



***The World's Largest Open Access Agricultural & Applied Economics Digital Library***

**This document is discoverable and free to researchers across the globe due to the work of AgEcon Search.**

**Help ensure our sustainability.**

Give to AgEcon Search

AgEcon Search  
<http://ageconsearch.umn.edu>  
[aesearch@umn.edu](mailto:aesearch@umn.edu)

Papers downloaded from **AgEcon Search** may be used for non-commercial purposes and personal study only. No other use, including posting to another Internet site, is permitted without permission from the copyright owner (not AgEcon Search), or as allowed under the provisions of Fair Use, U.S. Copyright Act, Title 17 U.S.C.

No endorsement of AgEcon Search or its fundraising activities by the author(s) of the following work or their employer(s) is intended or implied.

# A Framework to Understand Gender and Structural Vulnerability to Climate Change in the Ganges River Basin: Lessons from Bangladesh, India and Nepal



Fraser Sugden, Sanjiv de Silva, Floriane Clement, Niki Maskey-Amatya,  
Vidya Ramesh, Anil Philip and Luna Bharati

## **Working Papers**

The publications in this series record the work and thinking of IWMI researchers, and knowledge that the Institute's scientific management feels is worthy of documenting. This series will ensure that scientific data and other information gathered or prepared as a part of the research work of the Institute are recorded and referenced. Working Papers could include project reports, case studies, conference or workshop proceedings, discussion papers or reports on progress of research, country-specific research reports, monographs, etc. Working Papers may be copublished, by IWMI and partner organizations.

Although most of the reports are published by IWMI staff and their collaborators, we welcome contributions from others. Each report is reviewed internally by IWMI staff. The reports are published and distributed both in hard copy and electronically ([www.iwmi.org](http://www.iwmi.org)) and where possible all data and analyses will be available as separate downloadable files. Reports may be copied freely and cited with due acknowledgment.

## **About IWMI**

IWMI's mission is to *provide evidence-based solutions to sustainably manage water and land resources for food security, people's livelihoods and the environment*. IWMI works in partnership with governments, civil society and the private sector to develop scalable agricultural water management solutions that have a tangible impact on poverty reduction, food security and ecosystem health.

**IWMI Working Paper 159**

**A Framework to Understand Gender and Structural  
Vulnerability to Climate Change in the Ganges River Basin:  
Lessons from Bangladesh, India and Nepal**

*Fraser Sugden, Sanjiv de Silva, Floriane Clement, Niki Maskey-Amatya,  
Vidya Ramesh, Anil Philip and Luna Bharati*

International Water Management Institute (IWMI)  
P. O. Box 2075, Colombo, Sri Lanka

*The authors:* Fraser Sugden is a Researcher – Social Science at the Nepal Office of the International Water Management Institute (IWMI) in Kathmandu, Nepal; Sanjiv de Silva is a Researcher – Institutions and Policy at the headquarters of IWMI in Colombo, Sri Lanka; Floriane Clement is a Researcher – Institutional and Policy Analysis at the Nepal Office of IWMI in Kathmandu, Nepal; Niki Maskey-Amatya is a Research Officer – Social Science at the Nepal Office of IWMI in Kathmandu, Nepal; Vidya Ramesh was a Senior Scientific Officer at the Hyderabad Office of IWMI in Andhra Pradesh, India, at the time this research study was conducted; Anil Philip is a Scientific Officer at the Hyderabad Office of IWMI in Andhra Pradesh, India; and Luna Bharati is a Senior Researcher – Hydrology and Water Resources, and Head of the Nepal Office of IWMI in Kathmandu, Nepal.

Sugden, F.; de Silva, S.; Clement, F.; Maskey-Amatya, N.; Ramesh, V.; Philip, A.; Bharati, L. 2014. *A framework to understand gender and structural vulnerability to climate change in the Ganges River Basin: lessons from Bangladesh, India and Nepal*. Colombo, Sri Lanka: International Water Management Institute (IWMI). 50p. (IWMI Working Paper 159). doi: 10.5337/2014.230

/ climate change / adaptation / gender / river basins / economic aspects / income / microfinance / social structure / political aspects / labor / health hazards / risk management / waterborne diseases / natural disasters / education / living standards / poverty / households / agriculture / collective action / Bangladesh / India / Nepal /

ISSN 2012-5763  
ISBN 978-92-9090-806-7

Copyright © 2014, by IWMI. All rights reserved. IWMI encourages the use of its material provided that the organization is acknowledged and kept informed in all such instances.

Please direct inquiries and comments to: *IWMI-Publications@cgiar.org*

A free copy of this publication can be downloaded at  
[www.iwmi.org/Publications/Working\\_Papers/index.aspx](http://www.iwmi.org/Publications/Working_Papers/index.aspx)

## Acknowledgements

### Project

This research study was initiated as part of the *Gender, vulnerability and adaptation to climate change in the Gangetic Plains* project.

### Donors

This research was funded by the following:



This work was undertaken as part of the CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS), which is a strategic partnership of CGIAR and Future Earth.

CGIAR is a global research partnership for a food-secure future. The views expressed in this document cannot be taken to reflect the official opinions of CGIAR or Future Earth.



## Contents

Summary .....	vii
Introduction.....	1
Climatic Hazards in the Ganges River Basin.....	2
The Study Site.....	2
Impact of Future Climate Change.....	2
Climate Change and Livelihoods.....	3
<i>Understanding Existing Climate Change Impact</i> .....	3
<i>Bangladesh</i> .....	3
<i>India</i> .....	4
<i>Nepal</i> .....	5
Social Structures and Vulnerability .....	6
Defining Vulnerability and Social Structures .....	6
<i>Risk-hazard Approach</i> .....	6
<i>The Social Constructivist or Political Economy Approach</i> .....	6
<i>Integrative Frameworks</i> .....	6
Gendered Division of Labor .....	7
<i>Traditional Division of Labor in India, Bangladesh and Nepal</i> .....	7
<i>Gendered Division of Labor and Changing Work Burden in the Context of Climate</i> .....	8
<i>Differential Effect of Climate Change on the Income of Women and Men</i> .....	10
Migration and Climate Change.....	11
<i>Out-migration Increasing due to Climate Change and External Factors</i> .....	11
<i>Out-migration Can Increase Vulnerability of Those Left Behind</i> .....	13
Gender, Welfare and Climate Change .....	14
<i>Climate Change and Health Risks for Men and Women</i> .....	14
<i>Natural Disasters</i> .....	15
<i>Nutrition and Climate Change</i> .....	16
<i>Waterborne Diseases and Water Contamination</i> .....	17
<i>Psychological Welfare</i> .....	17
<i>Climate Change and Violence against Women</i> .....	17
Social Structures and Adaptation.....	18
Adaptation.....	18
<i>Access to the Means of Production</i> .....	19
<i>Access to Finance</i> .....	21
<i>Access to Education, Information and Social Networks</i> .....	23
<i>Access to Markets</i> .....	25

The Role of the State .....	25
<i>Accessing State Resources</i> .....	25
<i>Having a Voice in Decision Making</i> .....	27
Participation in Interventions to Address Climate Change and Gender .....	28
<i>Inclusion of Men and Women in Planning</i> .....	28
<i>Voicing Different Priorities for Men and Women</i> .....	29
<i>Poor Accounting for Men's and Women's Agroecological Knowledge</i> .....	29
<i>Disaster Preparedness Programs</i> .....	30
Conclusions and Ways Forward .....	31
Gender, Vulnerability and Climate Change: In Sum.....	31
Ways Forward.....	31
<i>Secure Land Rights for Women Farmers</i> .....	31
<i>Effective Use of Microfinance</i> .....	32
<i>Promote Collective Action</i> .....	32
<i>Valuing Indigenous Knowledge</i> .....	32
<i>Bottom-up Climate Change Adaptation Planning</i> .....	33
<i>Importance of Poverty Alleviation and Class</i> .....	33
<i>Tackling Gender Inequality at a Broader Level</i> .....	33
References.....	34

## **Summary**

As the reality of climate change becomes accepted in the scientific community, it is critical to continue to understand its impact on the ground, particularly for communities dependent on agriculture and natural resources. To do so, the analysis of vulnerability – in other words, the capacity of communities to cope with the effects of change – is critical. An extension of this is the analysis of social structures, and how they shape patterns of vulnerability and the capacity for individuals or groups to adapt. This review presents a framework for understanding structural vulnerability to climate change in the Ganges River Basin countries—Nepal, India and Bangladesh – with a focus on the role of gender in shaping vulnerability. This paper reviews the extensive academic and ‘gray’ literature from the region to identify a set of key economic and social inequalities which shape how men and women are differently affected by climate change and their capacity to adapt.

The impact of climate change in the Ganges River Basin is complex. With regard to agriculture, the most notable stress is the increased unpredictability of weather patterns. This includes extreme weather events such as droughts, floods and cyclones, not to mention more subtle changes related to the onset of the monsoon and the frequency of rainfall. An increase in temperature extremes is also a notable concern, affecting both winter and summer cropping. The impact has locally specific manifestations according to the geography. For example, falling water tables exacerbated by droughts is a concern in some parts of the Gangetic Plains; extreme events such as flooding or cyclones can lead to an increase in saline intrusion in the Ganges Delta, while they can cause more frequent landslides or other mass movements in the Himalayas.

With regard to ‘vulnerability’ in the context of climatic stress, this paper takes a broadly social constructivist approach. In other words, vulnerability is not considered as a consequence of natural hazards alone. Instead, it is related to one’s resilience and capacity to cope with, or adapt to, the context of natural hazards, a process which is intricately connected to social structures such as gender, class, caste and ethnicity.

A first form of ‘gendered’ vulnerability to climate change relates to labor. In a region with highly inequitable gender division of labor, the workload of women can be increased by climate change. Women often play an important role in natural resource-based livelihood activities which fall within the sphere of reproduction such as the collection of fuelwood and water. Ecological changes such as salinity intrusion or changes in groundwater availability can force women to travel longer distances. There is often a class dimension, whereby women from wealthier households have their own resources such as tube wells in their homesteads, and thus their burden is less.

A second reason why the gender division of labor is important for vulnerability is that women and men often have separate control over different income sources. If climate change undermines a particular livelihood activity, this may differentially impact men’s or women’s individual incomes. This impacts women in South Asia in particular, as the personal income they can control is often more limited than that of men. Gender norms which restrict their involvement in the public sphere in activities such as labor and trade mean that agriculture and natural resource-based livelihood activities often represent the primary sources of personal cash income. These activities are highly vulnerable to climate change.

Gendered vulnerability can also emerge from more complex processes such as male out-migration, which is often a primary response to climate stress on agriculture for the most marginal cultivators. While the seasonal or permanent migration of male household members can increase women’s control over income and household affairs, it can also increase their vulnerability to shocks. For example, women-headed households that have increased following male out-migration are

particularly vulnerable to natural disasters such as floods, with the loss of family support networks. Similarly, their workload is often increased as they have to take on responsibilities of former male labor on the farm, particularly in poorer households that cannot afford to hire outside laborers.

Climate change not only puts women under increased economic stress, but can also affect their welfare in other more complex ways. For example, women are more likely than their male counterparts to suffer in the period following natural disasters when, often, a larger number of females than males face fatalities. This can occur for multiple reasons including the fact that women often leave the homestead last, have less access to information and warnings, or face restrictions on entering public storm shelters. Similarly, during food crises which follow natural disasters, women often forgo an adequate diet to ensure that children and other family members remain well fed. The economic stress brought about by climate change and associated natural disasters has also been shown to increase cases of violence against women. This includes an increase in the trafficking of girls, as well as an increase in violence and harassment of women brought about by increased competition for resources both within the household, and between households.

Another set of questions this review addresses relates to the capacity for households and individuals to adapt to climate change. In particular, women's capacity to adapt to climate stress has been shown to be more limited than men's, for multiple complex reasons. In South Asia, women face numerous legal and cultural barriers in owning or inheriting property. The tendency for land to be registered in the male name restricts women's bargaining power in the sale of the produce of their land, and women-owned holdings are often too small for many productivity-enhancing or climate-smart technologies. Lack of land also restricts women's access to agricultural services (for which landownership papers are required), and renders them more dependent upon common-property-resource-dependent activities, such as livestock-rearing, which are often highly vulnerable to climate stress. A related challenge for women's adaptation to climate change is accessing finance, lower levels of education, and more restricted social networks and access to markets, all of which restrict their capacity to diversify into new livelihood activities.

There are numerous state programs aimed at facilitating climate change adaptation at a local level including those oriented at disaster preparedness and improving the resilience of agriculture. However, the capacity of women to benefit from state resources or to contribute to local-level decision making is often limited. Even in the context of equal rights on paper, women often face discrimination due to entrenched cultural norms when policies are implemented. At the same time, national-level policies and practices often fail to account for the needs of women or value women's agroecological knowledge.

Policy interventions to facilitate equitable climate change adaptation for both men and women include ensuring women's rights to land, making more effective use of microfinance through a more integrated approach. Other proposals include the promotion of collective action and cooperative structures amongst women, and the integration of indigenous knowledge into programs for adaptation to climate change. Underlying this is a need for bottom-up climate change adaptation planning, which understands local needs and knowledge, including those of both men and women. Programs and policies for adaptation of climate change will also be more effective if the roles of local institutions which provide incentives for collective action are better understood.

It is also clear that gendered vulnerability to climate change intersects class inequalities. Addressing *structural* poverty at a much broader level clearly emerges as being a central condition for successful adaptation and mitigation, particularly given that women from poorer households are the most vulnerable to climate change. There is also a need for strong enabling policies and institutional mechanisms that embed a commitment to tackle gender equality across society. Legal and societal commitments to gender equality are essential so that poor women, their families and their communities are given the capacity to adapt to the adverse impact of climate change.

## INTRODUCTION

A considerable focus of vulnerability research today is concerned with climate change. The Fourth Assessment of the Intergovernmental Panel on Climate Change (IPCC 2007) states that due to increasing concentration of greenhouse gases in the atmosphere, for the next two decades, a warming of about 0.2 °C per decade is projected. The rise in temperature will affect the hydrological cycle, which in turn will have an impact on rainfall and runoff patterns and the general availability of water. Furthermore, climate change has an effect not only on water resources, but also on agricultural production systems, forestry, fisheries, human settlements and health in many parts of the world. The South Asian region faces alarming environmental and socioeconomic challenges in its effort to protect valuable natural resources, and the uncertainty and risks associated with climate change are likely to exacerbate these challenges. Illness and malnutrition attributable to the global burden of climate change were already highest in South Asian countries including Bangladesh, Bhutan, India, Maldives, Myanmar and Nepal in 2000 (UNFCCC 2007). Across Asia up to one billion people could face critical water shortages, culminating in drought and land degradation by the 2050s (Cruz et al. 2007). An overwhelming body of scientific evidence now clearly indicates that climate change is a serious and urgent issue (Stern 2007).

The IPCC defines vulnerability in the context of climate change as “the degree, to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes” (McCarthy et al. 2001: 6). However, it is crucial to note that vulnerability is intricately connected with existing social structures. This paper presents a framework for understanding vulnerability to climate change in the Ganges River Basin, focusing on Nepal, India and Bangladesh – with a focus on the role of gender in shaping vulnerability. While this by no means accounts for all of the social structures which lead to gendered patterns of vulnerability, this paper reviews the extensive academic and ‘gray’ literature from the region to identify a set of key economic and social inequalities which shape how men and women are differently affected by climate change, and their capacity to adapt to these stresses.

The Ganges River Basin covers 981,371 km<sup>2</sup> shared by India, Nepal, China (Tibet) and Bangladesh, and is home to a population of 655 million. The basin is drained by the Ganges River and its tributaries. The Ganges River originates in Uttar Pradesh, India, and many important tributaries including the Mahakali, Gandak, Koshi and Karnali originate in Nepal and Tibet. The region is facing significant pressures of population and poverty, unregulated utilization of resources and low levels of productivity (Sharma et al. 2010).

This review draws on literature from the countries in which much of the Ganges River Basin is situated – namely, Nepal, India and Bangladesh. Although it draws on literature from elsewhere the focus, where possible, is on studies within the Ganges River Basin itself. Having outlined the main climatic ‘hazards’ in the region, the study reviews the main intra-household social relations which differentiate men and women which have been identified from the literature, and explores the ways in which this has led to gendered patterns of vulnerability in the context of climate change. The next part of the paper looks at the different capacities of men and women to adapt to climate change as a result of these social structures, before outlining ways in which state and non-state actors can formulate effective policies to promote equitable adaptation strategies.

## **CLIMATIC HAZARDS IN THE GANGES RIVER BASIN**

### **The Study Site**

Across the Ganges River Basin, there is large variation in the spatiotemporal distribution of water. The primary source of water is the summer monsoon (June to September) and snowmelt from the Himalayan Mountains in Nepal, China and Uttarkhand of India. The monsoon provides a significant proportion (67-92%) of the region's annual precipitation over a duration of just 4 months, which means this region has the highest seasonal concentration and variability of rainfall in the world (World Bank 2009). Water is plentiful during the monsoonal period and flooding may occur. In contrast, during the dry period between monsoons, areas become water-stressed and flows may be inadequate to supply irrigation demand, significantly reducing outflow to the Bay of Bengal (Nishat and Faisal 2000; Karim 2004; Majumder 2004; Islam and Gnauck 2007). During the dry months, ice and snowmelt from the region's mountains are of critical importance. Moreover, when monsoons are weak or delayed, water supply from melting ice and snow may limit or avert catastrophic drought (Barnett et al. 2005; Jianchu et al. 2007).

The population density within the basin varies from less than two persons per square kilometer in the upper reaches of the Ganges in Nepal and China to more than 500 people per the same area downstream in parts of India's Bihar and West Bengal, as well as Bangladesh. However, with industrialization, urbanization and population growth rates of 1.5% in India, 1.6% in Nepal and 1.3% in Bangladesh, water and food demands will continue to increase in the coming decades (Hosterman et al. 2009).

### **Impact of Future Climate Change**

Future changes in air surface temperature and precipitation due to climate change are anticipated to affect monsoonal patterns and intensity, mountain ice and snowmelt and the variability of other climate and water systems (Hosterman et al. 2009). Recent studies report gradual widespread warming which is expected to increase temperatures by up to 2 °C in 2050 and 4 °C by 2100 (Moors et al. 2011). Furthermore, surface air warming has been recorded as being progressively greater at higher altitudes (Liu and Chen 2000; Moors et al. 2011). Increased warming at higher altitudes is predicted to result in earlier thawing of snow and ice, sublimation of snowpack and glacial water, and formation of glacial lakes which, as a result, will impact runoff and thus water availability (Hosterman et al. 2009).

Annual total precipitation changes in the Ganges are still uncertain. Regional differences in future precipitation levels suggest a small decrease is more likely towards the western part of the Ganges River Basin by 2100, though with an increase towards the east (Moors et al. 2011). The variability of precipitation is reported to increase, particularly in terms of interannual variability of daily precipitation (Cruz et al. 2007). Furthermore, high seasonal concentration and variability of precipitation are predicted to increase the intensity and frequency of extreme events, with increased sediment erosion and flooding during wet spells, and droughts during dry spells (Trenberth et al. 2007; Bates et al. 2008; Hosterman et al. 2009; Moors et al. 2011).

## **Climate Change and Livelihoods**

### ***Understanding Existing Climate Change Impact***

The literature on climate change from all three countries suggests that agriculture is the livelihood activity which is at risk by far the most owing to its vulnerability to multiple hazards that are likely to be aggravated by changing weather patterns. The potential future livelihoods impact can be observed by documenting the existing impact of climate-induced stress on agriculture in each of the three countries.

#### ***Bangladesh***

As noted by the Bangladesh Parliament's All Party Group on Climate Change and Environment and the UK All Party Parliamentary Climate Change Group (2009), almost two-thirds of the workforce in Bangladesh is employed in agriculture which itself accounts for about 20% of the country's GDP. Farming communities in Bangladesh remain some of the most vulnerable, with agriculture being affected by changes in temperature, rainfall and humidity, as well as hazards linked to its coastal location including storm surges and salinity intrusion (CCC 2009b).

Flooding in Bangladesh causes extensive damage to crops, particularly for the spring and monsoonal rice crop. The prolonged flood of 1988 did not allow farmers to transplant on time, leading to a 45% loss in production (Karim et al. 1996). In the aftermath of flooding, cultivated land sometimes gets buried under sand (CCC 2006), decreasing soil productivity (WEDO 2008). Furthermore, increases in waterlogging and acidification related to changing precipitation patterns affect 0.7 million hectares (Mha) and 0.6 Mha of cropland, respectively, in the country (CCC 2007). An inadequacy of fodder due to waterlogging means livestock-rearing cannot be sustained, while homestead vegetable production also becomes difficult (CCC 2009a). Chadwick et al. (2001) note that the loss of land due to erosion is also a significant problem where communities are settled outside of polders along river banks.

Aside from extreme precipitation events, annually, droughts in Bangladesh affect about 2.32 Mha of cropped land during *Kharif* (summer monsoon) and 1.2 Mha of such land during *Rabi* (winter) seasons (CCC 2007). Combined with increased spread of floodwaters and longer duration of flooding in the monsoon, and a reduction in *Boro* (spring) rice cultivation due to reduced availability of groundwater and surface water, the total area suitable for rice production may stagnate or possibly decrease in the future. Under a severe climate-change scenario associated with 60% moisture stress, yields of *Boro* rice might even reduce by 55 to 62% (CCC 2006).

Irrigation is a widely used method to reduce drought risks; in the absence of rainfall, irrigation from surface water and groundwater sources prevents drought-related crop damage. However, constraints are emerging due to low flows in rivers during the pre-monsoonal months. In the southwestern parts of the country, due to a reduced flow regime in the Ganges-dependent areas, surface irrigation becomes extremely difficult (CCC 2006). CCC (2009b) claims that, other than in the low-flow season, available water resources are sufficient to meet present irrigation demand. However, over the next 25 years, due to the increase in the absolute size of Bangladesh's population, the per capita water availability will be progressively reduced. The annual per capita water availability in 2025 is estimated to become just 7,670 m<sup>3</sup> as compared to 12,162 m<sup>3</sup> in 1991 (Ahmad 2006).

Salinity intrusion is a more acute problem in the coastal region, and this is expected to have an extra bearing on agriculture and the availability of potable water, especially in the winter

months. In the absence of sufficient rainfall, the soil in the coastal areas starts to desiccate, and because of capillary actions salt rises up at the surface of the soil and accumulates at the root zones (CCC 2009b). The salinity conditions in the coastal areas are also exacerbated by reduced dry-season freshwater supplies from upstream sources, and saline water intrusion due to sea-level rise (CCC 2009b). The rise of sea-level along the southwestern region is likely to cause areas suitable for monsoonal paddy production to decrease significantly in the years to come. Salinity problems are often intensified when high spring tides inundate low-lying coastal areas, especially when they are associated with cyclonic storm surges. Many of the crop varieties, especially those of food grain varieties, are not salinity-tolerant. As a result, a large extent of land in the coastal districts is already unsuitable for a number of crops.

Aquaculture in fishponds is an important livelihood in Bangladesh. It is already known that climate change would increase the extent of monsoonal flooding. Therefore, the potential threat to culture fisheries would also increase under climate change (CCC 2006). Cyclones and saline water have caused *ghers* (shrimp ponds) to be damaged and fish to die.

### **India**

The agriculture sector represents 35% of India's GNP and sustains the livelihoods of nearly 75% of the population (GoI 2004; Scott 2008). This sector is also highly dependent on the southwest monsoon (June-September), and 60% of the crop area is under rain-fed agriculture which is therefore highly vulnerable to climate variability and change (GoI 2004; Scott 2008).

The Ganges River Basin in India includes some of the most populated and agriculture-dependent regions of the country, in particular the plains states of West Bengal, Bihar and Uttar Pradesh. In these states the combined pressures of climate change and population growth are likely to have a significant impact on agriculture in the years to come. Unlike Bangladesh, salinity intrusion and cyclones are not present to the same degree in the Indian section of the Ganges River Basin. Nevertheless, large parts of Bihar and Uttar Pradesh are drought-prone, and floods occur with regularity along the main rivers. Any increased variability in precipitation is going to put severe pressure on agricultural production. In over 50 years there have been 15 major droughts in India (Mall et al. 2006). In 1987, there was a severe drought which caused a decrease in food production by 3%. A more recent example occurred during 2002-2003, when there was a 19% decline in the annual summer monsoon leading to an 18% decline in food grain production. The grain production during the drought of 2002-03 decreased to 174.19 million tons (Mt) from a record level of 212.02 Mt in 2001-02 (Mall et al. 2006). Similarly, increased incidences of flooding will increase soil erosion, increase the rate of sedimentation in rivers and reservoirs, and shorten the life span of dams which provide irrigation water (Mall et al. 2006).

As with Bangladesh, rising population will reduce the scope for irrigation to cope with changes in precipitation. An integrated vegetation and hydrology model estimated that the water demand for irrigation in the context of both climate change and rising population would increase from 383 to 953 km<sup>3</sup>/yr. This is reportedly 2.5 times higher than the scenarios of the 2008-2011 period (Rost et al. 2008; Fader et al. 2010; Biemans et al. 2011). However, the available surface water and reservoirs cannot meet the demand. Most of the additional supply should come from other sources such as groundwater or interbasin transfers. Total crop production could grow by up to 90% if all the crops are fully irrigated (Paroda and Kumar 2000; Moors et al. 2011). However, intensification of agriculture and industrial development affect the quantity and quality of both groundwater and surface water.

A decline of the groundwater table has been observed in many parts in the Ganges River Basin. Between 1994 and 2005 the average rate of decline was about 0.15 m/year in the western Gangetic Plains and in some places it was as high as 0.35–0.4 m/year (Samadder et al. 2011). Based on satellite data, Rodell et al. (2009) estimated a depletion rate of the groundwater aquifer by  $0.04 \pm 0.01$  m/year between 2002 and 2008. They attributed this to increased tube well irrigation and other anthropogenic uses. Even in areas where the groundwater is underutilized, such as the eastern Gangetic Plains, it is poorly developed due to low rural electrification, high prices for diesel fuel, and tiny and scattered landholdings (Shah 2007; Sugden et al. Forthcoming).

Other climate-change-induced hazards which affect agriculture in the Gangetic Plains of India include abnormal temperatures and humidity which affect crop productivity, and the incidence of pest infestation and epidemics. Pathak et al. (2003) note also that the negative trends in solar radiation and an increase in minimum temperature result in falling yields of rice and wheat across India's Gangetic Plains. A Wheat Growth Simulator model identified that a temperature increase in January results in a decline in wheat yield (Hussain et al. 2005). For every increase in mean temperature, there is a decline in grain yield by 428 kg/ha (Hussain et al. 2005). With increase in temperature, pest activity can increase as its hibernation is delayed. Similarly, during severe winters the plant's defensive systems are lowered and they become susceptible to pest attacks (Hussain et al. 2005).

### ***Nepal***

Out of the three countries, Nepal – which lies entirely within the Ganges River Basin – remains the most dependent on agriculture, with over 80% of the population dependent on subsistence agriculture for their livelihoods (World Bank 2009). The risk analysis organization, Maplecroft, ranked Nepal as the fourth most vulnerable country in the world based on 2010 vulnerability assessment and mapping of climate change in vulnerable countries (Maplecroft 2012). Climate change projections predict an increase in precipitation extremes such as floods and droughts, having wide-ranging consequences (Karki et al. 2009; NPC 2010). Communities are vulnerable to the same drought and flooding events which affect communities to the south in northern India. In 2008, the Koshi River floods displaced thousands in the lowlands, and inundated large areas of farmland, while in 2009, Nepal recovered from a severe drought, the worst in 40 years. Although groundwater depletion is not as severe a problem as in some parts of the Gangetic Plains further west, as in India, there remain socioeconomic constraints to accessing groundwater to cope with droughts (Bhandari and Pandey 2006).

In the hills, there are an additional set of hazards including landslides and other mass movements (Karki et al. 2009; NPC 2010) which are likely to increase with a rise in extreme precipitation events, causing considerable damage to land and property. In the mountains, declining snowfall due to rising temperatures affects seasonal water availability at higher altitudes, while also increasing the rate of glacier retreat. Reductions in water availability due to reduced glacial storage are also likely to change the hydrological flow regimes not only of Nepal's major rivers, but across the entire Ganges River Basin, reducing what is available for agriculture downstream (Webersik and Thapa 2008; Karki et al. 2009).

## **SOCIAL STRUCTURES AND VULNERABILITY**

### **Defining Vulnerability and Social Structures**

The concept of vulnerability has multiple definitions, but in general it refers to a tool to measure the extent to which a system or population is susceptible to harm (Adger 2006: 6). The study of vulnerability usually has the aim of identifying means through which well-being can be enhanced through reducing risk and promoting resilience (Adger 2006). Ribot (2010) distinguishes two approaches to analyze vulnerability: the risk-hazard and social constructivist frameworks.

#### ***Risk-hazard Approach***

This tends to understand vulnerability as multiple outcomes of one biophysical event (as an impact analysis), as a “dose-response relation between an exogenous hazard to a system and its adverse effects” (Fussel and Klein 2006: 305).

#### ***The Social Constructivist or Political Economy Approach***

This seeks to explain vulnerability as due to multiple causes. The focus is on lack of entitlements. Entitlements are a key concept in Sen’s analysis of vulnerability to hunger and famine. Entitlements are the rights and opportunities people own or claim to command different commodity bundles (Dreze and Sen 1991). In a vulnerability analysis, one can consider how assets are sufficient to cope with climate-induced stresses and shocks. The concept of entitlements is similar to that of ‘assets’ which is utilized in the Sustainable Livelihoods Approach. A central methodology of the Sustainable Livelihoods Approach is to examine the different types of ‘livelihood resources’ or ‘assets’ available to households or individuals (e.g., economic, physical, social), which in turn affect vulnerability to shocks (Scoones 1998; Moser 1998).

#### ***Integrative Frameworks***

The integrative frameworks, which this analysis will utilize have expanded on the social constructivist framework, and vulnerability is viewed as resulting from a combination of biophysical and social factors. These frameworks bring together the different approaches. Adger (2006) uses the concept of a social-ecological system which suggests that social and natural structures are interrelated, and that distinctions between the two are arbitrary. Using an integrative framework Bohle et al. (1994) identified the three following components to vulnerability:

- a. Risk of exposure to crises, stresses and shocks (e.g., drought, flood, unpredictability of rainfall, etc.).
- b. Risk of inadequate capacities (e.g., lack of entitlements/assets) to cope with stresses, crises and shocks.
- c. Risk of severe consequences of crises, risks and shocks.

This study will explore how vulnerability is induced by the livelihood resources or assets one has at his or her disposal in the context of biophysical hazards induced by climate change – these include access to land, finance, natural resources, social networks and human capital such

as education. While this draws on the Sustainable Livelihoods Approach, Scoones (2009) argues that the original framework must be expanded to acknowledge the structural bases of power. In other words, analysis of assets is not sufficient unless one understands what structures access to assets and services. Such an approach, grounded in political economy, requires an engagement with the entrenched *social structures* which mediate access to different livelihood resources in given contexts. Little (1991) defines a structure as a feature of a social system that persists over an extended period of time, whose properties are independent of the particular persons who take up roles within it. Social structures can be imbued with power relations grounded in class, religion, ethnicity or gender. The focus of this paper is to identify the social *structures* which shape access to assets in the context of climate change, and affect patterns of vulnerability and resilience.

Agrawal (2008) emphasizes that structural and group characteristics such as gender, caste, race, age, ethnic affiliation, and indigeneity, even when they are not consistent predictors, are often closely related with vulnerability. The sensitivity and vulnerability of different groups to climate impacts vary enormously depending on their institutional links, material endowments, occupational patterns and asset portfolios, and social networks. Especially important in this context is the role of institutions which mediate individual and group access to assets and services. This study reviews the extensive literature to identify gendered social structures, and how these shape patterns of vulnerability.

## **Gendered Division of Labor**

### ***Traditional Division of Labor in India, Bangladesh and Nepal***

One of the most significant means through which gender structures vulnerability is associated with the distinct intra-household division of labor in Nepal, Bangladesh and India. The gendered division of labor refers to the system through which work is divided between men and women. A division of labor in the greater part of the world, whereby women bear the burden of both productive and reproductive tasks but do not retain an equal share of household income, has been well documented (Deere and de-Janvry 1979; Benholtd-Thomson 1982; Deere and Leon de Leal 1982; Folbre 1982; Gibson-Graham 1996; Agarwal 1998; Gibson-Graham et al. 2001). In other words, women bear disproportionate responsibility for activities such as child-rearing, food preparation, and meeting the households' water and fuel needs, while having to simultaneously work on the farm alongside their male counterparts. They are not however, able to control the income from the farm in proportion to the input of their labor.

In rural Nepal, a significant 'reproductive' labor burden is collecting water, a phenomenon aggravated by the rugged geography. Studies have shown how women in Nepal contribute up to 70% of the labor required for water management, with up to 30% of their daily labor time being taken up collecting water (WfWP 2004). In a study from three villages in western Nepal, it was found that women work up to 18 hours a day (collecting fuel, fodder and water),<sup>1</sup> while men normally work up to 13 hours (plowing fields and herding) (Regmi and Fawcett 1999). In 'leisure' hours, women knit, weave and sew (activities within the domain of reproduction), while men were found to spend their leisure time drinking and playing cards. In all the communities interviewed, the women reported that they used to collect water four to five times a day, totaling 80 liters per family per day (Regmi and Fawcett 1999).

---

<sup>1</sup> In all the communities interviewed, the women reported that they used to collect water 4-5 times a day, amounting to a total of 80 liters per family per day (Regmi and Fawcett 1999).

Gendered labor contributions in India and Bangladesh are no less skewed (Upadhyay 2004; Sultana 2009). In a common household in rural Bangladesh a woman is expected to maintain hygiene, ensure water supply, collect fuelwood, cook for the family, care for children, the sick, and the elderly, undertake the burden of post-processing of all agricultural produce, raise poultry, and maintain a courtyard vegetable garden. Reproductive responsibilities in particular are considered unmasculine. For instance, men rarely participate in fetching domestic water (drinking, cooking) as that is deemed a feminine task for younger women and girls (Sultana 2009). Also in Bangladesh, women and girls have been found to walk 2 to 5 hours a day to collect water (Crow and Sultana 2002).

Leaving aside ‘reproductive responsibilities,’ in many contexts women perform more agricultural labor than men in the first place. Women have been found to be responsible for a significant 75% of household food production in sub-Saharan Africa, 65% in Asia and 45% in Latin America (Stoparic 2006). A research report undertaken by ICIMOD (2008) noted that, in India, women carry out 4.6 to 5.7 times the agricultural work of men, while in Nepal, the corresponding figure is 6.3 to 6.6. According to Venkateswaran (1995: 20), women in India are estimated to contribute, on average, from 55 to 60% of the total labor of farm production.

### ***Gendered Division of Labor and Changing Work Burden in the Context of Climate***

While it has been established that an unequal division of labor exists, how does this affect vulnerability to climate change? Firstly, a number of studies have shown how a changing climate can *increase* the already high labor burden for women. When one considers the time already taken for women to collect water, increased water scarcities in the future may mean women and girls have to spend more time on this already arduous task. This decreases the opportunities for girls to attend school or invest time and labor in other income-generating activities (Cap-Net et al. 2006). In Bangladesh, it has been shown how the severe disruption of local freshwater sources following floods, cyclones and saline intrusion has created an acute crisis for households. However, it is up to women, irrespective of their physical condition, to provide drinking water for their families. Women in Bangladesh need to walk long distances, sometimes up to 10 kilometers every day over rough terrain, in search of water. This consumes an enormous amount of their time and effort (WEDO 2008). In saline- and drought-prone regions for instance, women have to find extra time to combat the impacts of salinity on availability of potable water and fuelwood, to avoid having their husbands complain about delays in serving food, often leading to physical assault of the wives (CCC 2009a). As availability of these natural resources declines, women have to walk longer distances to collect them. Similar findings were evident in Upadhyay’s (2004) study from North Gujarat in India. During periods of water scarcity, women often have to walk for up to 2 hours a day to wells in neighboring villages, reducing the time they have for other livelihood activities. This also applies to livestock-rearing, a productive task in which women bear a disproportionate responsibility. Women often have to travel to distant areas to locate water for their herds.

Women are regularly compelled to make trade-offs in order to balance their multiple chores. Crow and Sultana (2002) reveal that access to higher-quality water might have to be forgone, for example, in order that children can be kept safe or other household chores can be completed on time – increasing the vulnerability of the household as a whole. With regard to Nepal, it has been argued that responsibility to take care of the family increases with declining water availability, jeopardizing women’s opportunities to work outside the home or attend school (Mitchel et al. 2007; FAO 2007).

The burden of collecting fuelwood has also increased for women in the context of ecological change. In developing countries, rural women depend on fuelwood as an energy source to cook food for the family and they spend more time collecting this resource than men or urban dwellers (WEN 2010; FAO 2011). In the hill villages of Nepal, women perform 82% of the fuelwood collection work, yet with climate change forest productivity is impacted, reducing the availability of fuelwood and increasing the workload of women (WEN 2010).

The workload of women has also been shown to increase in the context of natural disasters induced by climate change. For example, following flooding in Bangladesh, day-to-day tasks such as cooking become more time-consuming as rising water levels compel women to raise their stoves or go to neighbors' houses to prepare food. There is also an increase in tasks such as cleaning and maintaining the house following a flooding event (World Bank 2010). In the absence of agriculture, many people in the waterlogged areas cannot easily provide fodder for their cattle, and women have to go to distant places to gather grass. In marginal land such as *chars* (river islands) and river embankments, with rising water levels in adjacent rivers, women tend to take responsibility for a significant part of the relocation work (CCC 2009a).

While it is clear from the examples above that climate change can lead to an increased work burden for women, this also varies considerably according to other axes of inequality – most notably caste and class relations. For example, while the number of labor hours required to collect water has increased due to climate change, wealthier households often have a reduced burden due to favorable access to year-round water sources such as tube wells. In a study of three villages in the western Nepal Tarai (southern plain land) it is shown how women from the lower caste Mallah community often have to travel much further to collect water from tube wells than their higher caste counterparts who would only need to travel 5 to 10 minutes. This is because the husbands of the better-off farmers have been able to influence the installation of tube wells so that they could be close to their homes (Regmi and Fawcett 1999). Similar findings are evident in Bangladesh. Sultana (2009) notes that while women in wealthier households may be powerless within their own families, they may at least have access to the privately owned tube wells of their families (and thus with easier access to water). Similarly, when women are members of a landowning or powerful family, they are generally able to command some control over the women in sharecropping, agricultural laboring, or poorer/dependent families, in helping them fetch safe water (Sultana 2009). Similar findings were evident in the tidal belt where a few members of the Rakhaire tribal community of that village had no source of safe water supply, unlike their Bengali counterparts, meaning girls had to walk long distances to fetch water (World Bank 2010).

Varying cultural norms between differentially situated households, combined with economic realities can also amplify differences between women. In Bangladesh, Sultana (2009) finds that while some women exercise their limited agencies in a variety of ways, it would appear that the majority of women have internalized certain norms of female behavior. These are grounded in their understandings of what it means to be a good mother, daughter or wife. In this context, it is a sign of family honor to be able to keep daughters-in-law within the house and its vicinity and not subject them to public visibility (Sultana 2009). The sentiments of wealthier households were stronger on this front, resulting in a reduced workload for tasks such as fetching water (Sultana 2009). Khondker (1996) suggests that economic necessities are rapidly eroding values of female honor, especially amongst poorer women who have little option but to engage with society to secure increasingly scarce resources such as potable water. In contrast, women from wealthier classes who employ laborers have the option of paying others to procure such resources. Therefore, the impact of values regarding sex segregation is not uniform across classes and appears in such instances to have an inverse influence on gender equality.

### ***Differential Effect of Climate Change on the Income of Women and Men***

A second reason for the importance of the gender division of labor is that women and men often have separate control over different income sources. If climate change undermines a particular livelihood activity, this may differentially impact men's or women's individual income sources. This impacts women in South Asia in particular, as the sources of personal income they can control are often more limited than those of men.

First, in the sphere of nonfarm labor, women often receive less pay than male counterparts, ranging from 57 to 79% of men's salaries in Nepal, India, Pakistan and Bangladesh, putting them again at a disadvantage when it comes to financial resources and buffers to cope with climate change and disasters (CBS 2009; FAO 2011). A case study from Dolakha in Nepal found discrimination in wage structure in three enterprises studied – even though women had higher proportional representation in the decision-making body than men (Acharya 2009).

Second, and perhaps most significantly, women often have far more limited engagement in the public sphere, limiting their income-generating opportunities. In Bangladesh in particular, gender plays a central role in the organization of social structures and norms through the differentiation of rights and responsibilities of the individual within his or her personal space, the family and household, and society at large. This combines with the influence of the tradition of purdah or separation of women from men (Lönnqvist et al. 2010) that defines and enforces rules of feminine "modesty" with respect to their dress, behavior and activities within and outside the household (Sultana 2009). Although less pronounced in Nepal and India, gender ideologies still limit women's involvement in the public sphere. In Nepal for example, men are traditionally more engaged in livelihood activities which are commercial and in the public domain, while women play a disproportionate role in livelihood activities which do not involve market engagement (Saxena 2011). Nellemann et al. (2011) point out that much of the labor performed by women in rural Nepal is unpaid, casual in nature and restricted to the home and farm and thus receives no economic recognition.

One consequence is that women often have fewer opportunities to labor for cash outside the household. More significant perhaps though is that women often have limited control over agricultural income. Women in India, as in most countries, perform the greatest share of agricultural labor, yet they often have little control over the product of their labor (Agarwal 1998). In Upadhyay's (2004) study from Gujarat, women are shown to be heavily involved in agricultural activities such as sowing, weeding and harvesting, while men bear a greater responsibility for the marketing of produce – and this income is controlled entirely by men. Even with regard to livestock, drawing from data in Nepal, Table 1 shows that while women are often involved in tending livestock, men are more often in charge of selling and buying. Nevertheless, livestock remains an important asset for women in Nepal, particularly when they do not own land (IFAD et al. 2009; Nellemann et al. 2011).

Bearing in mind that women have more limited income sources, particularly with regard to controlling what is earned from crop sales, how does this differentially affect their vulnerability to climate change? On one level, in the first instance, the loss of cereal-producing agricultural land due to natural disasters will directly affect men who are almost always the owners or lessees of agricultural land and the primary beneficiaries from the labor demand and income derived from agriculture. However, men are more likely to have alternative income sources, while for women, vegetable production and home gardens combined with rearing livestock are often their core sources of income (WEDO 2008). Livestock activities, in particular, such as dairy production, are often one of the few income streams that women control, as Upadhyay (2004) shows with regard

TABLE 1. Involvement in livestock activities in Nepal by gender (%).

Activities Grouping	Percentage involvement		
	Male	Female	Child
Cutting grass	30	60	10
Cutting fodder	25	75	-
Feeding (concentrate)	20	80	-
Watering	30	60	10
Grazing the animals	50	40	10
Cleaning sheds	40	40	20
Milking	40	60	-
Selling livestock products (milk, ghee)	70	30	-

Source: FAO 1998.

to Gujarat. Any adverse impact of climate change on these activities alongside cereal production is likely to disproportionately affect women. In Bangladesh, vegetable production is frequently undermined by waterlogging, acidification, inundation and salinity intrusion. This causes a direct dent in women's income and undermines their ability to provide food for their families (CCC 2009a). Also a large number of livestock deaths occur in cyclonic storm surges (World Bank 2010). Following flooding, it is more difficult for women to collect fodder for livestock, and disruption to travel means that veterinarians cannot visit villages, and local people cannot easily procure medicines for their animals (WEDO 2008).

Aside from the risks that climate change poses for agriculture-based activities women depend on, the degradation of common property resources also disproportionately affects women's access to income. The role of common property and open-access resources are integral to the food security of poorer rural households, livelihoods and coping strategies in Bangladesh, Nepal and India (Rahman et al. 2007). Beck and Ghosh (2000) argue, for example, that 12-13% of poor people's income in India is derived from common property resources, but that within these land-poor communities, 70-78% of the resource-harvesting activities are in the women's domain. Resource harvesting from communal ecosystems are often one of the few sources of cash women can personally control (Agarwal 1998). In this context, the degradation of wetland, forest and river ecosystems often disproportionately affects women.

Despite this, it is worth noting that even when women are able to directly earn income themselves, this does not necessarily mean they will control it. For instance, Kelkar (2009) suggests that the proportion of women who are not able to retain their earned income in Bangladesh is over 40%. This is in addition to the fact that rural women's average wages are only 60% of those of men (ADB 2010).

## Migration and Climate Change

### ***Out-migration Increasing due to Climate Change and External Factors***

Climate change has accentuated migration in many areas of Gangetic Plains. First, people migrate from their homes in response to rapid onset of disasters like flooding or landslides or, slow onset disasters like drought and land degradation which affect their access to basic needs such as food and water (WEN 2010). It has been estimated that by 2050 around 150 million people (Myers

1993; Stern 2007), will be displaced permanently by climate-related phenomena such as droughts, floods and hurricanes (Stern 2007).

It is important to note that permanent migration is triggered by a combination of social and environmental factors (Kraler et al. 2011). In Nepal, the overall impact of climate change on migration is difficult to predict because the latter is highly variable due to varying political, social and economic structures at the local level (Boano et al. 2008). A study conducted in the Chitwan Valley of Nepal showed that environmental factors do not appear to significantly affect the migratory behavior of better-off high-caste Hindus. The latter's migration choice is instead shaped by human capital, social capital, and demographic factors (Massey et al. 2007). The same study showed that the odds of undertaking a local move are 31% greater for lower-caste Hindu and non-Hindu groups when they perceive agricultural productivity to be declining, and the odds of moving locally rise by 10% for these groups with each additional 100 minutes required to gather fuelwood.

Similarly, the causes of migration in Bangladesh vary according to location and social factors. In a study based in nine different locations in Bangladesh, Ahmad (2012) reports that of those households reporting migration, only 6% had members who migrated permanently, and over 60% migrated for livelihood reasons, while 14% migrated because of climatic hazards. These ratios are however quite different in the coastal areas. For example, the rapid growth of Khulna (coastal southwest) as an urban center is attributed to people being forced to migrate in search of alternative livelihoods from rural coastal areas by climate-related disasters (IDS 2011).

Out-migration is a coping strategy adopted by both men and women but there are significant gender outcomes. Ahmad (2012) reports that in the past decade, an average of 77% men compared to 23% women have migrated from nine study areas in Bangladesh. Therefore, women-headed households have become an important part of the rural economy. They are estimated to form between 15 (Mitchel et al. 2007) and 20-30% of households in Bangladesh (ADB 2010). This may be of a temporary nature (seasonal male migration) or permanent if the husbands go outside the area for employment and never come back (CCC 2009a), or have died during a climate disaster.

In general, men are known to migrate to nearby areas and work as agricultural or other laborers, while women migrate to large cities, because there are limited economic opportunities for them in rural areas (Ahmad 2012). In the coastal zone of Bangladesh, besides lifetime migration, people also resort to seasonal migration to seek employment and for other reasons. Male workers stay for longer periods (averaging 74 days) than female workers (14 days). Murshid and Yasmeen (2004) believe, however, that female migration is likely to increase because poverty, natural disasters and mobility are correlated. The frequent cyclones make coastal women particularly vulnerable. Impoverished women increasingly seek jobs outside their homes. In these contexts the challenge is much greater than that of men as it contests the 'nonmobile' construction of women's role in society.

A notable trend in Bangladesh is the large number of young single women migrating to urban centers (Ahmad 2012). The same author indicates that poor migrants are not able to escape climate variability as they live in city slums located in lower-lying areas. This is likely to be the case especially for women. As observed by the Women's Environmental Network (WEN 2010), the prospects for many women who do migrate are hampered by their limited skills (besides farming) and educational levels, and they struggle to adapt to a radically different situation, having left their community and other assets behind. ADB (2010) confirms that the proportion of women is increasing and women now predominate among migrants of ages 15-25, and suggests that such migration flows will contribute to larger patterns of social change.

In Nepal, women primarily migrate within Nepal (Table 2). Women formed only 11% of the total population of over 762,000 out-migrating from Nepal in 2001/02 (CBS 2001), a figure which has risen significantly in recent years. As overseas migrants are the majority, the proportion of female-headed households has steadily increased from 13.6% in 1995/96 to 19.6% in the 2003/2004 Nepal Living Standards Survey and 26.6% in the 2010/2011 survey, a phenomenon particularly acute in rural areas (Table 3). This results in new forms of vulnerability which will be discussed in the next section.

TABLE 2. Migration destinations for men and women in Nepal in 2006.

Migrations destination	Women (%)	Men (%)
Internal (within Nepal)	85.9	50.1
To India	11.6	37.2
To countries other than India	2.5	14.4

Source: MoHP et al. 2007.

TABLE 3. Women-headed households in Nepal.

Household headed by	Urban (%)	Rural (%)	Total
Men	79.9	76.0	76.6
Women	20.1	24.0	23.4
Total	100.0	100.0	

Source: MoHP et al. 2007.

### ***Out-migration Can Increase Vulnerability of Those Left Behind***

Migration may lead to growing insecurity and instability in the regions of origin, transit and destination, due to increased competition over resources such as water and land. Moreover, a deterioration of state capacity under the stress of climate change could lead to an increase in social disorder and instability. Ansorg and Donnelly (2008) note the sizeable role played by both intra-country and cross-border migration in Bangladesh. They show that sociopolitical pressures are increasing as more and more people migrate due to more frequent flooding, rising water salinity and inundation of land. Saul (2012) cites the intense competition over ‘free’ but scarce *khas* (state-owned land). This has led to tensions and violence between migrants themselves, as well as between migrants and local communities. This includes local gangs seeking to charge rent on such lands.

The impact of migration can have a selective effect according to gender and other axes of differentiation. Male out-migration may result in increased workloads for the women left behind and barriers for accessing services like healthcare and relief (Zahur 2009; Kraler et al. 2011). Female-headed households are particularly vulnerable. Clearly, the burdens placed on such women will be greater than normal as women will be required to assume the roles played by their husbands, especially of primary income earners. Over 95% of female-headed households in Bangladesh are below the poverty line, underlining the acute vulnerability of this significant subset of women. Female-headed households tend to suffer more frequently from food insecurity,

and their livelihoods and coping capacities are constrained by low education, poor skills, and low earning ability. Many of these households also consist of women who have been divorced or widowed, and who are culturally discouraged from remarrying. These women are forced to engage in income-generating activities outside the home for their survival, but generally earn less than their male counterparts (Islam 2011). The same author gives the example of women working in fisheries in the Sunderbans where they are usually paid 70% of the wage that men earn for doing the same job. In India, men's migration was also reported to increase gendered vulnerability by leaving women, who have fewer resources, to take control of agriculture (Alston 2006).

Raihan et al. (2010) found that while the men are away, women left behind have to often borrow money at high interest rates to buy food. Any money saved is often only enough to pay back the debt. Sometimes people borrow money to get through the lean period by selling labor to the large landowners in advance, although the price for labor sold in advance is only 50% of the price in the agricultural season. Many women are thus caught up in a vicious circle of debt, having to take out a new loan to pay off the old one. In tidal flood-prone areas, men usually stay near the sea for fishing for months, leaving the women in the villages. World Bank (2010) found that social insecurity is high as theft increases and women become susceptible to harassment by other men. An interesting finding is that, in order to ensure that their wives do not become disloyal to them behind their backs, the men usually feel more comfortable leaving their wives behind when they are pregnant.

A report by the CCC (2009a) notes that members of women-headed households are concerned with loss of homesteads, loss of housing for months and years, physical insecurity, the loss of self- as well as family-esteem, lack of both production opportunities and food security in the aftermath of climate events. When men are away, the onus of household well-being falls on the relatively under-empowered women.

Masika (2002) however questions this widely held view that male out-migration (or death) makes women more vulnerable because in some instances male migration can give women greater decision-making powers, and open up new livelihood possibilities for them. Even with regard to female migrants themselves, Ahmad (2012) found that migrants in Bangladesh, especially women, have greater access to economic opportunities and markets compared to those in rural areas despite being disadvantaged by poor education and illiteracy. Despite this, migrants' earning capacity increases in urban areas, increasing their potential to acquire assets and capital.

It is important also to note the inter-sectionality of gender with class and caste when looking at the levels and impact of male out-migration. In a study from Chitwan in Nepal, the role of falling agricultural productivity on encouraging local and distant out-migration was confined to lower-caste Hindu and non-Hindu groups suggesting that caste privilege may protect people from the negative effects of environmental deterioration (Massey et al. 2007). This shows women's vulnerability is rooted in multiple mechanisms.

## **Gender, Welfare and Climate Change**

### ***Climate Change and Health Risks for Men and Women***

A recent study from the World Health Organization assessed gender inequality in life expectancy, comparing shortfalls in longevity for males and females with their respective biological maxima. It revealed large differences between shortfall inequalities of women and men in low-income countries as well as large shortfall inequalities in life expectancy among women in low-income countries (Hosseinpour et al. 2012). Worldwide, on average, women's life expectancy is 4.69

years higher than that of men. In Bangladesh, India, and Nepal, the relationship is opposite, a phenomenon which has commonly been attributed to the traditional cultural bias against females in these countries (Neumayer and Plumper 2007).

South Asia is also characterized by imbalanced sex ratios. Fikree and Pasha (2004) argue that discrimination at each stage of a woman's life contributes to this imbalance, ranging from selective abortions, neglect of daughters, and poor access to health care for girls and women. This reflects how women in South Asia are more vulnerable than men in terms of health. The following sections examine to what extent such vulnerability intersects with health risks induced by climate change.

### ***Natural Disasters***

There is ample evidence that during natural disasters, women and girls are more prone to mortality compared to men and boys. Statistics from Nepal and Bangladesh are compelling. In Nepal, flood-related fatalities were found to be significantly higher according to gender and age. One study recorded them at 13.3 per 1,000 for girls (aged between 2 and 9 years), 9.4 per 1,000 for boys of the same ages, 6.1 per 1,000 for adult women and a much lower 4.1 per 1,000 for adult men (WHO 2005; Bartlett 2008). In cyclone-prone areas in Bangladesh, it was found that most casualties of cyclone Aila were women (World Bank 2010). The mortality rates of females in flood-, drought- and salinity-prone areas in Bangladesh were 33, 42 and 25%, respectively. In contrast, the mortality rate of men in both flood- and salinity-prone areas was only 17% of the total (Rabbani et al. 2009).

The causes of this difference are complex. Studies from Bangladesh and Nepal have suggested that, in the case of natural disasters, women are more susceptible to injuries and death than men because they do not get information in time (World Bank 2010). Furthermore, after disasters, poor and low-caste women who have less access to public space due to domestic responsibilities, also face difficulties accessing assistance and information extended in the time of disasters (Dhungel and Ojha 2012). The traditional gender division of labor was also found to impact men's and women's vulnerability to natural disasters. In India, it is reported that during the 2004 Indian Ocean tsunami, many women were waiting at the seashore for the fishermen to arrive home (Oxfam International 2005) and as a result more women were hit by the waves, which had their most fatal impact when reaching the coast.

Women's vulnerability during disasters however, intersects with their socioeconomic and class status with women from poorer households more vulnerable than their better-off counterparts (Neumayer and Plumper 2007). For instance, better-off households in Bangladesh often have bricked or semi-bricked houses which are more resistant to floods, therefore minimizing the loss of lives and assets. The better-off can also afford to avoid living in disaster-prone areas, and due to their economic condition they can better withstand the losses caused by floods (Khondker 1996). The most vulnerable group affected by Hurricane 07B in the Godavari Delta in India was reportedly migrant and scheduled (low) caste women who formed the major part of the landless agricultural laborers (O'Hare 2001).

Social norms also have an influence on gendered vulnerability to disasters, particularly in Bangladesh where the rule of the purdah prevails. For instance, in the case of cyclones, the cultural norms dictating that women cannot leave the household until everyone else has evacuated was a major reason why a disproportionate number of women died in the 1991 cyclone (Nelson et al. 2002; Dasgupta et al. 2010). Women in Bangladesh do not feel comfortable to go to public

shelters, which are often overcrowded and lack user-friendly facilities for women. Even in cases where they are willing to take refuge in public shelters, their husbands are often found to be reluctant to accompany them due to anticipated adverse social and religious responses (CCC 2009a). Similarly, in earthquakes in India, more men survive events at night because men sleep outside when it is warm (e.g., on rooftops). This is socially unacceptable for most women, and thus they remain trapped inside their homes (Krishnaraj 1997).

More anecdotal, it is also reported that social norms on dressing codes also affect women's vulnerability to natural disasters as some women suffered injuries and were disabled when their sarees got entangled with tree branches on their way to cyclone shelters (World Bank 2010). Similarly, an ODI study in Nepal found that the way rural women and girls wear clothes limits their swimming capabilities in times of flood, impairing their adaptive capacity (Jones 2010).

### ***Nutrition and Climate Change***

Insecurity of food related to climate change is likely to increase the risks for women's nutrition. Women's diet is not only crucial for their health but also for fetus and infant development during pregnancy and breast-feeding periods. Yet, in South Asia women's diet is often neglected and, during crises, might be sacrificed to meet the nutritional requirements of other members of the household. In some famines, it was reported that a larger number of females than male victims die at a very young age or as infants. This reflects a discriminatory access to food during crises with a bias against female babies and children, as argued by Greenough (1982) and Agarwal (1990) for the Bengal famine of 1943/1944, and Dyson (1991a, b) for South Asian famines more generally. In some instances, during a period of food scarcity, a woman may be malnourished even though she has to lactate an infant and nurture another child in her womb (CCC 2009a), resulting in low birth weights and poor health outcomes for newborn babies.

Khondker (1996) observes that ideologies rooted in self-sacrifice and obedience to the husband as household head lead women to put their own interests last. Such values and beliefs are prevalent in patriarchal societies like in Bangladesh, where rural men sometimes pay limited attention to women's diet (Baten and Khan 2010). The distribution of food within the household is highly gender-biased with women typically eating last what is left.

This is exacerbated during climatic events such as floods, droughts, cyclones, and waterlogging. Such events reduce agricultural production and cause food insecurity in the household because poor people cannot afford to purchase food from the market. The intra-household food allocation has been a traditional coping strategy for dealing with food scarcity based on the 'value' and 'worth' culturally assigned to men and women. In a recent study conducted in Andhra Pradesh, India, such a strategy appeared to be exacerbated during a dry year (Lambrou and Nelson 2010).

Findings from flood, drought and saline areas of Bangladesh presented by Rabbani et al. (2009) however seem to suggest that the above view of women's disadvantaged nutritional status during hazards is a generalization that does not always hold true. Rather than women being consistently the worst affected, men, women and children are differently affected in different hazard contexts. Women were in fact the most vulnerable (90%) in the flood-prone area in terms of food availability whereas males were the worst affected (95%) in the drought-prone area. On the other hand, children suffer much more (95%) during a hazard period in the salinity-prone area.

### ***Waterborne Diseases and Water Contamination***

Global warming is creating favorable temperatures for many epidemics. Regional increases in mean temperature and precipitation, resulting in greater humidity, have facilitated the spread of many vector-borne infectious diseases such as malaria, dengue and encephalitis (Tsai and Liu 2005). In Bangladesh, floods, waterlogging, drainage congestion, and cyclones due to climatic change, have increased the incidence of diarrhea, cholera and typhoid. In Nepal, the prevalence of typhoid, cholera and diarrheal diseases has been amplified due to extreme droughts, flooding, and poor sanitation (Regmi et al. 2008). The spread of these waterborne diseases is tightly related to the effectiveness of sanitation systems. In the case of floods, sanitation systems are often under waist-high water, contaminating the entire waterbody (Neelormi et al. 2009). Furthermore, in Bangladesh, females were found to be the prime consumers of saline water within their family (CCC 2009a), and the salinization of drinking water presents a particular threat to the large numbers of pregnant women in coastal areas who are already being diagnosed with preeclampsia, eclampsia and hypertension (Nicholls et al. 2007). Sultana (2009) notes that social norms mean families sometimes consume contaminated water rather than risking family honor by allowing women to travel far from the home to collect better-quality water.

### ***Psychological Welfare***

Besides material losses and physical assaults, increased climate stress is exposing a growing number of girls and women to the psycho-social impacts of hazards. These hazards include anxiety and lack of sleep and a feeling of being desperate and helpless. After disasters, families often have to relocate, sometimes permanently, to safer grounds. This has a severe impact on social support networks and family ties which are particularly important for women to cope with – as they have less access to formal services and support than men. While such stresses are not restricted to women, due to their role as care-givers, they also face the burden of looking after other family members, even when they themselves are in great distress (Mitchel et al. 2007).

### ***Climate Change and Violence against Women***

Aside from increased vulnerability to health risks for women, climate change can also increase the ‘social’ vulnerability of women with an increase in violence against them. WEDO (2008) states that female migration, mostly from female-headed households, contributes a major share to the informal urban labor market, and that the majority of these women come from areas affected by weather-related disasters. It also notes that migration does not always improve their lives as some are left with little choice but to compromise dignity by begging. More critically however, such young women are often lured into prostitution by professional gangs, with the promise of jobs elsewhere (CCC 2009a). In fact, according to Swarup et al. (2011) there is anecdotal evidence of an increase in child trafficking as a result of climate-induced disasters. These children include both economic migrants and girls who have been orphaned by a climate disaster as they have no legal support, psycho-social support, vocational training, or livelihood opportunities. Swarup et al. (2011) found that following Cyclone Sidr in 2007, a significant proportion of girls of a schooling age migrated to the towns to work as domestic workers and in the garment industry. Most of them never returned to school. Some were forced into prostitution, particularly those from the poorest families.

There also appears to be some evidence that the social instability associated with the degradation of resources during and after natural disasters is fueling an increase in violence against women in Bangladesh (Darlymple et al. 2009). Lack of employment, income and resources during and after hazards can increase psychological stress and tensions in households and lead to domestic abuse. Male relatives of many women have been reported to express their frustration verbally or physically. Reasons for this abuse which are reported include women not being able to serve food on time, to not being able to procure relief materials (WEDO 2008). In a survey recently conducted in six drought-prone villages of Andhra Pradesh, India, almost 30% of both men and women respondents reported an increase in fights and arguments in the family which were connected to climate stress over the last 30 years (Lambrou and Nelson 2010).

Apart from domestic violence, natural disasters also put women more at risk regarding harassment and violence outside the household. According to Ahmad (2012) women and girls experience increased levels of violence during and after hazards, and women from extremely poor households face increased levels of physical violence outside the home (10%). Women from middle-income groups are usually more sheltered from abuse outside as they have to abide by social norms and family honor, although greater violence is reported within the home for this group (30%).

In the cyclone-prone areas of Bangladesh, it is common that young girls and even adult women are harassed on their way to cyclone shelters. In the drainage congested and flood-prone areas, when women have to stay on the roads or cyclone shelters for prolonged periods, they feel uncomfortable sharing the space with strange men (World Bank 2010). Women also face harassment when collecting relief supplies as sometimes they have to walk long distances through water (WEDO 2008) and stand in long queues with male strangers for collection. Moreover, such an act on the part of a woman is not considered to be ‘respectable’ in social norms and those queuing for relief generally face hardships in post-flood normal life (CCC 2009a). In Nepal, it is also reported that during natural disasters, women and girls are frequently subjected to intimidation, harassment and gender-based violence (Nellemann et al. 2011), notably when traveling long distances in search of resources like fuelwood and water (UN Women Watch 2009).

## SOCIAL STRUCTURES AND ADAPTATION

### Adaptation

It has been established that gender inequality combined with the additional structures of class and caste increases the vulnerability of some women to climate change, particularly those from poorer socioeconomic groups. However, it is also useful to approach the issue of vulnerability through the lens of resilience and adaptation. Vulnerability stems not only from the impact that climate change has upon the labor burden, income or one’s health and welfare but also from the reduced capacity of some social groups to *adapt* to ecological change. It is in this context that access to livelihood resources or ‘assets’ becomes particularly important, as these are key criteria which can facilitate adaptation. At the same time, unequal distribution of these resources is one of the key reasons for vulnerability to often parallel existing social structures. Rural women, from all income groups in India, Bangladesh and Nepal have less control than men over all types of livelihood resources (human, social, natural, physical and financial capital). As women have less control, they are not able to transform capital into diversified livelihoods and incomes, especially to climate-resilient incomes.

In Bangladesh, women's livelihood strategies are strongly influenced by various factors, such as inadequate access to land, knowledge and information, not to mention commercial isolation from markets (Siddika 2008). Similarly, concerning Nepal, it has been argued that, with more limited access to land, education, information and social networks, women have reduced opportunities to adapt to natural disasters and agricultural decline under climate stress (Dhungel and Ojha 2012; Jungehulsing 2012). At the same time, women from indigenous and *Dalit* communities in Nepal are predicted to be more vulnerable still, given that they face dual discrimination (ICIMOD 2008).

Different livelihood resources which shape adaptive capacity will be reviewed in this section, and the degree to which access is gendered will also be explored.

### ***Access to the Means of Production***

The construction and rigid enforcement of gendered social practices over ownership of resources and rights regarding decisions over their management operate to significantly disadvantage women. One of the most significant examples of this is women's inability to own property in their marital home or access their parents' inheritance (World Bank and AusAID 2007). Land is a critical asset for women in developing countries as they rely on subsistence agriculture for livelihoods, particularly for female-headed households due to the migration of male members of the household, death, or divorce of their husbands (RDI 2009).

Some of the most notable challenges are evident in Nepal. Despite recent political changes, women's access to land has been impeded by antiquated laws which do not accept women as individuals, but rather define them in the context of her relationships with their grandfather, father, husband, or son. Nepal's citizenship laws are still essentially based upon patrilineal decent, meaning that a woman without a father or husband still finds it difficult to acquire citizenship documents which allow her to purchase land or inherit property (Mahato 2012). Even for those with citizenship documents, inheriting property is by no means straightforward. The Interim Constitution which was in place at the time of writing is influenced by the amended Country Code or *Muluki Ain* (Eleventh amendment 2002) which combines Hindu laws and beliefs, British and Indian codes, and traditional rules amongst the Newars in the Kathmandu Valley (RDI 2009). The amended civil code discriminates against women through numerous provisions and laws. For example, it states that a widow has the right to inherit her husband's property but has to return the property if she remarries. Daughters may inherit equally with sons; however, if she is married after inheriting, she must return her share to her parents. Recently, some improvement has been made to this Country Code, through allowing unmarried daughters to inherit ancestral property regardless of age, although they still need permission from a male family member to buy properties or sell them. Even when women possess land or property, it is inherited by their male heirs, i.e., sons after their death (Rich-Zendel 2006; RDI 2009; SIGI 2012). A consequence is that women often struggle to receive their fair share of property. In Nepal, women contribute 60% of agricultural production but they own only 10% of land including 4% of arable land (CEDAW 2010; Action Aid 2010; SIGI 2012).

In India, land inheritance and ownership laws vary by state, and different laws are present for different groups of people on the basis of their religion (RDI 2009). Under Hindu personal law, 'ancestral land' is inherited and co-owned by male family members following their birth. 'Separate property' is divided into equal shares amongst male and female children, and the widow or mother of the deceased. The 2005 Succession Amendment Act considers daughters also as

co-owners of ancestral land, entitled to part of the property. Nevertheless, widows still do not have this right. Other inequities are present under the Muslim personal law, whereby widows and daughters can inherit property, but only half of what is received by their male counterpart. Under Christian law, the widow receives one-third and the sons and daughters receive equal shares, unless there are no children. Individuals can choose to avail of the secular family law, but this is rare (RDI 2009). Although there are discriminatory provisions in religion-based laws, women are also excluded from owning property due to custom, and it is common for women themselves to choose to not take up their rights to property (Agarwal 1998). As a result, privately owned land is invariably held in the name of the male family members. A recent survey suggested that only 10% of private land owned across the country was in the name of women. Similarly, land reforms since independence have often resulted in communal land over which women once had rights being registered in the name of men (RDI 2009).

Similar inequities in women's access to land are present in Bangladesh. Despite equal access to property being enshrined in the legal system that grants women the same legal rights as men to purchase and own land or hold joint titles with husbands, out of 17.8 million agricultural holdings<sup>2</sup> only 3.5% (0.62 million) were female-owned in 1996 (World Bank and AusAID 2007). According to Islamic law, daughter, mother and wife are under all circumstances entitled to some share in the inheritance, yet they are not treated at par with their male counterparts, i.e., son, father and husband. Women can inherit the property of their husband or father, but their inheritance is half that of brothers and children. Usually women give their inheritance to their brothers, so as to remain on good terms with them and be able to visit the parental home. In cases of divorce or abandonment, women do not have joint property rights and have to seek shelter with brothers (Sarwar et al. 2007; Holmes et al. 2010; Ahmad 2012). Women from Hindu communities do not inherit their parents' property, but they receive dowry/gifts at the time of their marriage in the form of money, assets and jewelry, which are not in their names. A widow under Hindu law inherits the same share as a son. However, social and customary practices effectively exclude women from accessing land and other assets (Sarwar et al. 2007; Holmes et al. 2010). Ahmad (2012) found that due to inheritance and personal laws, lack of information about legal rights, and/or inability to access the judicial system many women and girls lost access to property after their husbands or fathers died in the cyclone Sidr.

While it is clear that there are inequalities in men's and women's access to land, how does this affect their vulnerability to climate change? First, lack of access to land reduces women's access to income which can facilitate adaptation through livelihood diversification. Ownership of land has the potential to increase women's bargaining power and control over the sale of the produce of the land. Therefore, despite the high proportion of agricultural work women are expected to perform and the importance of this work for household livelihoods, women often have little personal control over their income (Agarwal 1998). The land which women do have some control over (if not ownership rights) is usually restricted to their homesteads. With regard to Bangladesh, however, Naved (2000) notes how the relatively small size of women-operated holdings limits the feasibility of some technologies and the choice of agricultural crops. This makes it more difficult for women to adapt their agricultural practices to a changing climate. At the same time, the gender division of the workplace between men and women validated by the system of purdah sometimes does not allow women in Bangladesh to grow their own crops in the cultivable land owned by the family.

<sup>2</sup> There is a limit on private landownership introduced in 1961 when the limit was 375 Bigha (approximately 50 ha) by each family. This was reduced to 100 Bigha (approximately 13.4 ha) in 1972 and to 60 Bigha (approximately 8 ha) in 1984 (Sarwar et al. 2007).

Second, lack of landownership can also result in exclusion from agricultural services. An ADB (2010) report makes the interesting and relevant observation that women in Bangladesh are often not considered “farmers,” in part because they do not own land, and consequently with agricultural extension and information on new technologies being usually directed to men. Thus women miss out on agricultural extension and information about new technologies such as crop diversification, livestock varieties, hybrids and animal breeds with new varieties with higher drought-, heat-, flood- and salinity-tolerance, which are recommended as adaptation options to climate change.

Third, lack of landownership often renders women more dependent upon resource harvesting from common property resources such as forests and grazing lands (Agarwal 1998; Meinzen-Dick and Zwartewinkel 2001; Saxena 2011). As noted above, degradation of common property resources, aggravated by climate change, puts women in a more vulnerable position than their male counterparts who have alternative income sources. Dependence on ecosystems can lead to further insecurities in the context of ecological degradation, not to mention exclusion from the management of these resources. For example, Beck and Ghosh (2000) give the example of a cooperative which was formed to manage a fishery tank in West Bengal. Although it improved livelihoods and conserved the aquatic ecosystem, membership was mostly limited to men. Women who had previously enjoyed open access to collect fish, fodder and water lilies were now excluded as they were not members and had limited influence over the rule-making process (Beck and Ghosh 2000). Community forest management in Nepal has been considered a success story in alleviating poverty and enhancing conservation and sustainable development (Uprety et al. 2012). However, studies have also shown gender and caste/ethnic disparities regarding forest management. For example, the participation level of women in the decision-making body studied in 58 community forest users in Nawalparasi, Lalitpur and Baglung was found to be 43%, when compared to 58% for men (Uprety et al. 2012).

Of course, it is important to note again that gender and class intersect, particularly when it comes to women’s access to land. Richer households are more likely to have plots of land which women can control. In a study from Bangladesh, Ahmad (2012) notes that among income groups, women from the nonpoor group had the highest level of adaptive capacity, as determined by their asset base, transformative capacity and income, and hence were the least vulnerable. With regard to access to, and control over, common property ecosystems as well, there are class and caste differences. In the study of community forest user groups in Nepal by Uprety et al. (2012) it was found that Dalit men and women had more limited participation level in decision-making bodies.

### ***Access to Finance***

Adapting to climate change through investment in new technologies or changing agricultural practices invariably requires capital. Women, however, have much more limited access to financial resources. As noted above, women have far more limited access to income within the household due to lack of landownership, and limited involvement in the marketing of produce. However, women in India, Bangladesh and Nepal also face constraints in accessing credit from banks – something which is essential for large-scale investments.

Again, this is related to landownership. Without land titles in their names, women lack collateral to receive loans from the banks (Ahmad 2012). Nevertheless, there has been a growth of microfinance schemes across the region, providing collateral-free loans, phenomena which have fundamentally changed women’s access to financial services in rural areas (World Bank and AusAID 2007). Holmes et al. (2010), however, find that the impacts of credit on

women's empowerment in Bangladesh have been mixed, while recognizing a significant shift in the visibility of women in rural villages. According to Murshid and Yasmeen (2004) women sometimes manage to use credit to make small purchases and hold assets in their own names. They also make the point that access to loans also has risks for women particularly when the loans taken are used and controlled by the men, and women have no say in deciding where and how to invest/spend the money, although it is they who are liable for their repayment. World Bank and AusAID (2007) also note that microcredit financed activities that women are likely to take up (food processing, bamboo craft, livestock) have lower returns than activities that men take up (tailoring, rickshaw-pulling and market activities). Similar constraints with microfinance schemes for women in the context of Nepal are noted by Rankin (2001). A worrying trend is the tendency for women to find themselves in patterns of indebtedness to microfinance banks, taking multiple new loans to pay their debts.

In Nepal, poor and vulnerable groups can access microcredit, microinsurance or microsavings through membership in user groups or cooperatives formed by nongovernment organizations (NGOs) to sustain their livelihoods and cope with negative impact of climate change (ILO 2007; Hammill et al. 2008). An IFAD study in Asia has found that women's access to microfinance has provided them with economic empowerment, increased self-confidence and self-esteem and bargaining power at the household and community level. In Nepal, it has been found to have allowed a 68% increase in decision-making power of women in the areas of maternal and children's health and education, business investments, buying and selling of property and decreased domestic violence (Kulkarni 2011). There are however, challenges also. Microfinance may provide space for men to use women as new sources of 'revenues' as lenders prefer women as their clients due to higher repayment rates and reliability (Goetz and Gupta 1996; ILO 2007). Furthermore, women borrowers invest mostly on household nutrition, health, children's education and sanitation when compared to male borrowers (Goetz and Gupta 1996; ILO 2007; Hammill et al. 2008).

However, some scholars argue that although women are borrowers of money they have less control over it due to two reasons; men's monopoly over the market and gender relations (Goetz and Gupta 1996; Kulkarni 2011). Once again the gendered division of labor limits women to household activities, giving space for men's economic control. Gender relations means women transfer credits to survive marriage (Hammill et al. 2008). From these arguments it can be concluded that women have less access to credit and capacity to invest on household utility than men, while market inaccessibility may devoid them of livelihood opportunities and family welfare in times of crises.

Climate funds targeted for vulnerable groups therefore need to be carefully administered to bring expected impacts in facilitating adaptation. However, it is important that such initiatives identify women's and men's specific roles and responsibilities in the community, their access and control over resources, their inclusion in decision-making processes, as well as their particular capacities and needs in relation to climate change adaptation (Prasai 2010).

In India, various microcredit schemes have also been implemented by both government agencies and NGOs, especially in South India. Almost three-quarters of the total microfinance clients in India are concentrated in just four southern states: Andhra Pradesh, Karnataka, Kerala and Tamil Nadu (Latifee 2006). However, large parts of northern and northeastern states have limited coverage. Existing evidence of the impact of microfinance programs on women's empowerment is limited. Research from Bangladesh and India reaches different conclusions even when evaluating the impact of the same programs (Kabeer 1998). Beyond economic empowerment or increased well-being, some of these programs like SEWA and Working Women's Forum in

India are said to have been effective in linking rural women to macro-level gender advocacy. This has made women's informal contribution to economic sectors more visible in national and international policy debates (Mayoux 2000).

### ***Access to Education, Information and Social Networks***

India and Nepal are still characterized by a wide gender gap in literacy rate despite a sharp increase in women's literacy over the past 20 years (Tables 4 and 5).

TABLE 4. Literacy rate among men and women in India from 2001 to 2011.

Literacy rate (%)	Total	Men	Women
2001	64.83	75.3	53.6
2011	74.4	82.1	65.5

*Source:* GoI (2011).

TABLE 5. Literacy rate among men and women in Nepal from 2001 to 2011.

Literacy rate (%)	Total	Men	Women
2001	54.1	65.5	42.8
2011	60.9	72.2	51.4

*Sources:* CBS (2001, 2011).

In both Nepal and India, these averages conceal disparities among different castes, ethnicities and religions (Table 2). In Nepal, Tarai Dalits have the highest rate with 76.4% not going to school at all, compared with 62.4% for Muslims, 56.8% for Tarai middle castes and 45% for Janjatis. Gender disparities are again high in the Tarai middle caste group, where only 6% of the 6-10 year old boys compared to 42% of the girls are not in school (Bennett 2005). In India, the 2001 census suggests a Muslim woman has fewer chances to be literate than a Christian or a Hindu woman. However, the influence of caste and religion in India was found to be intricately linked to individual and community circumstances, such as one's parents' education (Borooh and Iyer 2005).

Educational levels of girls in South Asia are largely driven by social norms. In Bangladesh, education is tightly related to marriage norms and practices. Daughters only 'belong' to their natal family, both culturally and economically, until they are married (World Bank and AusAID 2007). Therefore, parents have few economic incentives to invest in girls' education. Furthermore, girls usually have to stop their education when they get married. Overall, Bangladesh has the highest rate of early marriage in Asia and ranks among the highest worldwide. It has been estimated that in 2004, 48% of all girls between 15 and 19 years of age were married, divorced or widowed (Holmes et al. 2010). In India, Gandhi Kingdon (2002) similarly argues that the gender gap in literacy can be explained by parents' differential treatment of sons and daughters in education and women's role in the society. Parents sometimes believe that a daughter's enrolment in school is not necessary if they are destined to be a housewife (Gandhi Kingdon 2002). In Nepal, a primary reason for the gender gap in education is that girls have to work in lieu of their mothers in household labor and therefore have fewer opportunities for formal education than boys (Oxfam International 2009). Another item of statistics from the Nepal Living Standards Survey in Nepal

shows that 31% of rural girls (age 6-24 years) do not attend school at all with the reason being listed as ‘help at home’ compared to 13% of rural boys with the same reason.

Climate change also affects women’s education by a complex interplay with existing social norms. When climatic hazards deteriorate the livelihood status of a household in Bangladesh, marrying off young girls can be a means of shedding some of the financial burden (World Bank 2010). Such girls are required to abandon their schooling so they can focus on their duties as wives. Early marriage was found to be relatively high in drought-prone areas, where there is chronic poverty due to crop loss and generally low levels of education (World Bank 2010). Early and forced marriages have also risen as a result of climate-induced disasters in Bangladesh (Swarup et al. 2011). For example, this was observed in the aftermath of Cyclone Sidr in 2007 where one interviewee claimed that as many as 50% of the girls in her school left due to marriage. In Nepal, changing climate was also found to affect girls’ education by increasing their labor burden to gather wood and collect water when resources become scarce. This has triggered school dropouts in many areas (Oxfam International 2009; Baten and Khan 2010; Nellemann et al. 2011).

The links between education and women’s ability to use livelihood diversification as a coping and adaptation strategy in the face of climate change are not difficult to see. Lower levels of education reduce the capacity of women to access information (e.g., about their legal rights to hold land titles) and limit their means to interpret that information. Uneducated women and girls have also more limited access to resources such as credit or knowledge of new technologies, and have a reduced ability to make their voice heard in decision making over resources management at home and in the community. This can affect their capacity to understand and to act on information concerning climate risks and adaptation options (Prasai 2010).

In India, men’s and women’s education and literacy levels were found to affect their access to information on the weather (Lambrou and Nelson 2010). In Bangladesh, Mitchel et al. (2007) found that adopting hybrid seeds requires knowledge and skills that are often lacking in poor, remote and marginalized communities. Since women are less likely to have an education and have limited access to information, their engagement in activities like this, which might contribute to improving their safety, capacity and well-being, is curtailed. Rabbani et al. (2009) believe that technology adoption by women is undermined also because culturally, women in Bangladesh, especially in rural areas, are reluctant to take any decisions on their own.

Lastly, the impact of education on intra-household decision making in Bangladesh was the focus of World Bank and AusAID (2007) which looked at actual education levels of interviewees and their attitude to educational equality between spouses. It found that education beyond primary level increases the likelihood of women being consulted on major consumption decisions, but it is more important for older women whose age may give them an advantage. It is necessary to challenge the conventional view that since men interact with the outside world, they possess more intelligence and thus have more legitimacy to take decisions.

As women often do not have legal rights or do not take part in formal decision-making processes, social networks and informal rights are also of particular importance to them in order to secure access to resources and assets (Jackson 1998). In a case study in a village of Orissa, India, it was found that social networks and privileged kinship ties were key factors that helped upper-caste women to better cope with disasters, notably by providing them adequate shelter (Ray-Bennett 2009).

### ***Access to Markets***

Women's access to markets has an important role in shaping their independence in terms of access to cash, which influences their capacity to make decisions on health, education or nutrition. Women's roles in agriculture are significant, e.g., producing homestead crops and looking after livestock. In Bangladesh, women's post-harvest activities are estimated to contribute over 50% of value to crop production (Thomas 2004). Yet, fewer than 10% of rural women have access to markets, largely because of social and cultural norms which do not allow women to interact with men in public. Women are largely dependent on male family members to buy and sell produce, restricting their independent economic activities outside the household (Holmes et al. 2010). Similarly, a study carried out in 12 villages across six districts of Nepal and India indicated that marketing falls into the male's domain (Nellemann et al. 2011). The prevailing gender division of labor implies that women have less direct access to monetary benefits which put them in a vulnerable situation accentuated by their 'landless' status and formal and customary laws that make them devoid of assets to cope with the changing climate (Jones 2010).

### **The Role of the State**

#### ***Accessing State Resources***

The state plays a crucial role in facilitating adaptation to climate change for communities in the Ganges River Basin through mediating in disputes in access to livelihood resources at the local level. However, as with accessing the means of production, finance, education and social networks, access to state services or having a say in government decision making is not necessarily equal for men and women.

Bangladesh is committed to international and national laws, institutions and policies to promote gender equality. The country has ratified the UN Convention on the Elimination of All Forms of Discrimination Against Women (CEDAW) and agreed to the Optional Protocol in 2000. At the national level, Bangladesh has also enacted a number of laws to protect equality of rights and opportunities. For example, the Constitution of Bangladesh grants equal rights to women and men in all spheres of public life and this has been supplemented by a number of acts and ordinances to protect women's rights. These include the Dowry Prohibition Act of 1980, the Child Marriage Restraint Act (amended in 1984) and the Family Courts Ordinance of 1985 (Holmes et al. 2010). Although women's right to freedom from discrimination is a constitutionally entrenched fundamental right, it is overshadowed by the operation of traditional ideologies and social norms that continue to undermine women's rights to equality (Holmes et al. 2010).

In Bangladesh, the National Agriculture Policy (MoA 2008) includes commitments to women's access to agricultural extension and their technological empowerment through efforts to ensure women's equal access to agricultural inputs (e.g., seed, fertilizer, credit, education and training, information, etc.). The need to ensure women's access to productive resources, inputs, and services is also highlighted in the National Food Policy (MoFDM 2006). The policy agenda outlined in the National Strategy for Accelerated Poverty Reduction (NSAPR-II) also makes numerous references to ensuring that extension services reach women in relation to crop production, including high-value cash crops, and to livestock, fisheries, and forestry, as noted by the ADB (2010).

However, Ahmad (2012) notes that access to local public institutions that can help increase adaptive capacity in Bangladesh is still gender-biased and, as a result, women are often not able

to access information and support. In both rural and urban areas, men are the primary contact with all public institutions supporting disaster-risk management (DRM) and climate change, while women are the primary contacts with NGOs (Ahmad 2012). Similarly, the study by Rabbani et al. (2009) indicates that women's participation in training related to climate change issues is insignificant. According to a recent study, fewer than 10% of women in Bangladesh have contact with state institutions, especially those that can help in recovery and adaptation. These include, for example, extension and local government services in rural areas and professional associations (Ahmad 2012).

Women's access to public institutions has remained relatively low for several reasons. First, despite more progressive laws and policies, extension services are, in practice, still excluding women because of persistent beliefs among male-dominated staff. In Bangladesh, most employees of governmental service-providing agencies are male, as are field-level workers of the Department of Agricultural Extension. In India, it was reported that extension personnel introducing new varieties intended for higher drought or heat tolerance rarely speak directly with women farmers (Kurukulasuriya and Rosenthal 2003).

Social norms also considerably hinder women's access to public institutions, support and information. Even when extension officers in Bangladesh are willing to interact with women, the dominance of men in public life constraints women's access to state services and cuts off their ability to communicate their specific needs and ideas on how these should be met. Ahmad (2012) notes that women in Bangladesh have to face restrictions on mobility, which limit their access to extension staff and training opportunities. Furthermore, women in rural Bangladesh are usually less assertive in front of outsiders and are, therefore, not comfortable in sharing their knowledge, findings and learning with male officials (Anwar and Rozario 2012). Moreover, as already noted, the few women who are elected to local government bodies (Upazilas and Union Parishads) are unable to take the leadership to disseminate local knowledge within their respective Upazilas or Unions (Anwar and Rozario 2012).

In Nepal, multiple programs have targeted women farmers. However, according to a study in the eastern Nepal Tarai, women's capacity to form and participate in farmer groups appears to be considerably lower than men's (Sugden 2009). This parallels national-level concerns in the Agricultural Perspective Plan-Implementation Action Plan which reports that fewer than 40% of participants in farmer groups are women, out of whom only one in four occupies roles in their executive committees (The IDL Group 2006). As in Bangladesh, gender ideologies restrict women from participating in public life and interacting with men. The latter discourage them from joining male-dominated farmer groups and the associated training programs (Sugden 2009). Most women felt that it was immediately assumed by farmer group organizers that they were 'less educated' and thus not suitable candidates to participate in programs, whether or not this was the case. Furthermore, the higher work burdens of women, particularly those from poorer classes, meant that they would not have time to participate in lengthy group meetings (Sugden 2009).

Khondker (1996) notes that in Bangladesh during natural disasters, the traditional gendered social norms (which forbid women from interacting with men who are not family members) and gender-insensitive arrangements are two reasons why the majority of women do not go to the relief centers. Their decisions also reflect rational calculations to protect their domestic assets. The government's insensitivity towards the social norms within which women must act was seen again in the fact that women were not represented in the personnel involved in distributing relief goods.

### ***Having a Voice in Decision Making***

ADB (2010) cites limited awareness and understanding of women's rights and needs within local government organizations as an important impediment to women's participation, and thus to their ability to ensure essential services are provided. In Bangladesh, the primary units of local government, namely Upazilas Parishads (UZPs) and Union Parishads (UPs), have a broad set of responsibilities in relation to village development (see next section for details). Despite having an important role in identifying the poor for relief and social safety-net programs, their elected members and chairpersons (mainly men) were found to have little awareness and understanding of women's rights and needs (ADB 2010).

Despite the provision of reserved seats in UZPs and UPs, women face various structural and cultural barriers that limit their capacity to act as effective representatives (Nazneen and Tasneem 2010). This includes the disapproval and resistance by men, of women taking up such public roles, and more general constraints faced by women in a patriarchal social structure.

Hossain and Akhter (2011) note that women remain visibly marginalized and lack functional authority at the UZP level. Women's representatives' offices are often not centrally located, while they face constraints accessing day-to-day office resources by all-male UZP chairs. World Bank and AusAID (2007) also note that women members face serious problems in participating in UP functions due to resistance by the chairman and other members. These differences meant that decisions over contentious issues were left to the (often male) chairman to take. Nazneen and Tasneem (2010) also suggest that the gendered division of labor in Bangladesh limits women's time and ability to participate in formal political and planning activities.

Women are also either wholly absent or present as a form of tokenism in local resource management institutions. Prime examples include the Water Management Organizations (WMOs) in the coastal polders of Bangladesh, introduced by the government to decentralize and democratize the management of water resources and associated infrastructure. Increased participation by women is a key theme of the National Water Policy (1999), which includes commitments to ensuring an enabling environment for women to play a key role in community organizations for the management of water resources. This is also reiterated in the Guidelines for Participatory Water Management, issued in 2000 by the Bangladesh Ministry of Water Resources which is applicable to all flood-control, drainage, and irrigation projects. The National Agriculture Policy also commits the government to facilitating increased participation by women in decision making. Research (unpublished) by the International Water Management Institute into the performance and workings of WMOs, Water Management Associations and sluice gate committees has highlighted the almost total dominance of men despite express legal provisions for the inclusion of women in these institutions. The confinement of women's roles mainly to the homestead is again a major factor both directly and indirectly. Men's attitudes are important, and it may be necessary to persuade them to support the involvement of their wives and other women. The findings of one survey were that women participated at lower rates in communities in which a significant proportion of men objected to the participation of their wives (ADB 2010).

With regard to irrigation management associations in Nepal, the study by Zwarteveld and Neupane (1996) provides evidence of women unconsciously choosing not to participate in the association due to culturally embedded ideas of proper gender roles. In India, research conducted by Agarwal (2001) on participation in joint forestry management projects indicates that while women may be active in all-women community groups, their participation in other mixed community-based organizations is generally low. In some cases, women were actively excluded by men even though spaces were reserved for women in the local councils (Roy and Venema 2002).

## **Participation in Interventions to Address Climate Change and Gender**

### ***Inclusion of Men and Women in Planning***

In the Ganges River Basin, a number of organizations are involved in implementing climate change adaptation projects. Where adaptation activities do exist however, they are often uncoordinated, and fail to create conditions that enable and support adaptive strategies based on an understanding of differential vulnerability according to gender divisions (Ahmed and Fajber 2009).

In Nepal for example, investments have mostly been made in agriculture, promoting technologies to build resilience of farmers, as well as in water management, biodiversity management, and capacity building of government officials. Research organizations *like World Wide Fund for Nature (WWF), Department for International Development (DFID) and Food and Agriculture Organization of the United Nations (FAO)* are implementing adaptation projects for communities (MoE 2010). Climate change adaptation funds mostly transfer support in the form of a loan or grant bilaterally, multilaterally or directly through NGOs and international nongovernment organizations (INGOs). These funds are then mobilized by the communities in the sectors of food security, health, education, and disaster risk reduction as per the National Adaptation Plan (NAP) (MoE 2010). Nepal has a strategy for adaptation programs to target the most vulnerable groups like marginalized Dalits women, and disabled persons (GoN 2009). Adaptation funds are accessed through group membership. However, a study has concluded that Dalit men and women have no time to be involved in group activities or their participation is dominated by men and women from higher castes (Bennett 2005). To make national climate change adaptation policies effective, strong steps must be taken to ensure men and women of poor Dalit and ethnic communities can participate to access adaptation funds.

Ayers (2011) suggests that in Bangladesh the framing of adaptation as ‘impacts-based’ in the 2008 National Adaptation Programme of Action (NAPA) creates challenges in enabling vulnerable people to define their own adaptation priorities. Although the guidelines for NAPA development state the importance of “bottom-up, participatory approaches” in developing NAPAs, the focus on impacts has resulted in a technocratic approach to identifying risks by first dividing analysis into sectorally based working groups, then defining risks as climate change impacts geographically and by sector. It is only after this that communities are consulted to verify this information. This, in turn, has led to incorrect inferences and assumptions leading to ineffective policy responses. Of critical importance also is the failure to change the vision of communities as homogenous groups, thereby failing to incorporate spaces for the different communities and their specific vulnerability contexts, including intersecting divisions such as gender and age. NAPA, for example, makes only a few references to children as being amongst the most vulnerable population groups, and the needs of certain vulnerable groups such as adolescent girls are not acknowledged (Swarup et al. 2011).

In India, the National Action Plan on Climate Change (NAPCC) recognizes that climate change has different effects on men and women, the latter of whom it suggests are the most vulnerable. Unfortunately, Ahmed and Fajber (2009) note that this understanding has not been translated into NAPCC’s assessment of the mechanisms to support adaptation. This is due to the limited availability of gender disaggregated data on climate risks and the relatively poor documentation of adaptation programs or the lessons they can provide in terms of building resilient communities.

### ***Voicing Different Priorities for Men and Women***

A key challenge for men and women in adapting to climate change is the ability to voice their different needs and perceptions in the planning and implementation of initiatives that address climate change. In India – and across South Asia – gender identity intersects with other social stratifiers such as caste and class (Ahmed and Fajber 2009). Climatic risks often overlay with power-laden tensions between different identity groups, making it difficult for vulnerable women to voice their concerns, or to participate in planning activities.

Poverty and lack of voice, according to World Bank and AusAID (2007) are the most significant barriers to participation. The structure of the decision-making systems – the traditional emphasis on elders and men – excludes several categories of individuals from these systems. Age is also one of the most important determinants of hierarchy and participation, with younger citizens (men and women) often excluded from these decision-making processes. Although WEDO (2008) claims that compared to the 1980s, barriers to women's involvement in decision making have been largely removed, it acknowledges that women still face challenges in influencing processes that matter most to them.

The limited participation of women is important given that men and women often have different needs in the context of climate change. The division of labor between men and women implies differences in priorities and perceptions of the reality (Nellemann et al. 2011). For example, in a study in the hills in Sankhuswabha District of Nepal by ICIMOD, men considered water shortages for irrigation a serious problem while many women viewed sanitation and household water access and supply as the most serious issues, a perception linked with their responsibility for collecting and carrying water (cf. Nellemann et al. 2011). Similar observations were made in areas affected by floods such as Assam and Bihar in India where men related disasters to migration while women were concerned by immediate household livelihoods and sustenance (cf. Nellemann et al. 2011). The distinct roles and responsibilities of men and women in providing food to their families might influence the way climate change has affected their livelihoods and their perspectives on potential solutions (Lambrou and Nelson 2010). While it is evident that men and women have different priorities or perceptions of the impact of climate change, these have been poorly integrated in climate change interventions.

### ***Poor Accounting for Men's and Women's Agroecological Knowledge***

While the value and potential of local (and especially women's) traditional knowledge are recognized by social scientists, this does not seem to be the case with formal and informal planning and decision-making structures at local and national scales. Thus WEN (2010) notes that women's vast knowledge about water resources is often ignored as they rarely participate in decision-making structures, and Rahman et al. (2007) lament that this knowledge is rarely taken into consideration in the design and implementation of adaptation strategies.

This risk is especially high given that women in rural Bangladesh are marginal groups and do participate in decision making and influence policymaking in the same way as their male counterparts. As a result, gender-mediated wisdom on climate change adaptation has not been considered in the design, dissemination and replication of methodologies (Anwar and Rozario 2012). In farming communities, knowledge about farming is shared and exchanged in public places such as markets, mosques, temples, and shops, etc., spaces which are generally dominated by men. Women often feel their voices are ignored in these contexts, being viewed as 'farmwives' rather than real farmers (Anwar and Rozario 2012). The same authors also point out that society

as a whole always ignores the value of indigenous knowledge by continuing to perceive the knowledge and practices of women as unscientific or as a hindrance to development.

Anwar and Rozario (2012), again with regard to Bangladesh, also found that there were few initiatives for women to establish linkages with local government institutions so that they could play an active role in sharing their knowledge and coping strategies concerning climate change. The situation was different in the indigenous communities involved in the study such as the Marma community. Here, the village headman and elders take women's views and opinions into account by allocating land to them for farming. This grants them access to, and control over, productive resources leading to more efficient use of resources and increased productivity.

### ***Disaster Preparedness Programs***

Another area where women's participation is limited is disaster-response preparedness. In a study from India by Ahmed and Fajber (2009), women reported that during or after a disaster, they are not consulted in community-level decision making. In fact, Ahmad (2011) suggests that even the local governments of many rural and vulnerable communities had limited awareness of, or 'voice' in, the climate preparedness programs at higher levels of government. Therefore, there seems to be a major gap between national programs trying to develop communities' resilience and the local needs of women and men.

While it may be inappropriate to make generalizations, research by Wong (2009) suggests that disaster-preparedness projects can be prone to not appreciating the particular dynamics of empowering women since this itself challenges entrenched gendered social structures. The research found that in the coastal zone of Bangladesh, women were included in local committees largely for practical reasons because most of the men are out at sea. While project organizers needed the women to make day-to-day decisions during this time, when men returned they were allowed to challenge the decisions and make amendments. Furthermore, the officials from the participatory government agency, the Local Government Engineering Department (LGED), felt that technical posts should be taken up only by men as women were perceived as either less technically competent or lacking interest in certain issues.

A close examination of the division of labor within the committees also showed that the female committee members did not challenge gender inequality and stereotyping (Wong 2009). Males would often be in control of external communications, while women did more general administrative tasks. Women who were interviewed explained that they were 'less educated, (and have) fewer vocabularies than men,' so it was better for men to represent the community and to liaise with the government officials. This self-exclusion constrained women from building wider social networks, and showed the extent to which they rationalize their own subordinate social position. The findings by Wong (2009) also suggested that women who did participate were not the poorest in their village. The women on the committees had already been active in local affairs. In contrast, the very poor women, such as those who were widowed or the disabled, and women without sons, had very limited participation.

Rabbani et al. (2009) also find that participation of females in disaster-risk management (DRM) plan/processes in Bangladesh is imbalanced. Over 90% of people interviewed in several study sites were not involved in any DRM activities or plans. In the salinity-prone area only 9% of respondents were involved in DRM-related activities compared with 7% in the flood-prone area and 2% in the drought-prone area. It appears that most of the women involved in the DRM activity/plan/committee only join seminars or meetings, and only 12% of them are involved in the decision-making process.

## **CONCLUSIONS AND WAYS FORWARD**

### **Gender, Vulnerability and Climate Change: In Sum**

It is clear that men and women are affected in different ways by climate change in India, Nepal and Bangladesh. On the whole, the literature suggests that women are rendered more vulnerable due to existing social structures. In the context of an entrenched gendered division of labor, women face an increased workload both directly, due to climate-induced agroecological stress, and indirectly due to male out-migration. Furthermore, when gender-specific livelihood activities are undermined due to ecological change, both genders are affected, but the lack of alternative income sources for women often causes greater vulnerability, particularly given their disproportionate dependence upon livelihoods based on common property resources. However, it must be emphasized that the impact of the gendered division of labor on vulnerability is highly dependent upon other axes of inequality such as class and caste. Another form of vulnerability is related to the health and welfare of men and women, a phenomenon particularly acute following frequent natural disasters.

It has also been shown how gendered vulnerability to climate change can be better understood if one accounts for the different adaptation capacities of men and women in the context of climate stress. First, women's more limited access to key livelihood resources, namely land, finance, educational resources and information can limit the potential for them to diversify their income. This is aggravated when women are excluded from, or face discrimination in, accessing state services. Second, an important adaptation strategy is migration. While this can offer new sources of income, it is often heavily gendered, with most migration in India, Nepal and Bangladesh being limited to men. This can also increase the vulnerability of those left behind, particularly women-headed households that can be left with a greater workload and more limited resources. A final reason for women to face difficulties in adapting is their more limited participation in projects and planning to address climate change at both the local and national level.

### **Ways Forward**

The remaining question in this context is how can state and non-state policies and interventions support local institutions and foster the local capacity of men and women to equitably adapt to climate change?

#### ***Secure Land Rights for Women Farmers***

It is important for state and non-state actors to raise awareness in communities of women's rights to inherit and buy property. Access to property in women's names can increase their bargaining power within the household, and even their control over agricultural income, allowing more diverse climate-smart livelihoods. Even if women cannot acquire land rights, there are other ways for women to access the means of production to provide a source of personal income. Kelkar (2009), for example, notes that rural microcredit loan programs in parts of Bangladesh have enabled women to circumvent these practices by leasing land (largely for growing vegetables, not field crops) as well as by taking over the management of fishponds from their husbands.

### ***Effective Use of Microfinance***

Microfinance can offer opportunities for women's empowerment to facilitate livelihood diversification, but programs should be integrated with appropriate training and extension for productive activities. Naved (2000) and Kelkar (2009), for example, look at project interventions by donors and NGOs in Bangladesh to assist women to break into the male-dominated aquaculture sector, by obtaining user rights over fishponds from the government, by providing training and credit. The author highlights the value of group formation which enabled the women to withstand the pressure applied by men. Naved (2000) recognizes that an important dimension of this mechanism is that it challenges the traditional gender division of labor. When the project was proven successful in bringing about financial returns, women's position within households and communities was strengthened. These findings therefore suggest that the ability to collectivize and pool capital and bargaining power may be one strategy for women to gain some degree of emancipation from the everyday forms of male dominance.

### ***Promote Collective Action***

Following on from the last point, it is seen that collective action enables people to move from their own individual capacities to collective, systematized action (Raihan et al. 2010). GENDERNET (2011) also presents the view that when women band together in a cooperative structure, both their economic and social standing in the household improves, increasing the options for livelihood diversification in the context of climate change. A case study from Bangladesh shows how women have formed an organic farming cooperative and pooled their resources. This has allowed them to extend loans to its members to buy seed and other farming inputs without resorting to microcredit which, it claims is often inflexible, has an exorbitantly high interest rate attached to it and requires repayment to begin immediately, putting enormous psychological pressure on the borrowers.

### ***Valuing Indigenous Knowledge***

Over the decades, rural communities have used their indigenous knowledge to reduce their vulnerability to past climate variability and change (Rahman et al. 2007). Including this knowledge into disaster preparedness and climate change adaptation programs can contribute to local empowerment and enhance sustainability. In Bangladesh, Siddika (2008) acknowledges that women are at the heart of such adaptation. Women have knowledge of protecting communities from flooding by managing and maintaining water sources, building wind-resistant housing, planting trees to mitigate erosion, preserving seeds, composting to improve soil quality, and conserving safe drinking water. In many communities, women hold the most reliable knowledge about promoting food security, preserving threatened food supplies, and ensuring their family's survival in the face of shortages. Anwar and Rozario (2012) provide further illustrative examples from Bangladesh, such as the use of sugar to reduce soil salinity, and the raising of cultivable land to save it from inundation during flooding and tidal surges. The authors also emphasize that women's relation with, and perception of, their environment, tend to be comprehensive and multidimensional.

### ***Bottom-up Climate Change Adaptation Planning***

There is a need for global policy frameworks on adaptation which give adequate attention to local perceptions of risk and vulnerability (Ayers 2011). This should give direction to national government priorities and program-planning processes. Ayers (2011) notes that the present ‘impacts-based’ approach emphasizes external scientific and technological expertise to define climate change problems, while formulating technological adaptation solutions. However, such an approach does not account for how the impacts of climate change are, in fact, experienced on the ground. Therefore, adaptation programs need to be planned, implemented and managed locally wherever possible to ensure greater sensitivity to social structures and the different needs and experiences of men and women. Ayers (2011) also notes that the framing of risk should be changed so it acknowledges the interaction between local drivers of vulnerability and climate impacts, as well as the associated factors of culture and social organization that would facilitate or inhibit adaptation options.

It is crucial that women and other marginalized groups are fully involved in decision making, and that their needs are reflected in both policies and interventions. A major reason this has not happened is that the processes involved in policy articulation and program development tend to be top-down and operate on untested assumptions of what people need, rather than asking the people themselves for the information. Effective examples include, for example, the representation of women in Union Parishads in Bangladesh which was viewed as tokenistic by some (e.g., World Bank and AusAID 2007; Haque 2009), while others (e.g., Nazneen and Tasneem 2010; Hossain and Akhter 2011) have recognized the potential this provides for channeling a wide range of development and disaster management support from both the state and non-state actors to meet diverse needs of men and women.

### ***Importance of Poverty Alleviation and Class***

It is clear that gendered vulnerability to climate change intersects with class inequalities, and women from marginalized and poor households are often those who face the greatest challenges to adaptation. Addressing poverty clearly emerges as being a central condition for successful adaptation and mitigation, and several authors have concluded that adaptation can only happen through addressing the development gap (Raihan et al. 2010). It is important therefore that adaptation to climate change in India, Bangladesh and Nepal goes side by side with interventions which seek to address entrenched inequalities. In Nepal, for example, this includes maintaining dialogue with government departments to inform debate on critical issues such as land reform (Sugden and Gurung 2012).

### ***Tackling Gender Inequality at a Broader Level***

Adaptation planning and funding alone however cannot respond to the needs of poor communities and women. It also requires strong enabling policies and institutional mechanisms that embed a commitment to tackle gender equality across society. For adaptation financing to be effective and equitable, legislative and societal commitments to gender equality are essential to allow poor women, their families and their communities the capacity to adapt to the adverse impact of climate change. Nongovernmental and governmental actors need to advocate for legislation which guarantees equal rights for women, such as those relating to inheritance and citizenship rights, while greater efforts are required to mainstream gender equality norms within the structures of the bureaucracy.

## REFERENCES

- Acharya, R.P. 2009. Socio-economic impacts of community based forest enterprises in the mid hills of Nepal – Case study from Dolakha District. *Banko Janakari* 15(2): 43-47.
- Action Aid. 2010. *Her mile: Women's rights and access to land. The last stretch of road to eradicate hunger*. Available at <http://www.landcoalition.org/publications/her-mile-women%E2%80%99s-rights-and-access-land> (accessed on February 22, 2013).
- ADB (Asian Development Bank). 2010. *Gender equality results case studies: Bangladesh*. Mandaluyong City, Philippines: Asian Development Bank.
- Adger, W.N. 2006. Vulnerability. *Global Environmental Change* 16: 268-281.
- Agarwal, B. 1990. Social security and the family: Coping with seasonality and calamity in rural India. In: *Social security in developing countries*, ed., Ahmad, E.; Dre`ze, J.; Hills, J.; Sen, A.K. 171-244. Oxford, UK: Oxford University Press.
- Agarwal, B. 1998. Environmental management, equity and ecofeminism: Debating India's experience. *Journal of Peasant Studies* 25: 55-95.
- Agarwal, B. 2001. Participatory exclusions, community forestry and gender: An analysis for South Asia and a conceptual framework. *World Development* 29(10): 123-148.
- Agrawal, A. 2008. *The role of local institutions in adaptation to climate change*. Washington, DC: Social Development Department, The World Bank.
- Ahmad, A.U. 2006. *Bangladesh climate change impacts and vulnerability*. Dhaka: Comprehensive Disaster Management Programme, Ministry of Disaster Management and Relief.
- Ahmad, N. 2011. *Gender and climate change: Myth vs. reality*. Available at <http://blogs.worldbank.org/endpovertyinsouthasia/gender-and-climate-change-myth-vs-reality> (accessed November-December 2012).
- Ahmad, N. 2012. *Gender and climate change in Bangladesh: The role of institutions in reducing gender gaps in adaptation program*. Social Development Working Papers. Paper No. 126. Washington, DC: The World Bank.
- Ahmed, S.; Fajber, E. 2009. Engendering adaptation to climate variability in Gujarat, India, *Gender and Development* 17(1): 33-50.
- Alston, M. 2006. The gendered impact of drought. In: *Rural gender relations*, ed., Bock, B.; Shortall, S. London: CABI, pp. 165-80.
- Ansorg, T.; Donnelly, T. 2008. *Climate change in Bangladesh: Coping and conflict. Safe World*. Available at [http://www.isis-europe.eu/sites/default/files/programmes-downloads/\\_2008\\_arrel\\_194\\_esr40-climate-security.pdf](http://www.isis-europe.eu/sites/default/files/programmes-downloads/_2008_arrel_194_esr40-climate-security.pdf) (accessed on October 14, 2013).
- Anwar, S.; Rozario, A.R. 2012. Case study, Bangladesh: Increasing responsibility of women for agricultural production. In: *Women farmers adapting to climate change - Four examples from three continents of women's use of local knowledge in climate change adaptation*, ed., Franke, I.; Jenrich, J.; Lottje, C.; Neuenroth, C. Stuttgart, Germany: Diakonisches Werk der EKD e.V, pp. 22-32.
- Ayers, J. 2011. Resolving the adaptation paradox: Exploring the potential for deliberative adaptation policy-making in Bangladesh. *Global Environmental Politics* 11(1): 62-88.
- Bangladesh Parliament's All Party Group on Climate Change and Environment and the UK All Party Parliamentary Climate Change Group. 2009. *Climate change equity: Is it a plan, an aspiration or a fashion statement?* A report of a joint inquiry by Bangladesh Parliament's All Party Group on Climate Change and Environment and the UK All Party Parliamentary Climate Change Group. Dhaka, London and Copenhagen. 52p. Available at <http://www.csrlbd.org/resources/climatechange-resources/APPCCG%20Climate%20Change%20Equity%20Report.pdf> (accessed November-December 2012).
- Barnett, T.P.; Adam, J.C.; Lettenmaier, D.P. 2005. Potential impacts of a warming climate on water availability in snow-dominated regions. *Nature* 438: 303-309.
- Bartlett, S. 2008. *Climate change and urban children: Impacts and implications for adaptation in low and middle income countries*. IIED Human Settlements Discussion Paper – Climate Change and Cities 2. London: International Institute for Environment and Development (IIED).
- Baten, M.A.; Khan, N.A. 2010. *Gender issue in climate change discourse: Theory versus reality*. Dhaka: Unnayan Onneshan - The Innovators.

- Bates, B.C.; Kundzewicz, Z.W.; Wu, S.; Palutikof, J.P. eds. 2008. *Climate change and water*. Technical Paper of the Intergovernmental Panel on Climate Change (IPCC). Geneva: IPCC Secretariat.
- Beck, T.; Ghosh, M.G. 2000. Common property resources and the poor: Findings from West Bengal. *Economic and Political Weekly* 35: 147-153.
- Benholtd-Thomson, V. 1982. Subsistence production and extended reproduction: A contribution to the discussions of modes of production. *Journal of Peasant Studies* 9: 241-254.
- Bennett, L. 2005. *Gender, caste, ethnic exclusion in Nepal: Following the policy process from analysis to action*. Arusha Conference, "New Frontiers of Social Policy" – December 12-15, 2005. Washington, DC: World Bank.
- Bhandari, H.; Pandey, S. 2006. Economics of groundwater irrigation in Nepal: Some farm-level evidences. *Journal of Agricultural and Applied Economics* 38: 185-199.
- Biemans, H.; Haddeland, I.; Kabat, P.; Ludwig, F.; Hutjes, R.W.A.; Heinke, J.; Gerten, D. 2011. *Impact of reservoirs on river discharge and irrigation water supply during the 20<sup>th</sup> century*. Water Resources Research 47. W03509, doi:10.1029/2009WR008929. Available at <http://onlinelibrary.wiley.com/doi/10.1029/2009WR008929/abstract> (accessed on March 12, 2013).
- Boano, C.; Zetter, R.; Morris, T. 2008. *Environmentally displaced people: Understanding the linkages between environmental change, livelihoods and forced migration*. Forced Migration Policy Briefing 1. Refugee Study Center. Oxford: Oxford Department of International Development, University of Oxford.
- Bohle, H.G.; Downing, T.E.; Watts, M.J. 1994. Climate change and social vulnerability: Towards a sociology and geography of food insecurity. *Global Environmental Change* 4: 37-48.
- Borooh, V.K.; Iyer, S. 2005. Vidya, Veda, and Varna: The influence of religion and caste on education in rural India. *The Journal of Development Studies* 41(8): 1369-1404.
- Cap-Net (International Network for Capacity Development in Sustainable Water Management); GWA (Gender and Water Alliance); UNDP (United Nations Development Programme). 2006. *Why gender matters: A tutorial for water managers*. Multimedia CD and booklet. Delft: Cap-Net (International Network for Capacity Development in Sustainable Water Management).
- CBS (Central Bureau of Statistics). 2001. *Population Census, National Report*. Kathmandu, Nepal.
- CBS. 2009. *Nepal Labour Force Survey*. 2008. Statistical Report. Kathmandu: National Planning Commission Secretariat.
- CBS. 2011. *Nepal Population Report 2011*. Ministry of Health and Population, Government of Nepal. Population Division. Available at [www.mohp.gov.np/population](http://www.mohp.gov.np/population) (accessed in March, 2013).
- CCC (Climate Change Cell). 2006. *Bangladesh climate change impacts and vulnerability: A synthesis*. Dhaka: CCC, DoE (Department of Environment), MoEF (Ministry of Environment and Forests).
- CCC. 2007. *Climate change and Bangladesh*. Dhaka: CCC, DoE, MoEF, 24p.
- CCC. 2009a. *Climate change, gender and vulnerable groups in Bangladesh*. Dhaka: CCC, DoE, MoEF, Component 4b, Comprehensive Disaster Management Program and Ministry of Food and Disaster Management.
- CCC. 2009b. *Adaptive crop agriculture including innovative farming practices in the coastal zone of Bangladesh*. Dhaka: CCC, DoE, MoEF.
- CEDAW (Convention on the Elimination of All Forms of Discrimination Against Women). 2010. *Consideration of reports submitted by states parties under Article 18 of the Convention on the Elimination of All Forms of Discrimination Against Women*. Nepal: Combined Fourth and Fifth Periodic Reports of States Parties. New York, NY: CEDAW/C/NPL/24-5, CEDAW.
- Chadwick, M.T.; Soussan, J.G.; Martin, T.C.; Mallick, D.; Alam, S.S. 2001. Bank robbery: The real losers in the 1998 Bangladesh flood. *Land Degradation & Development Special Issue: Rethinking Environment and Development in Africa and Asia* 12(3): 251-260.
- Crow, B; Sultana, F. 2002. Gender, class, and access to water: Three cases in a poor and crowded delta. *Society & Natural Resources* 15(8): 709-724.
- Cruz, R.V.; Harasawa, H.; Lal, M.; Wu, S.; Anokhin, Y.; Punsalmaa, B.; Honda, Y.; Jafari, M.; Li, C.; Huu Ninh, N. 2007. Asia climate change 2007: Impacts, adaptation and vulnerability. In: *Contribution of working group II to the fourth assessment report of the Intergovernmental Panel on Climate Change*, ed., Parry, L.; Canziani, O.F.; Palutikof, J.P.; van der Linden, P.J.; Hanson, C.E. Cambridge: Cambridge University Press, pp. 469-506.

- Darlymple, S.; Hiscock, D.; Azad, A.K.; Husain, N.; Rahman, Z. 2009. *Climate change and security in Bangladesh - A case study*. London: Saferworld.
- Dasgupta, S.; Huq, M.; Khan, Z.H.; Ahmed, M.M.Z.; Mukherjee, N.; Khan, M.F.; Pandey, K. 2010. *Vulnerability of Bangladesh to cyclones in a changing climate potential damages and adaptation cost*. Policy Research Working Paper 5280. Washington, DC, USA: The World Bank.
- Deere, C.D.; de Janvry, A. 1979. A conceptual framework for the empirical analysis of peasants. *American Journal of Agricultural Economics* 61: 601-611.
- Deere, C.D.; Leon de Leal, M. 1982. *Women in Andean agriculture*. Geneva: International Labour Office.
- Dhungel, R.; Ojha, R. 2012. Women's empowerment for disaster risk reduction and emergency response in Nepal. *Gender & Development* 20(2): 12.
- Dreze, J.; Sen, A. 1991. Hunger and public action. *Development in Practice* 1(1): 373.
- Dyson, T. 1991a. On the demography of South Asian famines, Part I. *Population Studies* 45(1): 5-25.
- Dyson, T. 1991b. On the demography of South Asian famines, Part II. *Population Studies* 45(2): 279-97.
- Fader, M.; Rost, S.; Muller, C.; Bondeau, A.; Gerten, D. 2010. Virtual water content of temperate cereals and maize: Present and potential future patterns. *Journal of Hydrology* 384: 218-231.
- FAO (Food and Agriculture Organization of the United Nations). 1998. *Gender and participation in agricultural development planning*. Rome: FAO. Available at <http://www.fao.org/docrep/X0254E/X0254E00.htm> (accessed in November-December 2012).
- FAO. 2007. *Coping with water scarcity: Challenge of the twenty-first century*. Available at <http://www.fao.org/nr/water/docs/escarcity.pdf> (accessed on September 19, 2012).
- FAO. 2011. *Role of women in agriculture*. ESA Working Paper No. 11-02. Available at <http://www.fao.org/publications/sofa/en/> (accessed in March, 2013).
- Fikree, F.F.; Pasha, O. 2004. Role of gender in health disparity: The South Asian context. *British Medical Journal* 328(7443): 823-826.
- Folbre, N. 1982. Exploitation comes home: A critique of the Marxian theory of family labour. *Cambridge Journal of Economics* 6: 317-329.
- Fussel, H.M.; Klein, R.J.T. 2006. Climate change vulnerability assessments: An evolution of conceptual thinking. *Climatic Change* 75(2): 301-329.
- Gandhi Kingdon, G. 2002. The gender gap in educational attainment in India: How much can be explained? *The Journal of Development Studies* 39(2): 25-53.
- GENDERNET (DAC Network on Gender). 2011. Equality Women's Economic Empowerment. Issues paper. OECD. Available at [http://www.ituc-csi.org/IMG/pdf/OECD\\_-Women's\\_Economic\\_Empowerment.pdf](http://www.ituc-csi.org/IMG/pdf/OECD_-Women's_Economic_Empowerment.pdf) (accessed November-December 2012).
- Gibson-Graham, J.K. 1996. *The end of capitalism (as we knew it)*. Oxford: Blackwell.
- Gibson-Graham, J.K.; Resnick, S.; Wolff, R.D. 2001. Towards a poststructuralist political economy. In: *Re/presenting class: Essays in post-modern Marxism*, ed., Gibson-Graham, G.K.; Resnick, S.; Wolff, R.D. Durham and London: Duke University Press.
- Goetz, A.M.; Sen Gupta, R. 1996. Who takes the credit? Gender, power and control over loan. Use in rural credit programs in Bangladesh. *World Development* 24(1): 45-64.
- GoI. 2004. *First national communication on climate change*. Available from <http://unfccc.int/2860.php> (accessed in March 2012).
- GoI (Government of India). 2011. *Census data. Provisional population totals*. [http://censusindia.gov.in/2011-prov-results/prov\\_results\\_paper1\\_india.html](http://censusindia.gov.in/2011-prov-results/prov_results_paper1_india.html) (accessed in March 2012).
- GoN (Government of Nepal). 2009. *National strategy for disaster risk management, 2009*. Nepal: Government of Nepal, Ministry of Home Affairs.
- Greenough, P.R. 1982. *Prosperity and misery in modern Bengal: The famine of 1943-1944*. Oxford, UK: Oxford University Press.
- Hammill, A.; Matthew, R.; McCarter, E. 2008. Microfinance and climate change adaptation. *IDS Bulletin* 39(4): 113-122.

- Haque, T.M. 2009. Challenges of people's participation at local governance: A case study on the standing committees of Union Parishad in Bangladesh. *Nepalese Journal of Public Policy and Governance* xxiv(1): 43-61.
- Holmes, R.; Mannan, F.; Dhali, H.H.; Parveen, M.S. 2010. *Gendered risks, poverty and vulnerability in Bangladesh: Case study of the Challenging the Frontiers of Poverty Reduction (CFPR) programme, Specially Targeted Ultra Poor II (STUP II)*. UK: Overseas Development Institute.
- Hossain, N.; Akhter, S. 2011. *Gender, power and politics in Bangladesh: A study for the Upazila Support Project*. Bangladesh: United Nations Development Programme (UNDP).
- Hosseinpoor, R.A.; Harper, S.; Lee, J.H.; Lynch, J.; Mathers, C.; Abou-Zahr, C. 2012. International shortfall inequality in life expectancy in women and in men, 1950-2010. *Bulletin of the World Health Organization* 90: 588-594.
- Hosterman, H.R.; McCornick, P.G.; Kistin, E.J.; Pant, A.; Sharma, B.; Bharati, L. 2009. *Water, climate change, and adaptation focus on the Ganges River Basin*. Working Paper NI WP 09-03. Nicholas Institute for Environmental Policy Solutions. USA: Duke University.
- Hussain, M.Z; Kalra, N.; Chander, S.; Sehgal, M.; Ramesh, P.K; Sharma, A. 2005. Impact of climate change and its variability on agriculture. *SAARC Journal of Agriculture* 3: 129-149.
- ICIMOD (International Centre for Integrated Mountain Development). 2008. *Case study: Gender and climate change in the Hindu Kush Himalayas of Nepal*. Commissioned by WEDO (Women's Environment and Development Organisation).
- IDS (Institute of Development Studies). 2011. *Exploring climate change and disaster governance issues*. 36p. Available at: [http://www.ids.ac.uk/files/dmfile/CDGreport\\_web.pdf](http://www.ids.ac.uk/files/dmfile/CDGreport_web.pdf) (accessed on March 12, 2013).
- IFAD (International Fund for Agricultural Development); FAO (Food and Agriculture Organization of the United Nations); World Bank. 2009. *Gender in agriculture: Source book*. 2009. Washington, DC: The World Bank.
- ILO (International Labour Organization). 2007. *Small change; Big changes: Women and microfinance*. Available at [http://www.ilo.org/wcmsp5/groups/public/@dgreports/@gender/documents/meetingdocument/wcms\\_091581.pdf](http://www.ilo.org/wcmsp5/groups/public/@dgreports/@gender/documents/meetingdocument/wcms_091581.pdf) (accessed on December 14, 2012).
- IPCC (Intergovernmental Panel on Climate Change). 2007. *Climate change 2007: Synthesis report*. An assessment report. IPCC Plenary XXVII, Valencia, Spain.
- Islam, M.M. 2011. Living on the margin: The poverty-vulnerability nexus in the small-scale fisheries of Bangladesh, In: *Poverty mosaics: Realities and prospects in small-scale fisheries*, ed., Jentoft, S.; Eide, A. Netherlands: Springer, pp. 71-96.
- Islam, S.N.; Gnauck, A. 2007. Mangrove wetland ecosystems in Ganges-Brahmaputra delta in Bangladesh. *Frontiers of Earth Science in China* 2(4): 439-448.
- Jackson, C. 1998. Gender, irrigation, and environment: Arguing for agency. *Agriculture and Human Values* 15(4): 313-324.
- Jianchu, X.; Shrestha, A.; Vaidya, R.; Eriksson, M.; Hewitt, K. 2007. *The melting Himalayas: Regional challenges and local impacts of climate change on mountain ecosystems and livelihoods*. ICIMOD Technical Paper. Kathmandu, Nepal: ICIMOD.
- Jones, L. 2010. *Overcoming social barriers to adaptation*. ODI Background Note. UK: Overseas Development Institute.
- Jungehulsing, J. 2012. *Gender relations and women's vulnerability to climate change*. Mexico, Central America and Caribbean Office. Mexico City: Heinrich BöllStiftung.
- Kabeer, N. 1998. *Money can't buy me love? Re-evaluating gender, credit and empowerment in rural Bangladesh*. Brighton: Institute of Development Studies.
- Karim, A. 2004. Implications on ecosystems in Bangladesh. In: *The Ganges water diversion: Environmental effects and implications*, ed., Mirza, M.M. Water Science and Technology Library 49. The Netherlands: Kluwer Academic Publishers, pp.125-159.
- Karim, Z.; Hussain, S.G.; Ahmed, M. 1996. Assessing impacts of climate variations on foodgrain production in Bangladesh. *Water, Air, and Soil Pollution* 92: 53-62.
- Karki, M.; Mool, P.; Shrestha, A. 2009. Climate change and its increasing impacts in Nepal. *The Initiation* 3: 30-37.
- Kelkar, G. 2009. *The feminization of agriculture in Asia: Implications for women's agency and productivity*. New Delhi: United Nations Development Fund for Women (UNIFEM) South-Asia Regional Office.

- Khondker, H. 1996. Women and floods in Bangladesh. *International Journal of Mass Emergencies and Disasters* 14(3): 281-292.
- Kraler, A.; Cernie, T.; Noack, M. 2011. "Climate refugees" - Legal and policy responses to environmentally induced migration. European Parliament, 2011. Available at <http://www.europarl.europa.eu/activities/committees/studies.do?language=EN> (accessed on September 14, 2012).
- Krishnaraj, M. 1997. Gender issues in disaster management: The Latur earthquake. *Gender, Technology and Development* 1(3): 395-411.
- Kulkarni, V.S. 2011. *Women empowerment and micro-finance: An Asian perspective study*. IFAD Discussion Paper 13. International Fund for Agricultural Development (IFAD), Asia Pacific Division.
- Kurukulasuriya, P.; Rosenthal, S. 2003. *Climate change and agriculture: A review of impacts and adaptations*. Paper no. 91. Climate Change Series. Washington, DC: The World Bank.
- Lambrou, Y.; Nelson, S. 2010. *Farmers in a changing climate. Does gender matter? Food security in Andhra Pradesh, India*. Rome: Food and Agriculture Organization of the United Nations (FAO).
- Latifee, H.I. 2006. *The future of microfinance: Visioning the who, what, when, where, why, and how of microfinance expansion over the next 10 years*. The Global Microcredit Summit 2006, November 12-15, Halifax, Nova Scotia, Canada. Bangladesh: Grameen Trust.
- Little, D. 1991. *Varieties of social explanation: An introduction to the philosophy of social science*. Boulder: Westview Press.
- Liu, X.; Chen, B. 2000. Climatic warming in the Tibetan Plateau during recent decades. *International Journal of Climatology* 20: 1729-1742.
- Lönnqvist, L.; Huda, N.; Kabir, N.; Kaisari, R.Z.; Khandker, M.; Chandra, S.S. 2010. *Shortcut to the frontline: Supporting local NGOs on climate change in Bangladesh*. Research Report. Oxford, United Kingdom: INTRAC (International NGO Training and Research Centre)/PRIP (Private Rural Initiatives Program) Trust.
- Mahato, R. 2012. *In the name of the father. The Nepali state still does not recognise maternal lineage as a basis for citizenship*. Nepali Times, 3<sup>rd</sup> February.
- Majumder, K.M. 2004. Bangladesh: Ganga under threat. In: *Disputes over the Ganga: A look at potential water-related conflicts in South Asia*. Kathmandu, Nepal: Panos Institute, South Asia.
- Mall, R.K.; Singh, R.; Gupta, A.; Srinivasan, G.; Rathore, L.S. 2006. Impact of climate change on Indian agriculture: A review. *Climate Change* 78: 445-478.
- Maplecroft. 2012. Climate change vulnerability map 2011. Bath, UK: Maplecroft. Available at [http://qualenergia.it/sites/default/files/articolodoc/Maplecroft\\_Climate\\_Change\\_CCVI\\_Map\\_2011.pdf](http://qualenergia.it/sites/default/files/articolodoc/Maplecroft_Climate_Change_CCVI_Map_2011.pdf) (accessed on October 18, 2012).
- Masika, R. 2002. Climate change (Editorial, special issue). *Gender & Development* 10(2): 2-9.
- Massey, D.; Axinn, W.; Ghimire, D. 2007. Environment change and out-migration: Evidence from Nepal. *Population Studies Center Research Report* 07: 615.
- Mayoux, L. 2000. *Micro-finance and the empowerment of women: A review of the key issues*. Geneva: International Labour Organization.
- McCarthy, J.J.; Canziani, O.F.; Leary, N.A.; Dokken, D.J.; White, K.S. 2001. *Climate change 2001: Impacts, adaptatation, and vulnerability*. Cambridge: Intergovernmental Panel on Climate Change (IPCC), Cambridge University Press.
- Meinzen-Dick, R.S.; Zwarteeven, M. 2001. Gender dimensions of community resource management: A case of water users' associations in South Asia. In: *Communities and the environment: Ethnicity, gender and the state in community based conservation*, ed. Agrawal, A.; Gibson, C.C. New Brunswick, New Jersey and London: Rutgers University Press, 63-88.
- Mitchel, T.; Tanner, T.; Lussier, K. 2007. *We know what we need. South Asian women speak out on climate change adaptation*. UK: Institute of Development Studies (IDS), the University of Sussex.
- MoA (Ministry of Agriculture, Bangladesh). 2008. *National agriculture policy*. Dhaka, Bangladesh: Government of the People's Republic of Bangladesh.
- MoE (Ministry of Environment, Nepal). 2010. *National adaptation programme of action to climate change*. National Policy. Kathmandu, Nepal: Government of Nepal.

- MoFDM (Ministry of Food and Disaster Management, Bangladesh). 2006. *National food policy*. Dhaka, Bangladesh: Government of the People's Republic of Bangladesh.
- MoHP (Ministry of Health and Population, Nepal); New ERA; Macro International Inc. 2007. *Nepal demographic and health survey 2006*. Kathmandu, Nepal.
- Moors, E.J.; Groot, A.; Biemans, H.; van Scheltinga, C.T.; Siderius, C.; Stoffel, M.; Huggel, C.; Wiltshire, A.; Mathison, C.; Ridley, J.; Jacob, D.; Kumar, P.; Bhadwal, S.; Gosain, A.; Collins, D.N. 2011. Adaptation to changing water resources in the Ganges basin, northern India. *Environmental Science & Policy* 14(7): 758-769.
- Moser, C. 1998. The asset vulnerability framework: Reassessing urban poverty reduction strategies. *World Development* 26: 1-19.
- Murshid, S.; Yasmeen, A. 2004. *Women of the coast: A gender status paper on the coastal zone*. Working Paper 27. Gender status paper. Bangladesh: Program Development Office for Integrated Coastal Zone Management Plan (PDO-ICZMP).
- Myers, N. 1993. Environmental refugees in a globally warmed world. *Bioscience* 43(11): 752.
- Naved, R.T. 2000. *Intrahousehold impact of the transfer of modern agricultural technology: A gender perspective*. Food Consumption and Nutrition Division (International Food Policy Research Institute). Discussion Paper No. 85. Washington, DC: International Food Policy Research Institute (IFPRI).
- Nazneen, S.; Tasneem, S. 2010. A silver lining: Women in reserved seats in Local Government in Bangladesh. *IDS Bulletin* 41(5): 35-42.
- Neelormi, S.; Adri, N.; Ahmed, A.U. 2009. Gender dimensions of differential health effects of climate change induced waterlogging: A case study from coastal Bangladesh. *IOP Conference Series: Earth and Environmental Science* 6: 142026.
- Nellemann, C.; Verma, R.; Hislop, L. eds. 2011. *Women at the frontline of climate change: Gender risks and hopes*. A Rapid Response Assessment. Arendal: United Nations Environment Programme, GRID-Arendal.
- Nelson, V.; Meadows, K.; Cannon, T.; Morton, J.; Martin, A. 2002. Uncertain predictions, invisible impacts, and the need to mainstream gender in climate change adaptations. *Gender & Development* 10(2): 51-59.
- Neumayer, E.; Plumper, T. 2007. The gendered nature of natural disasters: The impact of catastrophic events on the gender gap in life expectancy, 1981-2002. *Annals of the Association of American Geographers* 97(3): 551-566.
- Nicholls, R.J.; Wong, P.P.; Burkett, V.R.; Codignotto, J.O.; Hay, J.E.; McLean, R.F.; Ragoonaden, S.; Woodroffe. 2007. Coastal systems and low-lying areas. In: *Climate change 2007: Impacts, adaptation and vulnerability*, ed., Parry, M.L.; Canziani, O.F.; Palutikof, J.P.; van der Linden, P.J.; Hanson, C.E. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge: Cambridge University Press. Pp. 315-356.
- Nishat, A.; Faisal, I.M. 2000. An assessment of the institutional mechanisms for water negotiations in the Ganges-Brahmaputra-Meghna system. *International Negotiation* 5: 210-310.
- NPC (Nepal Planning Commission). 2010. The food security atlas of Nepal. Food Security Monitoring Task Force.
- O'Hare, G. 2001. Hurricane 07B in the Godavari delta, Andhra Pradesh, India: Vulnerability, mitigation and the spatial impact. *Geographical Journal* 167(1): 23-38.
- Oxfam International. 2009. *Even the Himalayas has stopped smiling: Climate change, poverty and adaptation in Nepal*. Summary report. Lalitpur, Nepal: Oxfam Nepal.
- Oxfam International. 2005. *The tsunami's impact on women*. Oxford, UK: Oxfam.
- Paroda, R.S.; Kumar, P. 2000. Food production and demand in South Asia. *Agricultural Economics Research Review* 13(1): 1-24.
- Pathak, H.; Ladha, J.K.; Aggarwal, P.K.; Peng, S.; Das, S.; Singh, Y.; Singh, B.; Kamra, S.K.; Mishra, B.; Sastri, A.S.R.A.S.; Aggarwal, H.P.; Das, D.K.; Gupta R.K. 2003. Trends of climatic potential and on-farm yields of rice and wheat in the Indo-Gangetic Plains. *Field Crops Research* 80: 223-234.
- Prasai, B.K. 2010. *National issue paper on agriculture sector (adaptation)*. United Nations Development Programme (UNDP). Available at [http://www.undpcc.org/docs/National%20issues%20papers/Agriculture%20\(adaptation\)/17\\_Nepal%20NIP\\_%20agriculture%20adaptation.pdf](http://www.undpcc.org/docs/National%20issues%20papers/Agriculture%20(adaptation)/17_Nepal%20NIP_%20agriculture%20adaptation.pdf) (accessed on September 18, 2012).
- Rabbani, M.D.; Rahman, A.; Mainuddin, K. 2009. Women's vulnerability to water-related hazards: Comparing three areas affected by climate change in Bangladesh. *Waterlines* 28(3): 235-249.

- Rahman, A.A.; Alam, M.; Alam, S.S.; Uzzaman, M.R.; Rashid, M.; Rabbani, G. 2007. *Risks, vulnerability and adaptation in Bangladesh*. Occasional Paper. Bangladesh: Human Development Report Office.
- Raihan, M.; Huq, S.; Jahedul, M.; Gerstrøm, A.N.; Andreasen, M.H. 2010. *Understanding climate change from below, addressing barriers from above: Practical experience and learning from a community-based adaptation project in Bangladesh*. Bangladesh: ActionAid.
- Rankin, K.N. 2001. Governing development: Neoliberalism, microcredit and rational economic women. *Economy and Society* 30: 18-37.
- Ray-Bennett, N. 2009. The influence of caste, class and gender in surviving multiple disasters: A case study from Orissa, India. *Environmental Hazards* 8(1): 5-22.
- RDI (Rural Development Institute). 2009. *Women's inheritance rights to land and property in South Asia: A study of Afghanistan, Bangladesh, India, Nepal, Pakistan, and Sri Lanka*. A report by Elisa Scalise. Seattle: Rural Development Institute.
- Regmi, B.R.; Pandit, A.; Pradhan, B.; Kovats, S.; Lama, P. 2008. *Climate change and health in Nepal*. CLACC Working Paper 3. IIED and The Ring Alliance of Policy Research Organizations. Available at [https://www.academia.edu/2106422/Climate\\_change\\_and\\_health\\_in\\_Nepal](https://www.academia.edu/2106422/Climate_change_and_health_in_Nepal) (accessed on November 15, 2013).
- Regmi, S.C.; Fawcett, B. 1999. Integrating gender needs into drinking water projects in Nepal. *Gender & Development* 7(3): 62-72.
- Ribot, J.C. 2010. Vulnerability does not just fall from the sky: Toward multi-scale pro-poor climate policy. In: *Social dimensions of climate change: Equity and vulnerability in a warming world*, ed., Mearns, R.; Norton, A. Washington, DC: The World Bank.
- Rich-Zendel, S. 2006. *Behind the bars of justice: Gender inequality in the Nepalese legal and penal systems*. PARHAD studentship, 2006. Canada: University of Calgary.
- Rodell, M.; Velicogna, I.; Famiglietti, J.S. 2009. Satellite-based estimates of groundwater depletion in India. *Nature* 460: 999-1002.
- Rost, S.; Gerten, D.; Bondeau, A.; Lucht, W.; Rohwer, J.; Schaphoff, S. 2008. Agricultural green and blue water consumption and its influence on the global water system. *Water Resources Research* 44(9).
- Roy, M.; Venema, H.D. 2002. Reducing risk and vulnerability to climate change in India: The capabilities approach. *Gender & Development* 10(2):78-83.
- Samadder, R.K.; Gupta, R.P.; Kumar, S. 2011. Paleochannels and their potential for artificial groundwater recharge in the western Ganga plains. *Journal of Hydrology* 400(1-2): 154-164 (accessed in April, 2013).
- Sarwar, G.; Islam, R.; Monzoor, S. 2007. *Women's rights to land in Bangladesh: Roles, limitations and transformation*. Dhaka, Bangladesh: Unnayan Onneshan.
- Saul, B. 2012. *The security risks of climate change displacement in Bangladesh*. Legal Studies Research Paper No. 12/58. University of Sydney, Available at <http://ssrn.com/abstract=2138006> (accessed on April 05, 2013).
- Saxena, N.C. 2011. *Women's right to forest spaces and resources*. New Delhi, India: UN Women. South Asia Subregional Office.
- Scoones, I. 1998. *Sustainable rural livelihoods: A framework for analysis*. IDS Working Paper 72. UK: University of Sussex.
- Scoones, I. 2009. Livelihoods perspectives and rural development. *Journal of Peasant Studies* 36: 171-196.
- Scott, L. 2008. *Climate variability and climate change: Implications for chronic poverty*. Working Paper No. 108. UK: Chronic Poverty Research Centre, Overseas Development Institute (ODI). 34p.
- Shah, T. 2007. The irrigation economy of the Indo-Gangetic Basin: In the throes of a transition. In: *Water for irrigated agriculture and the environment: Finding a flow for all. Proceedings of ATSE Crawford Fund Conference, held at Parliament House, Canberra, Australia, August 16, 2006*, ed., Brown, A.G. Session: Balancing the demands for agriculture and the environment: World best practices or disasters? pp. 49-54.
- Sharma, B.; Amarasinghe, U.; Cai, X.; de Condappa, D.; Shah, T.; Mukherji, A.; Bharati, L.; Ambili, G.; Qureshi, A.; Pant, D.; Xenarios, S.; Singh, R.; Smakhtin, V. 2010. The Indus and the Ganges: River basins under extreme pressure. *Water International* 35(5): 493-521. Available at <http://www.tandfonline.com/doi/abs/10.1080/02508060.2010.512996> (accessed on March 5, 2013).
- Siddika, Z. 2008. *Women's livelihood resilience and adaptation options for climate change*. A dissertation for the degree of Masters (MSc) in Disaster Management. Dhaka: BRAC University.

- SIGI (Social Institutions and Gender Index). 2012. Social Institutions and Gender Index (SIGI) of 2012. Available at <http://genderindex.org/country/nepal> (accessed on October 22, 2012).
- Stern, N. 2007. The economics of climate change: The Stern review. Cambridge, UK: Cambridge University Press. Available at [http://webarchive.nationalarchives.gov.uk/+/http://www.hm-treasury.gov.uk/media/4/3/Executive\\_Summary.pdf](http://webarchive.nationalarchives.gov.uk/+/http://www.hm-treasury.gov.uk/media/4/3/Executive_Summary.pdf) (accessed on October 17, 2014).
- Stoparic, B. 2006. *Climate change is a women's issue*. Women's e-News, April 8. Available at <http://www.alternet.org/story/38659> (accessed on October 9, 2012).
- Sugden, F. 2009. Agrarian change and pre-capitalist reproduction on the Nepal Terai, University of Edinburgh. PhD thesis (duplicated).
- Sugden, F.; Gurung, G. 2012. *Absentee landlordism and agrarian stagnation in Nepal: A case from the eastern Terai, Kathmandu*. Nepal: Nepal Institute of Development Studies.
- Sugden, F.; Maskey, N.; Clement, F.; Ramesh, V.; Philip, A.; Rai, A. 2014. Agrarian stress and climate change in the Eastern Gangetic Plains: Gendered vulnerability in a stratified social formation. *Global Environmental Change* 29: 258-269.
- Sultana, F. 2009. Fluid lives: Subjectivities, gender and water in rural Bangladesh. *Gender, Place and Culture* 16(4): 427-444.
- Swarup, A.; Dankelman, I.; Ahluwalia, K.; Hawrylyshyn, K. 2011. Weathering the storm: Adolescent girls and climate change. *Plan International*. Available at <http://www.plan-uk.org/resources/documents/35316/> (accessed on March 12, 2013).
- The IDL Group (International Development Consultants). 2006. *APP implementation status report*. Bristol, UK: The IDL Group.
- Thomas, H. 2004. *Bangladesh, gender, poverty and the MDGs*. ADB Country Gender Strategy. Manila: Asian Development Bank.
- Trenberth, K.E.; Jones, P.D.; Ambenje, P.; Bojariu, R.; Easterling, D.; Klein Tank, A.; Parker, D.; Rahimzadeh, F.; Renwick, J.A.; Rusticucci, M.; Soden, B.; Zhai, P. 2007. Observations: Surface and atmospheric climate change. In: *Climate Change 2007: The Physical Science Basis*. Contribution of Working Group I to the Fourth Assessment Report of the Inter-governmental Panel on Climate Change. Cambridge and New York: Cambridge University Press.
- Tsai, H.; Liu, T. 2005. Effects of global climate change on disease epidemics and social instability around the world. Human Security and Climate Change, an International Workshop. Asker 21-23 June 2005.
- UNFCCC (United Nations Framework Conventions on Climate Change). 2007. *Climate change: Impacts, vulnerabilities, and adaptation in developing countries*. Available at <http://unfccc.int/resource/docs/publications/impacts.pdf> (accessed on October 22, 2012).
- UN Women Watch. 2009. *Women, gender equality and climate change*: Factsheet. Available at [http://www.un.org/womenwatch/feature/climate\\_change/downloads/Women\\_and\\_Climate\\_Change\\_Factsheet.pdf](http://www.un.org/womenwatch/feature/climate_change/downloads/Women_and_Climate_Change_Factsheet.pdf) (accessed on October 17, 2014).
- Upadhyay, B. 2004. *Gender roles and multiple uses of water in North Gujarat*. Colombo, Sri Lanka: International Water Management Institute (IWMI).
- Upadhyay, D.R.; Gurung, A.; Bista, R.; Karki, R.; Bhandari, K. 2012. Community forestry in Nepal: A scenario of exclusiveness and its implications. *Frontiers in Science* 2(3): 41-46. (accessed on March 14, 2013).
- Venkateswaran, S. 1995. *Environment, development and the gender gap*. University of Michigan. New Delhi, India: Sage Publications.
- Webersik, C.; Thapa, M. 2008. *Nepal climate change and security factsheet*. United Nations University, Institute of Advanced Studies.
- WEDO (Women's Environment and Development Organization). 2008. *Gender, climate change, and human security: Lessons from Bangladesh, Ghana, and Senegal*. Available at <http://www.wedo.org/wp-content/uploads/hsn-study-final-may-20-2008.pdf> (accessed on May 23, 2013).
- WEN (Women's Environment Network). 2010. *Gender and the climate change agenda: The impacts of climate change on women and public policy*. London, UK: WEN.
- WfWP (Women for Water Partnership). 2004. *Role of women in management of water and sanitation: A case of Chadeni VDC*. Available at <http://www.womenforwater.org/docs/Nepal.pdf> (accessed on April, 2013).

- WHO (World Health Organization). 2005. *Gender, climate change and health*. Draft Discussion Paper. Available at <http://www.who.int/globalchange/GenderClimateChangeHealthfinal.pdf?ua=1> (accessed on April 12, 2013).
- Wong, S. 2009. Climate change and sustainable technology: Re-linking poverty, gender, and governance. *Gender & Development* 17(1): 95-108.
- World Bank. 2009. South Asia climate change strategy. Draft Technical Report. Available at <http://siteresources.worldbank.org/SOUTHASIAEXT/Resources/Publications/448813-1231439344179/5726136-1232505590830/1SARCCSJanuary192009.pdf> (accessed on June 19, 2010).
- World Bank. 2010. *The social dimensions of adaptation to climate change in Bangladesh*. Discussion Paper No. 12. Washington, DC: World Bank.
- World Bank; AusAID. 2007. *Whispers to voices: Gender and social transformation in Bangladesh*. Available at <http://siteresources.worldbank.org/INTBANGLADESH/Resources/295657-1205740286726/genderReport.pdf> (accessed on November 15, 2012).
- Zahur, M. 2009. *Climate change, migration and gender: Reflection from Balochistan, Pakistan drought 1998-2002*. Bonn: Gender CC/Gender Disaster Network. Available at <http://www.gendercc.net/fileadmin/inhalte/Dokumente/Actions/final-maira-original.pdf> (accessed on September 17, 2012).
- Zwarteveen, M.; Neupane, N. 1996. *Free-riders or victims: Women's nonparticipation in irrigation management in Nepal's Chhattis Mauja Irrigation Scheme*. Colombo, Sri Lanka: International Irrigation Management Institute (IIMI). 29p. (IIMI Research Report 7).

## IWMI Working Papers

---

- 159 *A Framework to Understand Gender and Structural Vulnerability to Climate Change in the Ganges River Basin: Lessons from Bangladesh, India and Nepal.* Fraser Sugden, Sanjiv de Silva, Floriane Clement, Niki Maskey-Amatya, Vidya Ramesh, Anil Philip and Luna Bharati. 2014.
- 158 *Review of Literature on Chronic Kidney Disease of Unknown Etiology (CKDu) in Sri Lanka.* Andrew Noble, Priyanie Amerasinghe, Herath Manthrithilake and Sutharsiny Arasalingam. 2014.
- 157 *Hydrogeology of the Eastern Ganges Basin: An Overview.* N. Rajmohan and S. A. Prathapar. 2013.
- 156 *Rapid Assessment of Water Availability and Appropriate Technologies for Small-scale Farming: Guidelines for Practitioners.* Andrew Keller, Elizabeth Weight and Stuart Taylor. 2013. (Also available in French)
- 155 *Manual Well Drilling Investment Opportunity in Ethiopia.* Elizabeth Weight, Robert Yoder and Andrew Keller. 2013.
- 154 *Improving the Supply Chain of Motor Pumps to Expand Small-scale Private Irrigation in Zambia.* Willem Colenbrander and Barbara van Koppen. 2012.
- 153 *Gender Aspects of Small-scale Private Irrigation in Africa.* Barbara van Koppen, Lesley Hope and Willem Colenbrander. 2012.
- 152 *Investing in Agricultural Water Management to Benefit Smallholder Farmers in Ethiopia. AgWater Solutions Project Country Synthesis Report.* Alexandra E. V. Evans, Meredith Giordano and Terry Clayton (Editors). 2012.
- 151 *Investing in Agricultural Water Management to Benefit Smallholder Farmers in Madhya Pradesh, India. AgWater Solutions Project Country Synthesis Report.* Alexandra E. V. Evans, Meredith Giordano and Terry Clayton (Editors). 2012.
- 150 *Investing in Agricultural Water Management to Benefit Smallholder Farmers in Zambia. AgWater Solutions Project Country Synthesis Report.* Alexandra E. V. Evans, Meredith Giordano and Terry Clayton (Editors). 2012.
- 149 *Investing in Agricultural Water Management to Benefit Smallholder Farmers in Burkina Faso. AgWater Solutions Project Country Synthesis Report.* Alexandra E. V. Evans, Meredith Giordano and Terry Clayton (Editors). 2012. (Also available in French).

**IWMI provides free access to all its publications.**

**Visit**

**[www.iwmi.org/publications/index.aspx](http://www.iwmi.org/publications/index.aspx)**

**Postal Address**

P O Box 2075  
Colombo  
Sri Lanka

**Location**

127 Sunil Mawatha  
Pelawatta  
Battaramulla  
Sri Lanka

**Telephone**

+94-11-2880000

**Fax**

+94-11-2786854

**E-mail**

[iwmi@cgiar.org](mailto:iwmi@cgiar.org)

**Website**

[www.iwmi.org](http://www.iwmi.org)



IWMI is a member of the CGIAR Consortium and leads the:



RESEARCH PROGRAM ON  
Water, Land and Ecosystems

ISSN: 2012-5763  
ISBN: 978-92-9090-806-7