



Asking the right questions in adaptation research and practice: Seeing beyond climate impacts in rural Nepal



Jonathan Edward Ensor^{a,*}, Patrick Wennström^b, Anil Bhattarai^c, Andrea Joslyn Nightingale^{b,d}, Siri Eriksen^d, Jana Sillmann^e

^a Stockholm Environment Institute, Department of Environment and Geography, University of York, Heslington, York YO10 5DD, UK

^b Department of Urban and Rural Development, Swedish University of Agricultural Sciences, Ulls väg 27, Uppsala 75007, Sweden

^c Department of Geography, University of Toronto, Toronto, ON M5S 2E5, Canada

^d International Environment and Development Studies, Norwegian University of Life Sciences, Universitetstunet 3, Ås 1433, Norway

^e CICERO Center for International Climate Research, Gaustadalléen 21, Oslo 0349, Norway

ARTICLE INFO

Keywords:

Adaptation
Climate change
Nepal
South Asia
Rural transformation
Rural development

ABSTRACT

Adaptation research and practice too often overlooks the wider social context within which climate change is experienced. Mainstream approaches frame adaptation problems in terms of the consequences that flow from biophysical impacts and as a result, we argue, ask the wrong questions. A complementary approach gaining ground in the field, foregrounding the social, economic and political context, reveals differentiation in adaptation need, and how climate impacts interconnect with wider processes of change. In this paper, we illustrate how this kind of approach frames a different set of questions about adaptation using the case of Nepal. Drawing on fieldwork and a review of literature, we contrast the questions that emerge from adaptation research and practice that take climate risk as a starting point with the questions that emerge from examination of contemporary rural livelihoods. We find that while adaptation efforts are often centred around securing agricultural production and are predicated on climate risk management, rural livelihoods are caught in a wider process of transformation. The numbers of people involved in farming are declining, and households are experiencing the effects of rising education, abandonment of rural land, increasing wages, burgeoning mechanisation, and high levels of migration into the global labour market. We find the epistemological framing of adaptation too narrow to account for these changes, as it understands the experiences of rural communities through the lens of climate risk. We propose that rather than seeking to integrate local understandings into a fixed, impacts-orientated epistemology, it is necessary to premise adaptation on an epistemology capable of exploring how change occurs. Asking the right questions thus means opening up adaptation by asking: ‘what are the most significant changes taking place in people’s lives?’, along with the more standard: ‘what are the impacts of climate change?’ Viewing adaptation as occurring between and within these two perspectives has the potential to reveal new vulnerabilities and opportunities for adaptation practice to act upon.

1. Introduction

What does adaptation mean in South Asia, one of the most climate vulnerable regions in the world? Climate models suggest that increased temperatures and changed precipitation patterns are likely (Hossain et al., 2016). Already home to one third of the world’s malnourished people, yields of rice and wheat are expected to fall in the region (Arshad et al., 2017). As the effects of climate change become more evident, there is increasing attention on how farming systems can adapt. Yet, simultaneously, interconnected socio-political and demographic transitions are transforming livelihoods, fundamentally altering

rural political economies, shaping adaptation needs, defining the role of non-agricultural incomes in adaptation, and setting the stage in which the consequences of adaptation play out (Korzenevica and Agergaard, 2017; O’Brien et al., 2004; Ohlan, 2016; Sugden, 2017). It is therefore remarkable that comparatively little attention has been paid in most international research and practice efforts to where climate change adaptation fits into this wider context.

This juxtaposition of climate change adaptation and everyday realities for farming households leads us to ask: what is it that farming households are adapting to, and what aspects of rural livelihoods are they adapting? We argue that while climate change clearly impacts

* Corresponding author.

E-mail address: jon.ensor@york.ac.uk (J.E. Ensor).

<https://doi.org/10.1016/j.envsci.2019.01.013>

Received 12 September 2018; Received in revised form 24 January 2019; Accepted 24 January 2019

Available online 11 February 2019

1462-9011/ © 2019 The Authors. Published by Elsevier Ltd. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

agricultural production practices, adaptation efforts risk being irrelevant to agricultural households if their relationship with wider cultural, socio-economic and political processes is not considered adequately (Eriksen et al., 2011; Eriksen et al., 2015).

For a large section of the scholarly and policy community, the biophysical impacts rendered by climate change form the basis for adaptation planning (Biagini et al., 2014; for critiques of this view, see Bassett and Fogelman, 2013; Hulme, 2011), placing the consequences of climate change for agricultural yields as a central focus. As a result, international research and development efforts have primarily looked to enable changes in on-farm practices: expanding farmer's knowledge, developing new technical solutions, or supporting innovative agricultural practices (e.g. Janila et al., 2016; Singh et al., 2017). While social, ecosystem and institutional perspectives are increasingly integrated, technical innovation geared towards production is generally seen as “the key to farming system adaptation” (FAO, 2016, p. 50).

With this paper, we contribute to a growing body of literature that, in different ways, argues for the need to reframe the adaptation challenge (Bee et al., 2015; Beveridge et al., 2018; Eriksen et al., 2015; Nightingale, 2016). A significant body of research has investigated the multiple socio-environmental stressors (including economic globalisation, demographic change, changing resource access regimes, political change and conflict, and climate change) to which rural households respond in managing their livelihoods (Leichenko and O'Brien, 2008; Eriksen and Silva, 2009; Quinn et al., 2011; Reid and Vogel, 2006; McDowell and Hess, 2012). Building on this research, O'Brien et al. (2007) argue that how vulnerability is framed and studied – whether as an outcome of biophysical climate change or as an inherent and dynamic context shaped by interacting socio-environmental processes – determines what climate change measures are promoted. They question the predominant research and policy focus on outcome vulnerability, leading to sectoral and techno-managerial measures, and conclude that adaptation research and practice instead needs to address contextual vulnerability and focus on the socio-environmental stressors producing vulnerability. These and similar insights have precipitated a shift towards a wide range of approaches that explicitly consider social context, but which still take climate risk as an epistemological starting point. In this paper, we refer to such approaches as ‘mainstream adaptation approaches’, and we suggest that they extend some problematic assumptions. First, that adaptation takes place as one or more actions orchestrated by policy makers or other clearly defined decision-makers (experts, policy makers, local elites/leaders or particular – often male – members of a household). Second, that adaptation is separate from societal change at large, and climate change is separate from society. And third, it is often the case that climate risk is taken to be the main driver of rural transformations. These assumptions limit our understanding of adaptation, how it takes place, who makes decisions, and how it relates to transformation in socio-political relations, leading towards a focus on climate drivers of agrarian change and techno-managerial solutions. As such, mainstream adaptation can easily slip back into the assumptions of outcome vulnerability (Vincent et al., 2013; Ojha et al., 2015).

Recent calls for transformative adaptation (O'Brien et al., 2015; Pelling, 2011; Vermeulen et al., 2018) imply a need to go beyond interrogating the multiple stressors to which people adapt, to understanding how people's lives are transforming more fundamentally, such as the transformation of socio-political relations of class, ethnicity, gender, production, and livelihoods, and how climate change is located within these transformations (Eriksen et al., 2015; Tschakert et al., 2016; Rao et al., 2017). Aligned with these calls, our aim is to refocus our adaptation research towards the dynamics of household reproduction and changing rural political economies. In so doing, we probe contemporary changes in farming households in two districts in Nepal, and demonstrate the significance of these findings to understanding the challenge of adaptation in rural South Asia more widely. Rather than beginning from an epistemological stance that assumes adaptation

needs flow from projected biophysical impacts, we turn our quest for knowledge inside out, and begin from the standpoint of farming households and the deeper transformations in livelihoods and socio-political relations that they go through. While participatory approaches are increasingly recognised as necessary to broaden the voices heard in adaptation planning, we argue that inviting participation in a project about climate change is different to inviting participation in a project about livelihood change. Thus, instead of asking about climate risks, for example, we ask, what are the significant social, political and/or economic processes at play for rural households? How do they determine the consequences of biophysical impacts, such as yield changes, for different groups of people? Foregrounding such questions renders visible historically situated but shifting socio-cultural and political-economic relations that have profound significance for the meaning of adaptation on the ground: mediating generalised risks into socially-differentiated hazards; aligning adaptation planning with the interests of powerful elites; or determining the significance of climate change relative to access to services or emerging markets (Bee, 2016; Jones and Boyd, 2011; Klein and Juhola, 2014; Nagoda and Nightingale, 2017).

Specifically, through the analysis of fieldwork undertaken in two districts in rural Nepal and a review of the wider South Asian adaptation literature, we argue that alternative epistemological starting points for adaptation research and practice are not only possible but essential for building more effective responses to climate change (Nightingale, 2016). This allows adaptation work to ‘see beyond’ the climatic drivers of change in agrarian communities and probe more complex entanglements of social, cultural, economic, political and biophysical change. Nightingale (2016) has argued for using multiple starting points in adaptation research. By probing what can be known and what is not known when ‘seeing’ adaptation through different disciplinary lenses, new insights for practice emerge from conceptualising adaptation through different onto-epistemological frames. Rather than adjustments to climate impacts, adaptation is placed within long-term transformations in agricultural household reproduction strategies. For the study here, the most important insights from this conceptual exercise are that asking about adaptation to climate change or extreme events fails to offer convincing explanations for why households engage in the adaptation practices observed.

In the next section we review current literature to investigate the focus of adaptation activities in Nepal, which we find to be predominantly on agricultural production and premised in terms of climate risk management. Next, we contrast this with the realities of continuity and change in rural livelihoods in Nepal, drawing on recent literature, census data and qualitative research undertaken with rural agricultural households in Nepal. This section synthesises the results of fieldwork in the Kaski and Chitwan districts of Nepal undertaken as part of a larger project on extreme events, air pollution and climate change. The research was conducted by authors 3 and 4 during six weeks in December 2015. Semi- and un-structured qualitative interviews were undertaken with farmers, based on transect walks through areas chosen for either their proximity to urban areas (down-wind, in the peri-urban areas most effected by air pollution), or their land use types (mixed farm size). Questions were asked about farming challenges, changes in farming practices and perceptions of environmental change. Ten in-depth interviews were completed in Chitwan and Kaski, along with over twenty less formal conversations with local residents in each district. The interviewing responded to the particular context of the interviewee. For example, respondents who had recently diversified away from an exclusive focus on farming narrated changing livelihoods, household composition and income sources, as well as the challenges experienced while farming. Field visits were undertaken daily, from early morning to late evening, enabling interaction with farmers with different farm sizes and farmers and labourers from different caste groups, as well as with individuals such as those working in the vegetable and grain markets and agricultural input shops. The goal of the research was to gain insights into how farmers understood climate

change and why they were making choices (rather than *what* choices), therefore the methods looked for saturation in themes rather than a representative sample.

A discussion section follows, in which the gap between the focus of adaptation and the reality of rural transformations in Nepal is explored in terms of the shortcomings of an epistemological bias towards biophysical impacts as the premise for adaptation. New, important issues are revealed when this bias is removed and knowledge about adaptation is reframed as a problem of household reproduction. The conclusion summarises the contribution of the paper, and suggests that asking the right questions means asking: what are the most significant changes taking place in people's lives? What are the impacts of climate change? How, if at all, do these two connect and interact?

2. Adaptation research and practice in rural South Asia

The agricultural sector is inherently sensitive to weather conditions such as extreme temperatures and unusual precipitation patterns, but not all climate changes have negative effects on crop yields (Joshi et al., 2011). In Nepal, rice and barley are examples of crops that could thrive under a moderate increase in temperature during winter (Joshi et al., 2011) and elevated carbon dioxide (CO₂) concentrations would likely improve photosynthetic production and water efficiency in crops (Ruane et al., 2013). However, if average temperature continues to rise up to 4 °C, severe yield reductions of all crops is to be expected (Wang et al., 2017). Different estimates have been made regarding the effects of extreme heat on rice yields in South Asia, and although their exact figures might vary, they agree in predicting significant yield losses due to escalating temperatures (Arshad et al., 2017; Lobell et al., 2008; Peng et al., 2004).

These assessments are however based on long-term climatic trends. The wider research project within which this paper is situated was concerned with probing the links between extremes and crop yields. Observations show that the intensity and frequency of extreme heat waves are increasing (Revadekar et al., 2012), effecting the annual cropping cycle of farming households. Extreme weather events such as heat waves and unusual precipitation are known to cause serious damage to crops (Mittal et al., 2014). Post-harvest losses due to flooding are also common, although relatively easy to prevent through improved storage facilities (Lassa et al., 2016). Since a majority of the population in South Asia are dependent on agriculture, a heightened risk of extreme events is an alarming trend which could have devastating effects on the national economy and food security (Singh et al., 2014). Their impact on the agricultural sector is however difficult to predict since extreme weather events occur locally and within a globalised market, meaning one country's loss might benefit its neighbour through increased exports (Ruane et al., 2013).

Agricultural production is currently primarily managed by family households in much of South Asia including in Nepal. The direct involvement of Government institutions in agricultural production is limited to running a few experimental stations, and providing inputs and advice to farmer cooperatives. While commercial corporations have been involved in the production of specific crops, the scale of their involvement has remained limited. In reality major decisions over production are almost always taken by households, even in countries that are considered to have highly corporatized agriculture (Ploeg, 2014). However, in common with much of the Global South (Rigg, 2006; Rauch, 2014), South Asia is characterised by major changes in rural societies, as forces such as the globalisation of markets and increased mobilisation of people exert new pressures and deliver new opportunities for rural populations (Korzenevica and Agergaard, 2017; Sugden, 2017).

This backdrop of changing rural livelihoods in Nepal and South Asia suggests that adaptation is likely to be a more complex issue than one of identifying and responding to emerging climate change. Yet the evidence suggests that much adaptation research and practice remains

focused on the consequences of climate change for agriculture production. Improving access to technology and infrastructure remains a recurring theme within both the academic and practice literature, especially with regards to rural households (IPCC, 2014b). There is a substantial body of adaptation research that focuses on shifting agronomic practices and 'single crop strategies'. The former includes field-based practices such as crop diversification and production intensification (Janila et al., 2016), planting date adaptations (Laux et al., 2010), and rainwater harvesting (Pandey et al., 2003). The latter includes cultivar production and crop technology, often to enhance cultivar tolerance to extreme heat and droughts (e.g. Singh et al., 2017; Wassmann et al., 2009) and production of fast growing cultivars to enable additional planting within a growing season or to cope with changing seasonality (Van de Giesen et al., 2010). Scientific, technical and agronomic innovation, often focussed on specific crops, continues to be seen as essential for adapting the agricultural sector to a changing climate and for intensifying production while ensuring food security (Janila et al., 2016).

Similarly, according to FAO (2016, p. 50) innovation is "the key to farming system adaptation". For FAO, innovation mainly refers to management practices such as sustainable intensification, agroecological production, and improved water resource management, but biotechnology in some cases is also recognised as important (FAO, 2016). Shifting agronomic practices through the introduction of new crops, changed cropping patterns, and soil and water conservation are identified by IPCC (2014b) as important adaptation approaches for livelihood security. Equally, it is recognised that there is no universal formula for effective adaptation and all interventions need to be site-specific. Studies suggest that farming innovation is significantly influenced by contextual circumstances such as water availability, farm size and presence of resourceful NGOs (Aase et al., 2013). It has been shown that climatic variations can encourage the development of new technologies and adoption of climate tolerant crop varieties and agronomic practices (Chhetri et al., 2012). Similarly, extreme weather events such as unusual precipitation, floods or droughts have been identified as important stimuli for motivating adaptive change (Berrang-Ford et al., 2011), yet others have cautioned against attribution of extreme events as evidence of climate change (Hulme, 2011). Developing innovative technologies, practices, approaches and models are an important focus for NGOs working on the ground. For example, Nepali NGO LI-BIRD's "agricultural innovations for livelihood security" programme in Nepal looks to improve nutrition and household income by introducing new crops and livestock, improving irrigation, and increasing access to credit through value chain promotion of important products (LI BIRD, 2017).

Despite this emerging consensus around the significance of context to innovation, agricultural research focused on South Asian tends to prioritise studies on certain types of production constraints over others. Abiotic constraints such as droughts, high temperature stress, phosphorus restrictions and soil fertility depletion receive the most attention (in terms of numbers of scientific publications) (John and Fielding, 2014). Yet, it has been found that multiple factors, many outside of the biophysical domain, may influence farmer decision-making when faced with extreme weather events (Jain et al., 2015). Indeed, those factors that are most important for increasing yields among the most food-insecure, such as barriers to agricultural information, inadequate knowledge or training, and the high cost of irrigation, inputs and fertilizers, have received comparatively far less attention (John and Fielding, 2014). It is perhaps symptomatic of this trend that while the implications of research in terms of productivity improvements have been thoroughly examined, studies on the linkages between agricultural research investments and poverty or environmental outcomes are far less common (Hazell, 2008). John and Fielding (2014, p. 14) suggest that the result is a "shortage of research focused on socio-economic production constraints, despite that being the most important category of production constraints to South Asian rice farmers in terms

of contributing to yield losses". More generally, financial, institutional, technological and informational barriers have been identified as key constraints to household adaptation (Antwi-Agyei et al., 2015), while social barriers including caste and class have been shown to have significant impacts on adaptive capacity (Jones and Boyd, 2011; Nagoda and Nightingale, 2017).

In contrast, the policy and practitioner literature on climate change adaptation has a consistent focus on opportunities for diversification and a shift away from the agricultural sector (FAO, 2016; IPCC, 2014b). This is a strategy advocated at all levels – national, regional and household – as agriculture is becoming an increasingly unpredictable and unreliable source of income (IPCC, 2014a). Both on-farm (e.g. variety or breed diversification) and livelihood diversification (e.g. to include wage labour) are recognised as important ways of managing climate risks (FAO, 2016).

To summarise, the focus of adaptation activities – of what it is that adaptation is making changes to – varies according to the underlying interests represented in the literature. Agricultural research foregrounds innovation in the traits of specific crop varieties and responding to specific biophysical impacts. The focus here is agricultural productivity, rather than directly on the interests of the most food insecure. The non-governmental sector expand this focus to irrigation, livestock, the wider value chain, and agronomic practices such as rain water harvesting, sometimes as part of large development programmes focused on socio-economic change. This response to the challenges of climate change echoes the FAO's understanding that farm system innovation is a central adaptation activity. While the policy and practice literature recognises the significance of diversification and non-farm incomes, this is a mechanism to manage climate risks – underscoring the premise of adaptation and the focus on climate change as the central dynamic to be 'adapted to'.

3. Transitions and transformations in rural livelihoods

South Asian rural livelihoods have gone through fundamental socio-political transitions during the past several decades. After the radical change that the 'Green revolution' brought to farming systems, rural livelihoods have taken a turn towards decreased dependency on agriculture and the growing importance of non-farm income (Mallik, 2014). In India, rural transformation has been accelerated by the country's fast economic growth, although rural communities are still lagging behind urban areas in terms of receiving the benefits (Ohlan, 2016), and these processes are somewhat slower in Nepal. This shift away from dependency on agriculture and natural resources has strengthened rural-urban interdependencies (IPCC, 2014a). Even remote peripheral areas in Nepal and India are highly intertwined with global markets, and rural populations constitute a labour pool for urban centres (Sugden, 2017). Permanent, temporary or seasonal migration for wage work in urban areas is thus a key component for the subsistence of many rural households (FAO, 2016). Extreme weather events such as unusual heat, cold periods and erratic monsoons, which are experienced by many farmers, have been identified as only one out of several drivers that forces agricultural households to look for alternative incomes (Sugden, 2017). Each of these phenomenon, and their interconnections, were reported by respondents during our fieldwork in 2015. The narratives recounted to us reflect and expand on evidence available in the existing literature and Nepali census records, as the following sections set out.

3.1. Male out-migration

A central phenomenon across the research sites was a widespread lack of adequate labour available for agricultural work. The out-migration of young rural Nepalis, driven by work and education opportunities offered in urban centres and abroad (Korzenevica and Agergaard, 2017), has major implications for household farming

systems. Although migration is by no means a new phenomenon in this region, the scale and patterns of migration have changed radically in recent years. The number of emigrants from Nepal increased by more than 60% during the decade 2001–2011 (Central Bureau of and Statistics, 2014) and the Gulf countries and Malaysia have become common destinations for rural migrants. In some regions the rate of migration towards these overseas destinations is surpassing that of India, which was unthinkable only a couple of decades ago (Sugden, 2017). Remittances from migrants have played an important role in reducing poverty rates in Nepal, while at the same time the predominantly male out-migration has redistributed labour and responsibilities among those who remain (Adhikari and Hobley, 2015). Moreover, as limited labour is employed in different service sectors, the wage rate has gone up, making it highly unprofitable for households to run agricultural operations with hired hands.

Participants in our research reported that the cooperative labour that used to be common about two decades ago has simply ceased to exist. Often referred to as 'parma', households provided labour to each other at different times for tasks related to agricultural production: ploughing, planting, weeding, harvesting, processing, and cutting. Although some households still rely on this form of reciprocal labour exchange, most farmers explained that this is far less common than two decades ago. Against this backdrop, it is interesting that FAO (2016) sees migration as something that can be prevented through adaptation measures such as improved agricultural practices and infrastructure to cope with climate change that would allow people to remain in their home communities.

Migration stories were common during our fieldwork. For example, one household grew rice and corn on a small holding (approximately 5 *ropani*, or 0.25 ha) and produced vegetables for market (1.5 *ropani*). Previously, the male farmer worked in the police and then migrated to India for wage labour for 6 years to generate income, some of which was used to add a second story to their house. They have 3 sons, the youngest of whom was home when we met them (December 14, 2015) but less than 10 days later the son flew to 'Saudi' [Arabia] to join his brothers who were also working there. While they were happy about the remittances, and migration was clearly considered an exciting rite of passage to for this young man to establish himself (Sharma, 2016), the approximately 50 year old parents were left at home to manage the farm themselves. This example, along with our other qualitative interview data, suggest that an increasing number of rural households which own farmland receive the majority of their income from sources other than their own agricultural production. Particularly striking is the fact that all except for two of the households we interviewed have family members that have emigrated abroad or to urban areas, and most households rely on remittances for their primary income.

The changes in labour relations reported by fieldwork respondents reflect broader trends identified in Nepali census data. Family sizes have declined significantly in Nepal, across both rural and urban areas. Between 2001 and 2011 the average household size has decreased from 5.3 to 4.4 in Chitwan district and from 4.7 to 3.9 in Kaski district. Both are considerably smaller than the 2011 national average household size of 5.4, reflecting the fieldwork respondents' reports of a reduction in available labour and the out migration of young people in these regions (Central Bureau of and Statistics, 2013). More broadly, between 2001 and 2011 Nepal's 28 hill districts saw a net decline in population (Central Bureau of and Statistics, 2014), while the total number of migrants rose from 0.76 million to 1.92 million (Central Bureau of and Statistics, 2012). These demographic shifts are illustrative of the transformation occurring in rural communities across the region, characterised by migration and the decline of multi-generational households, factors that in turn connect into a reduction in rural labour, increases in mechanisation, and changing cropping and land management practices, including the abandonment of mountain land. The Nepali 2011 census data records farm income as comprising 38% and 28% of total household income in Kaski and Chitwan (respectively),

with non-farm (29% and 43%) and remittance income (21% and 18%) dominating the remainder (CBS 2014). This can be compared to thirty years ago when the majority of households would have had 80% or more of their incomes from farming (Blaikie et al., 2002; Rigg, 2006). Migrants are more likely to invest remittances in land acquisitions or land improvements compared to non-migrants, although rarely in agriculture per se, and like the general trend, our respondents preferred to move away from a dependency on farm income (Jaquet et al., 2016; Sunam and McCarthy, 2016). However, since migrant households are generally better off than the lowest socio-economic castes, migration in this way also seems to reproduce existing inequalities (Sijapati et al., 2017). One Dalit family we spoke to in Kaski had no family members working outside of Nepal, for example. And, our respondents indicated that renting land for sharecropping was still relatively common in our research areas even though the interviews all pointed to the significance of off-farm income sources and several landowning households have sold or rented out their land for housing or commercial activities.

3.2. Extreme weather events

Respondents in Kaski and Chitwan districts rarely referred to weather or climate as significant issues affecting livelihoods, and, although many aspects of social and livelihood change were discussed, no respondents attributed these to climate change. Only when specifically asked about changes in climate, did respondents describe variations and unusual weather and statements such as “this year the rain did not come in time” were common. In Kaski, the only major weather/climate event referred to by participants—and only when directly asked about punctuated, extreme events—was hail. Winter hail in Kaski according to our respondents is not unusual in itself. What has changed is the timing and intensity of hail events. Previously, hail came only during the daytime when people could see storm clouds approaching and take action to protect themselves, animals, and their vegetable crops (grain fields are too extensive to be protected). Now, hail events also come at night, and some described them as more severe. In a mountain village of Kaski, a female farmer recounted the problem of hail coming at night. We asked if the plastic sheeting she had been given by a development project to help cultivate tomatoes was useful to protect the crop. She replied, “no, if we see hail coming, we take the plastic off. It is expensive, NRS 5000 (approximately USD 50) per large sheet, we can use it for many years.” We were surprised the plastic was considered more valuable than the tomato crop, an indication that she was not dependent on individual harvests for everyday livelihood needs. Another male farmer in a village downstream of the peri-urban area of Kaski pointed to large dents on his metal roof and explained they had been caused by hail big enough to seriously injure someone. Hail of this sort can ruin an entire season's harvest, but he highlighted the impact on his bees rather than crops. Honey is a cash product for the household and he attributed the change in hail events and precipitation to a decline in the bees. “Hail kept the bees inside the hive for 3–4 days and they ate the honey” and he went on to explain it's been too dry, so there are not enough flowers for the bees. In a separate interview, a female farmer told of abandoning tomato as a cash crop due to problems with pests and hail. For her, adaptation to weather and pests mainly consisted of changing crop types as necessary. She also highlighted the wide fluctuations in market price for vegetables throughout the year. She and her husband explained that this made the timing and planning of their cropping difficult, more so than the weather.

3.3. On- and off-farm livelihood changes

Despite these discussions of climatic change and extreme events, our interviews revealed changes in farming practices were interconnected with three main factors: migration, labour availability and markets. The holdings in Kaski and Chitwan are now very small; we interviewed

people with holdings of approximately 0.25–1.53 ha. (5–30 *ropani*¹), reflecting the national trend where average farm size has decreased in the last five decades from 1.1 ha to 0.7 ha per holding (Central Bureau of Statistics, 2014). Households with fewer people to manage lands are shifting towards either renting land for commercial vegetable production, or incorporating perennial and other less labour demanding crops. For instance, in Chitwan's hill areas where many live part time in the plains, farmers told us that they have shifted to taro in locations where they used to grow corn and millet. Taro is relatively easy to grow. Once planted it needs little attention until harvest 5–6 months later. Taro is more profitable per hectare as it produces more quantity by volume and secures a higher market price than corn. Perennial fruit growing was preferred by some of our respondents over cereal production, as it requires less regular labour. Fruit is also desirable as it is sold in bulk to whole-sellers who pick up the fruit themselves. Vegetables are more labour intensive, requiring daily transport to markets, usually by bus or on foot by female household members. Farmers have also radically downsized their animal portfolio, to the extent that many households do not own animals. Ten years ago it was rare to see agricultural households without animals whereas now many villages are eerily quiet without the previously ubiquitous chickens and dogs. One respondent specifically mentioned the difficulties of finding bullocks to plough in the village as fewer people are keeping them.

In Chitwan and Kaski, ploughing, grain harvesting and processing are increasingly undertaken using tractors or machines of different sizes, rented for an hourly service payment. We came into close contact with tractors roaring down roads at high speed with 3–5 young men hanging on the seat in rural Kaski. Some of these high demand machines are owner-operated, while others are operated by men who lease them and sell their services by the hour (we have not observed any women operating agricultural machinery) and are indicative of agricultural contracting as a new livelihood activity. We observed harvesting and processing vehicles across Chitwan, moving from field to field (and village to village) providing hourly services. Respondents told us that within the last ten years most rice and wheat production has moved to mechanised harvesting and few farmers use manual labour in processing (threshing and winnowing) the rice, in contrast to our observations from 15 years ago when the use of machines was limited to a few development project areas and the wealthiest landowners.

Crop-specific labour arrangements vary in different stages of production, and our observations of agricultural activities indicate that mechanisation seems to be occurring only at discrete points in the process. For instance, our respondents indicated that rice planting, cutting rice and hauling it to a threshing/winnowing place is still done by manual labourers in Chitwan, although in different parts of Nepal small-scale rice-cutting machines are used. In Kaski, the areas visited are accessible by road and most fields are ploughed by tractors although planting is usually done by hand. Harvesting almost all crops (vegetables, fruits, grains) still occurs through manual labour, but the use of small-scale machinery (such as for pumping water from rivers) was reported by several households. When available, people in Kaski use buses, trucks or tractors to bring vegetables to market (daily), but while we were present, severe shortage of fuel meant that we met numerous women walking up to 2 h each way.

One middle aged male farmer we spoke to along a transect walk had “left farming altogether” the previous year, despite owning 1.5 ha (27 *ropani*) of prime rice paddy land (*khet*) in the mountains. He relies instead on income from his job in the government health post. He planned to start an integrated farmhouse resort on the land that would have fish, pigs, chickens and offer guests a ‘Nepali village experience’. Despite having sons (he did not indicate how many), they have their own businesses so would not join him in this venture. This was similar

¹ These figures are not exact because revealing one's land holdings is equivalent to revealing income. We asked for approximate figures only.

to another, elderly male farmer we met while grazing his buffalo in the peri urban rice fields. The fields were unplanted due to the time of year, and were dotted with relatively newly built (or under construction) houses. The buffalo owner claimed his extensive rice lands were under-utilised due to a lack of interest by the younger generation in farming (we were unable to corroborate his claim of extensive land holdings with other nearby residents, but everyone we spoke to indicated in different ways that younger generation is not interested in agriculture). This man's two sons had been educated and he proudly told us that one was an engineer and the other had a government service job. For him, and most people we spoke to, educating children so they could obtain professional jobs that freed them from the land was considered 'development' (*bikas*).

3.4. Changing socio-economic and demographic conditions

Overall, while the rural households interviewed in this study revealed livelihood and lifestyle adaptations that reach within and beyond the agricultural sector, these were connected more to the changing socio-political environment rather than perceived climate change impacts. Our work shows agrarian households are both adapting to and actively participating in changes in rural society. Changes are highly specific to places and particular to households, however: the demographic profile, the location of land, and the capacity to generate livelihoods from diverse sources are major driving forces of how livelihoods are adapting. For example, in Chitwan district, farmers in more remote hill areas have responded differently to farmers in the plains of the valley. Many households we met in the mountain areas had moved to areas near roads and in the plains. While one or two household members remain, they regularly move back and forth to roadside houses (holdings which often do not include farm land). Farms also varied widely in terms of their demographic composition, and can change quite radically at different times of the year. This has given rise to higher wages and has helped drive the shift to mechanisation of different farming activities (Gauchan and Shrestha, 2017).

These major shifts in use of land, and fieldwork informants' perceptions of demographic, economic and geographic shifts in rural society, are consistent with a nationally reported decline in farmed area between 2001 and 2011 of 4.84%, the first such fall in farmed land since 1971 (Table 1). In Kaski, the research team saw terraced fields reclaimed by wild grasses and shrubs, with many mountain terraces deteriorating or collapsing due to the lack of regular maintenance. The widespread abandonment of land, particularly in mountain villages away from major highways, is corroborated by qualitative, interview-based research and systematic observations by others in the region (Chidi, 2016; Jaquet et al., 2016). While the cultivated land area is decreasing, the overall number of agricultural holdings has increased, although at a slower rate than previously (Table 1). This fragmentation of already small holdings into even smaller parcels is a problem for the agricultural productivity of Nepal, and is the result of the land inheritance system, poor land use planning, and loosely enforced policies (CRCS, 2012).

Our interviews revealed that land fragmentation is not simply a localised phenomenon. Rather, we found widespread desire to move away from the villages to road-heads and to nearby towns or cities to secure access to education for children and to health care. As labour

opportunities are often better at road heads and urban areas downhill there is a substantial internal migration to these areas from uphill rural areas of Kaski district (Jaquet et al., 2016), and our observations in Chitwan indicated a similar trend, the taro growers being one example. For some of our participants, this meant selling land holdings, whereas for most we spoke to, they retained ownership of their land in the mountains but also sought land or residence in lower lying, road accessible areas. Previous research from Kaski district also shows that proximity to education, health centres and labour markets have led to large-scale land abandonment in the hill areas (Jaquet et al., 2016). If this trend continues, there will be a further decline in the population in hills and increase in the plains. In the Tarai plains, for example, field research revealed the spread of settlements, but as yet there is no evidence as to the scale of shift of agricultural land to non-agricultural uses. However, this movement of segments of the population from hills to the plains undoubtedly has implications for the future of agriculture in both areas.

Higher risks of natural calamities such as floods in the downhill regions does not seem to slow down the flow of migrants, as the perceived socio-economic benefits appear to outweigh such risks (Jaquet et al., 2016; Massey et al., 2010). Even in locations where such disasters had occurred very recently, people continue to move downhill to areas where the risk of hazardous flooding is high (Jaquet et al., 2016). In Kaski, we spoke to a respondent along one of our transects who described the changes in the river channel and heights of previous flood events, showing us flood waters that were well over the height of land that has now been 'plotted' for building sites as part of the expansion of the peri-urban area.

4. Discussion: adaptation in a time of change

The livelihood patterns of rural households are undergoing major shifts in Nepal and South Asia more broadly, most obviously captured in demographic shifts and a movement away from farming both in reality and in aspiration. Households are increasingly integrated into a cash-based economy not only for basic material goods, but also for services such as children's education, medical services, and entertainment, while farming knowledge and skills are in decline in a large section of the population (Sugden and Punch, 2016). Our qualitative observations and national level data, at least from Nepal, shows that there is a growing household involvement in non-agricultural economy. The fieldwork data presented here draws particular attention to changes at the household level where reductions in labour availability, aspirations for 'development' (*bikas*) and increasing wage costs are reducing the focus on and significance of agriculture in household reproduction strategies. These endogenous, household level adaptations are simultaneously driving and responding to a wider context of change that includes increasing youth education, burgeoning mechanisation and agricultural contracting service opportunities, and deepening connections between rural Nepal and a global labour market.

Against this backdrop, mainstream approaches to adaptation have an impoverished starting point. Most adaptation efforts begin by either teaching people about climate change or seeking to understand what local people already know. In many cases, farmer's knowledge about climate and extreme weather events has been shown to be consistent with scientific observations and climatic data (Chaudhary and Bawa,

Table 1

Total land area and number of agricultural holdings in Nepal 1961/62–2011/12. Source: Central Bureau of Statistics 1994, 2003, 2013.

	1961/62	1971/72	1981/82	1991/92	2001/02	2011/12
Area (ha)	1,685,400	1,654,000	2,463,700	2,597,400	2,654,000	2,525,639
% Change	–	–1.86%	+48.95%	+5.43%	+2.18%	–4.84%
Number of holdings	1,540,000	1,721,200	2,194,000	2,736,100	3,364,100	3,831,093
% Change	–	+11.77%	+27.47%	+24.71%	+22.95%	+13.88%

2011; Gentle and Maraseni, 2012). South Asian farmers perceive a changing climate and they are aware of the risks associated with increasingly unpredictable weather (Manandhar et al., 2011), but research also suggests a lack of understanding of climate change as a concept. As a consequence, the significance of awareness raising in adaptation is emphasised (Arshad et al., 2017; Hossain et al., 2016). In practice, gaining insight on key weather constraints, how they are influenced by climate change, and how to effectively communicate this to stakeholders, are prescribed essential preconditions for supporting the successful adaptation of smallholder farmers (FAO, 2016). Improving access to information has thus emerged as a fundamental adaptation issue (IPCC, 2014a), and access to ‘climate services’ is an increasing focus of I/NGO adaptation interventions including in Nepal (LI BIR.D, 2017; Paudel et al., 2017).

Yet while information and awareness raising occupy a privileged position in adaptation interventions, there is debate about whether farmers are adapting to long-term changes in climatic conditions, or if people respond to more short term, extreme events, or to cope with socioeconomic changes (Berrang-Ford et al., 2011; Tripathi and Mishra, 2017). Berrang-Berrang-Ford et al.’s (2011) comprehensive review of existing adaptation literature confirms that adaptation is often driven by other stressors. This was the case for farmers in this study, and for those in Biggs et al.’s (2013) study focused on the Mid-Hills of Nepal, where changing practices and behaviour aim to reduce vulnerability or build adaptive capacity in response to multiple stimuli, including financial drivers and population pressure, rather than to manage climate risks (Biggs et al., 2013).

This questioning of what adaptation means in the context of wider livelihood transformations chimes with recent literature in which there has been a renewed focus on the significance of how adaptation is framed. Echoing earlier concerns voiced by O’Brien et al. (2007) regarding the predominant focus of climate actions on addressing vulnerability as an outcome of biophysical change, Nightingale (2016) draws attention to how mainstream adaptation perspectives are rooted in an ontological preference for the biophysical (defining adaptation as a response to biophysical change) and that, in this epistemological framing, ‘seeing’ adaptation means understanding the biophysical drivers. Yet this preference is just that: a choice that neglects the potential of alternative conceptual starting points for adaptation. In adaptation research and practice, participation of local communities is increasingly relied upon to ground adaptation in local realities (Ensor et al., 2018; Forsyth, 2013). However, while these approaches are significant in taking seriously forms of knowledge that are conventionally hidden from view, they are fundamentally limited in seeking the *integration* of local knowledge into a fixed epistemology – one which sees adaptation in terms of the biophysical impacts of climate change.

For example, reflecting on the role of crop modelling in context of climate change, Beveridge et al. (2018) identify the integration of local understandings of adaptation with physical science as an epistemological challenge that needs to be met if adaptation is to respond to context. Their review highlights the significance of ‘place-based knowledge’ in the history of farming research and development, enabled through approaches such as participatory rural appraisal, farmer field schools, and participatory crop breeding, which “recognise the relevance and value of local knowledge and thus have sought to make it central to intervention planning within farming systems” (Beveridge et al., 2018, p. 3). They propose the broadening out of crop model parameters through iterative engagement with participatory research that explores contextualised understandings of vulnerability and adaptive capacity in relation to climate scenarios. Yet this approach of ‘adding in’ more factors presupposes the significance of changes in crop performance, and integrates contextual factors only to the extent that they inform the crop model (for example, through the inclusion of local interpretations of practices such as soil management). Such approaches, while aiming for co-designed adaptation strategies, remain committed to the conventional epistemology of adaptation that begins with the

biophysical.

The desire to integrate local, lay or indigenous knowledge similarly motivates participatory efforts in adaptation practice, most notably through community-based adaptation (CBA; Ensor et al., 2018; Schipper et al., 2014; Forsyth, 2013; Spires et al., 2014). CBA is a “community-led process, based on communities’ priorities, needs, knowledge, and capacities” and is predicated on methods to support the integration of scientific knowledge of climate change with local knowledge of trends and changes (Reid et al., 2009, p. 13). By exploring climate and environmental change impacts and responses in partnership with communities, the aim is to draw out local knowledge and understanding of the complex relationship between environmental hazards and livelihoods, improving the effectiveness of interventions. As researchers focused on NGO efforts to bridge development and adaptation conclude, “a structured approach to gathering locally held knowledge on the consequences of climate hazards appears to present a potentially valuable means of exploring the complex web of interactions between climate, livelihoods and vulnerability.” (Pringle and Conway, 2012, p. 1).

The danger with these approaches is an *a priori* narrowing of the scope of what counts as valid adaptation knowledge. This is both an epistemological and political problem, with the potential to shape the future according to dominant interests and associated ways of knowing (Eriksen et al., 2015; Rickards et al., 2014), neglecting or negating emerging rural political identities (Dodman and Mitlin, 2011). To recognise the equal validity of multiple epistemological starting points means stepping back from integration, and turning adaptation on its head. This means asking what climate change means when the starting point is how rural livelihoods and socio-political relations are transforming, rather than biophysical impacts or climate risk. Nightingale (2016) espouses this view and calls for research methods that enable plural epistemologies to be held in view, such that different starting points can be held in tension within research. This tension recognises that alternative and equally valid starting points ask questions of socio-economic and political change and thus ‘see’ adaptation in a very different light.

The fieldwork in rural Nepal reported above illustrates this approach. Along with questions about climate and weather, respondents were asked about changes affecting household reproduction – livelihoods, household composition, income sources, challenges to farming – in order to understand what transformations in socio-political relations these changes involved. This approach allowed the research to reveal (‘see’) on-going processes of adaptation in rural agricultural households that are both driven by and driving wider processes of change. To explore adaptation taking the impacts of current and projected future climate change as a starting point fails to take seriously how transformations in rural political economies are influencing adaptation needs, rendering invisible the social and political histories and contemporary trajectories of livelihoods (Nagoda and Nightingale, 2017; Ribot, 2011).

An implicit prioritisation of the biophysical in epistemological approaches to adaptation not only represents an inappropriate fetishising of climate change, ignoring the most significant concerns of households, but also distorts these concerns even where they are seen. As our discussion above indicates, while extreme weather events and climate change are causing changes in farming practices, these changes are equally, if not more, influenced by out-migration, changing income opportunities, and desires to shift away from land dependency. Integration of context into the climate change lens focuses only on those dynamics of the political economy that intersect with climate change adaptation needs, rather than seeking to understand these dynamics and asking what they mean for climate change adaptation.

In Nepal, this problem is seen among adaptation researchers and practitioners concerned with the nexus between agricultural production and climate change. Epistemologically, adaptation for these professionals means addressing impacts on wheat and rice yields, focusing attention on the potential of improved cultivars, irrigation and

livestock, value chain development, changes to agronomic practices, and access to climate change information. Yet turning the adaptation problem inside out reveals agricultural livelihoods that – while significant – are in decline, and caught in a wider set of dynamics that see farming households adapting to a wave of mechanisation, relocation, migration, youth education, rising wage labour, reduction in farming household numbers and the erosion of farmer knowledge.

In this context it is evident that investing adaptation resources exclusively into addressing the production constraints anticipated under climate change would be to misunderstand the multidimensional nature of the challenges faced by rural households, and overlook entirely the needs of those who have essentially left, or in the future will exit, agriculture. However, important, alternative questions are raised when the biophysical and rural transformation perspectives are considered together. Can adaptation interventions, such as multi-stakeholder visioning and scenario planning, identify desirable livelihood trajectories in a context of intersecting climate and political-economic change (Brown et al., 2016; Rickards et al., 2014)? What capacities do households need to take advantage of opportunities for development, such as those arising from education or new employment options? What are the different forms of vulnerability among, for example, those who have recently migrated to road heads, those who have left agriculture, and those that have remained in isolated rural communities? And how can adaptation support be channelled to meet their particular needs, for example through alignment with interests expressed through emerging grass roots movements or organisations (Dodman and Mitlin, 2011; Ensor et al., 2015)? Only by stepping back from an exclusively biophysical understanding of adaptation can these questions be opened up and explored.

5. Conclusion

Our aim with this work was to probe what picture emerges when we refocus our adaptation research towards the dynamics of household reproduction and changing rural political economies. This framing has allowed us to locate climate change within the lived experience of rural communities. The biophysical framing, by contrast, locates rural communities in relation to the impacts of climate change. This latter approach enables detailed disciplinary engagement (for example, in relation to crop-climate interactions), but artificially frames the problem context in such a way that, even when participatory approaches are adopted, the wider political economy is missed and therefore important drivers of adaptation activities are overlooked. We therefore argue that new questions need to be asked, ones that view climate change from multiple starting points and allow for the epistemological differences between them to be held in creative tension within research programmes. This approach is distinct from the integration of local knowledge into adaptation planning. Integration risks narrowing the scope of what counts as knowledge necessary for adaptation. Turning the adaptation problem inside out, beginning from the perspective of transformation of rural lives, allows for new knowledges to emerge that better encompass the entangled social, cultural, political, economic and biophysical pressures and challenges that are ultimately driving changes in agricultural yields.

We therefore propose that adaptation research and practice needs to broaden out and open up (cf. Ely et al., 2014): to be rooted in a broader framing derived from an epistemologically plural approach to context and drivers; and, consequently, to be opened up to adaptation options beyond those anticipated by and bound up within particular specialist knowledge. This latter presents a particular challenge as it requires being less certain at the outset about how the focus of research or an intervention will develop, suggesting that disciplinary-led enquiry (such as crop modelling) is insufficient for rigorous exploration of viable adaptation strategies. Asking the right questions means investigating the adaptation problem by asking: what are the most significant changes taking place in people's lives? What are the impacts of

climate change? How, if at all, do these two connect and interact? Premised around understanding the context and problem setting from multiple perspectives, adaptation research and practice would then be well placed to draw in the disciplines as they become significant to adaptation planning.

Acknowledgments

The authors were supported by the Research Council of Norway through the CiXPAG project (grant no. 244551).

References

- Aase, T.H., Chapagain, P.S., Tiwari, P.C., 2013. Innovation as an expression of adaptive capacity to change in Himalayan farming. *Mount. Res. Dev.* 33 (1), 4–10. <https://doi.org/10.1659/MRD-JOURNAL-D-12-00025.1>.
- Adhikari, J., Hobley, M., 2015. “Everyone is leaving Who will sow our fields?”: the livelihood effects on women of male migration from Khotang and Udaypur districts, Nepal, to the gulf countries and Malaysia. *Himalaya* 35 (1), 11–23.
- Antwi-Agyei, P., Dougill, A.J., Stringer, L.C., 2015. Barriers to climate change adaptation: evidence from northeast Ghana in the context of a systematic literature review. *Climate Dev.* 7 (4), 297–309. <https://doi.org/10.1080/17565529.2014.951013>.
- Arshad, M., Amjath-Babu, T.S., Krupnik, T.J., Aravindakshan, S., Abbas, A., Kächele, H., Müller, K., 2017. Climate variability and yield risk in South Asia's rice-wheat systems: emerging evidence from Pakistan. *Paddy Water Environ.* 15 (2), 249–261. <https://doi.org/10.1007/s10333-016-0544-0>.
- Bassett, T.J., Fogelman, C., 2013. Déjà vu or something new? The adaptation concept in the climate change literature. *Geoforum* 48, 42–53. <https://doi.org/10.1016/j.geoforum.2013.04.010>.
- Bee, B.A., 2016. Power, perception, and adaptation: exploring gender and social – environmental risk perception in northern Guanajuato, Mexico. *Geoforum* 69, 71–80. <https://doi.org/10.1016/j.geoforum.2015.12.006>.
- Bee, B.A., Rice, J., Trauger, A., 2015. A feminist approach to climate change governance: everyday and intimate politics. *Geogr. Compass* 9 (6), 339–350. <https://doi.org/10.1111/gec3.12218>.
- Berrang-Ford, L., Ford, J.D., Paterson, J., 2011. Are we adapting to climate change? *Global Environ. Change* 21 (1), 25–33. <https://doi.org/10.1016/j.gloenvcha.2010.09.012>.
- Beveridge, L., Whitfield, S., Challinor, A., 2018. Crop modelling: towards locally relevant and climate-informed adaptation. *Climate Change* 147 (3), 475–489. <https://doi.org/10.1007/s10584-018-2160-z>.
- Biagini, B., Bierbaum, R., Stults, M., Dobardzic, S., McNeeley, S.M., 2014. A typology of adaptation actions: a global look at climate adaptation actions financed through the Global Environment Facility. *Global Environ. Change* 25, 97–108. <https://doi.org/10.1016/j.gloenvcha.2014.01.003>.
- Biggs, E.M., Tompkins, E.L., Allen, J., Moon, C., Allen, R., 2013. Agricultural adaptation to climate change: observations from the Mid-Hills of Nepal. *Climate Dev.* 5 (2), 165–173. <https://doi.org/10.1080/17565529.2013.789791>.
- Blaikie, P., Cameron, J., Seddon, D., 2002. Understanding 20 years of change in west-central Nepal: continuity and change in lives and ideas. *World Dev.* 30 (7), 1255–1270. [https://doi.org/10.1016/S0305-750X\(02\)00031-1](https://doi.org/10.1016/S0305-750X(02)00031-1).
- Brown, I., Martin-Ortega, J., Waylen, K., Blackstock, K., 2016. Participatory scenario planning for developing innovation in community adaptation responses: three contrasting examples from Latin America. *Reg. Environ. Change* 1–16. <https://doi.org/10.1007/s10113-015-0898-7>.
- Central Bureau of Statistics, 2012. National Population and Housing Census 2011. Kathmandu, Nepal.
- Central Bureau of Statistics, 2013. National Sample Census of Agriculture Nepal 2011/12 National Report. Kathmandu, Nepal.
- Central Bureau of Statistics, 2014. Population Monograph of Nepal Volume III (Economic Demography).
- Chaudhary, P., Bawa, K.S., 2011. Local perceptions of climate change validated by scientific evidence in the Himalayas. *Biol. Lett.* <https://doi.org/10.1098/rsbl.2011.0269>.
- Chidi, C.L., 2016. Determinants of cultivated land abandonment in the hills of western Nepal. *Studia Universitatis Babeş-Bolyai. Geographia* 61 (April (1)), p89–p104.
- Chhetri, N., Chaudhary, P., Tiwari, P.R., Yadaw, R.B., 2012. Institutional and technological innovation: understanding agricultural adaptation to climate change in Nepal. *Appl. Geogr.* 33, 142–150. <https://doi.org/10.1016/j.apgeog.2011.10.006>.
- CRCS, 2012. Land Reform Monitoring Indicators, Nepal. Retrieved from Kathmandu, Nepal.
- Dodman, D., Mitlin, D., 2011. Challenges for community-based adaptation: discovering the potential for transformation. *J. Int. Dev.* <https://doi.org/10.1002/jid.1772>.
- Ely, A., Van Zwanenberg, P., Stirling, A., 2014. Broadening out and opening up technology assessment: approaches to enhance international development, co-ordination and democratisation. *Res. Policy* 43 (3), 505–518. <https://doi.org/10.1016/j.respol.2013.09.004>.
- Ensor, J.E., Park, S.E., Hoddy, E.T., Ratner, B.D., 2015. A rights-based perspective on adaptive capacity. *Global Environ. Change* 31, 38–49. <https://doi.org/10.1016/j.gloenvcha.2014.12.005>.
- Ensor, J.E., Park, S.E., Attwood, S.J., Kaminski, A.M., Johnson, J.E., 2018. Can community-based adaptation increase resilience? *Climate Dev.* 10 (2), 134–151. <https://doi.org/10.1080/17565529.2018.1484444>.

- 17565529.2016.1223595.
- Eriksen, S., Aldunce, P., Bahinipati, C.S., D'Almeida, R.M., Molefe, J.I., Nhemachena, C., Ulsrud, K., 2011. When not every response to climate change is a good one: identifying principles for sustainable adaptation. *Climate Dev.* 3 (1), 7–20. <https://doi.org/10.3763/cdev.2010.0060>.
- Eriksen, S., Nightingale, A.J., Eakin, H., 2015. Reframing adaptation: the political nature of climate change adaptation. *Global Environ. Change* 35, 523–533. <https://doi.org/10.1016/j.gloenvcha.2015.09.014>.
- Eriksen, S.H., Silva, J., 2009. The vulnerability context of a savanna area in Mozambique: household drought coping strategies and responses to economic change. *Environ. Sci. Policy* 12 (1), 33–52. <https://doi.org/10.1016/j.envsci.2008.10.007>.
- FAO, 2016. *State of Food and Agriculture 2016: Climate Change, Agriculture and Food Security*. Retrieved from Rome.
- Forsyth, T., 2013. Community-based adaptation: a review of past and future challenges. *Wiley Interdiscip. Rev.: Climate Change* 4 (5), 439–446. <https://doi.org/10.1002/wcc.231>.
- Gauchan, D., Shrestha, S., 2017. *Agricultural and Rural Mechanisation in Nepal: Status, Issues and Options For Future*: Institute for Inclusive Finance and Development (InM).
- Gentle, P., Maraseni, T.N., 2012. Climate change, poverty and livelihoods: adaptation practices by rural mountain communities in Nepal. *Environ. Sci. Policy* 21, 24–34. <https://doi.org/10.1016/j.envsci.2012.03.007>.
- Hazell, P.B.R., 2008. *An Assessment of the Impact of Agricultural Research in South Asia since the Green Revolution*. Science Council Secretariat, Rome, Italy.
- Hossain, M.N., Chowdhury, S., Paul, S.K., 2016. Farmer-level adaptation to climate change and agricultural drought: empirical evidences from the Barind region of Bangladesh. *Nat. Hazards* 83 (2), 1007–1026. <https://doi.org/10.1007/s11069-016-2360-7>.
- Hulme, M., 2011. Reducing the future to climate: a story of climate determinism and reductionism. *Osiris* 26 (1), 245–266.
- IPCC, 2014a. *Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*. Retrieved from Cambridge, United Kingdom and New York, NY, USA: (2014a). Climate Change.
- IPCC, 2014b. *Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*. Retrieved from Geneva, Switzerland: (2014b). Climate Change.
- Jain, M., Naeem, S., Orlove, B., Modi, V., DeFries, R.S., 2015. Understanding the causes and consequences of differential decision-making in adaptation research: adapting to a delayed monsoon onset in Gujarat, India. *Global Environ. Change* 31, 98–109. <https://doi.org/10.1016/j.gloenvcha.2014.12.008>.
- Janila, P., Rupavatharam, S., Sameer Kumar, C., Samineni, S., Gaur, P., Varshney, R., 2016. Technologies for intensification of production and uses of grain legumes for nutrition security. *Proc. Indian Natl. Sci. Acad.* 82 (5), 1541–1553.
- Jaquet, S., Shrestha, G., Kohler, T., Schwilch, G., 2016. The effects of migration on livelihoods, land management, and vulnerability to natural disasters in the Harpan watershed in western Nepal. *Mount. Res. Dev.* 36 (4), 494–505.
- John, A., Fielding, M., 2014. Rice production constraints and 'new' challenges for South Asian smallholders: insights into de facto research priorities. *Agric. Food Secur.* 3 (1), 18. <https://doi.org/10.1186/2048-7010-3-18>.
- Jones, L., Boyd, E., 2011. Exploring social barriers to adaptation: insights from Western Nepal. *Global Environ. Change* 21 (4), 1262–1274. <https://doi.org/10.1016/j.gloenvcha.2011.06.002>.
- Joshi, N.P., Maharjan, K.L., Luni, P., 2011. Effect of climate variables on yield of major food-crops in Nepal: a time-series analysis. *J. Contemp. India Stud.* 1, 19–26.
- Klein, R.J., Juhola, S., 2014. A framework for Nordic actor-oriented climate adaptation research. *Environ. Sci. Policy* 40, 101–115.
- Korzenevica, M., Agergaard, J., 2017. 'The house cannot stay empty': a case of young rural Nepalis negotiating multiloocal householding. *Asian Popul. Stud.* 13 (2), 124–139. <https://doi.org/10.1080/17441730.2017.1303110>.
- Lassa, J.A., Lai, A.Y.-H., Goh, T., 2016. Climate extremes: an observation and projection of its impacts on food production in ASEAN. *Nat. Hazards* 84 (1), 19–33. <https://doi.org/10.1007/s11069-015-2081-3>.
- Laux, P., Jäckel, G., Tingem, R.M., Kunstmann, H., 2010. Impact of climate change on agricultural productivity under rainfed conditions in Cameroon—a method to improve attainable crop yields by planting date adaptations. *Agric. For. Meteorol.* 150 (9), 1258–1271. <https://doi.org/10.1016/j.agrformet.2010.05.008>.
- Leichenko, R.M., O'Brien, K.L., 2008. *Double Exposure: Global Environmental Change in an Era of Globalization*. Oxford University Press, Oxford, UK.
- LI-BIR.D, 2017. *Annual Report 2015–16*. Retrieved from Pokhara, Nepal.
- Lobell, D.B., Burke, M.B., Tebaldi, C., Mastrandrea, M.D., Falcon, W.P., Naylor, R.L., 2008. Prioritizing climate change adaptation needs for food security in 2030. *Science* 319 (5863), 607–610. <https://doi.org/10.1126/science.1152339>.
- Mallik, C., 2014. Land dispossession and rural transformation: the case of fringe villages of Kolkata. *J. Rural Dev.* 33 (1), 51–71.
- Manandhar, S., Vogt, D.S., Perret, S.R., Kazama, F., 2011. Adapting cropping systems to climate change in Nepal: a cross-regional study of farmers' perception and practices. *Reg. Environ. Change* 11 (2), 335–348. <https://doi.org/10.1007/s10113-010-0137-1>.
- Massey, D.S., Axinn, W.G., Ghimire, D.J., 2010. Environmental change and out-migration: evidence from Nepal. *Popul. Environ.* 32 (2), 109–136. <https://doi.org/10.1007/s11111-010-0119-8>.
- McDowell, J., Hess, J., 2012. Accessing adaptation: multiple stressors on livelihoods in the Bolivian highlands under a changing climate. *Global Environ. Change* 22 (2), 342–352.
- Mittal, N., Mishra, A., Singh, R., Kumar, P., 2014. Assessing future changes in seasonal climatic extremes in the Ganges river basin using an ensemble of regional climate models. *Climate Change* 123 (2), 273–286.
- Nagoda, S., Nightingale, A.J., 2017. Participation and power in climate change adaptation policies: vulnerability in food security programs in Nepal. *World Dev.* 100, 85–93. <https://doi.org/10.1016/j.worlddev.2017.07.022>.
- Nightingale, A.J., 2016. Adaptive scholarship and situated knowledges? Hybrid methodologies and plural epistemologies in climate change adaptation research. *Area* 48 (1), 41–47. <https://doi.org/10.1111/area.12195>.
- Nightingale, A.J., 2017. Power and politics in climate change adaptation efforts: struggles over authority and recognition in the context of political instability. *Geoforum* 84, 11–20. <https://doi.org/10.1016/j.geoforum.2017.05.011>.
- O'Brien, K., Eriksen, S.H., Schjolden, A., Nygaard, L.P., 2007. Why different interpretations of vulnerability matter in climate change discourses. *Climate Policy* 7, 73–88. <https://doi.org/10.1080/14693062.2007.9685639>.
- O'Brien, K.L., Eriksen, S.H., Inderberg, T.H., Sygna, L., 2015. *Climate Change and Development: Adaptation through Transformation*. In: Inderberg, T.H., Eriksen, S.H., O'Brien, K.L., Sygna, L. (Eds.), *Climate change adaptation and development: changing paradigms and practices*. Routledge, Oxon and New York, pp. 273–289. ISBN: 978-1-138-02598-1.
- O'Brien, K., Leichenko, R., Kelkar, U., Venema, H., Aandahl, G., Tompkins, H., Javed, A., Bhadwal, S., Barg, S., Nygaard, L., West, J., 2004. 'Mapping multiple stressors: climate change and economic globalization in India'. *Global Environ. Change* 14, 303–313.
- Ohlan, R., 2016. Rural transformation in India in the decade of miraculous economic growth. *J. Land Rural Stud.* 4 (2), 188–205.
- Ojha, H.R., Ghimire, S., Pain, A., Nightingale, A., Khatri, D.B., Dhungana, H., 2015. Policy without politics: technocratic control of climate change adaptation policy making in Nepal. *Climate Policy* 415–433. <https://doi.org/10.1080/14693062.2014.1003775>.
- Pandey, D.N., Gupta, A.K., Anderson, D.M., 2003. Rainwater harvesting as an adaptation to climate change. *Curr. Sci.* 85 (1), 46–59.
- Paudel, B., Khanal, R.C., Khatri-Chhetri, A., Bhatta, K., Chaudari, P., 2017. *Climate-Smart Agriculture in Nepal: Champion Technologies and Their Pathways for Scaling Up*. Retrieved from London United Kingdom.
- Pelling, M., 2011. *Adaptation to Climate Change: From Resilience to Transformation*. Routledge, London.
- Peng, S., Huang, J., Sheehy, J.E., Laza, R.C., Visperas, R.M., Zhong, X., Cassman, K.G., 2004. Rice yields decline with higher night temperature from global warming. *Proc. Natl. Acad. Sci. USA* 101 (27), 9971–9975. <https://doi.org/10.1073/pnas.0403720101>.
- Ploeg, J.D.V.D., 2014. *Peasants and the Art of Farming: A Chayanovian Manifesto*. Fernwood, Winnipeg.
- Pringle, P., Conway, D., 2012. Voices from the frontline: the role of community-generated information in delivering climate adaptation and development objectives at project level. *Climate Dev.* 4 (2), 104–113. <https://doi.org/10.1080/17565529.2012.707608>.
- Quinn, C.H., Ziervogel, G., Taylor, A., Takama, T., Thomalla, F., 2011. Coping with multiple stresses in rural South Africa. *Ecol. Soc.* 16 (3), 2. www.ecologyandsociety.org/vol16/iss3/art2/.
- Rao, N., Lawson, E.T., Raditloang, W., Solomon, D., et al., 2017. Gendered vulnerabilities to climate change: insights from the semi-arid regions of Africa and Asia. *Climate Dev.* 1–17.
- Rauch, T., 2014. New ruralities in the context of global economic and environmental change? Are small-scale farmers bound to disappear? *Geog. Helv.* 69 (4), 227–237.
- Revadekar, J., Kothawale, D., Patwardhan, S., Pant, G., Kumar, K.R., 2012. About the observed and future changes in temperature extremes over India. *Nat. Hazards* 60 (3), 1133–1155.
- Reid, H., Alam, M., Berger, R., Cannon, T., 2009. Community-based adaptation to climate change. *Particip. Learn. Action* 60, 11–33.
- Reid, P., Vogel, C., 2006. Living and responding to multiple stressors in South Africa—glimpses from KwaZulu-Natal. *Global Environ. Change* 16, 195–206.
- Ribot, J., 2011. Vulnerability before adaptation: toward transformative climate action. *Global Environ. Change* 4 (21), 1160–1162.
- Rickards, L., Ison, R., Fänfgeld, H., Wiseman, J., 2014. Opening and closing the future: climate change, adaptation, and scenario planning. *Environ. Plan. C: Govern. Policy* 32 (4), 587–602. <https://doi.org/10.1068/c3204ed>.
- Rigg, J., 2006. Land, farming, livelihoods, and poverty: rethinking the links in the Rural South. *World Dev.* 34 (1), 180–202. <https://doi.org/10.1016/j.worlddev.2005.07.015>.
- Ruane, A.C., Major, D.C., Yu, W.H., Alam, M., Hussain, S.G., Khan, A.S., Rosenzweig, C., 2013. Multi-factor impact analysis of agricultural production in Bangladesh with climate change. *Global Environ. Change* 23 (1), 338–350. <https://doi.org/10.1016/j.gloenvcha.2012.09.001>.
- Schipper, E., ayers, J., Reid, H., Huq, S., Rahman, A., 2014. *Community-Based Adaptation to Climate Change: Scaling it Up*. Earthscan.
- Sharma, J.R., 2016. *Bodies in search of freedom*. Econ. Polit. Wkly.
- Sijapati, B., Lama, A.S., Baniya, J., Rinck, J., Jha, K., Gurung, A., 2017. *Labour Migration and the Remittance Economy: The Socio-Political Impact*. Retrieved from Kathmandu.
- Singh, D., Tsiang, M., Rajaratnam, B., Diffenbaugh, N.S., 2014. Observed changes in extreme wet and dry spells during the South Asian summer monsoon season. *Nat. Climate Change* 4, 456. <https://doi.org/10.1038/nclimate2208>. <https://www.nature.com/articles/nclimate2208-supplementary-information>.
- Singh, P., Boote, K.J., Kadiyala, M.D.M., Nedumaran, S., Gupta, S.K., Srinivas, K., Bantilan, M.C.S., 2017. An assessment of yield gains under climate change due to genetic modification of pearl millet. *Sci. Tot. Environ.* 601–602, 1226–1237. <https://doi.org/10.1016/j.scitotenv.2017.06.002>.
- Sugden, F., 2017. A mode of production flux: the transformation and reproduction of rural class relations in lowland Nepal and North Bihar. *Dialect. Anthropol.* 41 (2),

- 129–161 [10.1007/s10624-016-9436-3](https://doi.org/10.1007/s10624-016-9436-3).
- Sugden, F., Punch, S., 2016. Changing aspirations education, and migration: young people's declining agroecological knowledge in rural Asia. *Geogr. Global Issues: Change Threat* 1–17.
- Sunam, R.K., McCarthy, J.F., 2016. Reconsidering the links between poverty, international labour migration, and agrarian change: critical insights from Nepal. *J. Peasant Stud.* 43 (1), 39–63 [10.1080/03066150.2015.1041520](https://doi.org/10.1080/03066150.2015.1041520).
- Spires, M., Shackleton, S., Cundill, G., 2014. Barriers to implementing planned community-based adaptation in developing countries: a systematic literature review. *Climate Dev.* 6 (3), 277–287. <https://doi.org/10.1080/17565529.2014.886995>.
- Tripathi, A., Mishra, A.K., 2017. Knowledge and passive adaptation to climate change: an example from Indian farmers. *Climate Risk Manag.* 16, 195–207. <https://doi.org/10.1016/j.crm.2016.11.002>.
- Tschakert, P., Das, P.J., Shrestha Pradhan, N., Machado, M., Lamadrid, A., Buragohain, M., Hazarika, M.A., 2016. Micropolitics in collective learning spaces for adaptive decision making. *Global Environ. Change* 40, 182–194.
- Van de Giesen, N., Liebe, J., Jung, G., 2010. Adapting to climate change in the Volta Basin, West Africa. *Curr. Sci.* 98 (8), 1033–1037.
- Vincent, K., Næss, L.O., Goulden, M., 2013. National level policies versus local level realities – can the two be reconciled to promote sustainable adaptation? In: Sygna, L., O'Brien, L., Wolf, A.J. (Eds.), *Changing Environment for Human Security: Transformative Approaches to Research, Policy and Action*. Earthscan, London.
- Vermeulen, S.J., Dinesh, D., Howden, S.M., Cramer, L., Thornton, P.K., 2018. Transformation in practice: a review of empirical cases of transformational adaptation in agriculture under climate change. *Front. Sustain. Food Syst.* <https://doi.org/10.3389/fsufs.2018.00065>.
- Wang, S.W., Lee, W.-K., Son, Y., 2017. An assessment of climate change impacts and adaptation in South Asian agriculture. *Int. J. Climate Change Strateg. Manag.* 9 (4), 517–534.
- Wassmann, R., Jagadish, S.V.K., Heuer, S., Ismail, A., Redona, E., Serraj, R., Sumfleth, K., 2009. Chapter 2 climate change affecting rice production. *Adv. Agron.* 101, 59–122. [https://doi.org/10.1016/S0065-2113\(08\)00802-X](https://doi.org/10.1016/S0065-2113(08)00802-X).