HI-AWARE Working Paper 20

Migration in the Lives of Environmentally Vulnerable Populations in Four River Basins of the Hindu Kush Himalayan Region

Consortium members

About HI-AWARE Working Papers

This series is based on the work of the Himalayan Adaptation, Water and Resilience (HI-AWARE) consortium under the Collaborative Adaptation Research Initiative in Africa and Asia (CARIAA) with financial support from the UK Government's Department for International Development and the International Development Research Centre, Ottawa, Canada. CARIAA aims to build the resilience of vulnerable populations and their livelihoods in three climate change hot spots in Africa and Asia. The programme supports collaborative research to inform adaptation policy and practice.

HI-AWARE aims to enhance the adaptive capacities and climate resilience of the poor and vulnerable women, men, and children living in the mountains and flood plains of the Indus, Ganges, and Brahmaputra river basins. It seeks to do this through the development of robust evidence to inform people-centred and gender-inclusive climate change adaptation policies and practices for improving livelihoods.

The HI-AWARE consortium is led by the International Centre for Integrated Mountain Development (ICIMOD). The other consortium members are the Bangladesh Centre for Advanced Studies (BCAS), The Energy and Resources Institute (TERI), the Climate Change, Alternative Energy, and Water Resources Institute of the Pakistan Agricultural Research Council (CAEWRI-PARC) and Wageningen Environmental Research (Alterra). For more details see www.hi-aware.org.

Titles in this series are intended to share initial findings and lessons from research studies commissioned by HI-AWARE. Papers are intended to foster exchange and dialogue within science and policy circles concerned with climate change adaptation in vulnerability hotspots. As an interim output of the HI-AWARE consortium, they have only undergone an internal review process.

Feedback is welcomed as a means to strengthen these works: some may later be revised for peer-reviewed publication.

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Migration in the Lives of Environmentally Vulnerable Populations in Four River Basins of the Hindu Kush Himalayan Region

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Acronyms and Abbreviations

CARIAA	Collaborative Adaptation Research Initiative in Africa and Asia
HI-AWARE	Himalayan Adaptation, Water and Resilience Research
HKH	Hindu Kush Himalaya
ICIMOD	International Centre for Integrated Mountain Development
IPCC	Intergovernmental Panel on Climate Change
PPS	Probability Proportional to Size
USD	United States Dollars

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Abstract

This study is an effort to contribute to the empirical literature on the diverse patterns of migration, adaptation measures by households facing environmental changes, and the role of migration in augmenting household adaptive capacities in four river basins of the Hindu Kush Himalayan (HKH) region, namely the Gandaki, the Indus, the Upper Ganga and the Teesta. Recent studies indicate that migration can be a powerful adaptation strategy for populations facing global environmental changes, by increasing the ability of the households to rely on their existing resource base. However, there still exist gaps in empirical findings, particularly quantitative studies investigating migration and adaptation, to fully support this.

Migration patterns in the study sites are diverse, ranging from seasonal/circular migration to international migration. However, most migration is internal and international migration is limited mainly to South-South movement. Migration is mostly male-dominated; however, female migration is increasing with women getting more educated and seeking employment opportunities in urban destinations. The major driver of migration decisions is economic, but environmental displacement was also prevalent in the study sites. The reasons for migration were consistent across the study basins, but differed between different streams of the same basin.

The adaptive capacities of households in four key sectors are analysed – agriculture, livestock, forestry, and water. The capacity of households to adapt to the negative effects of environmental changes and shocks in the study sites was low, and the adaptation measures undertaken mostly autonomous, except in the case of the water sector. The linkage between migration and household adaptive capacity was found to be positive, but statistically significant only in the agricultural sector. Thus, migration helps households' adaptive capacity by spatially diversifying household income sources, but this potential is limited at present as remittances are small and mostly invested in meeting basic requirements. Thus, at present, migration is more a response strategy of the households to various changes, including environmental changes and their effects on local livelihoods.

1. Introduction

This study examines the patterns of migration, and its role in building adaptive capacities of households in four river basins – the Indus, the Upper Ganga, the Gandaki, and the Teesta – of the Hindu Kush Himalayan (HKH) region. The HKH region is one of the more environmentally vulnerable areas in the world (Eriksson et al., 2009; IPCC, 2013). Mountain ecosystems are as such highly fragile and the livelihoods of mountain people extremely vulnerable to various changes, including global environmental changes (Afifi et al., 2014; Milan and Ho, 2014; Milan et al., 2015). The livelihoods of people living in downstream areas of the HKH region are also highly vulnerable to changes happening in the mountain systems. People in the HKH region, both in the mountainous areas and downstream, have long adapted to living in a fragile environment, including by using labour migration to diversify their livelihoods and spread risk. Labour migration is defined as the "movement of persons from one country to another, or within their own country of residence, for the purpose of employment" (IOM, 2011).

The 'sedentary bias' in development argument overlooks the important role that human mobility and migration play in the livelihoods of mountain people and in hill societies. Development practitioners and policy-makers have looked to development as improving livelihoods of the people in their place of origin. This outlook does not consider the importance of multi-local livelihoods of the mountain people and considers migration as a hindrance to development. It explicitly or implicitly aims to stop the mobility and migration of people. Transhumance mobility is one of the oldest forms of mobility in human history and trans-Himalayan trade was a vibrant economic activity and important livelihood of people living in the higher Himalaya for centuries (Pathak et al., 2017). In due course, the patterns of migration changed and the destinations diversified, but migration continues to be an important livelihood strategy. The HKH region accounted for nearly 19% of the international migrant stock in 2013 and about 29% of the global remittance inflow in 2015 (World Bank, 2017). Internal migration is even higher and accounts for about 30% of India's total population (CoI, 2001), for 14% percent of the population in Nepal (CBS, 2012) and 10% in Bangladesh (BBS, 2015).

Migration has traditionally offered people the opportunity to escape socioeconomic and other pressures in their areas of origin, and to diversify livelihoods in ways that make their households less vulnerable to the impacts of global environmental changes (Greiner and Sakdapolrak, 2013; Hampshire, 2002; Leighton, 2006; Piguet, 2013). While environmental disasters result in displacement, temporary labour migration (in which one or a few members of a household migrate for work while the rest of the family stays behind) plays an important role in rural livelihood strategies in the face of slow-onset climate change impacts such as desertification, soil degradation, variable rainfall patterns, and temperature fluctuations and rise (Tacoli, 2011a). Studies from Burkina Faso have reported one million people, mostly men, participating in circular migration to urban centres or across borders in order to diversify their sources of income in the face of recurring droughts in the 1970s (Hampshire, 2002; Leighton, 2006). Remittances can help in building the adaptive capacities of households in vulnerable areas, particularly when the adaptation option involves significant cash investment by the households (Ng'ang'a et al., 2016). There is an understanding that migration itself can serve as an adaptation strategy in the areas vulnerable to the negative impacts of global environmental change (Bardsley and Hugo, 2010; Black et al., 2011; Lonergan, 1998; McLeman and Hunter, 2010; McLeman and Smit, 2006), by increasing the ability of the households to rely on the existing resources base (Tacoli, 2011b). However, there still exists gaps in empirical understanding as many studies are limited to single documented climatic events or livelihood sectors (Piguet, 2010) and quantitative studies investigating migration and adaptation in diverse environmental changes and multiple sectors are limited (Milan et al., 2015). This study is an effort to contribute to the empirical literature on the diverse patterns of migration, adaptation strategies, and the role of migration in building the adaptive capacities of households in multiple sectors in the HKH region. We analyse the adaptive capacities of households in four critical sectors – agriculture, livestock, forests, and water. The key research questions that this research seeks to answer are the following:

- What are the various types of migration in the study area, and what is the profile of the migrants?
- What are the perceptions of households regarding climate change and its effects on their livelihoods?
- What are the different measures undertaken by households in reducing the negative effects of climate change impacts on the four crucial areas of their lives – agriculture, livestock, forests, and water?
- What is the role of migration in augmenting household adaptive capacities in the study area?

This paper is organized into five sections. Section 1 introduces the topic, the knowledge gaps and objectives of the study. The research methodology follows in Section 2, which presents the study area, survey design and data. Section 3 presents in detail the major results and findings of the study. It is further subdivided into three sub-sections – the facets of migration, environmental changes and shocks, and the adaptation situation. The first sub-section covers the diverse patterns of migration observed in the study area, remittances, and the temporary displacement of households. The sub-section on environmental changes and shocks reports the perception of households about the changes in climatic variables and extreme events in the study sites. The third sub-section presents the proportion of households reporting adaptation measures they have undertaken in four crucial sectors – agriculture, livestock, forests, and water. This sub-section also presents the differences in adaptation by migrant and non-migrant households in the study sites. Section 4 discusses major the findings of the study, and Section 5 summarizes and concludes.

2. Research Methodology

2.1. Study Area

The study area consists of four river basins: the Indus, the Upper Ganga, the Gandaki, and the Teesta. Within the Indus basin, the focus areas are the upstream, glaciated catchment region of the Hunza district, the midstream region of Rawalpindi, and the downstream region of Gujranwala, and Sargodha districts. In the Upper Ganga basin, the study sites are the districts of Rudraprayag in the high mountains, Tehri Garhwal in the mid-hills, and the floodplains of Haridwar. The Gandaki basin's study sites, in Nepal, include Rasuwa district in upstream, Nuwakot district in midstream, and Chitwan district in downstream. They also include Paschim Champaran district in the state of Bihar, India. The study sites in the Teesta basin include the Indian state of Sikkim and Nilphamari and Rangpur districts in Bangladesh (Figure 1).

All the river basins are largely fed by rainfall, particularly the monsoon rains, although glacial melt and snowmelt also play an important role in basin run-off. An exception is the Upper Indus basin, where the contributions of glacial melt and snowmelt to the run-off in the river are comparatively high, whereas the mid-level and the Lower Indus basin is fed largely by rainfall, particularly the monsoon rains.

The topography of upstream and midstream regions is mountainous, whereas downstream areas tend to be flat, plains areas. Agriculture and related activities are the main source of livelihood across the four basins. People mostly practice subsistence agriculture in upstream and midstream areas. Agro-pastoral livelihoods are very popular in upstream areas. In upstream areas of the Indus basin, for instance, apricots, cherries, apples, peaches, pears, and melons are important sources of cash income. Horticulture accounted for nearly 16% of household income in Hunza in 2005 (AKRSP, 2007). In midstream areas of the Upper Ganga basin, other important sources of livelihood include the cottage industry, and tourism-related activities such as running shops, eateries, and guesthouses. Downstream areas are characterized by high-productivity agriculture, with good market access. Downstream areas of the Indus and Upper Ganga basins have good road and railway connectivity, as well as market access, and agriculture is much more commercialized.

In general, the socioeconomic situation in upstream and midstream areas is poor as compared to downstream areas due to constraints specific to mountainous areas, such as poor accessibility, fragility, and marginalization.[7] With limited employment opportunities in both farm and non-farm sectors, outmigration has been the key in the search for better livelihoods, particularly from the mountainous areas. For instance, in Uttarakhand, India, where the Upper Ganga catchment is confined, all the mountain districts have recorded less than 5% decadal growth rates in their population, including the study areas Rudraprayag and Tehri Garhwal. Indeed, the 36 hill and mountain districts in Nepal have recorded negative decadal growth rates of population, including the study sites, Rasuwa and Nuwakot districts. An exception again is Sikkim, part of Teesta river basin, where at the macro level, in-migration far exceeds outmigration. But even in Sikkim, the outmigration of educated youth in search of better employment is common.

[7] Sikkim in India is an exception due to the implementation of various state development programmes (GoS, 2015).

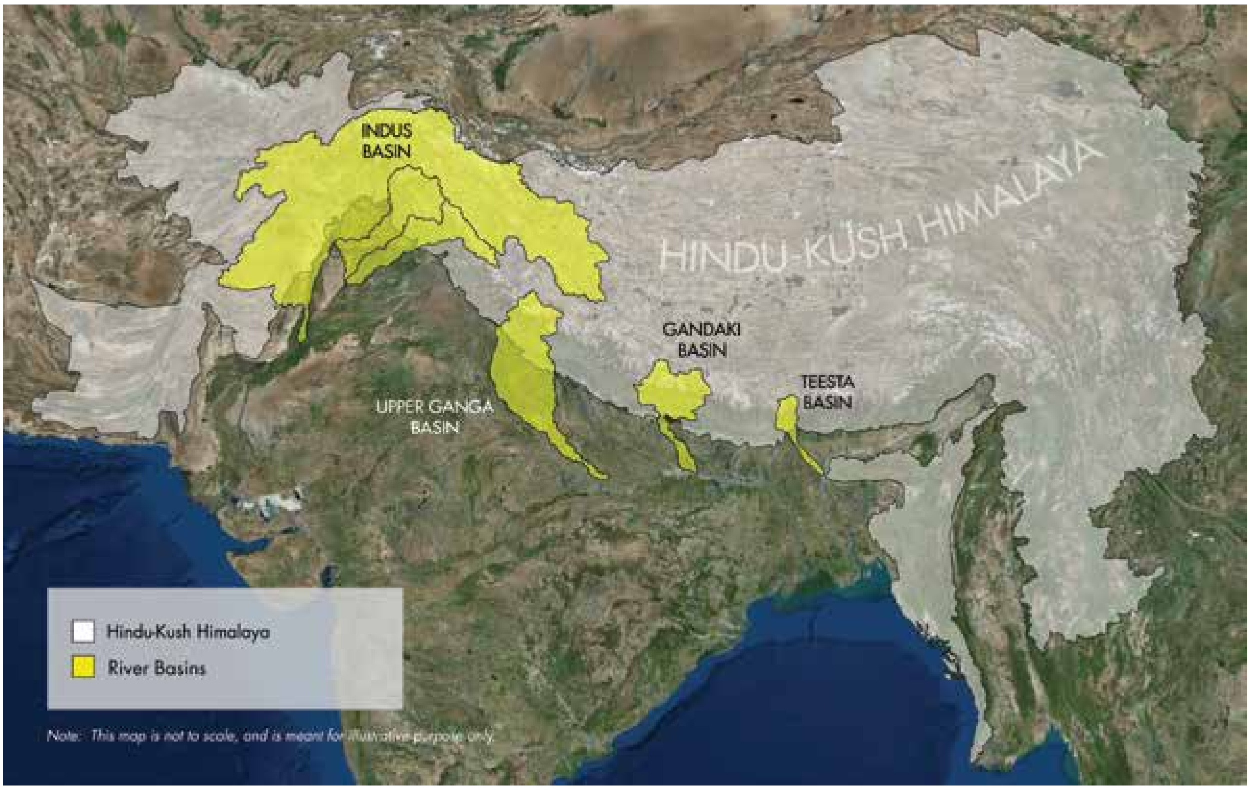

Figure 1: Map of the study sites across the four river basins

2.2. Survey Design and Data

To determine the sample size for the study sites in the four river basins – the Indus, the Upper Ganga, the Gandaki, and the Teesta – Cochran's sample size formula (Cochran, 1977) was used.

$$n = D \times \left[\frac{Z^2 \times (p) \times (1-p)}{e^2} \right] \qquad \text{..Eq.1}$$

Where,

n = sample size (?)

p = percentage of households picking a choice (expressed as decimal = 0.5), and *(p) x (1-p)* expresses an estimate of variance

Z = Z-value (1.96 for 95% confidence interval)

e = margin of error (0.06); and

D = design effect (1.50).

To compensate the loss of statistical robustness during the stratification procedure in sampling design, this study has considered 'design effect' in the sample size formula. Design effect is basically the ratio of the actual variance, under the sampling method actually used, to the variance computed under the assumption of simple random sampling.

Table 1: Sample size of the study areas

River basins and strata	Altitude	Determined sample size	Surveyed sample size
Indus (Pakistan)	Upstream	134	127
	Midstream	134	131
	Downstream	134	155
Sub-total (A)	-	402	413
Upper Ganga (India)	Upstream	134	164
	Midstream	134	159
	Downstream	134	161
Sub-total (B)	-	402	484
Gandaki (Nepal and India)	Upstream	134	202
	Midstream	134	200
	Downstream	134	201
Sub-total (C)	-	402	603
Teesta (India and Bangladesh)	Upstream	134	84
	Midstream	134	166
	Downstream	134	237
Sub-total (D)	-	402	487
Total (A+B+C+D)	-	1,608	1,987

Using Eq. 1, a sample size of 402 households was determined for each river basin. However, the number of actually surveyed households is higher than the determined sample sizes in all the four river basins (Table 1).

To survey these sampled households, a stratified sampling technique was adopted. For each river basin, three strata – upstream, midstream, and downstream – were established in view of the significant differences in terms of socioeconomic, climatic, and biophysical factors between these three strata. Sub-samples of an equal size were allocated to the strata to avoid unreliable stratum-specific results due to a low sample size, because there is a substantial difference in the household populations across strata. In each stratum, districts, and study settlements within districts, were selected purposively in view of their high vulnerability to climate change-induced impacts. The sub-sample of each stratum was distributed across selected settlements using the 'probability proportional to size' (PPS) method. The data and findings of the study may not be the true representative at the river basin and stratum levels due to the purposive selection of districts and settlements within districts.

A standardized questionnaire was prepared to collect data from households. The survey was administered from June to September 2017 in all the study sites. The enumerators were asked to select the respondents in households based on two factors. First, the respondent ought to be over 25 years of age because the questionnaire contained a number of questions regarding perceptions about past events, and they were required to recall the situation from 5–10 years ago. Second, if both female and male members (>25 years old) were present in the household, it was considered preferable to interview the female member (if involved in agriculture, livestock, and other livelihood activities) to allow their adequate representation in the sampling.

We begin the study by analysing the migration situation, major environmental stressors, and the household adaptation mechanisms in the study areas. The analysis is carried out using descriptive statistical tools (means, frequencies, percentages, and the unpaired t test), and supported by field narratives. We also present the diversity seen amongst the four river basins, as well as upstream, midstream, and downstream regions within the river basins.

Drip irrigation method to adapt to water stress in Sargodha (downstream area of Indus)

3. Results

This section presents the results of the study's findings about the migration situation, perceived changes in climatic variables and environmental shocks, adaptation measures, and the differences in household adaptive capacities between migrant and non-migrant households.

3.1. Different Facets of Migration

Migration is an important livelihood strategy in the study area, undertaken by households from different socioeconomic strata, their major objective being improving their livelihoods. On average, about 39% of the households reported having at least one migrant member (Table 2). A household member is considered as a migrant, if he/she spends more than three months away from home for work, study, or any other purpose. The proportion of households reporting migrant members was higher in mountainous areas as compared to the plains[8].

Table 2: Households (%) with at least one migrant

	Gandaki	Indus	Teesta	Upper Ganga	Total
Upstream	56	59	31	24	44
Midstream	47	31	37	75	48
Downstream	37	26	34	7	28
Total	47	38	35	35	39

This section presents the results of the study's findings about the migration situation, perceived changes in climatic variables and environmental shocks, adaptation measures, and the differences in household adaptive capacities between migrant and non-migrant households.

Female migration: About 17% of the households across the four basins reported having female migrant members. Higher levels of female migration were also reported from the mountains as compared to the plains (Table 3). The highest female migration was reported from the Teesta, upstream and midstream (Sikkim, India). Interestingly, the upstream areas in the Upper Indus also had 17% households with female migrants. Women in this region are highly educated, participate in the labour market, and often move for work. This is consistent with the findings of other studies from the region (Gioli et al., 2014). In fact, the enumerators in the Indus basin believe that these figures are an underestimate, as households often do not want to share information about their female family members.

Table 3: Proportion (%) of female migrants

	Gandaki	Indus	Teesta	Upper Ganga	Total
Upstream	35	17	38	17	29
Midstream	7	0	49	0	11
Downstream	9	2	8	8	7
Total	22	9	29	4	17

Note: As a percentage of total migrants.

[8] A similar elevation difference in migration has also been noted in Tanzania by Milan et al. (2015).

Labour migration: A household member is considered as a labour migrant, if he/she spends more than three months away from home for work purpose. Henceforth, the term 'migration' in this paper refers to 'labour migration'. About 29% of the households reported having at least one labour migrant (Table 4). The proportion of migrant households in each basin as a whole was very similar (around 30%) except for the Teesta basin (24%). However, in general, labour migration is higher in the mountainous areas (midstream and upstream) compared to the plains (downstream). In upstream areas, migration was the highest in the Upper Indus (46%), in midstream areas in the Upper Ganga (72%), and in downstream areas in the Teesta basin (31%). Of the four study basins, the Upper Ganga showed the highest variability in migration, with midstream areas reporting the highest migrant household proportion (72%) and downstream areas the lowest (7%).

Table 4: Households (%) with at least one labour migrant

River basin	Upstream	Midstream	Downstream	Overall
Gandaki	18	41	30	30
Indus	46	26	21	31
Teesta	21	15	31	24
Upper Ganga	16	72	7	31
Total	24	39	23	29

Type and duration of migration: A very high diversity in migration type (Table 5) and duration was observed in the study sites. Consistent with other findings (Gioli et al., 2014; Hugo 1996; Warner and Afifi, 2014), internal migration was found to be the most dominant migration type, reported by about 80% of the households across the four basins. This ranged from 47% (Gandaki) to 99% (Teesta). There was seasonal migration (spending less than six months in a year at the destination) to long-term migration (up to 25 years) reported. Seasonal migration is the most dominant form of migration in downstream Gandaki (Bihar, India) and downstream Teesta (Bangladesh). Temporary and long-term internal migration is the main migration type in the other two basins.

When migration destination was international, as seen in case of Gandaki and Teesta basin, it was mostly to Gulf countries and Malaysia.

Table 5: Type of migration (% households)

River basin	Migration	Upstream	Midstream	Downstream	Overall
Gandaki	Internal*	41	46	51	47
	International*	58	54	49	53
Indus	Internal	94	89	66	86
	International	6	10	34	14
Teesta	Internal	100	100	99	99
	International	0	0	1	1
Upper Ganga	Internal	100	96	75	95
	International	0	4	25	4
Total	Internal	82	82	76	80
	International	18	18	24	20

*computed among the households who sent at least one out-migrant

Varied reasons to migrate: As Faist and Shade (2013) have highlighted, people move in response to the world around them, an evolving relationship largely shaped by subjective and non-environmental factors. This observation also holds true in the study sites, where people reported various reasons for their decision to migrate. Not all household members move for purposes of labour or work. In 12% of the households surveyed, at least one member reported migrating for education. The proportion of education migrants was also generally higher from upstream areas, with the highest reported from upstream Gandaki (Rasuwa district, Nepal). This conforms with findings from other studies, which show that people migrate from mountainous areas due to a lack of access to basic services such as quality education, and health facilities (Pathak et al., 2017).

The reasons for migration were more consistent across the study basins but differed between different strata of the same basin. In upstream areas of all four basins, education was the major reason for migration followed by employment, whereas in midstream and downstream areas, seeking employment was the major driver (see Annexure 1).

Interestingly, in upstream areas of the Teesta and Upper Ganga basins, people moved to have better jobs as compared to the ones they were holding prior to migration. Thus, rather than unemployment, better paid employment was the reason for their decision to migrate. This was further confirmed when on being asked, "What was the occupation of the migrant before migration?", a large proportion of migrants reported holding full-time work before migration, particularly in upstream areas (Annexure 2). When asked further, "What is the reason for choosing a particular destination?", a majority of households reported better job opportunities and better wages as being the major drivers. Interestingly, very few households reported a migrant social network (having friends and family in the destination) and the cost of migration as being reasons for choosing a destination. This finding contrasts with other migration studies in the region, in which the migrant social network and cost of migration are considered important determinants of the decision to migrate as well as the choice of destination (Maharjan, 2010; Thieme, 2006).

Annual remittances: Of the migrant households, about 78% reported receiving remittances in the prior 12 months (Annexure 3). Upstream regions reported the lowest proportion of households receiving remittances (65%) as compared to households in midstream and downstream regions. The frequency of receiving remittances in a year was the lowest in upstream areas (five times annually) with the very lowest reported in upstream areas of the Gandaki basin (three times per annum). This indicates the difficulty in receiving remittances in mountainous areas, with their low access to financial institutions such as banks and money-transferring entities.

The average annual internal remittances were reported as USD 543 while international remittances were USD 1,703, more than three times internal remittances. International remittances were almost consistent across the basins, but internal remittances showed a high degree of variability, with the Indus basin reporting the highest average internal remittances (USD 1,041) and the Upper Ganga the lowest (USD 144). Similarly, differences were observed between households at different altitudes, with upstream areas reporting the highest amount (USD 965) (see Annexure 4 for more details). Migration also involves some financial costs, which expectedly was higher for international migration. This was USD 1,490 on average, as compared to USD 199 for internal migration. Again, similar to remittances, the cost of migration was reported being the highest for upstream regions (USD 326) and the lowest downstream (USD 79). Annexure 5 has more details.

Displacement: As the objective of this study is to explore various types of migration in the study area, the surveyed households were also asked about their experience regarding displacement. Displacement is defined as "a forced removal of a person from his or her home or country, often due to armed conflict or natural disasters" (IOM, 2011, p 29). When environmental degradation, deterioration, or destruction is a major cause of the displacement of people, even if not necessarily the sole one, they are known as environmentally displaced persons (IOM, 2011, p 34).

Our study shows that apart from labour migration, environmental changes, particularly extreme events, have resulted in the displacement of people, either temporarily or permanently. As permanently displaced households are not captured in our household survey, this is a limitation of the study that needs to be investigated in future studies. However, temporary displacement is captured by the question: "Have you been displaced temporarily due to extreme events in the last 10 years?" A higher proportion of the households reported being temporarily displaced by extreme events in the Indus (17%) and Teesta (16%) basins, followed by the Upper Ganga and Gandaki basins. Also, displacement was reported more by downstream households, except in the case of the Indus basin, where 22% households in upstream areas reported displacement (Table 6).

Table 6: Displacement due to natural hazards (% reporting households)

River basin	Upstream	Midstream	Downstream	Overall
Gandaki	1	3	5	3
Indus	22	4	22	16
Teesta	1	0	35	17
Upper Ganga	4.	6	1	3
Overall	7	3	17	10

Flooding has been a major cause of temporary displacement in downstream areas of the Indus and Teesta basins. In upstream regions of the Indus and Upper Ganga basins, extreme rainfall and cloudburst were reported as major drivers.

Another interesting finding pertains to the proportion of households reporting temporary displacement by migration status. A much higher proportion of migrant households reported having been temporarily displaced over the last decade, as compared to non-migrant households (Figure 2)

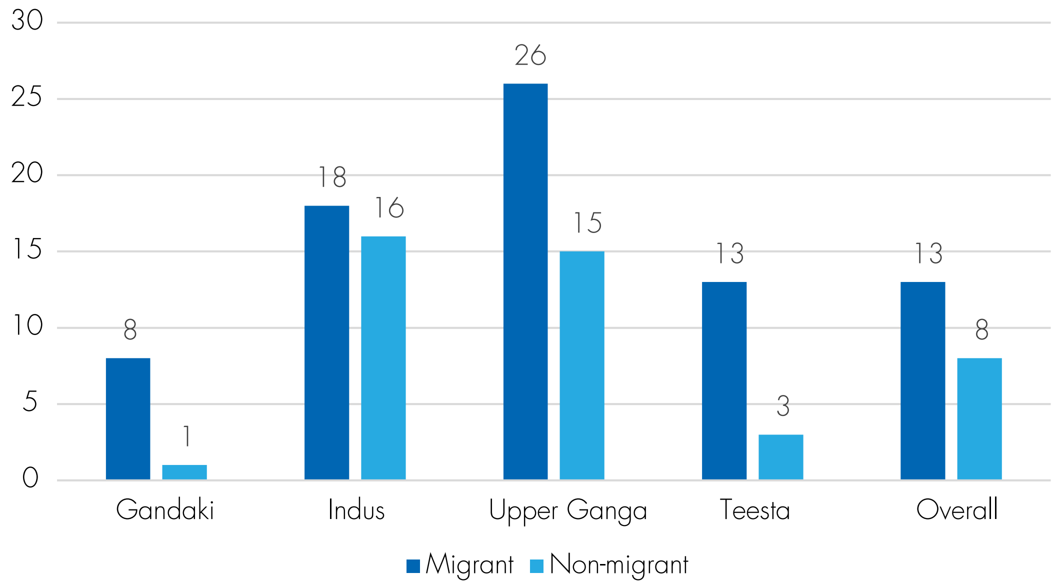

Figure 2: Households temporarily displaced due to extreme events, by migration status (%)

The households were further asked, "Have you lost property during extreme events in the last 10 years?" Their responses are given in Figure 3. Again, an interesting finding is that a higher proportion of households in the Indus and Teesta basins reported a loss of property due to an extreme event, and a greater proportion of migrant households reported losses than non-migrant households. It is not clear whether the higher losses of property and temporary displacement faced by migrant households vis-à-vis non-migrant households had any effect in their decision to migrate. A multi-causal analysis of the drivers of migration would help in better understanding.

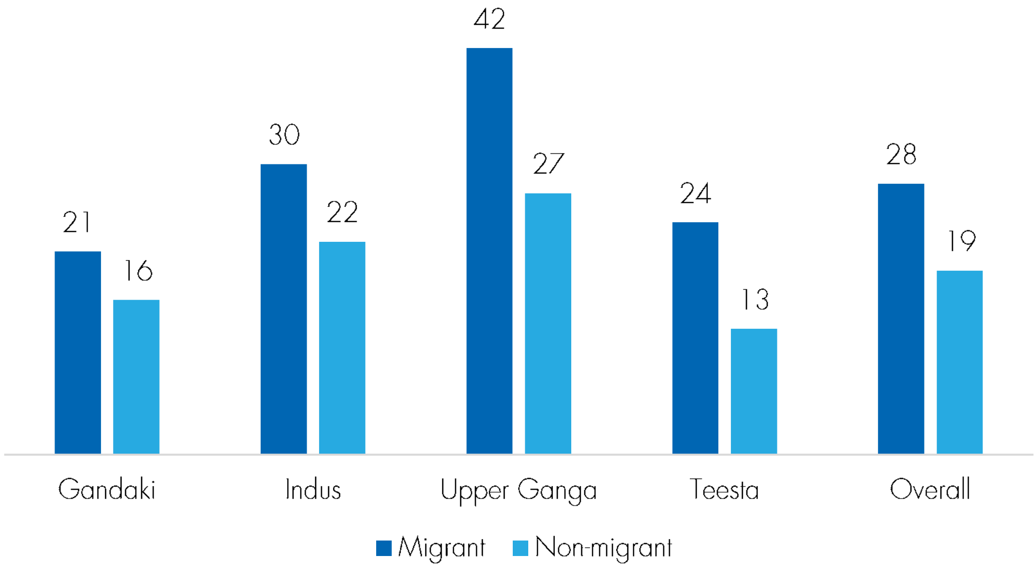

Figure 3: Households reporting a loss of property due to extreme events over last 10 years, by migration status (%)

3.2. Environmental Changes and Shocks

A wide range of environmental stressors were reported in the four river basins under study (Table 7). A majority of the households (91%) reported perceiving changes in the climate and experiencing environmental shocks over the last decade. There was no significant difference in the perception of environmental changes between migrant (86%) and non-migrant (93%) households, except in the Upper Ganga basin, where only 57% of migrant households perceived a change in climatic variables as compared to 89% of non-migrant households.

The perceptions of households about changes in various climatic variables in the last decade are presented in Table 7. A majority of households perceive an increase in annual average temperature, summer average temperature, and winter average temperature. Households also reported a decrease in rainfall but more erratic rainfall. Snowfall in upstream regions has decreased, except in the Teesta basin, where a higher proportion of households reported no change in snowfall. Hailstorms were also considered important, but perceptions about their occurrence differed across the river basins. In the Gandaki basin, a majority of the households (51%) reported that the incidence of hailstorms had decreased over the last decade, whereas in the Upper Ganga basin, 57% of the households felt it had increased. The level of perception between increase and no change was almost equal in the Indus and Teesta basins.

Table 7: Perceptions of households about changes in climatic variables (%)

Climatic variables	Gandaki	Indus	Teesta	Upper Ganga	Overall
Annual average temperature					
Decreased	2	0	19	4	6
Increased	85	96	66	79	81
No change	13	4	15	17	12
Summer average temperature					
Decreased	3	1	23	6	8
Increased	86	96	63	83	81
No change	12	3	15	11	11

Winter average temperature					
Decreased	26	33	37	19	28
Increased	59	61	46	58	56
No change	16	7	17	24	16
Erratic rainfall					
Decreased	23	9	8	1	11
Increased	63	62	80	90	73
No change	14	29	11	9	15
Average rainfall					
Decreased	70	46	48	60	57
Increased	24	38	38	31	32
No change	6	16	15	8.	11
Snowfall					
Decreased	32	30	15	44	30
Increased	2	8	1	2	3
No change	2	10	18	16	11
Not applicable	64	52	66	38	56
Hailstorms					
Decreased	51	16	22	9	27
Increased	32	27	32	58	37
No change	14	25	30	33	25
Not applicable	3	31	16	1	11

The households were also asked about changes observed in different sectors relating to their lives and livelihoods as a result of the environmental changes (Table 8). Their responses to this were much more diverse across the basins, as compared to perceptions regarding changes in climatic variables. Across the basins, households perceive an increase in the drying up of freshwater sources and the occurrence of other hazards. For other impacts such as water availability, health etc. the responses of households in the Gandaki and Teesta basins and that of the Indus and Upper Ganga basins were similar. A greater proportion of respondents in the Gandaki and Teesta basins reported 'no change' in the availability of water for domestic use and in the extent of human sickness, whereas a greater proportion of households in the Indus and Upper Ganga basins perceived an increase in both these variables.

The impacts on the agricultural sector have been diverse, with an increase in crop disease and pest attacks reported across the basins. Respondents in the Gandaki basin reported an increase in crop productivity whereas those in the other three basins reported a decline in crop productivity. It must be pointed out that among the four basins, Gandaki currently has the lowest crop productivity due to its lower agricultural input use, and thus it has the greatest potential for improvements in productivity.

A higher proportion of households in the Gandaki and Teesta basins reported no perceived changes in the kind or severity of livestock diseases (though it was still significant in the Gandaki basin, with about 37% households reporting it had increased). A majority of households in those two basins had a similar response regarding livestock productivity, whereas the Indus and Upper Ganga basins reported an increase in livestock disease and a decrease in livestock productivity. Similarly, a higher proportion of households in the Gandaki and Teesta reported 'no change' in the conditions of pasture land but in the Indus and Upper Ganga basins, an increase in the degradation of pasture land was reported.

Table 8: Perceptions of households about the impacts of climate change (%)

Climate change impacts	Gandaki	Indus	Teesta	Upper Ganga	Overall
Water availability for domestic use					
Decreased	30	21	26	33	28
Increased	31	45	30	45	34
No change	39	34	53	22	35
Water availability for crops and animals					
Decreased	39	27	24	18	28
Increased	28	41	17	28	28
No change	28	24	46	28	32
Not applicable	4	7	12	26	12
Drying up of freshwater sources					
Decreased	8	5	15	2	7
Increased	57	37	42	73	53
No change	25	33	35	21	28
Not applicable	10	25	7	4	11
Occurrence of sickness in human					
Decreased	7	6	12	1	7
Increased	32	74	34	66	49
No change	59	14	49	28	39
Not applicable	2	6	4	5	4
Crop productivity					
Decreased	35	50	30	53	41
Increased	42	20	28	5	25
No change	17	18	25	12	18
Not applicable	6.	11	16	29	15
Incidence of disease/pests in crops					
Decreased	5	5	7	1	5
Increased	75	69	56	61	65
No change	13	13	20	8	13
Not applicable	7	14	17	29	16
Livestock productivity					
Decreased	18	42	7	36	25
Increased	17	19	22	7	16
No change	46	29	51	26	39
Not applicable	19	10	19	31	20
Incidence of livestock diseases					
Decreased	4	6	7	3	5
Increased	37	62	23	41	40
No change	384	20	50	23	34
Not applicable	214	12	20	33	22

Degradation of pasture land					
Decreased	7	7	10	4	7
Increased	8	43	6	31	21
No change	22	22	22	9	19
Not applicable	63	28	62	56	54
Occurrence of other hazards					
Decreased	6	8	16	1	8
Increased	71	58	46	64	61
No change	22	27	35	20	25
Not applicable	1	7	4	14	6

The households were also asked about changes in the occurrence of extreme events over the last decade (Table 9). Most of the extreme events are related to water – droughts, floods, and intense rainfall being the most common across the four basins. An increase in droughts was reported by about 28% of the households across all four basins, in floods by 22%, and intense rainfall by 24% of households. Expectedly, perceptions about some of these events were more pronounced in some river basins than others, such as droughts in the Gandaki (54%), and floods in the Teesta (38%). Apart from these extreme events, an increase in heat waves was also reported in the Indus basin (30%) and cloudbursts in the Upper Ganga (19%).

Table 9: Perceptions about changes in the occurrence of extreme events in the last decade (% reporting households)

Environmental stressors	Gandaki	Indus	Teesta	Upper Ganga	Overall
Droughts	54	11	22	1	28
Floods	7	27	38	19	22
Intense rainfall	8	26	32	34	24
Landslides	5	9	13	13	10
Heat wave	2	30	0	3	8
Cold wave	0	5	2	0	2
Waterlogging	0	3	2	11	4
Storms/thunderstorms	4	0	14	2	5
Cloudbursts	0	1	0	19	5
Erosion	0	4	8	2	3

3.3. Adaptation Measures and the Role of Migration

Adaptation is defined as the process of adjustment to the actual or expected climatic change and its effects, which seeks to moderate the harmful, or exploit beneficial opportunities (IPCC, 2014). Adaptive capacity refers to 'the ability of people, the system, or society to transform structure, function or organization to manage better their response to weather hazards and other negative changes' (IPCC, 2012, p 72). Adaptation has a temporal dimension (short-term or long-term), and can be incremental or transformative. Sometimes, the measures taken by households and organizations to reduce the negative effects can also be a maladaptation, particularly when the temporal dimension is considered (see Magnan et al., 2016). However, in this study, the responses are simply referred to as adaptation measures.

Households were asked about the various measures they had undertaken to reduce the negative impacts of environmental changes (both slow onset changes and extreme events) in four key sectors – agriculture, livestock, forests, and water. The highest adaptation was in the water sector, followed by agriculture, livestock, and forests. Only in the case of the Gandaki basin is it different – the highest adaptation is in the agricultural sector (47%), followed by the water sector (21%). In the Gandaki basin, agriculture is the major source of livelihood for more than 80% of the households, thus the prioritization of this sector for adaptation by households there (Table 10).

Table 10: Proportion (%) of households practising at least one adaptation practice, by sector

River basin	Agriculture	Livestock	Forests	Water
Gandaki	46.6	11.44	9.92	21.39
Indus	32.13	29.95	17.87	42.75
Teesta	18.52	10.29	1.65	23.25
Upper Ganga	16.12	13.02	1.03	58.26
Total	29.29	15.40	7.30	35.28

3.3.1. Agricultural sector

Adaptation in the agricultural sector is diverse across the river basins and the three strata (Table 11). Overall, adaptation is lower in mountainous areas compared to the plains. The proportion of households reporting undertaking at least one adaptation option was the highest in the Gandaki basin (47%) and the lowest in the Upper Ganga (16%). In the Gandaki and Upper Ganga, the lowest adaptation occurred upstream, but it was the highest in the Indus and the Teesta basins.

Households in the Gandaki and the Upper Ganga basins reported the lowest number of adaptation measures taken (a maximum of four), whereas the Indus and the Teesta reported up to seven adaptation measures. On average, the highest average number of adaptation measures was reported in the Indus basin (3.24).

In upstream sites in both the Gandaki and Upper Ganga basins, a permanent outmigration of whole families is very high, as indicated by the negative decadal growth rate of population in the study districts (CBS, 2011; CoI, 2011). This large-scale depopulation has negatively impacted existing socioecological systems, increased human–wildlife conflict and increased invasive species, with negative consequences in the agricultural sector, including adaptation to environmental changes. The overall impact of these changes is contributing to the neglect or abandonment of agricultural lands in these study sites (Pathak et al., 2017).

Table 11: Proportion (%) of households reporting adaptation in the agriculture sector

River basin	Upstream	Midstream	Downstream	Overall
Gandaki	10	58	72	47
Indus	50	26	23	32
Teesta	30	8	22	18
Upper Ganga	2	25	21	16
Overall	20	31	35	30

The households were asked about the various adaptation practices they had undertaken to cushion the negative impacts of the environmental changes. Their adaptation practices vary among the four basins (Table 12), which is understandable given that the environmental stressors also vary across the study areas. The five most common ones across the study areas are: (i) adjusting the crop timing; (ii) the greater use of insecticides/pesticides; (iii) the introduction of new crop varieties; (iv) improved irrigation; and (v) shifting to non-farm activities.

The most popular adaptation measure reported from the Gandaki basin is using pesticides and insecticides (55%) to reduce crop damage from increased pest attacks and incidence of disease. A higher proportion of households in Gandaki basin had perceived an increase in pest attacks and disease, and hence this adaptation practice is logical. Changing the cropping cycle and crop timings were the most popular adaptation measure in the Indus and Teesta basins respectively. In the Upper Ganga basin, almost 60% of the households mentioned that they have shifted from farm to non-farm activity as a household strategy to adapt to the impacts of climate change. During focus group discussions, it was revealed that apart from climate change in the last decade, there has been an increase in wildlife and invasive species in the area. The declining village population means that there are fewer household cultivating crops thus proportionately increasing the damage from wildlife and invasive species on the limited cropped areas. As there is a lack of critical mass interested to invest in controlling these damage, the traditional ways of dealing with these challenges are ineffective, making agriculture extremely risky for those left behind. Thus, many households reported preferring to leave farming altogether. Such a shift in occupation might be a successful adaptation strategy if it were to lead to higher resilience, but could be a failure if household vulnerability increases. This phenomenon needs further investigation, and is beyond the scope of this study.

Table 12: Adaptation practices in different basins in the agricultural sector (%)

Major adaptation practices	Gandaki	Indus	Teesta	Upper Ganga	Overall
Adjustment of crop timings	31	26	34	5	27
Introduction of new crop varieties	31	36	19	3	27
Use of pesticides/insecticides	55	3	4	4	27
Improved irrigation	9	24	28	3	13
Shifting to non-farm activities	1	18	–	59	12
Use of organic fertilizer	7	20	25	1	11
Changes in cropping cycle	1	31	10	16	10
Change in cropping patterns	3	32	14	3	10
Introduction of new technologies	1	14	29	5	8
Improved harvesting system	–	28	14	1	7
Practice of growing compatible crops	1	12	11	13	6
Improved storage systems	2	19	8	–	6
Shift in system	–	18	1	–	3
Rainwater harvesting	–	6	7	–	2
External support	0	2	3	7	2
Adopting local seeds	0	3	5	–	1
Improved marketing	–	4	2	–	1
Accessed insurance	–	3		2	1

Note: Numbers refer to percentage of adopting households.

The differences in percentage of adapting households by status of migration (migrant and non-migrant) were analysed, and Pearson's Chi-square test of independence was applied to examine the statically relationship of migration status and adaptation. The results show that, overall, a higher proportion of migrant households reported undertaking adaptation measures to reduce the negative impacts of environmental changes (Table 13). Chi-square test results show that migration status and adaptation, except in Teesta basin, have statistical relationship.

Table 13: Households reporting adaptation in agriculture sector, by migration status (%)

River basin	Migrants		Non-migrants		Pearson Ch² test (P-values)
	Adapters [a]	Non-Adapters	Adapters	Non-Adapters	
Gandaki	42	58	51	49	0.035**
Indus	38	62	28	72	0.038**
Teesta	21	79	17	83	0.340
Upper Ganga	20	80	14	86	0.054*
Overall	32	68	28	72	0.033**

Note: ***, ** & * show statistical significance respectively at 1%, 5% and 10% levels. Significant values reveal that there is statistical relationship between migration status and adaptation.

[a] Adapters are those households who have taken at least one adaptation measures to reduce the negative effects of environmental change

3.3.2. Livestock sector

Overall, only 15% of the households reported undertaking adaptation measures in the livestock sector, the highest in the Indus basin (30%) and the lowest in the Teesta basin (10%). In this sector as well, adaptation was higher in the plain areas than in mountainous areas, and a wide variation was observed between the streams/strata in each basin. Among the basins, livestock forms an important part of local livelihoods in the upstream Indus basin, and thus adaptation is also the highest in this area (45%), whereas in other mountainous areas, it is very low (Table 14).

Table 14: Proportion (%) of households reporting adaptation in the livestock sector

River basin	Upstream	Midstream	Downstream	Overall
Gandaki	7	13	13	11
Indus	45	18	28	30
Teesta	1	1	20	10
Upper Ganga	1	5	33	13
Overall	13	9	23	15

The five most popular adaptation measures reported were: (i) improved animal sheds; (ii) investment in disease/pest control (medication and vaccinations); (iii) switching to native breeds; (iv) shifting to new breeds; and (v) external support. The preferred adaptation measures differed among the study basins (Table 15). In the Gandaki basin, investment in disease/pest control is the most popular measure; in the Indus and Teesta basins, improving sheds predominates; in the Upper Ganga basin, switching animal breeds is the preferred option. About 14% of the households also reported abandoning animal husbandry as an occupation and shifting to non-farm activities. About 10% reported undertaking livestock insurance to reduce losses; such households were higher in the Indus basin.

Table 15: Adaptation practices in different basins in the livestock sector (%)

Major adaptation practices	Gandaki	Indus	Teesta	Upper Ganga	Overall
Improved animal sheds	4	56	60	25	38
Investment to cope with pests and diseases	42	48	20	16	35
Switching to native breeds	–	9	25	63	21
Introduction of new breeds	5	16	17	44	20
External support	–	–	22	4	16
Shifting to non-farm occupations	3	35	3	–	15
Vaccinations and medication	45	–	2	8	12
Improved access to insurance	3	23	2	–	10
Use of new technologies and practices	3	15	17	3	10
Rehabilitation of ponds and the water supply system	1	18	7	1	9
Improved marketing		15	3	5	7

Note: same as under Table 12

In general, adaptation in the livestock sector was almost similar in both migrant than non-migrant households (Table 16). However, in Indus and Teesta, percentage of adapting households in livestock is higher among migrant households, compared to non-migrant households. Contrastingly, in Upper Ganga, percentage of adapting households among non-migrant households is higher. Chi-square test results shows that only in Upper Ganga, migration status and adaptation have statistical relationship.

Table 16: Households reporting adaptation in the livestock sector, by migration status (%)

River basin	Migrants		Non-migrants		Pearson Ch² test (P-values)
	Adapters	Non-Adapters	Adapters	Non-Adapters	
Gandaki	12	88	11	89	0.874
Indus	33	67	28	72	0.271
Teesta	13	88	9	91	0.243
Upper Ganga	6	94	17	83	0.001***
Overall	15	85	16	84	0.630

Note: same as under Table 13

3.3.3. Forestry sector

Adaptation in the forestry sector was the lowest among the four sectors under study, with only 7.3% of households overall reporting undertaking adaptation measures in forestry (Table 17). Forests in the study area either belong to the state or to the community; rarely are they privately owned. This explains the lower adaptation rates in this sector.

Basin-wise, the highest adaptation is in the Indus basin (18%) and the lowest in the Upper Ganga basin (1%). Among the four study sites, forest degradation is the highest in the Indus basin. The total area under forests in Pakistan is only about 5% (Rasul and Hussain, 2015; Shahbaz et al., 2007). Thus, the Government of Pakistan has put in forest protection and reforestation policy and programmes in the recent years, including in the Indus basin.

Table 17: Proportion (%) of households reporting adaptation in the forestry sector

River basin	Upstream	Midstream	Downstream	Overall
Gandaki	5	22	2	10
Indus	20	8	24	18
Teesta	0	1	3	2
Upper Ganga	1	0	2	1
Overall	7	8	7	7

Among the various adaptation measures undertaken in the forest sector to overcome the negative impact of environmental changes, the five most popular measures were: (i) rehabilitation of degraded areas; (ii) removal of invasive species; (iii) use of scientific forest management; (iv) conservation of rare and threatened species; and (v) soil and water management practices (Table 18). In the forestry sector, the most popular adaptation measure across the study basins is the use of scientific forest management, such as using improved nursery management, improved plantation methods, sustainable harvesting, etc.

Table 18: Adaptation practices in different basins in the forestry sector (%)

Major adaptation practices	Gandaki	Indus	Teesta	Upper Ganga	Overall
Rehabilitation of degraded areas	8	55	–	40	32
Removal of invasive species	30	33	25		30
Improved plantation methods	9	45	50		29
Use of scientific forest management	11	31	25		21
Conservation of rare and threatened species	3	33	–	–	18
Better forest management	42	–	–	–	18
Soil and water management practices	1	29	25	–	16
Improved disease/pest control	–	29	12	20	16
Use of fire protection measures	9	21	–	20	15
Improved nursery management practices	–	19	12	–	10
Community management of forests	5	–	–	–	2
Less use of firewood	–	1	–	20	1
Planting of trees on private land	3		–	–	1
Organic manuring		–	12	–	1
Shift to other crops				20	1
Own business	2		–	–	1

Note: same as under Table 12

The difference in the percentage of adapting households between migrant and non-migrant groups in the study basins was very small in the forestry sector (Table 19). In Gandaki, percentage of adapting households is slightly higher in migrant households compared to non-migrants. However, Chi-square test does not show any statistical relationship between migration status and adaptation.

Table 19: Households reporting adaptation in the forestry sector, by migration status (%)

River basin	Migrants		Non-migrants		Pearson Ch^2 test (P-values)
	Adapters	Non-Adapters	Adapters	Non-Adapters	
Gandaki	11	89	8	92	0.236
Indus	17	83	18	82	0.779
Teesta	2	98	2	98	0.860
Upper Ganga	0	100	2	98	0.097*
Overall	8	92	7	93	0.454

Note: same as under Table 13

3.3.4. Water sector

The overall rate of household adaptation in the water sector was 35%. Consistent with the other sectors, it was higher in the plains compared to mountainous areas (Table 20). However, there was a wide variation in the adaptation rate within the basins and across downstream areas of the different basins. The highest adaptation was reported in downstream areas of the Upper Ganga (86%), and the lowest in downstream areas of the Gandaki basin (9%). In downstream areas of the Upper Ganga, government investment in providing piped water supply replacing traditional practices has helped households to have better access to water, which is likely the reason for the high adaptation levels.

Table 20: Proportion (%) of households reporting adaptation in the water sector

River basin	Upstream	Midstream	Downstream	Overall
Gandaki	22	33	9	21
Indus	46	33	49	43
Teesta	18	13	32	23
Upper Ganga	39	50	86	58
Total	31	32	41	35

The most popular five adaptation practices to overcome the negative effects of environmental changes in water sector in the study sites are: (i) switching to an alternative water supply source (mostly piped water supply); (ii) the maintenance/protection of water sources; (iii) construction of water storage mechanisms; (iv) an improved recharge system; and (v) the construction of a resilient water supply system (Table 21). There was consistency among the adaptation measures across the study sites.

Table 21: Adaptation practices in different basins in the water sector (%)

Major adaptation practices	Gandaki	Indus	Teesta	Upper Ganga	Overall
Alternative water supply	37	43	48	87	60
Maintenance/protection of water sources	15	56	18	3	21
Construction of water storage mechanisms	30	16	7	1	11
Improved recharge system	–	17	22	–	8
Construction of a resilient water supply system	11	15	12	–	8
Water treatment and purification	3	14	4	7	7
Water-efficient technologies	3	10	19	1	6
Improved household and community hygiene	6	16	6	0	6

Health measures and services	–	12	6	1	4
Improved access to external support	–	10	8	0	4
Improved house structure	–	5	1	1	2
Maintain/change pump/tubewell location	2	–	–	2	1
Use of pump for water	4	–	–	0	1

Note: same as under Table 12

Overall, adaptation in water did not a considerable difference between migrant and non-migrant households. However, at river basin levels, there are notable differences in adaptation across migrant and non-migrant households (Table 22). In Gandaki and Teesta, the percentage of adapting households is higher in migrant households. On the other hand, In Upper Ganga and Indus, percentage of adapting households is higher in non-migrant households. Chi-square test results show that there is statistical relationship between migration status and adaptation in three river basins, i.e. Gandaki, Teesta and Upper Ganga.

Table 22: Households reporting adaptation in the water sector, by migration status (%)

River basin	Migrants		Non-migrants		Pearson Ch^2 test (P-values)
	Adapters	Non-Adapters	Adapters	Non-Adapters	
Gandaki	25	75	18	82	0.023**
Indus	39	61	45	55	0.210
Teesta	28	72	21	79	0.073*
Upper Ganga	50	50	63	37	0.005***
Overall	34	66	36	64	0.346

Note: same as under Table 13

Abandoned house of a permanent migrant family

4. Discussion

The environmental stressors that the study sites experience are mostly water-related, such as erratic and extreme rainfall. Together with temperature variability and rise, they result in both slow onset changes such as water scarcity and heat stress, and also extreme events such as flash floods, riverine floods, droughts, cloudbursts, landslides, etc. This is consistent with situational analysis reports of the four basins (Abbasi et al., 2017; Bhadwal et al., 2017; Dandekhya et al., 2017) and other perception-based studies in the region (Gioli et al., 2014; Hussain et al., 2018). The major environmental changes across the study sites vary, as shown by the perceptions of the surveyed households. These changes impact people's livelihoods in various ways such as an increase in disease/pests in crops and livestock, the drying up of water sources, etc. Importantly, this finding reiterates the need for adaptation planning to be location-specific.

The capacity of households to cope with or respond to the impacts of environmental changes and shocks are limited in the study sites. Only 35% of the households have reported at least one adaptation measure, despite more than 90% households perceiving a change in the climate. As compared to perceived changes in climate, changes in extreme events are reported to be lower but vary across the study sites. A similar finding has been reported by Hussain et al. (2018), in the Koshi river basin in Nepal. Also, in general, adaptation is much lower in the mountains as compared to the plains.

The response measures undertaken by households range from adaptation to a failure to adapt. Most of the measures are autonomous, and taken to ward off immediate risks rather than proactive adaptive strategies. This has also been reported in Pakistan by Gioli et al. (2014). For example, households reported shifting from farm to non-farm based livelihoods as an adaptation, which may or may not reduce household vulnerability. Other studies (Hussain et al., 2016; Saikia, 2012; Sarkar et al., 2012) have also reported households shifting from farm to new off-farm and non-farm activities as an adaptation strategy. However, as Sunam and McCarthy (2015) revealed in their study in rural Nepal analysing the poverty situation of households over a period of 22 years, households with multiple sources of livelihood are more successful in getting out of, and staying out of poverty. Thus, a successful adaptation depends more on whether households have managed to diversify their livelihoods in the non-farm sector or not, rather than a simple shift from the farm to the non-farm sector. In some cases, households reported that they had purchased pumps to extract more water from the piped system or have installed borewells to extract groundwater from deeper depths, which is a case of maladaptation rather than adaptation, because the water table gets further depleted due to such a measure.

In the study sites, migration is an important livelihood strategy that provides households with a source of income not directly affected by local environmental changes. Consistent with other studies (for example, Koubi et al., 2016; Warner and Afifi, 2014), economic factors, particularly better employment opportunities, are reported as major drivers of labour migration. But environmental factors play a direct and crucial role in the displacement of households, as also reported by other studies (for instance, Henry et al., 2003). As revealed in this study that a higher proportion of migrant households reported facing temporary displacement and the loss of property in the past, which might play an indirect role in their present decisions regarding labour migration. Only 29% of the households surveyed reported having one or more member involved in labour migration. This reveals that not every household exposed to environmental stress is capable of or willing to send a member out for work. For some households, migrating might not be an option due to the lack of resources (the lack of finance or the lack of a member suitable for migration) or due to lower returns (for more well-to-do households in particular, the returns from internal migration tend to be too meagre to be attractive). Thus, this reality questions the prediction of 'climate migrants' solely based on vulnerable populations.

This study shows that, overall, migration has a positive effect on household adaptive capacities, particularly in the agricultural sector. This finding corresponds with previous studies (Bardsley and Hugo, 2010; Black et al., 2011;

McLeman and Smit, 2006). Migration is mostly internal in the study sites, providing a limited remittance-earning capacity. It is often only sufficient to meet the household's basic food and non-food requirements, and hardly provides savings to invest in adaptation measures. This finding again confirms results from other studies, such as Abdurazakova (2011). International migration brings higher remittances, but is limited to the Gandaki and Indus basin among the study areas. Therefore, migration helps households to build their adaptive capacity through the diversification of livelihoods and spreading of risks rather than increasing overall household income and asset base. This finding conforms with the theoretical underpinnings of the New Economics of Labour Migration, which postulates migration as a risk-management strategy adopted at the household level (Lucas and Stark, 1985; Stark and Levhari, 1982). The positive relationship between migration and household adaptive capacity shows the potential of migration to be developed as an adaptation strategy given policy support in making migration outcomes more positive, and making a range of adaptation options available locally (Gioli et al., 2014; Warner and Afifi, 2014). Migration outcomes can be improved through reduced costs, skilling migrants, and ensuring protective nets for migrants. Similarly, for making adaptation options available locally, greater intervention from the government and other stakeholders in knowledge, information, and technology is important. This calls for a change in public perspective and policy outlook viewing migration as problematic; rather, one should focus on the developmental potential of migration, which has also been suggested by other studies (Black et al., 2011; DFID, 2013).

5. Conclusion

The Hindu Kush Himalayan region is highly vulnerable to the effects of global and local environmental changes. The areas covered by this research study face a wide range of environmental changes and shocks, mostly related to erratic and extreme rainfall, and temperature variability and rise. The decision to migrate, particularly short-term labour migration, in such a context, is a multi-causal one undertaken by the households to improve their overall livelihood situation by diversifying it. Migration plays an important role in augmenting the capacity of households living in vulnerable environmental situations to cope.

The patterns of migration are diverse in the study sites, ranging from seasonal/circular migration to international migration. However, most migration is internal; international migration is limited to mainly South–South movement (with the countries of Persian Gulf and Malaysia being the most common destinations). Migration is mostly male-dominated; however, female migration is increasing, with higher educational standards attained by women creating employment opportunities for them in urban destinations.

This study found that the capacity of households in the study sites to adapt to the negative effects of environmental changes and shocks in four crucial livelihood sectors – agriculture, livestock, forests, and water – was poor, with a maximum of 35% households undertaking at least one adaptation option, in the water sector. Moreover, the adaptation measures undertaken are mostly autonomous, except in the case of the water sector (with alternative water supply). The linkage between migration and household adaptive capacity was found to be positive, but statistically significant only in the agricultural sector. As agriculture is the major source of livelihood for households, earnings through remittances from migration is invested in agriculture. Thus, migration helps households' adaptive capacity by spatially diversifying the sources of income, and by building the resilience of local livelihood sources. This potential is limited at present as remittances are small and mostly invested in meeting household food and non-food requirements, such as education, personal health, and shelter. Thus, at present, migration is more a response strategy of the households to various changes, including environmental changes, and their effects on local livelihoods.

The positive association between the migration status of households and their adaptive capacity shows the potential of migration as a successful adaptation strategy. For this, firstly, the outcome of migration has to be improved. This can be done through improving the skill sets of migrants, by reducing the cost of migration, and by providing a welfare/social security net to the migrant populations at their destinations. Secondly, there is a need for greater involvement by governmental and other stakeholders in making cost-effective adaptation options available locally. Also, as migration is not an option available to all households, there is the need for more efforts to develop in-situ adaptation options, for households whose members cannot migrate due to various barriers. Lastly, the burden of adapting to the effects of global environmental changes should not be placed on the shoulders of migrants alone. The major responsibility lies with the international community and the national and local governments; migration can be only a vehicle to build the capacities of the households.

Adapting to water stress: a water storage pond constructed on a citrus farm in Sargodha (downstream area of Indus)

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7. Annexures

Annexure 1: Reasons for migration (multiple response)

Reasons for migration	Upstream	Midstream	Downstream	Overall
Gandaki basin	%	%	%	%
Education	83.41	15.80	19.54	51.63
Searching for a job/Employment	10.31	60.00	40.23	30.23
Marital situation	0.00	0.00	1.15	0.23
Family problems	2.24	13.30	6.90	6.28
Landlessness/Insufficient landholdings	1.79	–	18.39	4.65
Poor quality of land	0.45	0.0	0.00	0.23
Health problems	1.35	0.0	0.00	0.70
Others	0.45	10.8	13.79	6.05
Indus basin				
Education	30.00	13.64	17.07	22.86
Searching for a job/Employment	41.11	61.36	48.78	48.00
Marital situation	1.11	0.00	0.00	0.57
Family problems	1.11	2.27	0.00	1.14
Landlessness/Insufficient landholdings	2.22	0.00	4.88	2.29
Others	24.44	22.73	29.27	25.14
Teesta basin				
Education	32.35	66.67	8.82	35.40
Searching for a job/Employment	23.53	16.67	74.51	43.81
Marital situation	0.00	0.00	0.98	0.44
Family problems	0.00	0.00	7.84	3.54
Landlessness/Insufficient landholdings	0.00	1.11	2.94	1.77
Poor quality of land	5.88	0.00	0.00	0.88
Flooding	0.00	0.00	0.98	0.44
Others	38.24	15.56	3.92	13.72
Upper Ganga basin				
Education	37.50	6.54	7.69	12.00
Searching for a job/Employment	27.08	60.28	76.92	55.27
Marital situation	0.00	0.00	7.69	0.36
Landlessness/ Insufficient landholdings	0.00	16.82	0.00	13.09
Poor quality of land	0.00	8.41	0.00	6.55
Flooding	0.00	0.47	0.00	0.36
Others	35.42	7.48	7.69	12.36

Annexure 2: Occupation before migration (%)

Occupation	Upstream	Midstream	Downstream	Overall
Gandaki basin				
Paid full-time worker	24.39	31.00	27.54	28.57
Farm work	19.51	13.00	27.54	19.05
Non-farm work	12.20	13.00	8.70	11.43
Unemployed/looking for work	26.83	14.00	18.84	18.10
Housewife	7.32			1.43
Paid part-time worker		29.00	15.94	19.05
Others	9.76	–	1.45	2.38
Indus basin				
Paid full-time worker	57.14	52.63	46.88	53.38
Paid part-time worker	6.35	5.26	12.5	7.52
Self-employed farm	3.17	5.26	9.38	5.26
Self-employed non-farm	14.29	23.68	9.38	15.79
Unemployed/looking for work	17.46	13.16	21.88	17.29
Housewife	1.59			0.75
Teesta basin				
Paid full-time worker	72.73	50.00	21.51	35.17
Paid part-time worker			15.05	9.66
Self-employed farm	13.64	6.67	7.53	8.28
Self-employed non-farm	4.55	6.67	7.53	6.90
Unemployed/looking for work	9.09	33.33	46.24	37.93
Housewife		3.33	2.15	2.07
Upper Ganga basin				
Paid full-time worker	65.52	26.13	50.00	32.08
Paid part-time worker	13.79	4.02	8.33	5.42
Self-employed non-farm	3.45	27.64	–	23.33
Self-employed non-farm	–	4.02	16.67	4.17
Unemployed/looking for work	17.24	37.69	16.67	34.17
Housewife	–	–	8.33	0.42
Others	–	0.50	–	0.42

Note: The numbers represent a percentage of those who migrated.

Annexure 3: Households receiving remittances (% of migrant households)

River basin	Upstream	Midstream	Downstream	Overall
Gandaki	63.89	74.39	89.83	77.40
Indus	64.41	85.71	81.25	74.60
Teesta	88.89	76.00	72.97	76.07
Upper Ganga	51.85	90.35	90.91	83.55
Total	65.00	83.20	81.25	78.15

Note: The numbers represent a percentage of migrant households.

Annexure 4: Average annual remittances, per migrant (USD)

River basins	Upstream		Midstream		Downstream		Overall	
	Internal	International	Internal	International	Internal	International	Internal	International
Gandaki	502	1,338	730	2,151	477	1,364	589	1,748
Indus	1,145	391	882	491	1,086	1,990	1,042	1,509
Teesta	1,028	–	638	–	390	48	542	48
Upper Ganga	261	–	122	357	336	6,400	144	1,868
Total	965	1,233	409	1,948	504	1,611	543	1,703

Note: The numbers represent a percentage of those who migrated.

Annexure 5: Average cost of migration, per migrant (USD)

River basin	Upstream		Midstream		Downstream		Overall	
	Internal	International	Internal	International	Internal	International	Internal	International
Gandaki	226	2,032	184	1,333	43	1,334	134	1,472
Indus	332	920	235	1,081	212	2,148	279	1,804
Teesta	428	–	492		48	300	166	300
Upper Ganga	284	–	160	1,600	240	805	234	1,004
Total	326	1,982	268	1,320	79	1,469	199	1,490

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