Climate induced rural-to-urban migration in Pakistan

Working paper

SDPI
Sustainable Development Policy Institute

PRISE
Pathways to resilience in semi-arid economies

Research for climate–resilient futures

Climate induced rural-to urban migration in Pakistan

January 2016

Fahad Saeed

Kashif Majeed Salik

Sadia Ishfaq

This report has been produced as part of a series of preliminary papers to guide the long-term research agenda of the Pathways to Resilience in Semi-arid Economies (PRISE) project. PRISE is a five-year, multi-country research project that generates new knowledge about how economic development in semi-arid regions can be made more equitable and resilient to climate change.

Front cover image:
A tent city at sunset, Hahirpur district, Sindh province, Pakistan

Acknowledgements

The authors are thankful to a number of colleagues who have contributed to the development and finalisation of this paper. Special thanks are due to Dr. Abid Suleri and Dr. Vaqar Ahmed (Sustainable Development Policy Institute, SDPI) for providing their valuable insights. We are also grateful to Dr. Bara Guèye (IED Afrique) whose insightful comments helped us further refine our study. Thanks are also due to Waheed Zafar (SDPI) who provided support in data collection and data entry. This study would not have been possible without the financial support of the PRISE project, which is funded by IDRC and DFID.

Contents

Boxes and figures

Acronyms

ADB	Asian Development Bank
AR5	IPCC's Fifth Assessment Report
CMIP5	Coupled Model Intercomparison Project Phase 5
CORDEX	Coordinated Regional Climate Downscaling Experiment
DESA	Department of Economic and Social Affairs
ESMs	Earth System Models
GDP	Gross Domestic Product
GoP	Government of Pakistan
IOM	International Organization for Migration
IPCC	Intergovernmental Panel on Climate Change
KPK	Khyber Pakhtunkhwa
PMD	Pakistan Meteorological Department
PRISE	Pathways to Resilience in Semi-arid Economies
RCA	Rossby Centre regional Atmospheric climate model
RCMs	Regional Climate Models
RCP	Representative Concentration Pathways
SALs	Semi-Arid Lands
SSP	Shared Socioeconomic Pathways
UNDP	United Nations Development Programme
WB	World Bank
WMO	World Meteorological Organization

Executive summary

Over the past 20 years, new insights have been gained about climate–human interactions and their impact on human mobility and migration. The most significant of these is the conclusion the Intergovernmental Panel on Climate Change (IPCC) draws in its latest assessment report, namely that the magnitude of human displacement and migration may increase during the 21st century due to climate change. Quantitative research on the role of migration and climate change is limited, however, given the complexity and unpredictability of climate-induced migration patterns (Black et al., 2011) and the heterogeneity of individual and collective responses to climate change. Moreover, the uncertainty surrounding climate science itself presents a challenge to predicting precisely the impact on human settlements (Banerjee et al., 2011).

For most developing countries, the problem of climate-induced migration is compounded by the challenge of urbanisation that seems to couple with it (ADB, 2012). While a substantial proportion of the population in developing countries live in rural areas, it remains largely unknown how many rural people migrate internally to urban and peri-urban centres in response to climate change. This is important to understand, because most rural livelihoods are based on agriculture, and climate-induced losses in agricultural productivity have been shown to alter livelihoods (Barnett and Adger, 2007; Mueller et al., 2014), and this can potentially scale up urbanisation. Thus, for the purpose of this study, we analyse climate-induced internal migration in a developing country that is largely semi-arid and faces development challenges of urbanisation, rural poverty, and associated agricultural decline.

Pakistan is a low-middle-income country of 188 million people that ranks low in human development, with rural-urban disparities in poverty, income and development infrastructure. Rural poverty is widespread but more pronounced in arid and semi-arid zones. The country's urban economy contributes 78% to the national gross domestic product (GDP) although it is home to one third of the total population (World Bank (WB), 2014; Hussain, 2014). With an urbanisation rate of 3% per annum (Kugelman, 2014), many Pakistani cities have informally grown into large agglomerations with about 35% to 50% of urban population reportedly living in informal settlements (WB, 2014; Kugelman, 2014). Government projections suggest that by 2030 more than half of Pakistan's population will be residing in urban areas (GoP, 2014). Such estimates do not take into account the effects of climate change – on urbanisation, rural-urban migration, and population growth.

Agricultural productivity in rural areas is affected by variations in climate variables such as average temperature and precipitation. Heat stress in particular has shown to affect agricultural productivity of winter crops (Qin et al., 2014), such as wheat, a staple food grown in semi-arid and arid areas of Pakistan. According to a longitudinal study by Mueller et al. (2014), the benefits of migration outweigh the moving costs, especially following heat stress or heatwave in the winter season, which results in migration of all forms. Thus, to some extent, climate change may play a role, albeit marginal, in pushing up rural-to-urban migration, which presently constitutes 40% of total internal migration in the country (Arif, 2005).

The results of this study indicate that climate change acts in combination with many other socioeconomic determinants of migration. Climate shocks and slow-onset changes impact ecological conditions in rural lands that trigger shifts in agricultural productivity, thus eroding incomes of poor and marginal cultivators. Migratory decisions may be taken to escape from losses in rural incomes, which are variably intensified by climatic stress. We predict that by 2030 such changes are likely to be magnified in arid and semi-arid areas of Pakistan that are important in terms of wheat production and are home to large rural populations. Given the sensitivity of wheat crop to heat stress, we anticipate that decline in wheat production will affect rural poor and marginal households, who will be forced to cope. When coupled with prospects for improved life in urban centres, this will incentivise poor rural populations to out-migrate. Thus, while variability in weather patterns plays a role in influencing migration patterns, the development deficit in Pakistan's semi-arid rural areas, paralleled by higher investments in urban centres, together lure potential migrants from rural areas to urban settlements.

Thus, following are some initial recommendations of the study:

- Managing rapid urbanisation: Study results show that rural-urban migration may contribute to unplanned urbanisation and expansion of megacities like Karachi, Lahore, and Faisalabad, which may disrupt urban well-being. Therefore, one viable way to overcome this challenge is to develop intermediate cities or towns (Jamal and Ashraf, 2004), which can serve as pivots between large cities and rural areas by facilitating access to markets for agriculture outputs (Hussain, 2014).
- Monitoring of internal migration: The dearth of adequate data on rural-urban migrants hinders monitoring of internal migration flows, which presents a challenge to informed decision-making. Therefore, this study proposes a National Registration System that can capture population mobility data across Pakistan.
- Risk management in agriculture sector: Risk management in the agriculture sector needs innovative financial support mechanisms that improve poor farmers' access to finance during climate shocks (e.g. crop insurance to protect against crop failures).
- Improved rural and urban service delivery through decentralised governance: The revival of local governments under the 18th Constitutional Amendment is important for curbing rural-to-urban migration. Service delivery for rural and local populations is likely to increase; this would, however, need to be complemented by improved service provision in urban slums, which are likely to absorb the influx of informal rural migrants.
- Integrated approach to 'climate-proof' development: Given Pakistan's high vulnerability to climate change, and its existing level of development challenges, the country requires an integrated and multi-sectoral approach to climate-resilient economic development. Sectoral policies on population, agriculture and food security, environment, poverty alleviation and economic growth need to propose specific measures for climate resilience, as highlighted in National Climate Change Policy in 2012 and 'Framework for Implementation of Climate Change Policy (2014-2030)'.

1. Introduction

Over the past 20 years, new insights have been gained about climate-human interactions and their impact on human mobility and migration. The most significant of these is the conclusion of the latest Inter-governmental Panel on Climate Change (IPCC) assessment report: that the magnitude of human displacement and migration may rise during the 21st century due to climate change. Estimates indicate that climate change effects – including rainfall shifts, heat stress and water scarcity – may motivate anywhere from 25 million to 1 billion people to migrate by 2050 (Myers, 2005; Parry, 2007; Lovell and London, 2007). Those most likely to migrate will be populations living in precarious and vulnerable conditions, especially in rural areas of arid and semi-arid regions, where there is a high dependency on climate-sensitive, ecosystem-based livelihoods. Such mass movements are likely to be from rural areas to urban agglomerations, in line with present trends (Qin et al., 2014).

Presently, a major proportion of global migration is internal (about 80%), most of it from rural areas to urban settlements (Qin et al., 2014). Based on these trends, global urban population is estimated to rise to 59% by 2030, as compared to 10% in 1900 and 50% in 2009 (Grimm et al., 2008). This implies that climate change may not only alter migration patterns but also increase urbanisation rates especially in developing economies. However, given the dearth of empirical evidence, much of this research remains speculative in nature, leaving the climate-migration discourse inconclusive (Black et al., 2011). Picking from the recommendations of IPCC Fifth Assessment Report (AR5), this study offers local insights on climate-induced internal migration in Pakistan that is continually redefined by socioeconomic and climate trends.

Emerging literature identifies migration patterns as either permanent or temporary (seasonal or cyclic) that may be internal (within a country) or international (across countries) (UN Department of Economic and Social Affairs (DESA), 2011). IPCC describes migration as a multi-causal phenomenon characterised by a permanent or semi-permanent move by a person of at least one year that involves crossing an administrative, but not necessarily a national border (Brown and Bean, 2005). Although historically humans migrated in response to variability in local conditions (Foresight, 2011), earlier streams of research have focused more exclusively on migration’s socioeconomic determinants. Recent migration literature has, however, examined migrant moves in light of various causation factors, which include access to capital, finance, economic opportunities, governance, social capital and environmental conditions (Mazumdar, 1987; Irfan, 1986; Etzo, 2008; Kolev, 2013). These can be broadly classified under two categories: push factors and pull factors.

Push and pull factors arise due to socio-political, environmental and/or economic conditions of a country, that drive migrants to move from an imbalanced place to a balanced place (Black and Sward, 2008). Push factors are generally related to the place of origin; examples include poverty, illiteracy, limited economic opportunities, conflicts, natural disasters, and climate hazards, among others. Pull factors are related to the place of migrant destination, attracting people to certain locations. Examples of pull factors are access to better economic opportunities, basic services (education, health) and living conditions (environment, sanitation, human security), and political stability. Recent studies have identified additional factors – such as age, education, marital status, personal choices, community perceptions and network connections (especially with earlier migrants) – in framing migration patterns (Ketel, 2004; Reuveny, 2007; Brown, 2008).

In order to understand the quantum of migration, development organisations have made concerted efforts in recent years to monitor global migration. The World Bank has been publishing a yearly Migration and Remittances Factbook since 2008, and the International Organization for Migration (IOM) has annually published World Migration Report since 2009. Yet although international migration and internal displacement has received considerable interest in academic and development circles, research on internal migration and climate-induced migration has been slow to emerge. This is despite the availability of some data at country level on human mobility. Moreover, although in developing countries a substantial proportion of people live in rural areas, it remains largely unknown how many rural people migrate to urban and peri-urban areas in response to climate change. This is important to understand, because most rural livelihoods are based on agriculture, and climate-induced losses in agricultural productivity have shown to alter livelihoods in those countries (Barnett and Adger, 2007; Mueller et al., 2014), which can potentially intensify and scale up urbanisation. Additionally, rural poverty, often associated with landlessness and lack of access to assets (Naveed and Ali, 2012), may also trigger rural-to-urban migration. Attempts to escape from rural poverty may add to urbanisation problems by exerting pressure on urban services and infrastructure, exposing the urban residents to increased risks.

Based on these observations, this study, which serves as a Deep Dive for the Pathways to Resilience in Semi-arid Economies (PRISE) project, focuses on how rural-to-urban migration in Pakistan can best be understood in the context of long-term climate change. It analyses climate-induced migration in the context of development challenges of urbanisation, rural poverty, and associated agricultural decline. Another major aim of this study is to develop a methodology to identify potential 'hotspot' regions where future research on climate-induced migration can be carried out during the course of the PRISE project.

This study is structured into three main sections. Section 2 reviews the role of climate change in influencing global patterns in rural-urban migration, and the subsequent implications for urbanisation. Section 3 reviews similar issues but in the national and sub-national context of Pakistan. Section 4, based on robust research methodology, provides scientific evidence on potential migrants of Pakistan. Lastly, Section 5 expands upon the discussion, and Section 6 draws conclusions, makes recommendations, and points the way forward.

2. Link between migration and urbanisation: the role of climate change

Human migration has been occurring notwithstanding climate change. However, scientific evidence suggests that environmental change has played a role in shaping human mobility and settlement patterns since the Holocene (McKone et al., 1998; Hughes and Brown, 1992; Richerson et al., 2001; Morgan, 2009). Temporal and spatial variation in resource productivity due to environmental variability compelled people ('the hunter-gatherer') to migrate (Halstead, 1989) and helped them to agglomerate around intensified settlements for reduced exposure to risks (Low, 1990; Morgan, 2009). Even today, climate change continues to trigger human displacement and migration (Parry, 2007; Qin et al., 2014) by acting as a 'macro driver of many kinds of environmental changes' that trigger shifts in local environmental and biophysical conditions (Barnett and Adger, 2007). These changes may be slow-onset or sudden. The slow-onset environmental changes include decline in biodiversity, changes in water flows, degradation of ecosystems services, shifts in agricultural productivity, and soil degradation (Hoermann et al., 2010). Sudden or rapid climatic changes include increase in extreme events such as extreme rainfall, flash floods, glacial lake outburst floods, droughts, heatwaves, etc. In response to such environmental changes, many populations out-migrate voluntarily or by compulsion (Kalin, 2010; Hoermann et al., 2010).

But climate change rarely acts alone to push out-migration. It couples with socioeconomic, political and ecological stresses to unsettle human populations (Black et al., 2011; McLeman and Smit, 2006) through drastic social change (Barnett and Adger, 2007). Poverty, inequality, and market and institutional failures have shown to be the major causes of migration, as indicated in the literature on famines (Barnett and Adger, 2007). Not surprisingly, growing scientific research attributes migration as a transformational adaptation to climate change (Qin et al., 2014; Massey et al., 2010; Warner, 2010; McLeman and Hunter, 2010; Hoermann et al., 2010; Smith and McNamara, 2014), where people move out from high-risk areas to improve their access to opportunities and livelihoods and minimise their vulnerability to risks (Tacoli, 2009). Indeed, many developing countries (such as Bangladesh, Eritrea, Ethiopia, Haiti, and Mali) officially recognise migration and displacement as an adaptation option against climate disasters in their National Adaptation Programmes of actions (Banerjee et al., 2011). However, other scholars see migration as a failure to cope with climate change (Warner, 2010), since the locals move out of rural places and into urban settings (transformative adaptation) instead of adapting while staying in the same place (in situ adaptation).

Quantitative research on the role of migration and climate adaptation is, however, limited, given the complexity and unpredictability of climate-induced migration patterns (Black et al., 2011), and the heterogeneity of individual and collective responses to climate change. Moreover, the uncertainty surrounding climate science itself presents a challenge to predicting precisely the impact on human settlements (Banerjee et al., 2011). Making such a prediction includes asking questions about how people will migrate – and how many – as a result of climate change, how climate change will impact migrants in new settlements (e.g. cities) and what the direct impacts on human mobility will be. It is particularly challenging when the relation between climate change and migration is not linear (McLeman and Smit, 2006; Mueller et al., 2014) and is dependent on a multitude of factors (Black and Sward, 2008; Black et al., 2011; Barnett and Adger, 2007; Banerjee et al., 2011).

Patterns in climate-induced migration seem to couple with urbanisation (ADB, 2012), which most developing countries face today. In most developing countries, overspending of development budget in urban areas increases the 'pull' factor, which combines with the 'push' of environmental challenges in rural areas to influence people to out-migrate. Thus, urban areas become a 'magnet' for rural migrants and underemployed labour, spurring urbanisation (Hussain, 2014). Climate change can temporarily or permanently increase migration flows to cities (Adamo, 2010), which calls for policy measures to accommodate migrant influx. Apart from climate change, rural-to-urban migration has been posing different challenges in the past, has resulted in the development of various policies at national and sub-national levels. A brief description of some of these policies is presented in Box 1.

While migration may hold economic potential for places of both migrant-origin and destination (ADB, 2012), urbanisation presents many challenges, particularly in developing countries (Özden and Enwere, 2012; Black et al., 2011). Large changes in mobility patterns have the potential to induce pressure on infrastructure and service delivery in destination areas, resulting in competition and

Box 1: Rural-urban migration and urbanisation policies

Policies that directly and indirectly address migration and urbanisation issues can generally be classified into negative, manipulative and preventive policies (Mahmud et al., 2010). Negative policies refers to the use of force to limit the migration rate, such as enforced relocations from urban to rural areas, demolishing of unlawful settlements and prohibition of emigrant movement to cities (Parnwell, 1993). The manipulative approach seeks to redirect the migration flows, through policies facilitating urban, industrial and administrative decentralisation. This approach considers migration to be unavoidable for economic growth, and hence tries to capitalise the potential of value addition from the redirection of migration flows. The preventive approach generally involves creating more opportunities in the rural sector in order to prevent migration flows by reducing push and appeal to pull factors at home and destination place respectively. This is usually done by measures such as introduction of land reforms, agriculture intensification, agriculture extension, and rural infrastructural investment (Tacoli, 2003).

The issue of migration receives little attention in Pakistan's rural-urban development planning. For example, while the prevalence of poverty in rural and urban areas largely influences migration and urbanisation patterns, the Government's Poverty Reduction Strategy Paper (PRSP) and recently approved Vision 2025 fail to provide any strategy relevant to current and future urban planning or migration. A draft National Emigration Policy exists, but it discusses international migration issues exclusively, with no focus on internal, rural-urban migration.

conflict (Locke, 2009; Barnett and Webber, 2010). Although urbanisation provides opportunities for growth, it also causes income disparities within and between urban and rural areas (Hussain, 2014). In some places, newly arrived migrants in urban localities may be as vulnerable to climate hazards as they were in their places of origin (Black et al., 2011).

The IPCC reports with medium confidence, high agreement, and medium-level evidence that urban centres across the world are highly vulnerable to climate change risks, especially the informal urban settlements or slums (Qin et al., 2014). The major climate risks to such areas include heat stress, extreme precipitation, storm surges, inland and coastal flooding, landslides, drought, increased aridity, water and energy insecurity and air pollution. These may cause widespread negative impacts on human health, livelihood, property, and overall economy and ecosystems.

In the case of Pakistan, which is the fastest urbanising country in South Asia, the phenomenon of rural-to-urban migration is emerging as a major development challenge. However, lack of research in this area leaves a knowledge void that hinders meaningful policy-making and its implementation. In light of this, the next section discusses the relationship between urbanisation, rural-to-urban migration and climate change in the context of Pakistan.

3. Migration, urbanisation and climate change: the Pakistani context

Pakistan is a low-middle-income country of 188 million people that ranks low in human development, with rural-urban disparities in poverty, income and development infrastructure. The country is mainly semi-arid, and the agriculture sector is the largest employer, formally engaging 44% of the workforce (68% in rural areas) (GoP, 2014). Subsistence agriculture is predominant in rain-fed areas, whereas irrigation-based farming is common in semi-arid zones that have more sustainable access to water. Pastoralism is common in arid areas, where poorer communities migrate seasonally for food, water and fodder. Rural poverty is widespread but is more pronounced in arid and semi-arid zones. It is often associated with landlessness and exposure to climate risks and is accompanied by insecure access to basic necessities (Chun, 2014). Overall, about 50% of the rural population is landless (WB, 2002), whereas small farmers own 86% of farms (farm size of less than 12 acres) (GoP, 2009).

In contrast, Pakistan's urban economy contributes 78% to the national GDP although it is home to one-third of the total population (WB, 2014; Hussain, 2014). With an urbanisation rate of 3% per annum (Kugelman, 2014), many Pakistani cities have informally grown into large agglomerations with about 35% to 50% of the urban population reportedly living in informal settlements (WB, 2014; Kugelman, 2014). Government projections suggest that by 2030 more than half of Pakistan's population will be residing in urban areas (GoP, 2014). Such estimates do not take into account the effects of climate change – on urbanisation, rural-urban migration, and population growth.

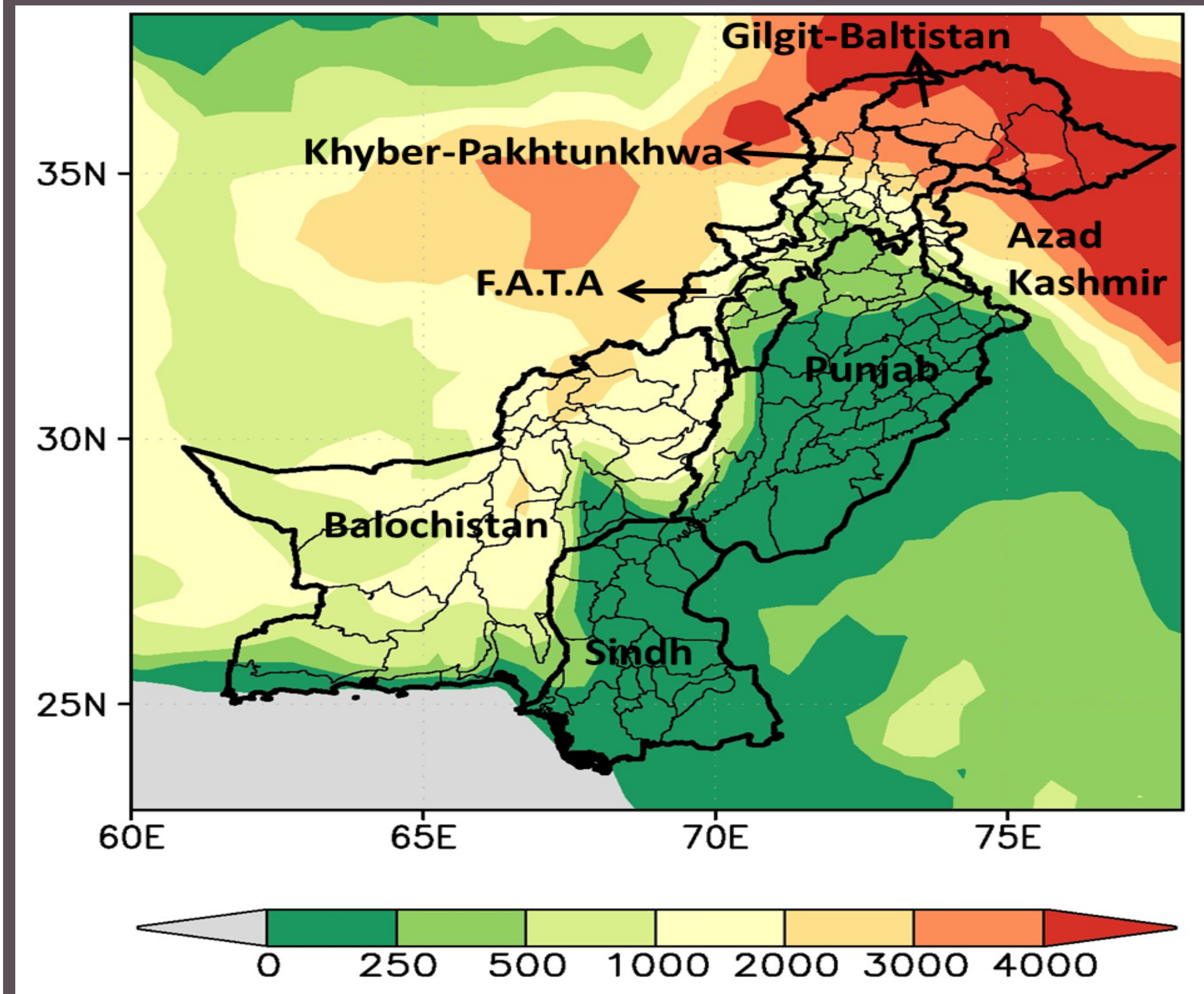
A handful of scientific studies and grey literature have tried to explore the relationship between these interlinked factors. These suggest that agricultural productivity in rural areas is affected by variations in climate variables such as average temperature and precipitation. Heat stress in particular has shown to affect agricultural productivity of winter crops (Qin et al., 2014). For example, the production of wheat crop, a staple food consumed by most Pakistanis, may decline by 5-25% as a result of climate change (Sultana et. al, 2009). Similar results were obtained by Majid and Zahir (2014) while studying climate change impacts on farm productivity and socioeconomic vulnerabilities in Punjab and Sindh. According to them, drought is the most important climate phenomenon that significantly impacts crop yields of wheat, rice, cotton and sugar cane. Decline in crop yields negatively impacts tenant farmers, compelling them to seek alternative livelihoods and sometimes even to move to urban settlements (Majid and Zahir, 2014). This is similar to the seminal work by Mueller et al. (2014), discussed in more detail in later sections, which finds that internal migration in Pakistan is caused to some extent by heat stresses. There are other studies that independently explore internal migration flows across Pakistan.

In a pioneer study, Irfan (1986) estimated that 42% of all migrants in Pakistan moved within districts, 39% across districts, and 19% across provincial boundaries. A more recent study by Arif (2005) estimates rural-to-urban migration to constitute 40% of total internal migration. Provincially, rural-to-urban migration is lowest in Sindh and Balochistan followed by Punjab and Khyber Pakhtunkhwa (KPK) (Mahmud et al., 2010). Remarkably, a majority of rural migrants tend to move toward districts having high population densities. For example, 63% of the people who migrated in the last ten years moved to an urban area, with 56% moving to the provincial or the federal capital (Mahmud et al., 2010), mainly due to family networks and higher concentrated development in these areas. In a more focused internal migration study carried out in Faisalabad district, Farooq et al. (2005) found that 80% and 13% of the respondents were 'pushed' out due to poor economic and educational opportunities respectively. Such research suggests that historically migration in Pakistan has been associated with differential in rural-urban labour productivity, human development, urban investments, and technological advances (Irfan, 1986; Khan et al., 2000; Mahmud et al., 2010).

It can be inferred from the discussion above that although there are studies focusing on climate change, food security, urbanisation and migration, these issues are often researched in isolation. In the following section, the link between migration and urbanisation in relation with climate change will be established. Moreover, in contrast to earlier studies, which focused on certain regions or districts, the analysis presented in this study is carried out at the national scale.

Box 2: Map of Pakistan

Pakistan is a major country in South Asia having an area of 796,096 sq. km. The map below shows the topography of the country (in metres) which is a profound blend of plains, deserts, hills, forests, and plateaus ranging from coastal areas in the South to the mountains in the North. The administrative units of Pakistan consist of four provinces (Punjab, Sindh, Khyber-Pakhtunkhwa and Balochistan), two autonomous territories (Gilgit-Baltistan and Azad Kashmir), and a group of federally administrated tribal areas (FATA). Pakistan is bordered with People's Republic of China to the north and India to the east while Afghanistan borders the country in the north-west and Iran to the west.



Source: author

Box 3: Cropping seasons

Pakistan has two major cropping seasons. Summer, or 'kharif', crops are sown from April to June and harvested from October to December; while winter, or 'rabi', crops are sown through October-December and harvested April-May. Winter crops generally include wheat and mustard.

4. Potential climate migrants in Pakistan

Given the definitional issues and the dearth of reliable and consistent official data on internal mobility, migration flows are difficult to calculate without substantial error (Irfan, 1986; Mahmud et al., 2010). The last population census was conducted seventeen years ago, in 1998, and did not include any information on the place of birth. The government of Pakistan annually publishes the Labour Force Survey with modest information on labour movement, but it fails to capture conclusive data on inter- and intra-district migrations. Furthermore, despite the availability of sufficient climate data, projecting the impacts of climate change on urbanisation and internal migration trends is difficult given the complex interrelationship between these multi-causal phenomena. Not surprisingly, very few studies focusing on climate-induced migration in Pakistan can be found in peer-reviewed literature, as indicated above.

One such study, published in Nature Climate Change, is by Mueller et al. (2014) and addresses the issue of rural-to-urban migration in semi-arid regions of Pakistan. The study is based on a 21-year longitudinal survey conducted in rural Pakistan (1991-2012) that explores the relationship between weather and long-term migration. Mueller et al. analysed key weather variables at village level, including cumulative rainfall during monsoon (June-September), average temperature during winter (November-April) when wheat is grown, a 12-month moisture index, and flood intensity in terms of number of deaths caused. The study reveals that extreme high temperatures in the winter season are strongly correlated with migration, as compared to other variables. Further, high temperatures during winter season wipe out over one third of agriculture yields, and therefore the magnitude and statistical significance of the estimates are most pronounced for the land- and asset-poor, and their moves are mostly out-of-the village moves. It is argued that the poor may have more locational flexibility as they are not tied to land or assets, which can be hard to sell and are at risk of loss if unattended. Hence, Mueller et al. (2014) conclude that for the poor, the benefits of migration outweigh the moving costs, especially following extreme heatwaves / heat stress, which results in migration of all forms.

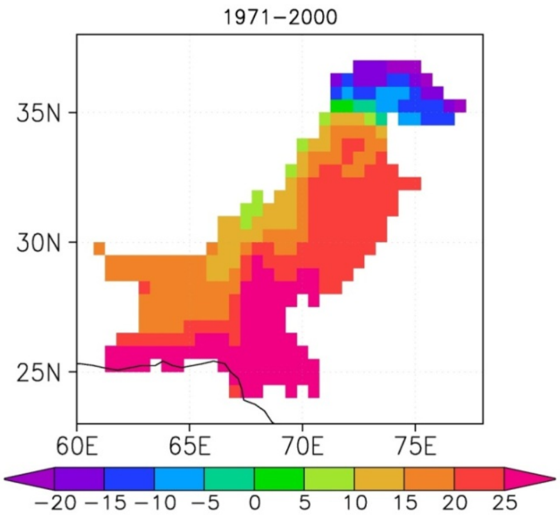
This study by Mueller et al. (2014) is one of the few studies found in published, peer-reviewed literature (with Impact Factor) that link human migration with weather variables in Pakistan. We therefore make this study the basis of our present research. Since the scope of the above-mentioned study is permanent migration, our study therefore also focuses on permanent internal (rural-to-urban) migration that results from long-term climate change rather than from sudden climate disasters.

In the sections below, the link between migration, heat stress and climate change is established in relevance with wheat production and poverty in the national context. This is followed by identification of semi-arid regions across Pakistan that are hotspots of potential migration, which is the main focus for future PRISE studies on migration.

Box 4: Climate models

Today, climate models, or more specifically the Earth System Models (ESMs), are considered to be the state-of-the-art numerical tools to carry out global climate simulations. The general circulation of the atmosphere can be effectively simulated by ESMs. However, the resolution of these ESMs is coarse, typically of the order of 150-250 km. Therefore, many regional-scale climatic features go beyond the scope of ESMs. In lieu of this, a regional climate modelling technique was developed to downscale the coarse ESMs results to the regional scale. These models are called Regional Climate Models (RCMs). RCMs have a typical horizontal resolution of 50-10 km, and even down to 1 km in some instances, on time scales up to 150 years (Saeed et al., 2009, 2014).

Figure 1: Mean maximum winter temperature over Pakistan (°C) for the period 1971-2000 from Swedish Meterological and Hydrological Institute's (SMHI) regional climate model RCA



Source: author

4.1 Data and methodology

In order to predict the pattern of heatwaves over Pakistan till 2030 (PRISE time frame), we used data of a regional climate model. A brief description of climate modelling is presented in Box 4. The data of the Rossby Centre's regional Atmospheric model (RCA4) has been analysed over CORDEX (Coordinated Regional Climate Downscaling Experiment) South Asian Domain forced by EC-Earth model. It is worth mentioning here that CORDEX is an initiative by the World Climate Research Project to downscale CMIP5 (Coupled Model Intercomparison Project Phase 5) simulations using different RCMs over different domains around the globe. For this study, we used RCA's data of control (1970-2000) as well as future (2010-2030) period using RCP8.5 concentration scenario, also called a 'business as usual' scenario (Riahi et al., 2011). The data was obtained from the database of the Centre for Climate Change Research at the Indian Institute of Tropical Meteorology, Pune.[1] In line with WMO definition, we define a heatwave in the winter season as more than six consecutive days with a daily maximum temperature that exceeds the average maximum temperature (of the winter season) by 5 °C. Where this occurs, it is considered as a heatwave and applied to RCA4 data. In order to be consistent with Mueller et al. (2014), the data of winter months from November to April has been analysed.

Finally, to map the potential internal climate migrants in Pakistan, the estimates of district ranking over the incidence of severe poverty, developed by Naveed and Ali (2012), along with the total rural population data of each district obtained from 1998 Census, have been used in this study. In addition, a district-wise map of wheat production has been developed based on data from Agriculture Census 2008-09.

In order to further strengthen our research, we have also used IPCC's urbanisation scenarios. The recent AR5 IPCC report is based on newly developed SSPs (Shared Socioeconomic Pathways). Some details about the SSPs are presented in Box 5. In the study we use the urbanisation data from SSP2 scenario, which is also called the 'middle of the road' scenario.

4.2 Results

Answers to the following questions will be addressed in this section: (1) In which areas of Pakistan are heatwaves projected to increase in future? (2) Are these areas also the major wheat-producing areas in the country? and finally (3) Do these areas of the country also have a high incidence of severe poverty? Further, we relate these linkages with incidence of severe poverty to identify 'hotspots' for future climate-induced migrants in Pakistan. Afterwards, an identification of hotspot regions for the PRISE project's future internal-migration study is also carried out, with a particular focus on semi-arid regions.

Future trend of heatwaves

The analysis of average maximum temperature data for the base winter period (1970-2000) for Pakistan is presented in Figure 1. A high spatial variation in the map can be seen, with highest temperatures found in the province of Sindh as well as along the Arabian Sea coast, followed by the plains of Punjab, and then in the provinces of Balochistan and Khyber Pakhtunkhwa. Smallest values of maximum temperatures are found in the northern areas of the country characterised by high-elevation snow and glacier-fed

[1] http://cccr.tropmet.res.in/cordex/files/downloads.jsp

catchments. In the top panel of Figure 2, the number of days where, in intervals of at least 6 consecutive days, maximum temperature remains more than 5°C above the average maximum temperature data of Figure 1 is presented for the decades 1971-1980, 1981-1990 and 1991-2000 (control period). It should be noted that Figure 2 represents the number of days that fall within the criterion. For example, if there are only 4 consecutive days where maximum temperatures remain more than 5°C above the average maximum, then these 4 days do not fall under the mentioned criterion and hence will not be counted towards Figure 2. However, if there are 8 consecutive days that fulfill the criterion, then all of these 8 days are counted as the heatwaves days. It can be seen from Figure 2 that there is generally an increasing trend of number of heatwave days throughout the country during the control period. However, this trend is not spatially consistent. A substantial increase in the number of heatwave days can be observed over the whole country, but this increase is more pronounced over the arid and semi-arid plains of the Punjab and Sindh provinces, as well as parts of Balochistan adjoining Iran. Furthermore, over the northern part of the country, which is characterised by complex topography containing high peaks, this trend is least pronounced.

The bottom panels of Figure 2 show the results for RCP8.5 for the decades 2011-2020 and 2021-2030 (future period). These results are again obtained using the WMO's definition described above, where the same base period from 1971-2000 is considered as reference as shown in Figure 1. Unlike in the base period, the increase over the northern areas is obvious from the bottom panels of Figure 2. Generally an increase in heatwave days can be seen over the whole country, and, in line with past trends, the increase is likely to be most pronounced over the arid and semi-arid plains of Punjab, Sindh and western Balochistan. It can also be noticed, from the bottom panels of Figure 2, that over the areas of Punjab and Sindh where the number of heatwave days was less than 350 days in the decade 1971-80, the number is likely to increase to more than 425 by 2021-2030. Therefore, to answer the first question – In which areas of Pakistan are heatwaves projected to increase in future? – these results clearly show that the trend in the occurrence of heatwave days will be positive till 2030, and the arid and semi-arid regions will have the greatest number of heatwave days.

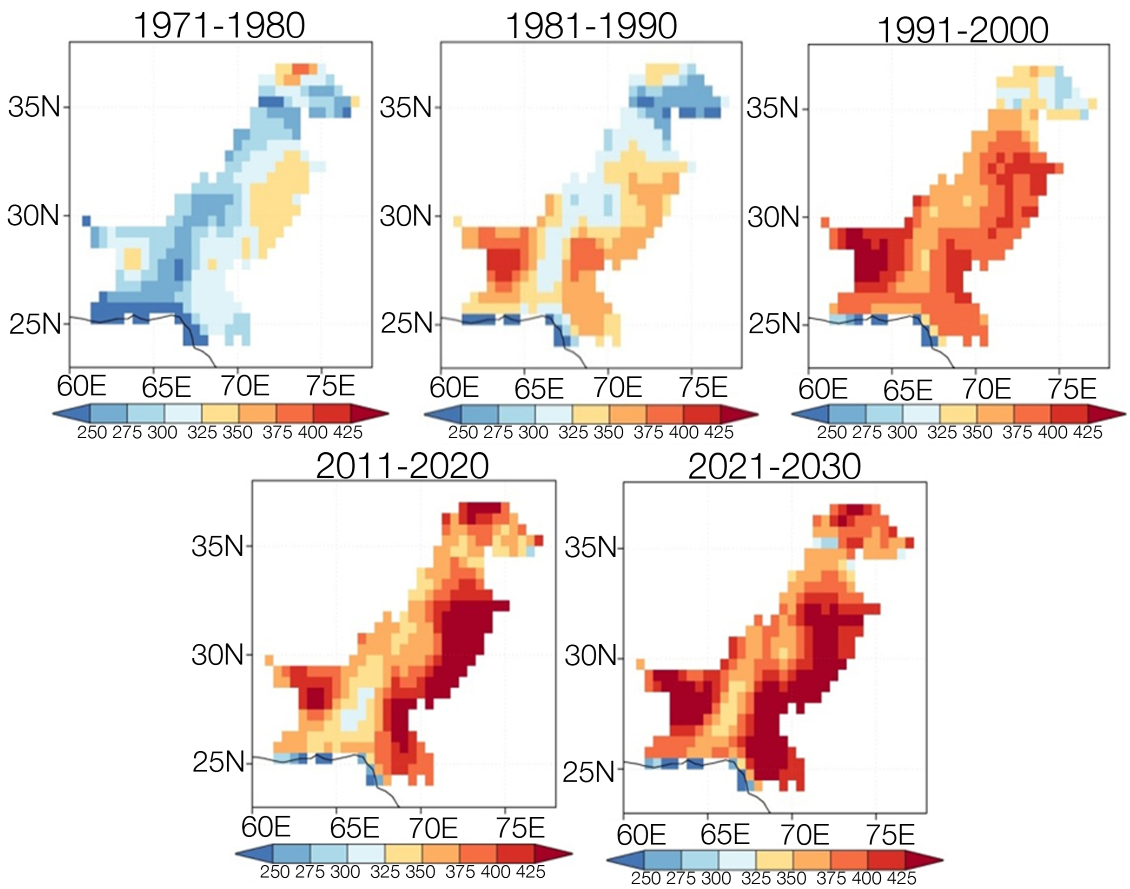
Wheat growing districts in Pakistan

In order to answer the second question in subsection 4.2.1, regarding how much wheat is grown in the areas showing an increase in heatwaves, district-wise wheat production is plotted in Figure 3 based on the Agriculture Census of 2008-09. Figure 3 shows that the wheat production is highly areas where the heatwaves are projected to increase substantially in future as shown in Figure 2.

Box 5: Socioeconomic modelling scenarios

In SSP scenarios, along with population and GDP scenarios developed by other institutes, the scenarios for future urbanisation trends are developed by the National Center for Atmospheric Research (NCAR) (https://secure.iiasa.ac.at/web-apps/ene/SspDb/static/download/ssp_suplementary%20text.pdf). For SSP, there were in total five story lines, with each one providing a brief narrative of the main characteristics of the future development path of an SSP (Kriegler et al., 2012). SSP2 scenario assumes the continuation of the present trends of urbanisation in all parts of the world, along with similar middle of the road assumptions about population growth, technological change and economic growth. In this scenario, it is assumed that the developed high-income countries continue their practices in urban development, whereas the developing countries generally follow the historical urbanisation experiences of the more developed countries.

Figure 2: Wintertime heatwaves over Pakistan as simulated by RCA



Note: the legend shows the number of days per decade associated with heat waves in the winter seasons. The top panel shows the control period, whereas the bottom panel shows the future period using RCP8.5.

Source: author

Assuming that an increase in heatwaves will negatively impact wheat production, as reported in the latest scientific literature and IPCC AR5, this in turn will result in the reduction of farm and non-farm income, thereby affecting the livelihoods of the rural population. Hence the future increase in heatwaves will be very critical to the major wheat producing areas of the country.

Incidence of Severe Poverty

The answer to the third question, regarding whether the areas identified in subsections 4.2.1 and 4.2.2 correlate with the incidence of severe poverty, is very important, as Mueller et al. (2014) established that the magnitude and statistical significance of migrants from rural to urban is most pronounced for the land- and asset-poor people. They argued that these people include not only those who are directly associated with agriculture but also those who generate incomes by providing goods and services to landowners. Therefore, in order to map the potential number of migrants due to climate change, we derive district-wise incidence of severe poverty estimates based on poverty ratios developed by Naveed and Ali (2012). Figure 4 shows the number of people living under severe poverty in rural areas based on estimates of Naveed and Ali (2012), where the total rural population data is obtained from the latest Population Census of 1998.[2]

The different colour scales indicate the number of people living in extreme poverty. The deeper the hue, the higher the number of extremely poor rural people living in that district. It can be seen from Figure 4 that although the north-western province of Khyber Pakhtunkhwa has a high number of extremely poor rural people, the occurrence of severe rural poverty interms of number of people is most obvious in central and southern Punjab as well as in Sindh. Interestingly, with the exception of a few districts in KPK, this is the same region where the heatwaves are projected to increase substantially due to climate change as shown in Figure 2.

[2] It is important to mention here that the last National Population Census was conducted in 1998. Given this data limitation, we used recent poverty estimates of Naveed and Ali (2012), which are based on the 2008-09 Pakistan Social and Living standards Measurement (PSLM) survey. Thus, poverty percentages for each district are obtained from Naveed and Ali (2012) and applied to the total rural population of that district, as obtained from data of 1998 Census. Naveed and Ali (2012) estimate district-wise (extreme) poverty using a multidimensional approach that measures aggregate deprivation of a household in multiple indicators relating to wealth, health, education and living standards. For more details, see chapter 2 of the study. Since data was not available for Federally Administered Tribal Areas and Gilgit-Baltistan in Census 1998, and Rajanpur in Naveed and Ali, 2012, these areas are omitted from the present study. Azad Jamu and Kashmir was also omitted from the study since it falls outside arid and semi-arid zones.

Figure 3: District-wise wheat production based on 2008-09 Agriculture Census

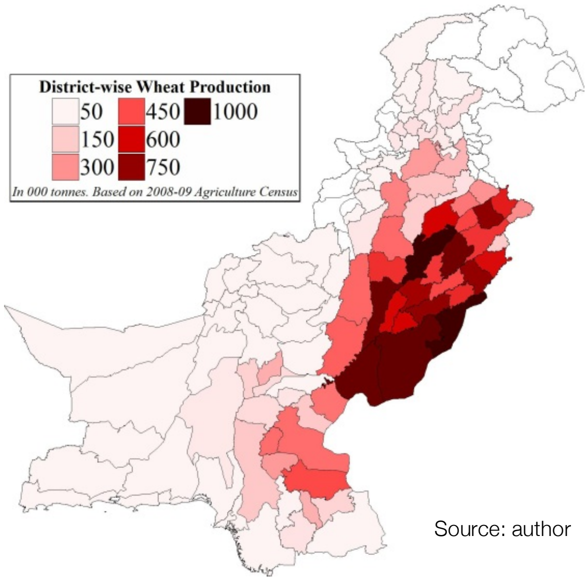


Figure 4: Number of severely poor people living in rural areas of each district based on Naveed and Ali (2012) and 1998 National Population Census data

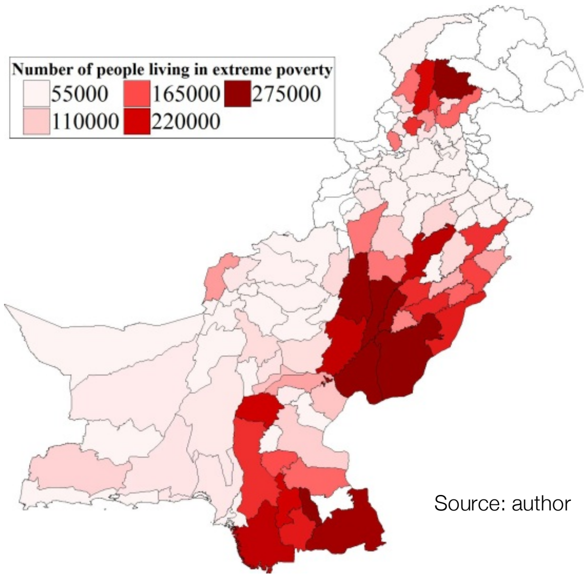
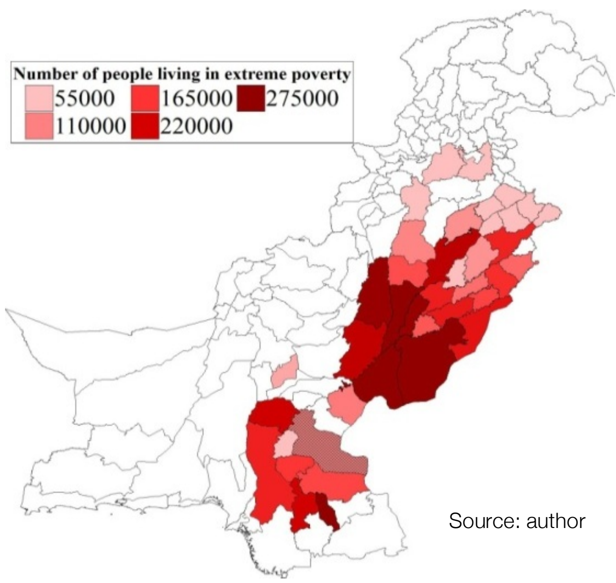


Figure 5: Number of severely poor people living in rural areas of each district based on Naveed and Ali (2012) and 1998 National Population Census data, but only for the districts producing wheat above the average threshold of all the districts



Identification of hotspot regions for migration

So far, we have identified areas that show an increasing trend of heatwaves, have substantial wheat production and contain a large number of extremely poor rural people. Yet there are certain districts having a large number of rural people living in severe poverty that do not have a substantial wheat production base. Since one of the aims of the study is to identify the districts/regions that are most vulnerable to the impacts of climate change in terms of migration relevant to wheat production, we therefore have mapped extreme rural poverty in those districts that produce wheat crop more than the average district-level wheat production. Based on agriculture census data of 2008-09, the average wheat production per district is calculated to be 207,000 tonnes. Further analysis reveals that 39 districts produce wheat crop greater than this value and altogether account for 85% of total wheat crop of the country. Figure 5 shows the number of people living under severe poverty in rural areas of these 39 districts. It is again obvious from Figure 5 that the highest numbers of severely poor rural people, who are most vulnerable to migration due to climate change, are located in the arid and semi-arid areas of Punjab and Sindh provinces.

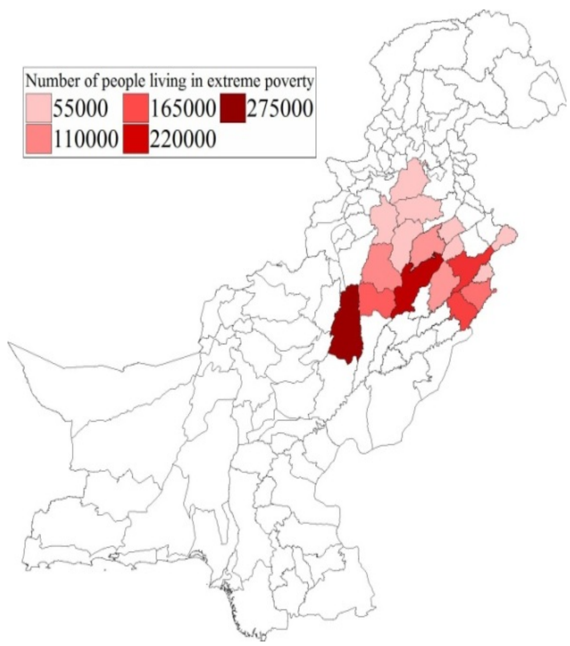
Identification of hotspots for PRISE project on internal migration

In order to identify the 'hotspot' areas in Pakistan where potential PRISE research may be carried out, Figure 6 shows the semi-arid districts based on the data provided by Pakistan Meteorological Department (PMD) for the years 1991-2010. The figure shows that semi-arid districts are located in Punjab, Khyber Pakhtunkhwa, Gilgit Baltistan and a couple in the Balochistan province. Hence we plotted Figure 7, which is similar to Figure 5 with the exception that it is over semi-arid districts of Figure 6 and the cut-off is chosen to be 150,000 tonnes instead of 207,000 tonnes. The cut-off is relaxed due to our proposed methodology for further research. The premise behind this relaxation is that the map shown in Figure 6 is based on station observations. There are several studies which show that station density is not adequate in Pakistan. Therefore, in order to increase our potential number of districts where the surveys can be conducted in coming years, we have relaxed the criteria a little.

Figure 6: Semi-arid districts of Pakistan based on Pakistan Meteorological Department's station data for the period 1991-2010

Source: author

Figure 7: Same as Figure 5 but for the semi-arid areas of Pakistan

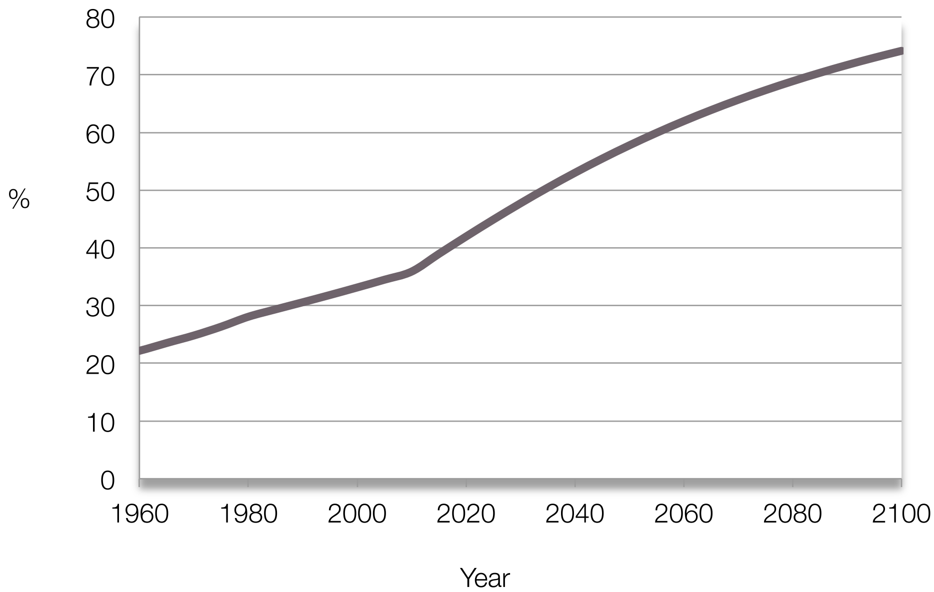


Source: author

5. Discussion

Under normal circumstances, rural-to-urban migration is often considered as an adaptation strategy, where a migrant moves to an urban centre in search of improved livelihood and better living standards. A dynamic urban centre may be considered as a proxy for development, as it is established that industrialisation and urbanisation are basic indicators of a country's transformation from a lower-income to a middle-income economy (WB, 2014). An exception here is the case of sub-Saharan Africa, where the rocketing pace of urbanisation does not seem to be in line with improvements in economic wealth (Fay and Opal, 1999). For sub-Saharan Africa, summertime precipitation extremes have shown a strong link with rural-to-urban migration. The case of Pakistan is somewhat similar to that of sub-Saharan Africa, with its high pace of urbanisation that is paralleled by inconsistent improvement in development indicators. In Pakistan, where the net rural-to-urban migration accounts for one fifth of the annual rise in urban population (Hussain, 2014), the high pace of urbanisation has raised concerns about the capacity of the country's urban systems to absorb such massive movements as well as the impact on sustainable development.

Figure 8: Percentage of urban to rural population in Pakistan based on IPCC SSP2 scenario



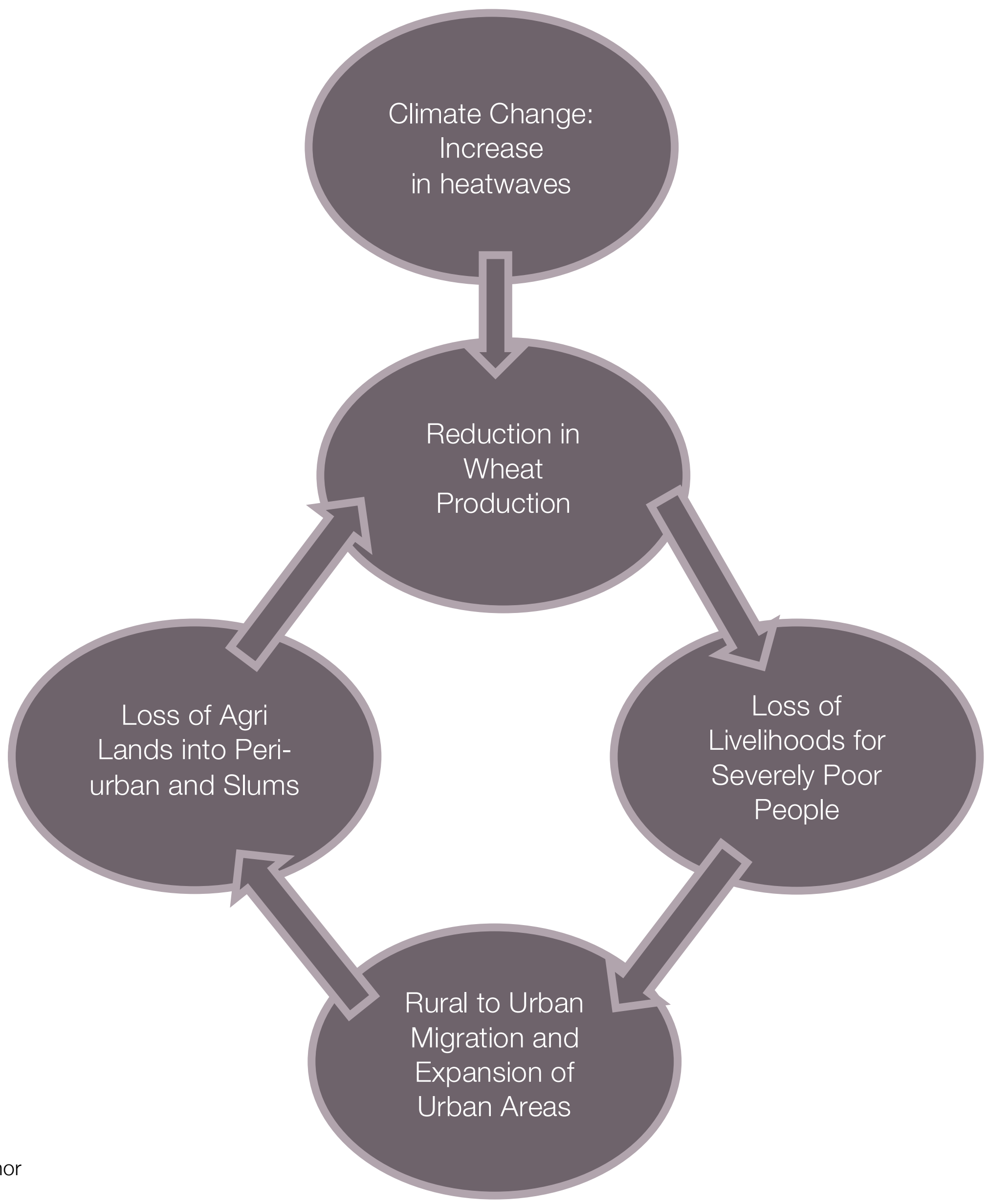
Source: author

Given the country's existing sociopolitical and economic challenges, the stress of climate change is likely to exacerbate development problems. From the results presented in the previous section, it can be inferred that the increasing trend of heatwaves under a future climate change scenario over wheat-producing districts will negatively impact the wheat yields, thus making the poor landless people more vulnerable to migration towards the urban regions. Along with this push factor, the allocation of more development funds and the major share of investments in big cities will result in an increased pull factor. Therefore, the simultaneous occurrence of both of these factors will result in higher migratory flows towards the cities, adding to the already existing problems of urban population explosion. Our results are further complemented by Figure 8, which uses International Institute for Applied System Analysis data of SSP2 scenario, which shows that urbanisation will rise to 50% in Pakistan by 2030/35 and 70% by the end of the 21st century. These findings are also in line with the UNDP's World Urbanization Prospects: The 2014 Revision. As elsewhere in the developing world, the most preferred destinations for these rural-to-urban migrant families are the peri-urban and urban slums of large cities, which results in unplanned expansion that normally is not a part of any city's development plan (Kugelman, 2014). Pakistan's four large cities – Karachi, Lahore, Gujranwala, and Faisalabad – together constitute about 50% of urban slum population in Pakistan (Ghani 2012). This unregulated expansion of urban areas results in the transformation of prime agricultural lands into housing schemes and slums. For example, 94% of the total area of the Lahore district was under agricultural use in 1972, which has reduced to 29.5% in 2010 (Zaman, 2012). This loss of agricultural land will directly affect the livelihoods of those associated with agriculture, especially the poorest of the poor, and will result in a feedback loop, depicted in Figure 9.

While the above results indicate a strong correlation between a rise in heatwaves and a decrease in wheat production, the scale and intensity at which this may occur is not indicated in the present study, given the limitations of predicting climate trends using low-resolution data. Nevertheless, given the critical importance of wheat in Pakistan's food security and national economy, such drastic changes in the rural and urban landscapes will affect not only the demographics of the sixth most populated country of the world but also the food security of a major global wheat exporter. However, this empirical finding needs to be validated with more in-depth research studies. This will help in identifying the different ways in which the rural and urban economies may be transformed over time as climate trends change.

Out-migration and declines in wheat production are likely to affect women, too, given their high socioeconomic vulnerability in rural Pakistan. Most data in Pakistan indicate that while male members of poor farmer households out-migrate to add to family incomes, female household members left behind are often forced to undertake additional roles that traditionally resided with men. Future climate extremes such as heatwaves are thus likely to affect women in terms of (i) their traditional household chores (like securing water and energy supplies); (ii) the additional male-dominated tasks they acquire, such as farming, of which they may hold limited traditional knowledge; and (iii) their overall well-being, as their existing socioeconomic vulnerabilities may be exacerbated during climate shocks (e.g. due to low education status, lack of job opportunities, and limited mobility).

Figure 9: The feedback loop



Source: author

6. Conclusions and recommendations

In line with existing climate-migration discourse, this study argues that climate change acts in combination with many other socioeconomic determinants of migration. The development deficit in Pakistan's semi-arid rural areas is paralleled by unequal investments in urban centres (such as in service provision and infrastructure) that lures potential migrants to urban settlements. However, the variability in weather patterns (climate shocks such as heatwaves) also plays a role in influencing migration patterns.

Climate shocks and slow-onset changes impact ecological conditions in rural lands that trigger shifts in agricultural productivity, thus eroding incomes of poor and marginal cultivators. Thus, migratory decisions may be taken to escape from losses in rural incomes, losses which are variably intensified by climatic stress. Using the latest climate modelling, we predict that such changes are likely to be magnified by 2030 in arid and semi-arid areas of Pakistan that are important in terms of wheat production and are home to large rural populations. Given the sensitivity of wheat crop to heat stress, we anticipate that a decline in wheat production will affect rural poor and marginal households, who will be forced to cope. When coupled with prospects for improved life in urban centres, this will incentivise poor rural populations to out-migrate. In cases where male members out-migrate selectively, female household members will be compelled to take over traditional male roles in the rural agriculture sector. Thus, simultaneous occurrences of push and pull factors will set off rural-to-urban migration, which will aggravate urbanisation challenges in Pakistan by exerting additional pressure on hard-pressed urban services and infrastructure.

Based on the above findings, we recommend a mix of adaptation measures, both manipulative and preventive measures that promote a check on the accelerated flow of masses from rural to urban areas.

Following are some initial recommendations of the study:

- Managing rapid urbanisation: Study results show that rural-urban migration may contribute to unplanned urbanisation and expansion of megacities like Karachi, Lahore, and Faisalabad, which may disrupt urban well-being (see section 5). Therefore, one viable solution is to develop intermediate cities or towns (Jamal and Ashraf, 2004), which can serve as pivots between large cities and rural areas by facilitating access to markets for agriculture outputs (Hussain, 2014). Such centres may additionally take off burden from large agglomerations by providing additional 'pull factor' facilities, such as improved access to education and health care services. Markets in intermediate cities may also help plug rural-urban income gaps by providing opportunities for seasonal employment to landless rural labour. While similar measures are also proposed in the Ministry of Climate Change's recently launched 'Framework for Implementation of Climate Change Policy (2014-2030)', they need to be materialised with a concrete action plan and necessary budgetary allocations.
- Monitoring of internal migration: The dearth of adequate data on rural-urban migrants hinders monitoring of internal migration flows, which presents a challenge to informed decision-making. Therefore, this study proposes a National Registration System that can capture population mobility data across Pakistan. This needs to be supported by legislative changes that make registration mandatory for persons moving to formal and informal urban areas. It will provide needed information to the government on flow and intensity of rural-urban migration to large cities. It will also help formalise the urban economy, which remains largely informal due to the large rural workforce that invisibly works there.
- Risk management in agriculture sector: Given Pakistan's critical role as a major wheat exporter in the global economy, the agriculture sector needs an innovative strategy that can not only address existing climate-threats but also capitalise on potential opportunities that climate change may present. For example, the national policy on agriculture and food security needs to innovate clear strategy for coping with slow-onset climatic impacts that may consistently affect the agriculture sector. Moreover, risk management in the agriculture sector needs innovative financial support mechanisms that improve poor farmers' access to finance during climate shocks (e.g. crop insurance to protect against crop failures).
- Improved rural and urban service delivery through decentralised governance: The revival of local governments under the 18th Constitutional Amendment is important for curbing rural-to-urban migration for two reasons. Firstly, in the absence of local governments, it is very likely that development

funds would continuously be allocated to megacities and provincial capitals (Mahmud et al., 2010), leaving only limited government decisions and development funds to trickle down to district, tehsil, union and village levels. Secondly, the balance distribution of power will allow local-level governments to make decisions and allocate funds that are directly relevant to local problems. This is likely to increase service delivery for rural and local populations. However, this would also need to be complemented by improved service provision in urban slums, which are likely to absorb the influx of informal rural migrants.

- Integrated approach to 'climate-proof' development: Given Pakistan's high vulnerability to climate change, and its existing level of development challenges, the country requires an integrated and multi-sectoral approach to climate-resilient economic development. Sectoral policies on population, agriculture and food security, environment, poverty alleviation and economic growth need to propose specific measures for climate resilience, as highlighted in National Climate Change Policy in 2012 and 'Framework for Implementation of Climate Change Policy (2014-2030)'. Moreover, this needs to be complemented by changes in policy implementation as well, by abolishment of structural barriers to inter-provincial coordination and inter-departmental communication (such as between PMD, disaster management authorities and water, power and irrigation departments), to ensure timely communication of early warnings to concerned institutions and (rural) communities (Saeed et al., 2014; Salik et al., 2015).

6.1 Way forward

The results of this study highlight the need for more in-depth research on different aspects of migration. This study has identified potential study sites (Figure 7), where climate-induced rural-urban migration may be studied in Pakistan during the course of PRISE project. Among the districts shown in Figure 7, we would select three districts (and hence the study sites) according to the high-, medium- and low-level incidence of severe rural poverty in order to study how the decision-making in rural-urban migration is affected by socioeconomic vulnerability. PRISE countries in Asia and Africa may use similar research methodology to identify potential study sites according to their research needs. Some of the key questions that will be investigated during the course of the PRISE project are the following:

- Under what circumstances does climate change and variability trigger migration?
    - What are the existing trends of migration patterns in the semi-arid lands (SALs) of Pakistan, Burkina Faso, Tanzania, and Kenya?
    - How are these migration patterns likely to be affected under future climate change in SALs?
- How is welfare affected by climate-induced migration patterns in ways that support climate-resilient economic development?
    - How does migration affect welfare indicators like income, health, education, etc., and to what extent does migration shape poverty, inequality, urbanisation, and conflicts over natural resources in SALs?
    - How is migration affecting and likely to affect the gender roles in SALs?
    - How does understanding of climate-induced migration patterns affect policies and institutions in terms of adaptation? Conversely, what are the direct and indirect linkages through which policies and institutions affect migration decisions of communities?

References

Adamo, S.B. (2010) 'Environmental migration and cities in the context of global environmental change', Current Opinion in Environmental Sustainability, 2(3): 161-165, doi:10.1016/j.cosust.2010.06.005.

ADB (2012) 'Addressing Climate Change and Migration in Asia and the Pacific', Hugo, G., Bardsley, D., Sharma, V., Tan Y., Williams, M., and Bedford, R. (eds), Asian Development Bank, Mandaluyong City, Philippines. ISBN: 978-92-9092-611-5

Agriculture Census Organization (2009). 2008-09 Pakistan Agriculture Census, Statistics Division. Islamabad. Government of Pakistan.

Arif, G.M. (2005) 'Internal migration and household wellbeing: Myth or reality', Internal Labour Migration in Pakistan, IDE Discussion Papers 72, Institute of Development Economies, Japan External Trade Organisation, Chiba, Japan.

Banerjee, S., Gerlitz, J.Y. and Hoermann, B. (2011) 'Labour migration as a response strategy to water hazards in the Hindu Kush-Himalayas'. Kathmandu: International Centre for Integrated Mountain Development. Available at: http://lib.icimod.org/record/26921/files/attachment_739.pdf

Barnett, J. and Adger, W.N. (2007) 'Climate change, human security and violent conflict', Political Geography, 26(6): 639-655.

Barnett, J.R. and Webber, M. (2010) 'Accommodating Migration to Promote Adaptation to Climate Change', World Bank Policy Research Working Paper Series, World Bank. Available at SSRN:http://ssrn.com/abstract=1589284

Black, R. and Sward, J. (2008) 'Measuring the Migration-Development Nexus: An Overview of Available Data', Briefing no. 13, Development Research Centre on Migration, Globalisation and Poverty. Available at: http://www.migrationdrc.org/publications/briefing_papers/BP13.pdf

Black, R., Bennett, S.R.G., Thomas, S.M. and Beddington, J.R. (2011) 'Climate change: Migration as adaptation', Nature, 478(7370): 447-449, doi: 10.1038/478477a

Brown, S. K., and Bean, F. D. (2005). International migration. In D. L.Poston & M.Micklin (Eds.), Handbook of population (pp. 347–382). New York: Kluwer.

Brown, O. (2008) 'Migration and climate change', IOM Migration Research Series no. 31, International Organization for Migration, Geneva.

Chun, J. (2014) 'Vulnerability to environmental stress: Household livelihoods, assets, and mobility in the Mekong delta, Viet Nam', IOM Migration Research Series no. 51, International Organization for Migration, Geneva.

DESA, UN (2011) 'Population distribution, Urbanization, Internal Migration and Development: An International Perspective'. ESA/P/WP/223. Available at: http://www.un.org/esa/population/publications/PopDistribUrbanization/PopulationDistributionUrbanization.pdf

Etzo, I. (2008) 'Internal migration: A review of the literature'. MPRA paper no. 8783, University of Cagliari, Cagliari. Available at: http://mpra.ub.uni-muenchen.de/8783/1/MPRA_paper_8783.pdf

Farooq, M., Mateen, A., and Cheema, M. (2005) 'Determinants of migration in Punjab: A case study of Faisalabad metropolitan', Journal of Agriculture and Social Sciences, 1(3): 280-282.

Fay, M. and Opal, C. (1999) 'Urbanization without Growth: A Not So-Uncommon Phenomenon'. Policy Research Working Papers.

Field, C.B., Barros, V.R., Dokken, D.J., Mach, K.J., Mastrandrea, M.D., Bilir, T.E., Chatterjee, M., Ebi, K.L., Estrada, Y.O., Genova, R.C., Girma, B., Kissel, E.S., Levy, A.N., MacCracken, S., Mastrandrea, P.R. and White, L.L. (eds) (2014) 'Climate Change 2014: 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, Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 755-791.

Foresight, UK (2011) 'Migration and Global Environmental Change: Final Project Report'. The Government Office for Science, London. Available at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/287717/11-1116-migration-and-global-environmental-change.pdf

Ghani, E. (2012) 'Urbanization in Pakistan: Challenges and Options'. Pakistan Institute of Development Economics (PIDE) Working Paper.

GoP (2009) 'Task Force on Food Security'. Planning Commission, Government of Pakistan. Available at: http://waterinfo.net.pk/sites/default/files/knowledge/Task%20Force%20Report%20on%20Food%20Security.pdf

GoP (2014) 'Pakistan Economic Survey 2013-14'. Finance Division of Government of Pakistan, Islamabad.

Grimm, N.B., Faeth, S.H., Golubiewski, N.E., Redman, C.L., Wu, J., Bai, X. and Briggs, J.M. (2008) 'Global change and the ecology of cities', Science, 319(5864): 756-760.

Halstead, P. (1989) ‘The economy has a normal surplus: economic stability and social change among early farming communities in Thessaly, Greece’. In: Halstead, P., O’Shea, J. (eds), Bad year economics: Cultural responses to risk and uncertainty, Cambridge University Press, Cambridge, pp. 68-80.

Hoermann, B., Banerjee, S. and Kollmair, M. (2010) ‘Labour migration for development in the western Hindu Kush-Himalayas: Understanding a livelihood strategy in the context of socioeconomic and environmental change’. International Centre for Integrated Mountain Development, Kathmandu. Available at: http://lib.icimod.org/record/8050/files/attachment_695.pdf

Hughes, M.K. and Brown, P.M. (1992) ‘Drought frequency in central California since 101 B.C. recorded in giant sequoia tree rings’, Climate Dynamics, 6(3-4): 161-167.

Hussain, I. (2014) ‘Urbanization in Pakistan’. Keynote address delivered at South Asia Cities Conference and Pakistan Urban Forum, 9 Jan 2014.

‘Internal migration patterns in Pakistan – The case for fiscal decentralisation’, The Pakistan Development Review, 49(4): 593-607.

Irfan, M. (1986) ‘Migration and development in Pakistan: Some selected issues’, The Pakistan Development Review, XXV(4). Available at: http://www.jstor.org/discover/10.2307/41258789?uid=2492735133&uid=3738832&uid=2134&uid=2&uid=70&uid=3&uid=60&uid=2492735123&sid=21106458453963

Jamal, Z. and Ashraf, M. 2004, ‘Development of Intermediate-size towns: an alternative form of urbanization’, Quarterly Science Vision, 9(1-2).

Kalin, W. (2010) ‘Conceptualizing climate-induced displacement’, in J. McAdam (ed.), Climate Change and Displacement: Multidisciplinary Perspectives, Oxford and Portland, OR: Hart, pp. 81-104.

Ketel, H.J. (2004) ‘Global warming and human migration’, Climate Change, Human Systems and Policy, EOLSS Publishers. Available at: http://www.eolss.net/ebooks/Sample%20Chapters/C12/E1-04-03-04.pdf

Khan, A.H., Shehnaz, L. and Ahmed, A.M. (2000) ‘Determinants of internal migration in Pakistan: Evidence from the Labour Force Survey, 1996-97’, The Pakistan Development Review, 39(4): 695-712.

Kolev, A. 2013, ‘Labour migration and development: A critical review of a controversial debate’, in Cazes, S. and Verick, S. (eds) Perspective on Labour Economics for Development, International Labour Office, Geneva.

Kriegler, E., O’Neill, B. C., Hallegatte, S., Kram, T., Lempert, R. J., Moss, R. H., and Wilbanks, T. (2012), ‘The need for and use of socio-economic scenarios for climate change analysis: a new approach based on shared socio-economic pathways’ Global Environmental Change, *22*(4), 807-822.

Kugelman, M. (ed.) (2014) ‘Pakistan’s runaway urbanization: What can be done?’ Wilson Center. ISBN: 978-1-938027-39-0.

Locke, J.T. (2009) ‘Climate change-induced migration in the Pacific region: sudden crisis and long-term developments’, The Geographical Journal, 175(3): 171-180. doi: 10.1111/j.1475-4959.2008.00317.x

Lovell, J. and London, M. (2007) ’Climate change to make one billion refugees-agency’, Reuters, 13 May 2007, http://www.reuters.com/article/latestCrisis/idUSL10710325

Low, B.S. (1990) Human responses to environmental extremeness and uncertainty: a cross-cultural perspective, in: Cashdan, E. (ed.), Risk and Uncertainty in Tribal and Peasant Economies, Westview Press, Boulder, Colorado, pp. 229-255.

Mahmud, M., Musaddiq, T. and Said, F. (2010) Determinants of internal migration in Pakistan – Lessons from existing patterns’ Pakistan Development Reivew 49(4): 593-607.

Majid, H. and Zahir, H. (2014) ‘Climate Change and the impact on farmer productivity: The role of socioeconomic vulnerability in rural Pakistan.’ Climate Change in Pakistan: Working Paper Series #1.

Massey, D.S., Axinn, W.G. and Ghimire, D.J. (2010) ‘Environmental change and out-migration: Evidence from Nepal’, Population and Environment, 32(2-3): 109-136.

Mazumdar, D. (1987) ‘Rural-urban migration in developing countries’, in E.S Mills (ed.): Handbook of regional and urban economics, Elsevier, Amsterdam, 2, pp. 1097-1128.

McKone, M.J., Kelly, D. and Lee, W.G. (1998) ‘Effect of climate change on mast-seeding species: frequency of mass flowering and escape from specialist insect seed predators, Global Change Biology, 4(6): 591-596.

McLeman, R. and Smit, B. (2006) ‘Migration as an Adaptation to climate change’, Climatic Change, 76(1-2): 31-53. DOI: 10.1007/s10584-005-9000-7

McLeman, R.A. and Hunter, L.M. (2010) Migration in the context of vulnerability and adaptation to climate change: Insights from analogues. Wiley Interdisciplinary Reviews: Climate Change, 1(3): 450-461. doi: 10.1002/wcc.51

Morgan, C. (2009) ‘Climate change, uncertainty and prehistoric hunter-gatherer mobility’, Journal of Anthropological Archaeology, 28(4): 382-396.

Mueller, V., Gray, C. and Kosec, K. (2014) ‘Heat stress increases long-term human migration in rural Pakistan’, Nature Climate Change, 4(3): 182-185, doi:10.1038/nclimate2103

Myers, N. (2005) ‘Environmental refugees: An emergent security issue’, paper for the 13th Economic Forum, Organisation for Security and Cooperation in Europe, Prague, May 2005, pp. 23-27.

Naveed, A. and Ali, K. (2012) ‘Clustered Deprivations: District Profile of Poverty in Pakistan’. Sustainable Development Policy Institute, Islamabad.

Özden, K. and Enwere, C. (2012) ‘Urbanization and its political challenges in developing countries’, Eurasian Journal of Business and Economics, 5(10): 99-120.

Parnwell, M. (1993) ‘Population Movements and the Third World’. Routledge, London.

Parry, M.L. (ed.) (2007) ‘Climate change 2007: Climate change impacts, adaptation and vulnerability’, Contribution of Working Group II to the Intergovernmental Panel on Climate Change Fourth Assessment Report, 4, Cambridge University Press. Available at: https://www.ipcc.ch/pdf/assessment-report/ar4/wg2/ar4-wg2-chapter7.pdf

Population Census Organization (2001). 1998 Census report of Pakistan, Statistics Division. Islamabad. Government of Pakistan.

Qin, D., Plattner, G.K., Tignor, M., Allen, S.K., Boschung, J., Nauels, A., ... and Midgley, P.M. (2014) ‘Climate change 2013: The physical science basis’, pp. 1535, T. Stocker (ed.), Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change, Cambridge University Press Cambridge, UK, and New York.

Reuveny, R. (2007) ‘Environmental change, migration and conflict: Theoretical analysis and empirical explorations’. Paper presented of the International Workshop on Human Security and Climate Change, 21-23, June 2005, Oslo, Norway.

Riahi, K., Rao, S., Krey, V., Cho, C., Chirkov, V., Fischer, G., Kindermann, G., Nakicenovic, N. and Rafa, P. (2011) ‘RCP 8.5—A scenario of comparatively high greenhouse gas emissions’, Climatic Change, 109(1-2): 33-57.

Richerson, P.J., Boyd, R. and Bettinger, R.L. (2001) ‘Was agriculture impossible during the Pleistocene but mandatory during the Holocene? A climate change hypothesis’, American Antiquity, pp. 387-412.

Saeed, F., Hagemann, S. and Jacob, D. (2009) ‘Impact of irrigation on the South Asian summer monsoon’, Geophysical Research Letters, 36(20).

Saeed, F., Suleri, A.Q. and Salik, K.M. (2014) ‘Planning for floods: Now or never’. Policy brief no. 44, Sustainable Development Policy Institute, Islamabad. Available at: https://www.sdpi.org/publications/files/Planning%20for%20Floods%20Now%20or%20Never%20(PB%20-%2044).pdf

Salik, K.M., Jahangir, S., Zahdi, W.Z. and Hasson, S. (2015) ‘Climate Change vulnerability and adaptation options for the coastal communities of Pakistan’, Ocean and Coastal Management 112: 61-73.

Smith, R. and McNamara, K.E. (2014) ‘Future migration form Tuvalu and Kiribati: Exploring government, civil society and donor perceptions’, Climate and Development, 7(1). DOI:10.1080/17565529.2014.900603

Sultana, H., Ali, N., Iqbal, M.M. and Khan, A.M. (2009) ‘Vulnerability and adaptability of wheat production in different climatic zones of Pakistan under climate change scenarios’, Climatic Change, 94(1-2): 123-142.

Tacoli, C. (2003) ‘The Links between urban and rural development’, Environment and Urbanization, 15(1): 3-12.

Tacoli, C. (2009) ‘Crisis or adaptation? Migration and climate change in a context of high mobility’, Environment and Urbanization, 21(2): 513-525. Doi: 10.1177/0956247809342182

Warner, K. (2010) ‘Global environmental change and migration: Governance challenges’, Global Environmental Change, 20(3): 402-413.

WB (2002) Poverty in Pakistan: Vulnerabilities, Social Gaps and Rural Dynamics, Pakistan Poverty Assessment, World Bank Report no. 24296-PAK .

WB (2014) Pakistan: Country snapshot, no. 91629, World Bank, Washington, DC. Available at: http://documents.worldbank.org/curated/en/2014/10/20306064/pakistan-country-snapshot

Zaman, K.U. (2012) ‘Urbanization of Arable Land in Lahore City in Pakistan: A Case-study’, European Journal of Sustainable Development, 1(1).

Walled city, Lahore, Pakistan

SDPI
Sustainable Development Policy Institute
38, Main Embassy Road, G-6/3
Islamabad, Pakistan
Tel. +92 51 2782134

www.sdpi.org

www.sdpi.tv

www.prise.odi.org
Research for climate-resilient futures

This work was carried out under the Collaborative Adaptation Research Initiative in Africa and Asia (CARIAA), with financial support from the UK Government's Department for International Development (DfID) and the International Development Research Centre (IDRC), Canada. The views expressed in this work are those of the creators and do not necessarily represent those of DfID and IDRC or its Board of Governors.

CARIAA
Collaborative Adaptation Research Initiative in Africa and Asia

UKaid from the British people

IDRC | CRDI
International Development Research Centre
Centre de recherches pour le développement international

Canada