LETTER

Climate change and adverse health events: community perceptions from the Tanahu district of Nepal

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Abstract

Nepal is a country economically dependent on climate-sensitive industries. It is highly vulnerable to the environmental, social, economic and health impacts of climate change. The objective of this study is to explore community perceptions of climate variability and human health risks. In this letter, we present a cross sectional study conducted between August 2013 and July 2014 in the Tanahu district of Nepal. Our analysis is based on 258 face-to-face interviews with household heads utilizing structured questionnaires. Over half of the respondents (54.7%) had perceived a change in climate, 53.9% had perceived an increase in temperature in the summer and 49.2% had perceived an increase in rainfall during the rainy season. Half of the respondents perceived an increase in the number of diseases during the summer, 46.5% perceived an increase during the rainy season and 48.8% during winter. Only 8.9% of the respondents felt that the government was doing enough to prevent climate change and its impact on their community. Belonging to the Janajati (indigenous) ethnic group, living in a pakki, super-pakki house and belonging to poor or mid-level income were related to higher odds of perceiving climate variability. Illiterates were less likely to perceive climate variability. Respondents living in a pakki house, super-pakki, or those who were poor were more likely to perceive health risks. Illiterates were less likely to perceive health risks.

Introduction

Nepal is diverse in its geography, ecosystem and culture. As a country economically dependent on climate-sensitive industries such as agriculture, forestry and ecotourism, it ranks 14th in the world when assessing for vulnerability to climate change [1]. Since 1975, the temperature of the country has risen 1.8 °C, with an average annual increase of 0.06 °C [2]. This may have detrimental effects [3]. The environmental, social and economic impacts of climate change are first and most strongly felt by communities who live in ecologically fragile areas [4]. Such communities often depend on local natural resources for survival. Assessing these communities’ perception and response to climate variability—such as short to medium term fluctuations in climate state—can identify early coping mechanisms that are adopted to mitigate the worst of climate change.

Climate change is arguably the biggest current threat to public health, contributing to the global burden of disease and premature death [5]. Variant climate patterns and global warming will alter the pattern and prevalence of infectious and vector-borne diseases [6]. Disease burden may also increase as a result of climate change related migration of reservoir hosts [7]. Additionally, climate variability will lead to a resurgence and increased endemicity of tropical diseases [6]. Globally, an estimated 166 000 deaths result from change in climate annually, relative to the average baseline measurements between 1961–1990 [8]. Diarrhea, the leading cause of under-five deaths in developing countries, is estimated to increase by 2–5%
by 2020. Furthermore, annually, 5.5 million disability adjusted life years (DALYs) can be attributed to climate change [9]. An earlier study reported five categories of health outcomes which are most likely to be affected by climate change: temperature-related morbidity and mortality; health effects of extreme weather events (storms, tornados, hurricanes, and precipitation extremes); air-pollution-related health effects; water-borne and food-borne diseases; and vector-borne and rodent-borne diseases [10].

In Southeast Asia, including Nepal, there is a likelihood of increased epidemics of malaria, dengue, other vector-borne diseases and climate-change attributed diarrhea [11–13]. As a result of rising global temperatures, rainfall is predicted to increase, thereby increasing the likelihood of flooding. Droughts and flooding will result in declining crop yields and subsequent malnutrition in this region [13]. Additionally, Nepal is vulnerable to flooding, mudslides and glacier lake outbursts secondary to the melting Himalayan glaciers, which will lead to fluctuations in the quality and quantity of water, available land mass and environmental safety [14]. Few studies have explored the spatial correlation between climate change and health outcomes [15–17]. Little is known about perceptions of climate variability and subsequent health risks in Nepal, particularly amongst the most at-risk communities. The following questions are explored in this study:

(i) What are local perceptions of climate variability; what form does climate variability take? (ii) does the local community perceive changes in patterns and burden of disease?

Our findings are useful to guide climate change policy for at-risk communities. Utilizing local people’s perception and coping strategies is essential if interventions are to be well targeted and well placed. Such data gathered amongst the most vulnerable communities are useful for the implementation of wider national and international policy and strategy.

Materials and methods

We performed a cross-sectional study in the Tanahu district of Nepal. This district is located in the central hilly region of the country. It covers an area of 1546 km$^2$ and has a population of 323,228 [18]. The district is at an elevation of 340–2134 m above sea level. The climate is tropical and sub-tropical, and the temperature ranges from 5 °C to 48 °C [19].

This study was conducted in the Bhimad village which was purposefully selected as a place where the Terai plain meets the hills. The village is orientated to commerce and tourism. This Village Development Committee (VDC; the lowest administrative unit in Nepal [20]) has a total of 2191 households and is inhabited by 8414 people [18].

Study samples were drawn using proportionate stratified random sampling. A comprehensive list of households was obtained from the office of the VDC and the existing administrative division of wards was used to stratify the VDC into 9 strata. Samples were selected in proportion to the population size of each strata using systematic random sampling. Heads of respective households were selected for face-to-face interviews. If the head of the household was not present at the time of the interview, the eldest person from the same house was selected for the interview. We selected 258 households, considering a 5 percent allowable error. This is based on a similar study completed in Bangladesh, which found that 80% of respondents perceived increased summer temperatures, a decrease in rainfall and warmer winters [21].

The study questionnaire was prepared in consideration with previous works for reference [21–24]. Earlier studies on perceptions of climate change have used a five point Likert scale, with a scale of 1 to 5 to denote perceptions of climate variability. However, these did not go so far as to measure what factors were attributed to variability [22]. In our study, we used a similar approach with additional exposure variables—e.g. perception of climate variability, health risk—measured dichotomously (‘yes’ and ‘no’). By calculating such variables, a new dimension is added to the existing literature. Prior to interviewing the 258 household heads, the questionnaire was pre-tested among 20 household heads in Nayapati VDC, Kathmandu, Nepal. The study tool assessed an individual’s: i) socio-demographic factors (age, sex, ethnicity, educational status, type of family, type of house, main source of income and area of cultivable land owned by the family) ii) perception of climate variability over the past five years, and iii) perception of health risks. Demographic characteristics were gathered through direct questioning and household observation. We further used classifications from the 2008 Household Budget Survey to identify house types (25). A super-pakki house is defined as the house in which both the walls and the roof are built in permanent materials, such as cement, concrete and bricks. A pakki house is a house where either wall or roof is built in permanent materials and the other is built in temporary materials. A Kachhi house is one where both walls and roof are built in temporary materials, such as mud, straw, bamboo or plastic.

Respondents were asked ‘whether they had experienced, observed or witnessed given climate-change related indicators’. Three options provided to the respondent were ‘yes’, ‘no’ and ‘do not know’. Total scores for climate variability and health risks were calculated. Perception of climate variability was indicated if the total score was greater than the median. The following questions were asked to the respondents to measure the perception of climate variability:

1. Have you perceived a change in the degree of hotness during the summer?
2. Have you perceived a change in the degree of coldness in the winter?

3. Have you perceived change in the amount of rainfall during the rainy season?

We further tested whether respondents had a perception of a change in disease occurrence. The perceived human health risk was indicated if the perceived health risk score was greater than the median. The following questions were asked to measure the perception of health risks:

1. Have you perceived a change in the occurrence of disease during the summer?
2. Have you perceived a change in the occurrence of disease during the winter?
3. Have you perceived a change in the occurrence of disease during the rainy season?

Data was entered into EpiData 3.1 and analyzed using SPSS Version 17 (SPSS Inc., Chicago). We considered all variables used in bivariate analysis for multiple logistic regressions to control for confounding [26].

This study was conducted from August 2013 to July 2014 and the participants’ enrollment was active from March to May 2014. The study protocol was approved by the Institutional Review Board (IRB) at the Institute of Medicine, Tribhuvan University, Nepal. Permission for conducting the study was also obtained from the VDC office. We obtained written informed consent from each household head after explaining the rationale of the study. We ensured the confidentiality and anonymity of participants. Respondents were informed of the right not to answer any of the asked questions or leave the interview without reason. A few of the respondents could not read or write and provided verbal consent for interview.

Results

Characteristics of the respondents
Of the 258 participants, 74.4% were female and 86.8% were aged 24 years or older. When asked about the size of family, 53.9% reported to be living in nuclear families. Agriculture was the main source of income for 33.6% of the households questioned, followed by foreign remittance at 28.3% of households. In terms of economic status, 15.5% self-rated as ‘poor’, and 76% as ‘middle income’. 27.1% percent were illiterate and 43.4% had a basic education (table not shown).

Perception of climate change and health risks
Over half of respondents had perceived a change in climate (54.7%). A total of 53.9% perceived an increase in hotness in the summer and 49.2% had perceived an increase in rainfall during the rainy season. Similarly, 50.0% had perceived an increase in the number of diseases during the summer, 46.5% perceived this increase during the rainy season and 48.8% during the winter (figure 1).

When asked about changes in local climate, 31.4% noted an increase in wind velocity during the summer, 43.4% said rainfall during the summer was adequate, though 5.8% had seen a spring dry up over the preceding five years (table not shown).

Household heads were asked for the necessity and adequacy of both personal and government efforts in mitigating climate change and its impact on the community. 3 in 10 respondents agreed that personal effort was essential for climate change mitigation. Only 8.9% felt that the government was doing enough (figure 2).

Being a female (aOR = 1.780, 95% CI (0.991; 3.200)), belonging to the Janajati (indigenous) ethnic group (aOR = 2.492, 95% CI (1.293; 4.801)), living in a pakki (aOR = 3.662, 95% CI (1.388–9.663)), super-pakki house (aOR = 5.862, 95% CI (2.119; 16.218)), or belonging to poor (aOR = 9.187, 95% CI (1.808–46.675)) and those with mid-level income (aOR = 5.193, 95% CI (1.342–20.098)) were related to higher odds of perceiving climate variability. The illiterate were less likely to perceive climate variability (aOR = 0.410, 95% CI (0.190–0.884)) (table 1).

Respondents living in a pakki house (aOR = 2.907, 95% CI (1.165–7.256)), super-pakki (aOR = 4.833, 95% CI (1.844–12.672)), and being poor (aOR = 5.163, 95% CI (1.138–23.416)) were more likely to perceive health risks. The illiterate were less likely to perceive health risks (aOR = 0.320, 95% CI (0.150–0.684)) (table 2).

Discussion and conclusions

Whilst this is the first study to report community perception of climate variability and health risks in Nepal, a number of limitations need to be considered. Firstly, all respondents’ perception of climate variability and health risks were measured from proxy indicators. Secondly, this study surveyed a large number of households in a single village of a mid-hill district of Nepal. Due to coverage of such a small study area, extrapolation of the findings to other parts of the country may be limited. Finally, measuring perception of climate variability and health risks is difficult. The responses recorded through indicators may suffer recall bias, and be subject to personal judgment [21]. Nevertheless, the findings of this study reflect the communities’ view on climate change and health, and will be important while launching programs to mitigate future adverse events.

Data confirm that Nepal has experienced a measurable change in climate, particularly in precipitation patterns and heat stress [15–17]. Our study findings
Table 1. Factors associated with perception of climate variability.

| Variables          | OR (95% CI) | aOR (95% CI) |
|--------------------|-------------|--------------|
| Age                | 0.674       |              |
| <20 years          | 1           |              |
| 20–45 years        | 1.175 (0.480–2.875) | 1.293–4.801  |
| >45 years          | 1.439 (0.537–3.718) |           |
| Sex                | 0.054       |              |
| Male               | 1           |              |
| Female             | 1.780 (0.991–3.200) | 0.261–1.414 |
| Ethnicity          | 0.000       | 0.000        |
| Brahmin/           | 1           | 1            |
| Chhetri            |             |              |
| Janajati           | 2.476a (1.338–4.580) | 1.293–4.801  |
| Dalit              | 0.763 (0.352–1.653) | 0.261–1.414 |
| Type of family     | 0.577       |              |
| Nuclear            | 1           |              |
| Joint              | 0.817 (0.494–1.351) | 1            |
| Extended           | 1.562 (0.337–7.242) |     |
| Education          | 0.197       | 0.066        |
| Educated           | 1           | 1            |
| Literate           | 0.998 (0.548–1.818) | 0.370–1.422 |
| Illiterate         | 0.601 (0.309–1.170) | 0.190–0.884 |
| Source of income   | 0.063       |              |
| Agriculture        | 1           |              |
| Skilled            | 1.863a (1.084–3.202) | 1            |
| Labor              | 1.073 (0.383–3.003) | 1            |
| House type         | 0.019       | 0.003        |
| Kachha             | 1           | 1            |
| Pakki              | 2.071 (0.920–4.660) | 3.662 (9.663) |
| Super-pakki        | 2.950a (1.368–6.362) | 2.119–16.218 |
| Economic level     | 0.096       | 0.027        |
| Poor               | 2.400 (0.581–9.908) | 9.187 (8.080–16.675) |
| Mid-level income   | 3.589 (0.983–13.100) | 5.193 (1.342–20.098) |
| Rich               | 1           | 1            |

*p < 0.05, statistically significant at 95% CI.

Table 2. Factors associated with perception of health risks.

| Variables          | OR (95% CI) | aOR (95% CI) |
|--------------------|-------------|--------------|
| Age                | 0.601       |              |
| <20 years          | 1           |              |
| 20–45 years        | 1.336 (0.546–3.266) | 1.293–4.801  |
| >45 years          | 1.596 (0.618–4.124) |           |
| Sex                | 0.199       |              |
| Male               | 1           |              |
| Female             | 1.454 (0.822–2.573) | 0.264–1.346 |
| Ethnicity          | 0.008       | 0.006        |
| Brahmin/           | 1           | 1            |
| Chhetri            |             |              |
| Janajati           | 1.900a (1.042–3.464) | 1.293–4.801  |
| Dalit              | 0.750 (0.357–1.574) | 0.264–1.346 |
| Type of family     | 0.86        |              |
| Nuclear            | 1           |              |
| Joint              | 0.987 (0.599–1.625) | 1            |
| Extended           | 1.518 (0.328–7.035) | 1            |
| Educational status | 0.038       | 0.111        |
| Educated           | 1           | 1            |
| Literate           | 0.880 (0.483–1.604) | 0.355–1.264 |
| Illiterate         | 0.477a (0.245–0.928) | 0.150–0.684 |
| Source of income   | 0.116       |              |
| Agriculture        | 1           |              |
| Skilled            | 1.662 (0.975–2.832) | 1            |
| Labor              | 0.883 (0.317–2.463) | 1            |
| Type of house      | 0.038       | 0.005        |
| Kachha             | 1           | 1            |
| Pakki              | 1.804 (0.826–3.941) | 1.165–7.256 |
| Super-pakki        | 2.560a (1.223–5.359) | 1.844–12.672 |
| Economic level     | 0.155       | 0.098        |
| Poor               | 1.833 (0.496–6.778) | 1.138–23.416 |
| Mid-level income   | 2.723 (0.839–8.835) | 3.384 (0.982–11.655) |
| Rich               | 1           | 1            |

*p < 0.05, statistically significant at 95% CI.

show these objective findings are reflected in subjective measurements of climate change at a community level. A significant proportion of respondents have a clear perception of climate variability, most notably through increased summer temperatures, higher wind velocity and increased rainfall during the rainy season.

People falling under the Janajati (indigenous) group were found to have higher odds of perceiving climate variability. This observed association could be accounted for their close relationship with and reliance upon environmental resources for survival. An earlier similar study conducted among indigenous people in Nigeria [27] reflects these findings, stating that over a few decades, 73% had experienced rising temperatures, 83.5% had expressed a decrease in rainfall and 75% had said the environment is becoming drier to the point of affecting human comfort. Our study found association between economic level and perception of climate variability and health risks. Those with lower economic level depend on natural resources such as forest, grassland and wetland [28], thus they are supposed to perceive climate variability and disease occurrence more compared to people of higher economic level. Education was positively associated with perception of climate variability and health risks. Literacy of the effects of climate change can be instrumental in achieving better adaptation at community level. Further research is needed to shed light on our speculations.

Compared to a similar study in Bangladesh [21], a smaller percentage of our research community perceived climate variability. Such differences may be an accurate perception due to floods and heat waves being more common in Bangladesh than in Nepal. In another study in Nepal, 73.2% of people believed that the weather was getting warmer, 67.2% believed that the onset of summer and monsoon had advanced during the last 10 years; furthermore, 46% believed that there was less snow on mountains than before and during the last 10 years; in addition, 46% felt that water sources were drying up [29]. Again, variation in results may be due to inherent differences in the study location.
At present, there are few studies reporting a correlation between climate change and diseases occurrence in Nepal. An earlier study reported a 1°C increase in minimum and mean temperatures and increased malaria incidence by 27% [30]. Public perception of climate change is not new to literature [21–24]; however, further analysis exploring predictors of climate variability and health risks have not been reported before. Our study format and findings can benefit further research in the field to link subjective and objective measures of climate change. Furthermore, our study pointed out strong evidence to support climate variability in Nepal. Perception of climate variability and diseases occurrence were predicted by a number of factors, including socio-demographic (ethnicity, education, house type) and economic level. The literature states that voluntary mitigation and adaptation is often the result of perception of climate variability [31]. In the light of this evidence, better awareness activities about climate variability and associated human health risks can yield better adaptation and mitigation practices in Nepal. Our findings can particularly be of higher importance to the ‘National Adaptation Program of Actions 2010’ (32) and the ‘Local Adaptation Plan of Action National Framework 2011’ launched by the Ministry of Science, Technology and Environment [33]. These two frameworks are keys to successfully adapting to and mitigating climate change in Nepal. As measures to address and mitigate climate change receive increasing priority, our data outcomes are valuable: to assist policy makers in mapping community vulnerability to climate change and adverse health outcomes, and to better direct the design of community-based mitigation and adaptation strategies in Nepal and beyond.

**Data accessibility**

Data will be made available upon the approval from Institutional Review Board of Institute of Medicine.
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Competing Interest

The authors declare no competing interests.

Author’s Contribution

SRM conceived the research work. PMB coordinated the field level data collection. SRM and SG carried out the data analysis. SRM wrote the draft of the manuscript. VK, RI and DN contributed in the literature review, interpretation of results and manuscript revision. All the authors contributed in the revision of the paper and agreed on the final manuscript.

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