide knowing the respondents. It seemed that our guide always told us when the respondent was a friend but it was hard to recognize the social codes of the sherpas to check this assumption. If the sample was overrepresented by our guides friends there might be a lot of trekking guides in the sample. The trekking industry is large in the investigation area and even if none of the respondents were our guides friends there would be a large share of trekking guides in the sample.

The survey design

First in the survey, that can be found in appendix 2, there are questions that refers to the age, gender and nationality of the respondent. For instance, old people can be expected to care more about the environment which is tested here.

In order to put the respondent in the right frame of mind this paper uses a carefully constructed scenario in the introduction of the survey. The scenario gives the respondent some basic information to motivate the upcoming questions of the survey. When constructing a scenario a conflict arises between how much information the survey can give and how much it needs to give. Most respondents can not handle to much information and given the language and illiteracy problems a short scenario was constructed. The information of the scenario contains the future change of the expected damage of a GLOF event with a reference to current research. This to show the respondents that a contribution is needed. The information of what needs to be done to protect the respondents of a GLOF event is also presented in order for the respondents to decide if they can contribute with work time. The work tasks are strengthening roads, strengthening bridges, improving structural measures to river bank settlements, controlling the outlet of the glacier lake dam and strengthening the glacier lake dam. It was confirmed with our guide and the secretary of the local sherpa association in Namche Bazar that no steps were taken to adapt to future GLOF events since then there is no need for the respondents to contribute with work time.

The respondents that for some reason can not contribute are identified with a question that asks the respondent if someone in the household is willing to contribute with work time to help your local community with GLOF safety measures. If the respondents answer is no there can be several reasons for this, for example that the respondents can not afford to contribute or that they are free riders.

After this section comes the part of the survey that tests the contribution with some open ended questions about contribution. The question "how many hours per month is your household willing to contribute to help your local community with glacier lake outburst flood safety measures?" tests the respondents willingness to contribute. Subsequently we add a question to test if respondents are willing to contribute more if they expect others also to

contribute. The question is: "How many hours per month and household do you expect other households to contribute to help the local community with GLOF safety measures?". This section is finished with the question "Suppose other households in average contribute twice as much as you stated in question 2, would that change your answer and if so, how much work time would you contribute with?" that tests for conditional cooperation given information about the other households contribution. The respondents can choose if they want to change their contribution or stay unchanged which tests the unconditional contribution.

After the questions that elicits the contribution there is a part that investigates the determinants of the contribution. It starts with an ordinal scale question about how large risk level the respondents believes they are in. The risk level can be a motivating factor that affects the contribution since if the respondents believes they are at risk of a GLOF event their motivation to contribute is assumed to increase. A question is asked about he amount of persons in each household and their ages. The amount of people old enough to work on safety measures can be a socio economic factor of the contribution. This question is followed by socio economic questions that investigates employment rate, occupation and education level. A question which investigates if the respondent owns land investigates if private property at risk is a factor that affects the willingness to contribute. The most sensitive question about the respondents income levels comes last. The respondent can choose one of the listed income levels that best describes his or hers monthly income. The income levels was constructed with assistance by Ganesh Sharma, the contact person of this paper, and Nepal Living Standards Survey (2011) published by Nepals central bureau of statistics.

Problems with the survey

The investigation is hypothetical and will therefore give hypothetical answers since none of the respondents are bound to build safety measures after responding. Also there is a problem for the respondents to calculate how much work time they can afford to contribute with. When calculating the contribution many respondents considered how large their willingness was per day and multiplied that value with thirty to calculate their contribution of work time in one month. This way of calculating can result in very high values if the respondents believe the duration of the work is only one month. There can also be a warm glow problem since it might be morally satisfying to raise the contribution level both in the contribution and

conditional contribution questions. (Kolstad, 2011) There will be more outliers in the data of a survey with open ended questions than in the data of a survey with closed ended questions (Pearce, Atkinson & Mourato, 2006). Some steps were taken to mitigate the problems with the survey. In order to prevent the hypothetical bias the respondents were informed of the different working tasks along the Dudh Kosi in detail and that the answers had to be within the respondents time constraints. The respondents was informed that the duration of the policy was until further notice and not only one month.

Analysis and results

The purpose of the paper is to investigate how many working hours the population of the upper Dudh Kosi valley would contribute to adapt to the effects of a GLOF event given their beliefs about others contribution, and wether they would increase their contribution given that they are informed that the other households contribution is twice as high as their own contribution. The cross section data was collected by interviewing local sherpa people in villages along the Dudh Kosi river between the village of Namche Bazar and Imja Lake. (A map of the area can be found in appendix 1.) The interviews were translated by a guide. Each interview was about ten minutes long and often performed in a kitchen with many family members and friends attending.

The respondents of the sample

The control variables that describes the respondents in this paper are the age, male, risk, persons, land, full time, education, income and distance to the Lake. All controls represent properties that can influence the willingness to contribute with work time due to ability, experience, knowledge and perception of the risk if you own land or not. The distance to the lake should have effect on the amount of work time the respondent can contribute with. The education should give awareness of effects and problems with climate change and should therefore have causal effect on the willingness to contribute. The income should have effect on the contribution level. One perspective on the causal effect of income is that if the respondent have a large income it may have no time to contribute since the respondent gains more utility from earning the income rather than contributing with work time. Another way to see this is if the respondent has a large income it can afford to contribute more since the respondent has more resources to do so.

The amount of respondents of the sample is 66. The mean age of the respondents were 34 years and the median age was 32. This tells us that the distribution of ages is asymmetrical. 77 per cent of the respondents were male and one explanation for the overweight of male respondents can be that four out of seven villages in the sub population are seasonal settlements dominated by men. 54.4 per cent of the respondents has primary school as highest education level and 16.7 per cent has secondary school as highest education level.

18.2 per cent of the respondents has higher secondary school as highest education level and 10.6 per cent has university as highest education level. These education level rates differs with the ICIMOD (2011) education statistics of the mountain district of Sankuwhashawa in Nepal where 23 per cent of the household heads completed primary school, nine per cent completed secondary school and 0.5 per cent completed university (ICIMOD education, 2011). The two main occupations amongst the respondents are trekking guide and hotel businessman. The mean of the grouped data of the respondents income is 13000 Nepal rupees per month which is a little bit less than the mean monthly household income according to Nepal Living Standards Survey (2011). The share of respondents with an monthly income below 9000 NPR is 24 per cent which is smaller than the Nepal poverty headcount at ratio 3.10 USD per day (≈ 9000 NPR per month) of 50 per cent 2010 (World bank, 2015). 47 per cent of the respondents are land owners which is a smaller share than the 83 per cent described in Nepal Living Standards Survey (2011) and 85 per cent of the respondents work full time. The mean amount of people above 18 years old in the respondents households are 2.2. The mean amount of people in the respondents households under 10 years old is 0.6 and the mean amount of people between 11 and 17 years old in the respondents households is 0.5. The explanation of the low amount of children in the households can be that so many of the villages are seasonal settlements where less children spend their time. In summation it can be said that the external validity of the sampled respondents are limited since many of the control variables of the households differ from the average Nepalese population. If the population frame is changed to the sherpa population that lives in high valleys with GLOF risk the representativity can be higher. This paper had trouble finding proper statistics of living standards of the sherpas and therefore it is hard to say if the sample is representative of the sherpa population living in high valleys.

The main variables of interest

The main variables of interest, that can be found in table 3, are the respondents contribution of work hours to adapt to the effects of GLOF when they are informed about how much the other households will contribute (Cond) and their contribution given their beliefs about the other households contribution (Contrib). The contribution of work hours when the respondents are informed of the other households contribution is defined as the conditional contribution of work time in hours per month. The information should have effect on the

contribution since the respondents can use the information to choose how they want to act. They can decide not to change their contribution, follow the norm and increase the contribution, react to the kindness of the others and increase the contribution or lower their contribution because there is no need for the household to contribute as much as they first stated.

Table 3. Variable names and definitions

Name	Definition
Non_contrib	A dummy variable that takes the value of one if the respondents household does not want to contribute with work time. Used as a determinant for detecting potential free riders.
Contrib	The respondents households contribution in hours per month.
Expect	The respondents expectation of the contribution of the other households in hours per month.
Uncond	A dummy variable that takes the value one if the respondents household would not change their contribution given that the other households double the respondents contribution. Used as a determinant for detecting unconditional contributors.
Cond_ref	Twice amount of Contrib used as a reference when investigating conditional contribution of work time in hours per month.
Cond	The respondents households conditional contribution of work time in hours per month.
Risk	The respondents perceived risk in a scale from one to five.

The beliefs about the other households contribution is described with the expect variable (Expect) which tells how many hours per month the respondent expects the other households to contribute with. The belief of the other households contribution should have an effect on the contribution since if the respondents believe the others contribution is high they may also want to contribute more. This causality might also be reversed since if the respondents want

to contribute with much work time they might also think that the other households should have the same willingness and consequently state a higher expectation to justify their own level. According to the descriptive statistics of table 4 the average contribution is 78.6 hours per month. Many respondents calculated their contribution level by finding out how many hours per day they that corresponded to their willingness and multiplied that value with thirty days to calculate the monthly value. There is a possibility that some respondents misunderstood the duration of the contribution. If the respondent got the impression that the duration of the contribution should be only one month the contribution can be upwards biased since the respondents probably would have contributed less if they thought it was no limit to the duration. The interviewer tried to be clear that the duration of the contribution was supposed to be until further notice and not just one month. Another reason for the high level of contribution can be the high endurance of the sherpas (McDonald, Shrestha, Chhetri, Sherpa, Sherpa, Murray & Sanati, 2015). The sherpas willingness to contribute can be upwards biased by the satisfaction the respondent gets from showing their capability to the others that sat in on the interviews.

Table 4. Descriptive statistics

Variable	Unit	Mean	SD	Min	Max	Freq.
Non_contrib	%	12.12	32.88	0	1	8
Contrib	Hours/Mo	78.62	65.37	0	300	66
Expect	Hours/Mo	79.98	70.87	0	360	66
Uncond	%	6.06	24.04	0	1	4
Cond	Hours/Mo	90.3	78.58	0	322	66
Cond_ref	Hours/Mo	157.2	130.7	0	600	66
Risk	Risk level	3.439	1.178	1	5	66

The average conditional contribution is 90 hours per month and the average expected contribution of the other households is 80 hours per month. As a comparison reference for the respondent the Cond_ref variable is constructed by doubling the answer of the contribution (Contrib). The mean perceived risk level of the respondents (Risk) is 3.43 which is between medium and large risk on the ordinal scale. This perceived risk level is supposed

have a positive effect on the contribution level since if the risk is higher the respondent should be willing to contribute more. The non contributors (No_contrib) are the respondents that do not want to contribute. The share of non contributors amongst the 66 respondents are 12 per cent. This can be compared to Kocher et al (2008) results of 8 per cent in the US, 22 per cent in Austria and 36 per cent in Japan. The amount of unconditional contributors was described by the variable Uncond. These four respondents answered that they did not want to change their contribution when they were presented with the information about the other households and are therefore in this paper not considered to act under influence of any conditions.

Table 5. Specific descriptive statistics

Variable	Unit	Mean	SD	Min	Max	Freq.
Cond (<Contrib)	Hours/Mo	53	57.1	41	148	10
Cond (>Contrib)	Hours/Mo	113	75.5	16	322	48

Table 5 shows the descriptive statistics of the respondents that have larger or smaller conditional contribution than the contribution. This breakdown of the conditional contribution can reveal behavioral factors affecting the conditional contribution. The behavior of the respondents with a conditional contribution lower than their contribution can be described by the altruism theory which implies that an individual would decrease its own contribution if informed of the other households contribution since the need for a contribution then is reduced (Sugden, 1984). The behavior of the respondents with a conditional contribution higher than their contribution can be described by conformity which is when the respondent is afraid of breaking the norm created by the other households or reciprocity where the respondent is inspired by the kindness of the other households contributions (Rabin,1993). 83 per cent of the conditional contributors contributed more with information and 17 per cent contributed less. In order to further analyze the behavioral factors that affects the conditional contribution there must be follow up questions asked. The mean of the conditional contribution that is higher than the contribution is 113 hours per month which is a high level of contribution. This high value can be explained in the same way the high average contribution level of table 4 is explained but also with the addition that the Cond_ref variable might bias the conditional contribution upwards since it in many cases was twice a very large contribution of work time.

Econometric analysis

As a first step of an econometric analysis a paired t-test shows that the difference between the conditional contribution and the contribution is statistically significant at five per cent level. Therefore the null hypothesis that the difference between the conditional contribution and the contribution is zero can be rejected. The interpretation of this test is that the informed respondent gives a significantly higher contribution than the uninformed and so there exists conditional contribution amongst the respondents. This in turn answers the empirical question if the information about the other households changes the respondents contribution.

The models

Two linear regression models were constructed to investigate the contribution and the conditional contribution. First one describes the how the contribution varies with the beliefs of the other households contribution and the second model describes the contribution given the information about the other households contribution. One variable were created out of the respondents answers and that was the contribution of the other households (cond_ref) which were twice the own contribution. Another variable was constructed after the data collection and that was the distance variable. Some of the respondents explained they had to walk for two days to get to the Imja Lake which meant there might be correlation between the contribution level and the distance from the Imja Lake to the respondents home. The distance variable had a positive effect of 1.29 hour per month per kilometer in the second model but it was not significant (p-value = 0.39). Before eliminating insignificant predictors the model 1 regression consisted of the variables Contrib, Expect, Male, Uncond, Age, Risk, Person_0_10, Person_11_17, Person_18_Up, Land, Fulltime, Primary, Secondary, Hi_secondary, Inc_9000 Inc_15000 Inc_24000, and Distance. A table of the full list of variable names and definitions can be found in appendix 3. The second model consisted of Cond_ref, Male, Uncond, Age, Expect, Risk, Person_0_10, Person_11_17, Person_18_Up, Land, Fulltime, Primary, Secondary, Hi_secondary, Inc_9000, Inc_15000, Inc_24000 and Distance. The backwards elimination search procedure was used to find the model. The procedure includes finding the variable with the lowest t-value and eliminating that variable (Cortinhas & Black, 2012). After eliminating this variable a new regression is executed and the

process continues until all variables are significant (ibid). The full description of model predictors can be seen in table 6.

Model 1:

Contrib = 32.2 + 0.43•Expect*** + 9.66•Risk* − 27.8•Inc_9000* − 40.5•Inc_15000**

Model 2:

Cond = 20.3** + 0.51•Cond_ref *** − 9.57•Person_11_17* − 17.1•Inc_9000*

Two outliers of the contribution regression was removed by graphically inspecting the plot of the regression for these outliers and removing them. When the outliers was removed the R^2 value increased which is an increase of the goodness of fit of the regression. The closer R^2 gets to 1 the better the fit. The two removed outliers decreased the mean of the contribution from the 78.6 to 75.3 hours per month and the mean of the expected contribution from 80.0 to 75.7 hours per month. The variance of the residuals are expected to be constant and if they are not there is heteroscedasticity present. The models were tested for heteroscedasticity with the Breusch-Pagan method which detected heteroscedasticity in the second model. Since the true variance of the population is not known the heteroscedasticity problem with the second model was adjusted with White's heteroscedasticity-corrected variances method. Heteroscedasticity-corrected variances are also known as robust standard errors. (Gujarati & Porter, 2009) The Ramsey regression specification-error test for omitted variables was used for both models in order to detect omitted variables. Both models failed to reject the null hypothesis of this test and therefore it was concluded there were no omitted variables. (Hamilton, 2003)

Model one shows how the households contribution varies with the beliefs of the other households contributions (Expect), the perceived risk level, the respondents income below 9000 NPR and the respondents income between 9000 and 15000 NPR. The economic interpretation of the first model is that if the respondents belief of the other households contribution increases one hour per month the contribution increases 0.43 hours per month and if the respondents perceived risk level increases one nominal degree the contribution increases with 9.66 hours per month. If the respondent has an income below 9000 NPR the contribution decreases with 27.8 hours per month and if the respondent has an income between 9000 and 15000 NPR the contribution decreases with 40.5 hours per month. The

coefficient of the expect variable is significant at one per cent level, the coefficient of income between 9000 and 15000 NPR variable is significant at 5 per cents level and the risk- and income below 9000 NPR variables are significant at ten per cent level.

Table 6. Conditional contribution amongst sherpas below Imja Lake (hours per month)

Model	Model 1	Model 2
Variable	Contribution	Cond. contribution
Cond_ref		0.51 (0.03)***
Expect	0.43 (0.10)***	
Risk	9.66 (5.57)*	
Person_11_17		-9.57 (4.93)*
Inc_9000	-27.8 (14.8)*	-17.1 (9.64)*
Inc_15000	-40.5 (15.3)**	
Constant	32.2 (20.5)	20.3 (9.07)**
R^2	0.42	0.79

Note: This table reports results from a OLS regression of contribution and conditional contribution on socioeconomic determinants. Standard errors in parentheses. *** $p<0.01$, **$p<0.05$,*$p<0.1$.

Model two shows how the conditional contribution varies with the information of the other households contribution (Cond_ref) , which is a reference variable that is two times the respondents own contribution. It also shows how the conditional contribution varies with the income below 9000 NPR and amount of persons in the household between 11 and 17 years of age. The economic interpretation of this model is that if household is informed that the other households contribution is two times their own contribution the conditional contribution is 1.02 times higher than their own contribution since Cond = 0.51 • 2 • Contrib = 1.02 • Contrib. If the amount of persons between 11 and 17 years of age in the household increases by one person the conditional contribution decreases by 9.57 hours per month and if the respondent has an income below 9000 NPR the conditional contribution decreases 17.1 hours per month. The coefficient of the cond_ref variable is significant at one per cent level. The intercept is significant at a 5 per cent level. The persons between 11 and 17 years of age

in the household and the income below 9000 NPR variables are significant at a ten per cent level.

The analysis establishes the aim of the paper by answering if and how the contribution of the respondents in the upper Dudh Kosi valley varies with the beliefs of the other households contribution and also if and how much the contribution increases if the respondents are informed that the other households contributes twice their contribution. The relationship between the beliefs of the other households contribution and the contribution implies that the respondents are more willing to contribute if they expect a higher contribution level of the other households. It can also be that the respondent want to justify his own contribution level with the stated expected level of contribution according to Ross, Green & House (1977). The mean of the expected contribution of 78.62 hours per month is almost the same as the mean of the contribution of 79.98 hours per month and a paired t-test shows that there is no significant difference between the mean of the expected contribution and the mean of the contribution. This can be interpreted as the sherpas of the upper Dudh Kosi valley on average expect the same contribution of other households as the contribution of their own household. Since model one shows correlation between the expected contribution and the contribution the respondents increase their contribution levels with higher beliefs of the other households contribution. The relationship between the information of the other households contribution and the conditional contribution implies that the respondents are more willing to contribute if they know there is a higher contribution level of the other households. The mean of the conditional contribution of 90.3 hours per month is higher than the mean of the contribution of 79.98 hours per month. In a comparison between model 1 and model 2 it can be seen that the coefficient of Cond_ref is a little larger than the coefficient of Expect (0.51>0.43). This means that the respondents will contribute more if they receive information that the other households increased their contribution one hour per month than if they expected the other households to increase their contribution one more hour. Simpler put, the respondents contributes a little more if they are being informed about the other households contributions.

The high level of the mean contribution can be explained by different biases. One bias can be caused by a systematic error when calculating the contribution per month. The respondents might have misunderstood the duration of the policy to be defined as just one month instead

of until further notice and therefore increased their bids. Another bias can be caused by the non anonymous interview situation that might bring up the contribution levels due to social pressure from the other members of the group. It was hard to make the interviews anonymous since they often were made in the kitchens of the sherpa homes. Being invited into a sherpa kitchen is an honor and starting to ask respondents to leave the kitchen in order to improve the interview anonymity might have comprised the interview itself. A translated survey version that the respondents could have filled in by themselves would probably have made the interviews more anonymous (Patel & Davidson, 2003). The distance to the Lake Imja can have a bias effect on the contribution since some respondents might include the time it takes to walk to the Imja Lake in their calculation of the willingness to contribute with work time. The distance was regressed and had a considerable effect on both models but since the effect was not significant (p=0.61 for model one and p=0.39 for model two) it is hard to draw any conclusions about the bias caused by the distance to the Imja Lake. The Cond_ref variable that is twice the respondents contribution can be considered unrealistic in the case of the respondent states a already high contribution. The Cond_ref variable was created to see if the respondents got affected by the information of the other households larger contributions and twice the contribution is an easy number to calculate but if the respondent contributes 150 hours per month the Cond_ref becomes 300 hours per month which is an unrealistic contribution of the other households. Hence the conditional contribution might be upwards biased.

This paper finds some significant socioeconomic factors that affects both the contribution and the conditional contribution. The income below 9000 NPR per month lowered both models contribution and lowered the contribution at a larger magnitude than the conditional contribution. This can be explained by if the respondent has an income below 9000 NPR per month she is more willing to contribute if she has information about the other households. The respondent with the higher income level between 9000 and 15000 NPR per month lowers the contribution of model one even more than the respondents from the lower income level. This can be explained by that the respondent with the higher income level between 9000 and 15000 NPR per month has less time to contribute with work time since the respondent gains more utility from earning the income rather than contributing with work time. There was no significant coefficient of the income level between 9000 and 15000 NPR per month in the conditional contribution model which could have further emphasized the

relation between the contribution levels of the two incomes. One have to consider that the three significant income level predictors of the two models have large 95 per cent confidence intervals which can have large effects on the output of each model. As an example the confidence interval of the coefficient of the income level Inc_15000 of model one is between -71.1 and -9.86 (± two standard deviations from predictor value). If the value of the coefficient is -9.86 the above given interpretation of the respondents contribution with this income level is overthrown. Hence, the model is sensitive for changes in the coefficients. The contribution is also affected by the risk level which is expected since if the respondents believes they are at higher risk of a GLOF event they probably want to contribute with more work time to adapt to the negative causes of such an event. The conditional contribution is affected by a factor -9.57 multiplied with how many persons between 11 and 17 years of age the respondent has in the household. This effect is somewhat surprising since it could be expected that the more teenagers that can help out in the household the easier it would be to contribute with work time but here it is the opposite. Perhaps the explanation can be that it takes more effort to take care of and support hungry teenagers than toddlers and this creates a lack of time for contributing with work time to build adaption measures.

Conclusion

A GLOF event can have catastrophic effects on the living conditions for the sherpas of the upper Dudh Kosi valley. Roads, bridges, live cattle, lives and buildings can be lost and as an indirect effect the agriculture, energy and tourist economy can also be affected. Work time can be spent on making safety measures like strengthening bridges and roads or controlling the glacier dam outlet in a way that decreases the risk. The goal of this paper was to find out how many work hours the sherpa people in the upper Dudh Kosi valley wants to contribute to decrease this risk, if the information about the others makes the household give more and how the contribution varies with the beliefs of the other households contribution. The paper also wants to find the causes of this contribution. This paper finds that the respondents wants to contribute a mean of 80.0 hours per month in order to adapt to a future GLOF event. This high mean level of contribution is assumed to be upwards biased by several factors such as systematic calculation errors and non anonymous interviews. This paper also finds significant evidence of conditional contribution at a mean level of 90.3 hours per month when given information about the other households contribution. This means that if you are informed of the others contribution you will increase your own contribution. Two significant socio economic causes of the conditional contribution are how many persons between 11 and 17 years of age that lives in the household and if the income level is below 9000 NPR. They both have negative effect on the conditional contribution. The paper also finds evidence for a relationship between the expected contribution of other households and the own contribution. In other words, if the household believes that the others will contribute much it will also contribute much. The risk has a significant positive effect which means the household gives a higher contribution if it believes it is at higher risk and can therefore be considered a motivating factor of the contribution. Two significant socio economic causes of the contribution are the two lowest income levels and they both have a negative effect on the contribution. In the sampled population the share of non contributors were 12 per cent, the unconditional cooperators were 6 per cent and the conditional cooperators were 82 per cent. 17 per cent of the conditional cooperators contributed less with information about the others households contribution which can be a sign of altruistic behavior. 83 per cent of the conditional cooperators contributed more when given information of the other households contribution which can be a sign of conformity or reciprocity behavior. In order to say more

of the nature of the behavioral factors that affects the contribution there must be more follow up questions asked so this paper can only give direction about further investigation.

This papers contribution to the literature is that it finds how much work time the sherpas of upper Dudh Kosi valley wants to contribute to adapt to a future GLOF. Another contribution is that this paper uses an elicitation of conditional contribution with willingness to pay with work time instead of monetary payment. The investigation uses a field experiment in rural Nepal with a realistic scenario of climate change and finds socio economic causes of the conditional cooperation. A shortcoming of this paper is the small sample size. If this paper had a chance to make the investigation again the limit of time the respondent is supposed to work would be clearly stated and the survey would also be translated.

Suggestions for further research would be to try to find out how much the sherpa people wants to take care of the glacier as a common resource. This kind of collective action can give them larger access to fresh water and hydro power and as a result give them a higher level of welfare. Another interesting study can be to evaluate how much the sherpas and other peoples down stream are willing to pay for the glacier melt water as a resource. The problem with this kind of evaluation is finding a future projection of the glacier melt water run off for the specific rivers of Hindu Kush in order to give the correct information of the scenario of such an investigation. Thus it is hard to describe how much less run off water there will be when the glaciers melts down. Furthermore looking at the behavioral economics side of the problem it would be interesting to verify causality between the expectation of the other households contribution and the own contribution. Can it be the expectations of the other households that causes the contribution level or can it be the other way around that the household justifies its contribution level with the expectation level? In other words; that the respondent believes the other households should have the same attitude as them self and therefore state a higher expectation level to justify their own level. Another interesting topic for further research is to find out if the action of conditionally contributing really is not motivated by self interest? The papers that make up the background of this paper states that the conditional contribution is not caused by self interest but mere behavioral causes like a reaction to kindness in the reciprocity theory or fear of being different in the eyes of the other households of the conformity theory. But being a good contributor in the eyes of the other households can be a rational act well in line with self interest since the cooperation level of

the household can be good for the relations with the other households and maybe also good for the business of that household.

Picture 2. Upper Dudh Kosi river basin.

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Appendix 1. The map of the research area
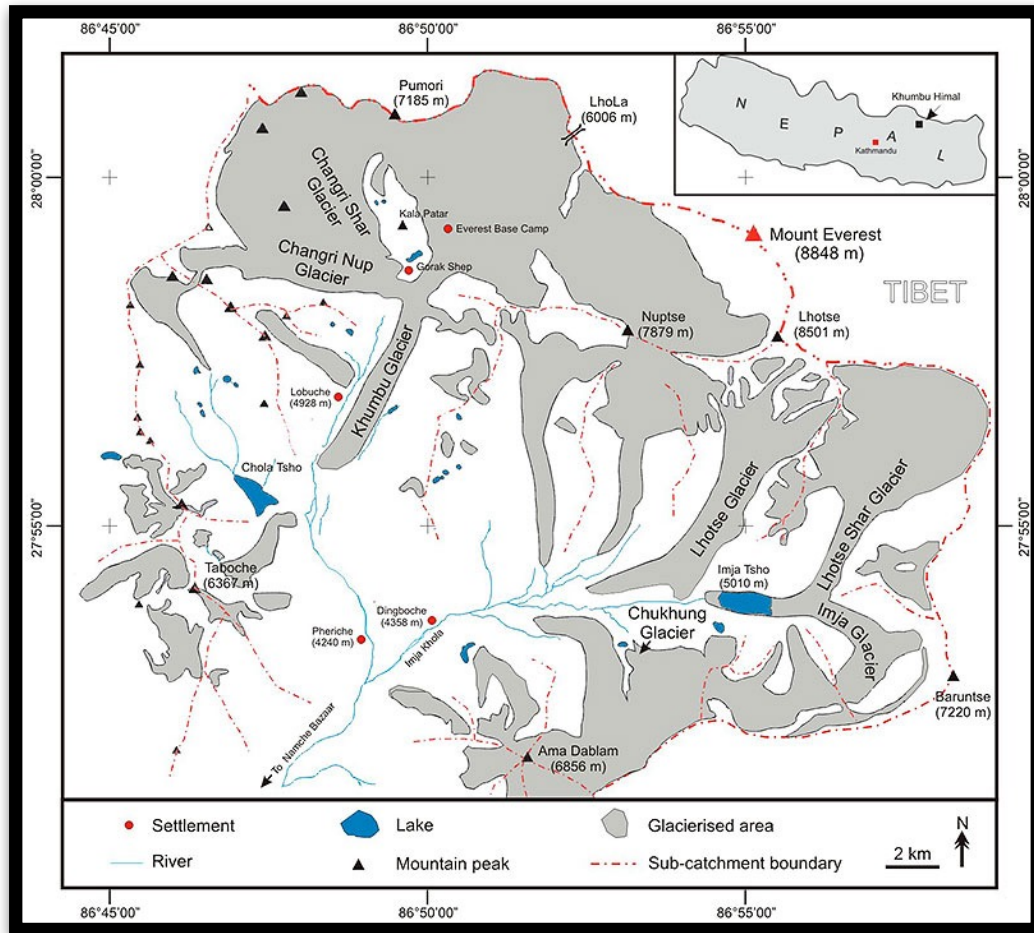
Appendix 2. The survey

Gender:
Age:
Nationality:

Information for respondent

According to the current research the risk of future glacier lake outburst floods is increasing in this area. The effects involve destruction of roads, bridges, buildings and lives. It is possible to decrease the effects of a glacier lake outburst flood by safety measures like strengthening roads, strengthening bridges, improving structural measures to river bank settlements, controlling the outlet of the glacier lake dam and strengthening the glacier lake dam. You can help your local community building these safety measures by contributing with your work time.

1. Will someone in your household be willing to contribute with work time to help your local community with glacier lake outburst flood safety measures?

☐ Yes
☐ No   (Please, go to 5.)

2. How many hours per month is your household willing to contribute to help your local community with glacier lake outburst flood safety measures? ....

3. How many hours per month and household do you expect other households to contribute to help the local community with glacier lake outburst flood safety measures? ....

4. Suppose other households in average contribute twice as much as you stated in question 2, would that change your answer and if so, how much work time would you contribute with?

☐ No, I would not change.
☐ Yes, I would contribute with .... hours.

5. Would you consider your neighborhood to be at risk of a glacier lake outburst flood? Risk:

☐ Very small ☐ Small ☐ Med ☐ Large ☐ Very large

6. How many persons are there in your household? Fill in amount.

0-10 years: ....
11-17 years: ....
above 18 years: ....

7. Do you own land in this area?

☐ Yes
☐ No

8. Do you work full time or part time?

☐ Full time
☐ Part time

9. What is your highest level of education?

☐ Primary
☐ Lower secondary
☐ Secondary
☐ Higher secondary
☐ University

10. What is your occupation? ....

11. What is your level of income after tax?

☐ 0 - 9000 NPR / month
☐ 10000 - 15000 NPR / month
☐ 16000 - 24000 NPR / month
☐ 25000 - more NPR / month

Thank you for your cooperation!

UNIVERSITY OF GOTHENBURG
SCHOOL OF BUSINESS, ECONOMICS AND LAW

Appendix 3. List of variable names and definitions

Name	Definition
Male	A dummy variable that takes the value of one if the respondent is a male.
Age	The respondents age
Nationality	The respondents nationality
Non_contrib	A dummy variable that takes the value of one if the respondents household does not want to contribute with work time. Used as a determinant for detecting potential free riders.
Contrib	The respondents households contribution in hours per month.
Expect	The respondents expectation of the contribution of the other households in hours per month.
Uncond	A dummy variable that takes the value one if the respondents household would not change their contribution given that the other households double the respondents contribution. Used as a determinant for detecting unconditional contributors.
Cond_ref	Twice amount of Contrib used as a reference when investigating conditional contribution of work time in hours per month.
Cond	The respondents households conditional contribution of work time in hours per month.
Risk	The respondents perceived risk in a scale from one to five.
Person_0_10	How many persons between zero and ten there are in the respondents household.
Person_11_17	How many persons between 11 and 17 there are in the respondents household.
Person_18_Up	How many persons above 18 there are in the respondents household
Land	A dummy variable that takes the value one if the respondent owns land in the research area.

Appendix 3 continued.

Fulltime	A dummy variable that takes the value one if the respondent work fulltime.
Primary	A dummy variable that takes the value one if the respondent highest level of education is primary level.
Secondary	A dummy variable that takes the value one if the respondent highest level of education is secondary level.
Hi_secondary	A dummy variable that takes the value one if the respondent highest level of education is higher secondary level.
University	A dummy variable that takes the value one if the respondent highest level of education is university.
Occupation	A variable that describes the occupation of the respondent.
Inc_9000	A dummy variable that takes the value one if the respondents highest level of income per month is 9000 NPR.
Inc_15000	A dummy variable that takes the value one if the respondents highest level of income per month is 15000 NPR.
Inc_24000	A dummy variable that takes the value one if the respondents highest level of income per month is 24000 NPR.
Inc_25000	A dummy variable that takes the value one if the respondents income level is above 25000 NPR.
Village	A variable that describes the village name the respondent lives in.
Distance	The distance to the Imja Lake from the respondents village.