Gender, Climate Change and Health

World Health Organization

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Abbreviations

CSW	Commission on the Status of Women
DSM-IV	Diagnostic and Statistical Manual of Mental Disorders, 4th edition
FAO	Food and Agriculture Organization
IPCC	Intergovernmental Panel on Climate Change
OECD	Organisation for Economic Co-operation and Development
PTSD	post-traumatic stress disorder
UNFCCC	United Nations Framework Convention on Climate Change
WHA	World Health Assembly
WHO	World Health Organization

Executive summary

There is now strong evidence that the earth's climate is changing rapidly, mainly due to human activities. Increasing temperatures, sea-level rises, changing patterns of precipitation, and more frequent and severe extreme events are expected to have largely adverse effects on key determinants of human health, including clean air and water, sufficient food and adequate shelter.

The effects of climate on human society, and our ability to mitigate and adapt to them, are mediated by social factors, including gender. This report provides a first review of the interactions between climate change, gender and health. It documents evidence for gender differences in health risks that are likely to be exacerbated by climate change, and in adaptation and mitigation measures that can help to protect and promote health. The aim is to provide a framework to strengthen World Health Organization (WHO) support to Member States in developing health risk assessments and climate policy interventions that are beneficial to both women and men.

Many of the health risks that are likely to be affected by ongoing climate change show gender differentials. Globally, natural disasters such as droughts, floods and storms kill more women than men, and tend to kill women at a younger age. These effects also interact with the nature of the event and social status. The gender-gap effects on life expectancy tend to be greater in more severe disasters, and in places where the socioeconomic status of women is particularly low. Other climate-sensitive health impacts, such as undernutrition and malaria, also show important gender differences.

Gender differences occur in health risks that are directly associated with meteorological hazards. These differences reflect a combined effect of physiological, behavioural and socially constructed influences. For example, the majority of European studies have shown that women are more at risk, in both relative and absolute terms, of dying in heatwaves. However, other studies have also shown that unmarried men tend to be at greater risk than unmarried women, and that social isolation, particularly of elderly men, may be a risk factor.

Differences are also found in vulnerability to the indirect and longer-term effects of climate-related hazards. For example, droughts in developing countries bring health hazards through reduced availability of water for drinking, cooking and hygiene, and through food insecurity. Women and girls (and their offspring) disproportionately suffer health consequences of nutritional deficiencies and the burdens associated with travelling further to collect water. In contrast, in both developed and developing countries, there is evidence that drought can disproportionately increase suicide rates among male farmers.

Women and men differ in their roles, behaviours and attitudes regarding actions that could help to mitigate climate change. Surveys show that in many countries men consume more energy than women, particularly for private transport, while women are often responsible for most of the household consumer decisions, including in relation to food, water and household energy. There is also evidence of gender differences in relation to the health and safety risks of new technologies to reduce greenhouse gas emissions. Such information could support more targeted, more effective efforts to bring about more healthy and environmentally friendly policies.

These differences are also reflected in the health implications of potential greenhouse gas mitigation policies. For example, inefficient burning of biomass in unventilated homes releases high levels of

black carbon, causing approximately 2 million deaths a year, mainly of women and children in the poorest communities in the world. The black carbon from such burning is also a significant contributor to local and regional warming. At the household level, women are sometimes critical decision-makers in terms of consumption patterns and therefore the main beneficiaries of access to cleaner energy sources.

Resources, attitudes and strategies to respond to weather-related hazards often differ between women and men. For example, studies in India have shown that women tend to have much lower access to critical information on weather alerts and cropping patterns, affecting their capacity to respond effectively to climate variability. The same study showed that when confronted with long-term weather shifts, men show a greater preference to migrate, while women show a greater preference for wage labour.

Evidence from case studies suggests that incorporation of a gender analysis can increase the effectiveness of measures to protect people from climate variability and change. In particular, women make an important contribution to disaster reduction, usually informally through participating in disaster management and acting as agents of social change. Many disaster-response programmes and some early warning initiatives now place particular emphasis on engaging women as key actors.

There are important opportunities to adapt to climate change and to enhance health equity. Approaches to adaptation have evolved from initial infrastructure-based interventions to a more development-oriented approach that aims to build broader resilience to climate hazards. This includes addressing the underlying causes of vulnerability, such as poverty, lack of empowerment, and weaknesses in health care, education, social safety nets and gender equity. These are also some of the most important social determinants of health and health equity.

Gender-sensitive assessments and gender-responsive interventions have the potential to enhance health and health equity and to provide more effective climate change mitigation and adaptation. Gender-sensitive research, including collection, analysis and reporting of sex-disaggregated data, is needed to better understand the health implications of climate change and climate policies. However, there is already sufficient information to support gender mainstreaming in climate policies, alongside empowerment of individuals to build their own resilience, a clear focus on adaptation and mitigation, a strong commitment (including of resources), and sustainable and equitable development.

"Climate change affects every aspect of society, from the health of the global economy to the health of our children. It is about the water in our wells and in our taps. It is about the food on the table and at the core of nearly all the major challenges we face today."[1]

1 UN Secretary-General Ban Ki-moon. Opening remarks to the World Business Summit on Climate Change, Copenhagen, Denmark, 24 May 2009 (http://www.un.org/apps/news/infocus/sgspeeches/search_full.asp?statID=500).

1. Background

Gender impacts of climate change have been identified as an issue requiring greater attention by the Commission on the Status of Women (CSW).[II] Gender norms, roles and relations (Box 1) are important factors in determining vulnerability and adaptive capacity to the health impacts of climate change (Box 2). Women's and men's vulnerability to the impact of extreme climate events is determined not only by biology but also by differences in their social roles and responsibilities (Easterling, 2000; Wisner et al., 2004). Although they vary, these roles and responsibilities exist in all societies. The expectation that women fulfil their roles and responsibilities as carers of their families often places extra burdens on them during extreme climate events. The expected role of men as economic providers for their families often places extra burdens on them in the aftermath of such events.

Box 1: Definition of sex and gender

In this document "sex" refers to the biological and physiological characteristics of women and men, and "gender" refers to the socially constructed norms, roles and relations that a given society considers appropriate for men and women. Gender determines what is expected, permitted and valued in a woman or a man in a determined context.

Source: WHO (2011a).

Box 2: Definition of climate change

Climate has always varied due to natural influences; however, there is now strong evidence that human actions, principally the burning of fossil fuels, are the main drivers of the recent increase in global temperatures and also affect precipitation patterns and extreme weather events.

This document follows the definition adopted by the Intergovernmental Panel on Climate Change (IPCC), in which "climate change" refers to any change in climate over time, whether due to natural variability or as a result of human activity. This usage differs from that in the United Nations Framework Convention on Climate Change (UNFCCC), which defines "climate change" as "a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods".

Source: IPCC (2001a).

II Fifty-second session of the Commission on the Status of Women, 25 February to 7 March 2008 (http://www.un.org/womenwatch/daw/csw/52sess.htm).

At the 2007 World Health Assembly (WHA), Member States of the World Health Organization (WHO) adopted Resolution WHA 60.25 on the integration of gender analysis and actions into the work of WHO at all levels (WHO, 2007). A year later, at the 2008 WHA, 193 WHO Member States committed through Resolution 61.19 to a series of actions to confront the health risks associated with climate change (WHO, 2008a).

The overall aim of this work is to provide a framework for gendered health risk assessment and adaptation/mitigation actions in relation to climate change. This aims to strengthen WHO support to Member States in developing standardized country-level health risk assessments and climate policy interventions that are beneficial to both women and men.

This report therefore adopts a risk-assessment approach in considering the existing evidence for gender differences in vulnerability. Climate change is a long-term process, acting against a background of shorter-term climate variability and many other influences on health. Under these circumstances, direct statistical attribution of even very large gender differences in health effects would generally require high-quality meteorological, health and other data collected over many years, and will therefore only be possible for a minority of effects, in specific locations. In contrast, there is strong evidence of gender differences in the health impacts of short-term climate variability and climate-sensitive conditions, such as malnutrition and incidence of infectious diseases. We use this information to assess likely gender differences in health risks and responses over the longer time periods associated with climate change.

1.1 Health and climate change

Effects of climate change on health will impact on most populations in the coming decades and put the lives and well-being of billions of people at increased risk (Costello et al, 2009). IPCC states that "climate change is projected to increase threats to human health".

Climate change can affect human health through a range of mechanisms. These include relatively direct effects of hazards such as heatwaves, floods and storms, and more complex pathways of altered infectious disease patterns, disruptions of agricultural and other supportive ecosystems, and potentially population displacement and conflict over depleted resources, such as water, fertile land and fisheries (Pachauri & Reisinger, 2007).

There is no clear dividing line between these divisions, and each pathway is also modulated by non-climatic determinants and human actions.

1.2 Health, gender and climate change

Limited case examples and research have analysed and highlighted the links between gender norms, roles, relations and health impacts of climate change (Box 3). The framework in Figure 1, adapted from the synthesis report of the International Scientific Congress on Climate Change (McMichael & Bertollini, 2009), is used in this paper to structure the available information on the gendered health implications of climate change, according to (i) the direct and indirect health impacts of meteorological conditions; (ii) the health implications of potential societal effects of climate change, for example on livelihoods, agriculture and migration; and (iii) capacities, resources, behaviours and attitudes related to health adaptation measures and mitigation policies that have health implications.

Box 3: Why gender and health?

The distinct roles and relations of men and women in a given culture, dictated by that culture's gender norms and values, give rise to gender differences.

Gender norms, roles and relations also give rise to gender inequalities – that is, differences between men and women that systematically value one group often to the detriment of the other. The fact that, throughout the world, women on average have lower cash incomes than men is an example of gender inequality.

Both gender differences and gender inequalities can give rise to inequities between men and women in health status and access to health care. For example:

- **a woman cannot receive needed health care because norms in her community prevent her from travelling alone to a clinic;**
- **an adolescent boy dies in an accident because of trying to live up to his peers' expectations that young men should be "bold" risk-takers, including on the road.**

In each of these cases, gender norms and values, and resulting behaviours, are negatively affecting health. But gender norms and values are not fixed and can evolve over time, can vary substantially from place to place, and are subject to change. Thus, the adverse health consequences resulting from gender differences and gender inequalities are not static. They can be changed.

Source: WHO (2011b).

Figure 1: Effects of climate change on human health and current responses: a gendered perspective

Impact pathways		Current responses	
Meteorological conditions exposure	**Human/social consequences of climate change**	**Mitigation actions**	**Adaptation actions**
Examples: • Warming • Humidity • Rainfall/drying • Winds • Extreme events	*Examples:* • Displacement • Shift in farming and land use	*Examples:* • Alternative energy • Accessible clean water	*Examples:* • Addressing water shortage • Crop substitution • Community education on early warning systems and hazard management
Examples of impact outcomes and responses that are gendered in their effects			
• Injury/death from hunger • Epidemics • Mental health issues • Water-related infections	• Migration • Exacerbation of malnutrition • Increased violence against women and girls	• Hydropower – leading to more snail hosts for schistosomiasis • Cleaner air – less cardiorespiratory diseases (gendered profiles)	• Unexpected nutrient deficiencies • Impacts of water quality • Fewer deaths in extreme events

Source: Adapted from McMichael & Bertollini (2009).

2. Impacts: health

2.1 Meteorological conditions and human exposure

There is good evidence showing that women and men suffer different negative health consequences following extreme events such as floods, windstorms, droughts and heatwaves. A review of census information on the effects of natural disasters across 141 countries showed that although disasters create hardships for everyone, on average they kill more women than men, or kill women at a younger age than men. These differences persist in proportion to the severity of disasters and depend on the relative socioeconomic status of women in the affected country. This effect is strongest in countries where women have very low social, economic and political status. In countries where women have comparable status to men, natural disasters affect men and women almost equally (Neumayer & Plümper, 2007The same study highlighted that physical differences between men and women are unlikely to explain these differences, and social norms may provide some additional explanation. The study also looked at the specific vulnerability of girls and women with respect to mortality from natural disasters and their aftermath; the study found that natural disasters lower the life expectancy in women more than in men. Since life expectancy of women is generally higher than that of men, natural disasters actually narrow the gender gap in life expectancy in most countries. The research also confirmed that the effect on the gender gap in life expectancy is proportional to the severity of disasters – that is, major calamities lead to more severe impacts on women's life expectancy compared with that of men. The study verified that the effect of the gender gap on the gender gap in life expectancy varied inversely in relation to women's socioeconomic status. This highlights the socially constructed and gender-specific vulnerability of women to natural disasters, which is integral to everyday socioeconomic patterns and leads to relatively higher disaster-related mortality rates in women compared with men (Neumayer & Plümper, 2007).

2.1.1 Heatwaves and increased hot weather

Warming and increased humidity have already contributed to observed increases in some health risks, and these can be anticipated to continue in the future.

Direct consequences

Several studies, mainly in cities in developed countries, have shown that death rates increase as temperatures depart, in either direction, from the optimum temperature for that population. There is therefore concern that although warmer temperatures may lead to fewer deaths in winter, they are likely to increase summer mortality. For example, it is estimated that a 2 °C rise would increase the annual death rate from heatwaves in many cities by approximately two-fold (McMichael & Bertollini, 2009). There is evidence that vulnerability varies by sex: more women than men died during the 2003 European heatwave, and the majority of European studies have shown that women are more at risk, in both relative and absolute terms, of dying in such events (Kovats & Hajat, 2008). There may be some physiological reasons for an increased risk among elderly women (Burse, 1979; Havenith et al., 1998). Social factors can also be important in determining the risk of negative impacts of heatwaves. For example, in the United States of America, elderly men seem to be more at risk than women in heatwaves, and this was

particularly apparent in the Chicago events of July 1995 (Semenza, 1996; Whitman et al., 1997). This vulnerability may be due to the level of social isolation among elderly men (Klinenberg, 2002). In Paris, France the heatwave-related risk increased for unmarried men but not for unmarried women (Canoui-Poitrine et al., 2006). Men may also be more at risk of heatstroke mortality because they are more likely than women to be active in hot weather (CDC, 2006).

Indirect consequences

Rising temperatures may increase the transmission of malaria in some locations, which already causes 300 million acute illnesses and kills almost 1 million people every year (WHO, 2008b). Pregnant women are particularly vulnerable to malaria as they are twice as "appealing" as non-pregnant women to malaria-carrying mosquitoes. A study that compared the relative "attractiveness" to mosquitoes of pregnant and non-pregnant women in rural Gambia found that the mechanisms underlying this vulnerability during pregnancy is likely to be related to at least two physiological factors. First, women in the advanced stages of pregnancy (mean gestational age 28 weeks or above) produce more exhaled breath (on average, 21% more volume) than their non-pregnant counterparts. There are several hundred different components in human breath, some of which help mosquitoes detect a host. At close range, body warmth, moist convection currents, host odours and visual stimuli allow the insect to locate its target. During pregnancy, blood flow to the skin increases, which helps heat dissipation, particularly in the hands and feet. The study also found that the abdomen of pregnant women was on average 0.7 °C hotter than that of non-pregnant women and that there may be an increase in the release of volatile substances from the skin surface and a larger host signature that allows mosquitoes to detect them more readily at close range. Changes in behaviour in pregnant women can also increase exposure to night-biting mosquitoes: pregnant women leave the protection of their bednet at night to urinate twice as frequently as non-pregnant women. Although the important role of immunity and nutrition is recognized, it is suggested that physiological and behavioural changes that occur during pregnancy could partly explain this increased risk of infection (Lindsay, 2000). Maternal malaria increases the risk of spontaneous abortion, premature delivery, stillbirth and low birth weight.

Evidence for connections between weather and pre-eclampsia varies between studies. Some studies have looked at links between meteorological conditions and the incidence of eclampsia in pregnancy; the studies found increased incidence during climatic conditions characterized by low temperature, high humidity or high precipitation, with an increased incidence especially during the first few months of the rainy season (Agobe et al., 1981; Crowther, 1985; Faye et al., 1991; Bergstroem et al., 1992; Neela & Raman, 1993; Obed et al., 1994; Subramaniam, 2007). A study from Kuwait found that incidence of pre-eclampsia was high in November, when the temperature was low and the humidity high (Makhseed et al., 1993). On the other hand, the incidence of pregnancy-induced hypertension was highest in June, when the temperature was very high and the humidity at its lowest. Another study, from the southern province of Zimbabwe, evaluated hypertensive complications during pregnancy and observed a distinctive change in the incidence of pre-eclampsia during the year. These changes corresponded with the seasonal variation in precipitation, with incidence increasing at the end of the dry season and in the first months of the rainy season. This observed relationship between season and the occurrence of pre-eclampsia raises new questions regarding the pathophysiology of pre-eclampsia. Possible explanations could be the impact of humidity and temperature on production of vasoactive substances. Dry and rainy seasons, through their influence

on agricultural yields, may also impact on the nutritional status and play a role in the pathophysiology of the women (Wacker et al., 1998).

2.1.2 Windstorms and tropical cyclones

Direct consequences

In the 1991 cyclone disasters that killed 140 000 people in Bangladesh, 90% of victims were women (Aguilar, 2004). The death rate among people aged 20–44 years was 71 per 1000 women, compared with 15 per 1000 men (WEDO, 2008). Explanations for this include the fact that more women than men are homebound, looking after children and valuables. Even if a warning is issued, many women die while waiting for their relatives to return home to accompany them to a safe place. Other reasons include the sari restricts the movement of women and puts them more at risk at the time of a tidal surge, and that women are less well nourished and hence physically less able than men to deal with these situations (Chowdhury et al., 1993; WEDO, 2008).

In May 2008, Cyclone Nargis came ashore in the Ayeyarwady Division of Myanmar. Among the 130 000 people dead or missing in the aftermath, 61% were female (Care Canada, 2010).

Indirect consequences

Women, young people, and people with low socioeconomic status are thought to be at comparatively high risk of anxiety and mood disorders after disasters (Norris et al., 2002). One study of anxiety and mood disorder (as defined by the fourth edition of the *Diagnostic and Statistical Manual of Mental Disorders*; DSM-IV) after Hurricane Katrina found the incidence was consistently associated with the following factors: age under 60 years; being a woman; education level lower than college completion; low family income; pre-hurricane employment status (largely unemployed and disabled); and being unmarried. In addition, Hispanic people and people of other racial/ethnic minorities (not including non-Hispanic black people) had a significantly lower estimated incidence of any disorder compared with non-Hispanic white people in the New Orleans area, as well as a significantly lower estimated prevalence of post-traumatic stress disorder (PTSD) in the remainder of the sample. These same associations have been found in community epidemiological surveys in the absence of disasters, suggesting that these associations might be related to pre-existing conditions (Galea et al., 2007). A follow-up study that looked at patterns and correlates of recovery from hurricane-related PTSD, broader anxiety and mood disorders and suicidal behaviour found a high prevalence of hurricane-related mental illness widely distributed in the population nearly 2 years after the hurricane (Kessler et al., 2008).

2.1.3 Sea-level rises, heavy rain and flooding

Increasing temperatures are contributing to sea-level rises, and precipitation is becoming heavier and more variable in many regions, potentially increasing flood risks and multiple associated health hazards. There has, however, been only limited systematic research and gender analysis on the health outcomes of flooding (Few et al., 2004). It is important to recognize that vulnerability to flooding is differentiated by social dimensions. In both developing and industrialized nations, health and other impacts may fall disproportionately on women, children, people with disabilities and elderly people (Few et al., 2004).

Direct consequences

A report on the health effects of climate change in the United Kingdom showed that age- and gender-related information on flood deaths is incomplete. Published reviews have shown, however, that men are much more at risk of drowning than women, probably due to taking more risky or "heroic" behaviour (Kovats & Allen, 2008) (Box 4).

Saline contamination is expected to be aggravated by climate change and sea-level rises (Nicholls et al., 2007). A paper on saline contamination of drinking water in Bangladesh indicated that large numbers of pregnant women in coastal areas are being diagnosed with pre-eclampsia, eclampsia and hypertension. Although local doctors and community representatives have blamed the problem on increased salinity, no formal epidemiological study has been done (Khan et al., 2008).

Box 4: How gender norms, roles and relations explain the differences in fatality between women and men in floods in Nepal

In 1993 a severe flash flood devastated the district of Sarlahi in the southern plains of Nepal. After an unprecedented 24-hour rainfall, a protective barrage on the Bagmati River was washed away during the night, sending a wall of water more than 7 metres high crashing through communities and killing more than 1600 people. Two months later, a follow-up survey assessed the impact of the flood. This survey was unusual in that an existing prospective research database was available to verify residency before the flood. As part of a large community-based nutrition programme, longitudinal data existed on children aged 2–9 years and their parents from 20 000 households, about 60% of the households in the study area. The survey established age- and sex-specific flood-related deaths among more than 40 000 registered participants (including deaths due to injury or illness in the weeks after the flood). Flood-related fatalities were 13.3 per 1000 girls aged 2–9 years, 9.4 per 1000 boys aged 2–9 years, 6.1 per 1000 adult women and 4.1 per 1000 adult men. The difference between boys' and girls' fatalities existed mostly among children under 5 years of age. This possibly reflects the gender-discriminatory practices that are known to exist in this poor area: when hard choices must be made in the allocation of resources, boys are more often the beneficiaries. This could be reflected in rescue attempts as much as in the distribution of food and medical attention.

Source: Adapted from Bartlett (2008).

Indirect consequences

In Bangladesh and the eastern region of India, where the arsenic contamination of groundwater is high, flooding intensifies the rate of exposure among rural people and other socioeconomically disadvantaged groups (Khan et al., 2003). Studies have also found a negative correlation between symptoms of arsenic poisoning and specific socioeconomic factors, in particular educational and nutritional status (Mitra et al., 2004; Rehman et al., 2006; Maharajan et al., 2007). Health problems resulting from arsenic poisoning include skin lesions, hardening of the skin, dark spots on the hands and feet, swollen limbs and loss of sensation in the hands and legs (UNICEF, 2008).

In the south-west region of Bangladesh, waterlogging (local increases in groundwater levels) has emerged as a pressing concern with health consequences. Women are often the primary caregivers of the family, shouldering the burden of managing and cooking food, collecting drinking water, and taking care of family members and livestock. Because of these responsibilities, women often spend time in waterlogged premises and other settings. Research reveals that waterlogging severely affects the health of women in affected communities. Women are forced to stay close to the community and drink unhygienic water, as tube wells frequently become polluted. Pregnant women have difficulty with mobility in marooned and slippery conditions and thus are often forced to stay indoors. Local health-care workers have reported that there are increasing trends of gynaecological problems due to unhygienic water use. Since men are often out of the area in search of work, they are frequently not as severely affected as their female counterparts. Waterlogging, therefore, has given rise to differential health effects in women and men in coastal Bangladesh (Neelormi et al., 2009).

Socially constructed roles also influence the individual disaster responses of men. Within Latino cultures, for instance, expectations of male "heroism" require men to act courageously, thus forcing them into risky behaviour patterns in the face of danger and making them more likely to die in an extreme event. In contrast, women's relative lack of decision-making power may pose a serious danger itself, especially when it keeps them from leaving their homes in spite of rising water levels, waiting for a male authority to grant them permission or to assist them in leaving (Bradshaw, 2010).

Girls and women may experience decreased access to important life skills due to gender norms or expectations around behaviours deemed "appropriate". For example, in some Latin American and Asian countries, women and girls are often not taught to swim, for reasons of modesty (Aguilar, 2004). In the South Asian context, social norms that regulate appropriate dress codes in accordance with notions of modesty may hinder women and girls from learning to swim, which can severely reduce their chances of survival in flooding disasters (Oxfam, 2005).

Possible health consequences of hazards associated with flooding and typhoons include stress-related illness and risk of malnutrition related to loss of income and subsistence, which are known to have a strong gender dimension (FAO, 2001, 2002; Cannon, 2002). Studies from Viet Nam found that stress factors were apparent at the household level. People interviewed in cities in the Mekong Delta referred to increased anxiety, fears or intra-household tension as a result of the dangers and damage associated with flooding and its livelihood impacts. Interviewees in the central provinces referred to food shortages and hunger potentially resulting from crop and income losses following destructive floods and typhoons (Few & Tran, 2010).

In flooded areas of Bangladesh, women are often the last people to receive assistance, as some men push them out of the way in the rush for supplies. Women who have lost clothing in the flood are unable to enter public areas to access aid because they can not cover themselves sufficiently (Skutsch, 2004). A further example of this is the loss of culturally appropriate clothing, which inhibits women from leaving temporary shelters to seek medical care or obtain essential resources (Neumayer & Plümper, 2007).

2.1.4 Drought

Direct consequences

Globally, fresh water resources are distributed unevenly, and areas of most severe physical water scarcity are those with the highest population densities. The health impacts of drought and their gender dimensions may be exacerbated further by climate change. Shifting rainfall patterns, increased rates of evaporation and melting of glaciers, and population and economic growth are expected to increase the number of people living in water-stressed water basins from about 1.5 billion in 1990 to 3–6 billion by 2050 (Arnell, 2004). Almost 90% of the burden of diarrhoeal disease is attributable to lack of access to safe water and sanitation (Prüss-Üstün et al., 2008; WHO, 2009a); reduction in the availability and reliability of fresh water supplies is expected to amplify this hazard.

In arid, semi-arid and dry sub-humid areas, drought already presents a serious threat to the well-being and health of the local populations. Extended periods of drought are linked not only to water shortages and food insecurity but also to increased risk of fires, decreased availability of fuel, conflicts, migration, limited access to health care and increased poverty. Few studies are available on the consequences of droughts for human health, but all of them point to differing impacts on men and women.

In times of water scarcity women have little choice but to carry water home from unsafe sources, including streams and ponds that are likely to be contaminated. This can lead to water-related diseases such as diarrhoeal disease, which in developing countries is a leading cause of death among children under 5 years of age (WHO & UNICEF, 2005). Moreover, when water is scarce, hygienic practices are commonly sacrificed to more pressing needs for water, such as drinking and cooking. The lack of hygiene can be followed by diseases such as trachoma and scabies, also referred to as "water-washed diseases" (WaterAid, 2007). Almost half of all urban residents in Africa, Asia and Latin America are already victims of diseases associated with poor water and sanitation facilities (WHO & UNICEF, 2006).

Indirect consequences

Droughts and drying can lead to social instability, food insecurity and long-term health problems and can damage or destroy related livelihoods (Pachauri & Reisinger, 2007).

In most developing countries, women are intrinsically tied to water. They are responsible for collecting, storing, protecting and distributing water. For women, long journeys walking to the nearest wells and carrying heavy pots of water not only causes exhaustion and damage to bones but also is accompanied by opportunity costs, such as time that could be spent productively going to school or working.

A study on drought management in Ninh Thuan, Viet Nam showed that 64% of respondents agreed that recurring disasters have differential impacts on women and men, and 74% of respondents believed that women were more severely affected than men by drought, due to differing needs for water. Women collect water from sources that are increasingly further away as each drought takes its toll. With fewer water sources nearby, women often walk long distances to fetch drinking water. Women also cook, clean, rear children and collect firewood, so they cope with enormous physical burdens on a daily basis (Oxfam, 2006).

Women and girls fetch water in pots, buckets and more modern narrow-necked containers, which are carried on the head or the hip. A family of five people needs approximately 100 litres of water, weighing 100 kg, each day to meet its minimum needs. Women and children may need to walk to the water source two or three times each day. The first of these trips often takes place before dawn, which involves sacrificing sleeping hours, which can pose a serious strain on health. During the dry season in rural India and Africa, 30% or more of a woman's daily energy intake is spent fetching water. Carrying heavy loads over long periods of time causes cumulative damage to the spine, the neck muscles and the lower back, thus leading to early ageing of the vertebral column (Mehretu & Mutambirwa, 1992; Dasgupta, 1993; Page, 1996; Seaforth, 2001; Research Foundation for Science, Technology and Ecology, 2005; Ray, 2007). More research is needed to uncover the negative health implications of the burden of daily carrying of water, as it seems to fall outside of the conventional categories of waterborne, water-washed and water-related ailmentsDrought increases the family's physiological need for water and also results in greater distances travelled to the water source. According to available data, the quantity of collected water per capita is reduced drastically if the walk to a water source takes 30 minutes or longer (WHO & UNICEF, 2005). As a result, the quantity of collected water often does not even cover the basic human physiological requirements. This puts women in a very difficult position, as in many societies women are socially responsible for the family's water supply. According to a study on water needs and women's health in Ghana, women who maintain traditional norms are particularly vulnerable during water scarcity, as they often give priority to their husbands, ensuring that the man's water needs are met before their own (Buor, 2003).

The stresses of lost incomes and associated indebtedness can spill over into mental health problems, despair and suicide among men. There is some empirical evidence linking drought and suicide among men in Australia (Nicholls et al., 2006). This negative health outcome among Australian rural farmers has been linked to stoicism and poor health-seeking behaviour, which is an intrinsic element of rural masculinity (Alston & Kent, 2008; Alston, 2010). In India, there has been consistent reporting of increased suicide among poor male farmers following periods of droughts in contiguous semi-arid regions (Behere & Behere, 2008; Nagaraj, 2008).

3. Impacts: social and human consequences of climate change

3.1 Migration and displacement

Climate change can affect migration (Box 5) in three distinct ways. First, the effects of warming and drying in some regions will reduce agricultural potential and undermine "ecosystem services" such as clean water and fertile soil. Second, the increase in extreme weather events – in particular, heavy precipitation and resulting flash or river floods in tropical regions – will affect ever more people and may generate mass displacement. Finally, sea-level rises are expected to destroy extensive and highly productive low-lying coastal areas that are home to millions of people, who will have to relocate permanently. In this context, health challenges can involve, among other things, the spread of communicable diseases and an increase in the prevalence of psychosocial problems due to stress associated with migration. The human and social consequences of climate change in this context are studied very poorly, if at all.

Box 5: Definition of environmental migrants used in the context of this document

"Environmental migrants are persons or groups of persons who, for compelling reasons of sudden or progressive changes in the environment that adversely affect their lives or living conditions, are obliged to leave their habitual homes, or choose to do so, either temporarily or permanently, and who move either within their country or abroad".

Source: International Organization for Migration (2007).

There are few studies on the linkages between extreme events and domestic and sexual violence. However, a report that looked into the issue of recovery after the Indian Ocean tsunami in 2004 indicated that women and children were very vulnerable in these situations. Although the occurrence of tsunamis is not attributable to weather or climate change, one can assume that in the aftermath of extreme events and the ensuing displacement of groups of people that may occur, scenarios similar to the post-tsunami conditions are plausible.

The *World Disaster Report* recognizes the widespread consensus that "women and girls are at higher risk of sexual violence, sexual exploitation and abuse, trafficking, and domestic violence in disasters" (IFRC, 2007). Women who were subjected to violence before a disaster are more likely to experience increased violence after the disaster, or they may become separated from family, friends and other potential support and protective systems. After a natural disaster, women are more likely to become victims of domestic and sexual violence and may avoid using shelters as a result of fear (Davis et al., 2005; IFRC, 2007).

Psychological stress is likely to be heightened after disasters, particularly where families are displaced and have to live in emergency or transitional housing. Overcrowding, lack of privacy and the collapse of regular routines and livelihood patterns can contribute to anger, frustration and violence, with children and women most vulnerable (Bartlett, 2008).

Adolescent girls report especially high levels of sexual harassment and abuse in the aftermath of disasters and complain of the lack of privacy in emergency shelters (Bartlett, 2008).

3.2 Shifts in farming and land use

For farmers, insecurity due to erratic rainfall and unseasonal temperatures can be compounded by a comparative lack of assets and arable land, and in some cases lack of rights to own the land they till. This means that credit available for suitable agriculture technology (e.g. watering implements, climate appropriate seed varieties, non-petroleum fertilizers, energy-efficient building design) is limited, as is their capacity to rebuild post-natural hazards in this context.

Loss of biodiversity can compound insecurity because many rural women in different parts of world depend on non-timber forest products for income, traditional medicinal use, nutritional supplements in times of food shortages, and a seed bank for plant varieties needed to source alternative crops under changing growing conditions. Thus, loss of biodiversity challenges the nutrition, health and livelihood of women and their communities (Boffa, 1999; Pisupati & Warner, 2003, Roe et al., 2006; Arnold, 2008).

Nutritional status partly determines the ability to cope with the effect of natural disasters (Cannon, 2002). Women are more prone to nutritional deficiencies because of their unique nutritional needs, especially when they are pregnant or breastfeeding, and some cultures have household food hierarchies. For example, in South Asia and South-East Asia, 45–60% of women of reproductive age are underweight and 80% of pregnant women have iron deficiencies. In sub-Saharan Africa, women carry greater loads than men but have a lower intake of calories because the cultural norm is for men to receive more food (FAO, 2001). For girls and women, poor nutritional status is associated with an increased prevalence of anaemia, pregnancy and delivery problems, and increased rates of intrauterine growth retardation, low birth weight and perinatal mortality. According to the Food and Agriculture Organization (FAO), in places where iron deficiency is prevalent, the risk of women dying during childbirth can be increased by as much as 20% (FAO, 2002).

Pregnant and lactating women face additional challenges, as they have an increased need for food and water, and their mobility is limited. Globally, at any given time, an average of 18–20% of the reproductive age population is either pregnant or lactating (Röhr, 2007). These biological factors create a highly vulnerable population within a group that is already at risk (Shrade & Delaney, 2000).

3.3 Increased livelihood, household and caring burdens

Apart from the nutritional impacts of livelihood, household and caring burdens, decline in food security and livelihood opportunities can also cause considerable stress for men and boys, given the socially ascribed expectation that they should provide economically for the household. This can lead to mental illness in some cases. It has been recognized that men and boys are less likely than women and girls to seek help for stress and mental health issues (Masika, 2002).

Women and girls are generally expected to care for the sick, including in times of disaster and environmental stress (Brody et al., 2008). This limits the time they have available for income generation and education, which, when coupled with the rising medical costs associated with

family illness, heightens levels of poverty, which is in turn a powerful determinant of health. It also means they have less time to contribute to community-level decision-making processes, including on climate change and disaster risk reduction. In addition, being faced with the burden of caring for dependents while being obliged to travel further for water and firewood makes women and girls prone to stress-related illnesses and exhaustion (CIDA, 2002; VSO, 2006).

Women and girls may also face barriers to accessing health-care services due to poor control over economic and other assets to avail themselves of health care, and cultural restrictions on their mobility that may prohibit them from travelling to seek health care.

Increased time spent collecting water means a decrease in available time for education and places women and girls at risk of violence when travelling long distances. A lower education status implies more constraints for women to access health information or early warning systems as they are developed. This also means that girls and women have decreased access and opportunities in the labour market, increased health risks associated with pregnancy and childbirth, and less control over their personal lives.

Elderly women may have heavy family and caring responsibilities that cause stress and fatigue, while also preventing wider social and economic participation. Their incomes may be low because they can no longer take on paid work or other forms of income generation. They may have inadequate understanding of their rights to access community and private-sector services. Even when they are aware of these services, nominal financial resources for clinic visits and drugs may be out of their reach. Access is further restricted for older women and older men living in rural areas, who are often unable to travel the long distances to the nearest health facility.

Older men are particularly disadvantaged by their tendency to be less connected than women to social networks and therefore unable to seek assistance from within the community when they need it (Consedine & Skamai, 2009).

3.4 Urban health

An individual's place of residence and their status within that place are important determinants of health. Urbanization is a dominant trend, with more people living in marginal conditions in cities in developing countries. Urban populations have distinct vulnerabilities to climate related health hazards (Campbell-Lendrum & Corvalan, 2007).

Limited access to land in rural areas, conflict, divorce and unemployment forces increasing numbers of women into living in marginalized urban and peri-urban areas and slums. These dwellings are often situated on ground with particular environmental risks, such as hillsides and low-lying plots.

The rising rate of female-headed households in urban/peri-urban areas results in a shift of urban sex ratios and feminization of urban poverty. Poverty, exposure of dwelling, and managing on their own the disproportionate daily burden of infrastructural needs such as waste management, fuel, water and sanitation make urban female heads of households particularly vulnerable to natural disasters (Chant, 2007).

4. Responses to climate change

"Climate change will affect, in profoundly adverse ways, some of the most fundamental determinants of health: food, air, water."[III]

"Climate change could vastly increase the current huge imbalance in health outcomes. Climate change can worsen an already unacceptable situation that the Millennium Development Goals were explicitly and intricately designed to address."[IV]

The international response to climate change is governed by the UNFCCC. The stated aim of the UNFCCC is to avoid the "adverse effects" of climate change, which it defines not only as impacts on "natural and managed ecosystems or on the operation of socio-economic systems" but also on "human health and welfare" (UN, 1992). Although climate change is widely considered to be one of the most significant threats to future human development, it is often analysed through an exclusively environmental or economic perspective, without adequately considering the extent to which it affects all aspects of human societies.

According to Article 4.f. of the UNFCCC, before parties propose new adaptation or mitigation initiatives, they shall assess its health benefits or negative impacts together with environmental and economic considerations. This article recognizes the importance of considering health and other social implications, including gender equality, when developing impact assessments and not basing decisions only on potential economic and environmental impacts. The correct implementation of this UNFCCC provision will bring opportunities to advance the sustainable development agenda.

In contrast, poorly designed policies could easily undermine gender equality, climate and health equity goals and reduce public support for their implementation. An essential aspect for achieving health equity and climate goals is therefore a commitment to intersectoral action to achieve "health equity and climate change in all policies" (Walpole et al., 2009).

Specific policies need to be carefully designed and assessed. Integrated assessment methods that consider the gendered range of effects on health and health equity can maximize synergies and optimize trade-offs between competing priorities. At the design stage, implementing safeguards and flanking measures, such as recycling revenue from carbon pricing measures, towards health outcomes for disadvantaged groups can help avoid or reduce inequitable effects (Walpole et al., 2009).

4.1 Mitigation actions and health co-benefits

The UNFCCC states that mitigation measures bringing about societal benefits should be prioritized. Health is one of the clearest of the societal benefits. Measures undertaken to reduce greenhouse gas emissions in the household energy, transport, food and agriculture, and electricity generation sectors, in both low- and high-income settings, can have ancillary health benefits (or "health co-benefits"), which are often substantial.

III Chan (2007).

IV Ibid.

There is growing interest in the links between gender and mitigation efforts. To develop effective mitigation policies and programmes that will also impact on key health outcomes, it is crucial that equity and gender perspectives are integrated into relevant policy and programme design.

There is accumulating evidence of important differences in the circumstances, attitudes and behaviours of women and men in relation to decisions on mitigation policies and their relation to health. For example, a study that looked at gender differences in energy consumption patterns and greenhouse gas emissions among single households in Greece, Sweden, Norway and Germany found that the average single man consumed more energy than the average single woman in all four countries studied. The largest difference in absolute energy use between single men and single women was in the category of transport (primarily due to cars). In the study the average single man spent more money on vehicles and fuel than did the average single woman. Men also spent more money on buying cars and other vehicles than did women, resulting in higher indirect energy use by men. Women on the other hand consistently used more energy than men in consumption categories such as food, hygiene, household effects and health, although the differences were small (Räty & Carlsson-Kanyama, 2010). Studies for the Organisation for Economic Co-operation and Development (OECD) have shown that women make over 80% of consumer decisions and are more likely to be sustainable consumers, with a higher propensity to recycle and placing a higher value on efficient energy compared with men (OECD, 2008). Such differences are likely to be particularly important in relation to choices such as food, because decisions such as moderating meat and dairy consumption can help to reduce the large contribution of agriculture to greenhouse gas emissions and at the same time bring very large health benefits.

Gender differences extend beyond individual consumer choices and also apply to attitudes to wider policy decisions. For example, a large survey in Australia examined attitudes towards carbon capture and storage from power plants and other stationary sources (IPCC & TEAP, 2005), which has been advocated as a potential measure to reduce greenhouse gases but which also raises environmental, health and safety concerns related to possible leakage of carbon dioxide. The survey showed women were less accepting of carbon capture and storage and more concerned than men about safety, risk and effectiveness (Miller et al., 2007).

When devising and applying policy instruments for energy efficiency or emission reductions, it is important to know the target groups. If women and men differ regarding their use of energy and emission profiles, then the mitigation policy instruments should reflect these differences to achieve the maximum benefits from the policies (Miller et al., 2007). The integration of a gender analysis component will help in understanding how gender norms, roles and relations determine the different patterns of obtaining and using fuel, energy and water by both women and men. The following sections examine these interactions for two of the sectors that make the largest contribution to greenhouse gas emissions and health outcomes, and that have the strongest evidence of gender-specific differences.

4.1.1 Access to energy

One of the main responsibilities of women in developing countries is ensuring energy supply and security at the household level. It is therefore crucial to involve women in the design, negotiation and implementation of clean energy choices that have the potential to improve health and well-being, both through reduced risks to health, and through savings in time and financial resources

(Aguilar, 2009). In addition, involving men is also important because they are often the decision-makers in households in many parts of the world. Involving both women and men will increase the chances of adoption and sustenance of alternative energy strategies. There is also a need to address existing, often unequal power relations regarding decision-making on household security and energy consumption through empowerment of women.

Lessening the reliance on coal-fired generation of power will reduce air pollution and associated respiratory and cardiopulmonary disease and death (von Hilderbrand, 2009). Indeed, the provision of affordable clean household energy in developing countries can contribute to the attainment of the Millennium Development Goals through both co-benefits to health and contributions to poverty reduction – attained by the provision of productive work and the reduction of unproductive time. This in turn can lead to a reduction of gender inequities (Wilkinson et al., 2007).

Approximately 2 billion people lack access to electricity and suffer substantial ill-health as a result. Around half the global population cooks daily with traditional biomass fuels (e.g. dung, crop residues, wood, charcoal), resulting (particularly for women and children) in exposure to very high concentrations of indoor air pollutants and impacting on health by increasing the risk of chronic obstructive pulmonary disease, worsening lung function (Behera et al., 2001; Liu et al., 2007), and contributing to childhood pneumonia and lung cancer. In addition, fuel shortages increase the workload of women in places where they are responsible for collecting fuel.

More energy-efficient cooking stoves are becoming increasingly available in a number of countries and can substantially cut the use of biomass fuels, with subsequent health, environmental and economic benefits (Haines et al., 2006) (for an example, see Box 6).

Box 6: The Nepal Biogas Support Programme

Inefficient burning of biomass in unventilated homes releases high levels of black carbon, causing approximately 2 million deaths a year, mainly among women and children in the poorest populations. The black carbon from such burning is also a significant contributor to local and regional warming. Improved access to clean energy therefore presents opportunities for improving health, livelihoods and the environment.

Biogas systems convert cattle dung and other animal or human wastes into methane. This flammable gas is a simple-to-use fuel for lighting and cooking: it burns cleanly and efficiently on a conventional low-pressure gas burner. In Nepal, the Biogas Support Programme has installed more than 120 000 biogas plants over the past 13 years. About 3% of Nepalese homes now benefit from this intervention, with much lower levels of indoor air pollution and reduced time spent gathering fuel, with particular gains for women. Moreover, 72% of the biogas plants are connected to latrines, leading to improved cleanliness and reduced health risks in the vicinity of the home. The residual slurry is a valuable organic fertilizer.

This biogas programme was the first to be recognized under the Clean Development Mechanism. It trades certified emission reductions; each operational biogas plant is worth 4.6 tonnes of carbon dioxide (CO_2) equivalent per year. This success story points to new synergies between household energy programmes and efforts to reduce climate change.

Source: Adapted from Netherlands Development Organization & Biogas Sector Partnership – Nepal (2004).

Although hydroelectric power is a clean and renewable energy source and attractive as a mitigation strategy to reduce greenhouse gases, hydropower plants can significantly impact on the surrounding area and provoke opposition for numerous social, environmental, economic and safety reasons. It is estimated that the construction of hydropower plants has already displaced some 30–60 million people,[V] usually poor people who are further impoverished economically and suffer cultural decline, high rates of sickness and death, and great psychological stress. As the majority of impoverished people are women, and women also suffer specific health consequences of forced migration, it is expected that such displacement would have a gender dimension (Davis et al., 2005; IFRC, 2007; Bartlett, 2008). The livelihoods of people downstream of dams can also be severely affected through the destruction of fisheries, the contamination of water supplies and the loss of seasonal floods, which bring fertile silt and water to agricultural land. Dam reservoirs can also become breeding grounds for water-related diseases such as malaria and schistosomiasis (Diop & Jobin, 1994; Ghebreyesus et al., 1999).

Sources of renewable energy such as photovoltaic, solar, thermal, wave and wind power do not appear to have any important adverse effects on health, and their overall impacts are likely to be overwhelmingly beneficial (Haines & Kammen, 2000).

4.1.2 Transportation

Transport is currently responsible for about 23% of world energy-related greenhouse gas emissions (IPCC, 2007a). Transport is projected to create the fastest proportional growth in greenhouse gas emissions of any sector from 1990 to 2020, with direct connections with urban air pollution (around 1.3 million related lung cancer deaths per year globally), road traffic accidents (the first leading cause of death in 2004 in men aged 15–44 years, over 1.2 million deaths per year, and 20–50 million non-fatal injuries per year) and physical inactivity (more than 3.2 million deaths in 2004) (WHO, 2009a,b). The need to reduce greenhouse gas emissions is prompting consideration of a more sustainable focus where the emphasis is on public transport, active transport and road safety. The gender dimensions need to be studied further.

In 2002, males accounted for 73% of all road traffic deaths, with an overall rate almost three times that for females (27.6 males per 100 000 population; 10.4 females per 100 000 population). Road traffic mortality rates are higher in men than in women in all regions, regardless of income level, and also are higher across all age groups. The gender difference in mortality rates is probably related to both exposure and risk-taking behaviour (Waldron et al., 2005).

Despite traditional engineering approaches favouring high-cost infrastructure that provides greater speed for vehicles, it has been shown that measures that truly improve urban transport overall are those that reduce speeds and provide a safer environment for pedestrians (Broaddus et al., 2009). Speed-reduction policies have big environmental impacts and also result in great public health benefits: for every 1 km/h reduction in average speed, there is a 3% reduction in the incidence of injury-incurring car crashes (WHO, 2004). For example, in Israel, major highway projects are usually based on cost–benefit analyses in which the value of time saved on car travel, especially travel to work, is weighted heavily. Yet highway development, which also encourages suburbanization and fragmentation of commercial and residential functions and degrades public transport, leads to a loss rather than a saving of women's time (Fletcher et al., 1999).

V See http://www.internationalrivers.org/en/node/570.

Promoting active transport such as cycling and walking by providing cycling lanes, pedestrian paths and pedestrian precincts could result in very large public health benefits. It is well known that physical activity is a protective factor for a wide range of diseases, including coronary heart disease, stroke, type 2 diabetes, hypertension, osteoporosis, dementia and some types of cancer. An urban environment that encourages active transport and lifestyle overall would bring social and mental health benefits and potentially lower obesity rates (Woodcock et al., 2009). The extent to which active transport can be integrated into everyday life depends on the distances to be travelled, the available infrastructure and resources, and the respective cultural and social norms of a country. Cultural restrictions on the mobility of women can make them resort to other means of transport.

In some parts of Africa, women who ride bicycles are highly stigmatized, and cultural constraints may not permit a woman to ride a bicycle or a scooter. This cultural norm inhibits women's range of mobility and makes them more dependent on their male counterparts, thereby hindering appropriate health-seeking.

Further restrictions on women include gender-based issues around vehicle ownership. Men are typically the first to get access to a private vehicle in a household and, when possible, also the first to motorize. Furthermore, men are more likely to get a driving licence. Women on the contrary usually use the vehicle that is left behind and often rely on public transport for travelling longer distances (GTZ & Federal Ministry for Economic Cooperation and Development, 2007). A study on road transport, environment and social equity conducted in Israel in 1999 found that gender roles dictated different travel patterns for women and men. Israeli women made more short journeys and fewer interurban trips than men – a factor probably related to their multiple roles in the workplace and home. In metropolitan Tel-Aviv-Jafo, women made about 50% more trips daily in their community of residence compared with men. Conversely, men made about 60% more interurban car trips compared with women. The special needs of women in relation to short-distance travel networks – including pedestrian and urban mass transit routes – receive little attention from policy-makers, who focus largely on the planning of improved interurban and urban bypass roads (Garb & Fletcher, 1999).

A study that examined transportation improvement strategies for a major urban highway corridor in Dhaka, Bangladesh examined the impacts of different road-improvement strategies on transit passengers and rickshaw pullers. The primary focus of the road-improvement strategy was to reduce congestion by restricting non-motorized transport modes such as rickshaws, which were a major part of the travel flow in the corridor. Many of those interviewed stated that although congestion on the major road declined, the road-improvement strategies had a negative impact on women, especially those in low- and middle-income groups, who find it extremely difficult to ride in overcrowded local buses during peak hours (Salma, 2004).

These examples demonstrate that gender is a key component for planning, designing and implementing transportation policies. An example from Bogotá, Colombia (Box 7) illustrates that the implementation of sustainable transportation policies does not only impact on the immediate environment but also can have an effect on gender equality, health and quality of life.

Box 7: Sustainable transport in Bogotá[VI]

Until recently, Bogotá's growth has placed a strain on its roads and public areas. Due to inadequate urban and transportation planning, Bogotá's streets were congested and polluted, and public urban spaces, including parks, open spaces and pedestrian paths, were disappearing in favour of uncontrolled urban sprawl. This hostile environment provided a fertile ground for social and economic inequality and environmental degradation in the city, and contributed to the city's urban decay.

As Bogotá's urban population passed 6 million, there was increasing awareness that local and national policy-makers would need to work jointly to provide effective solutions. The implementation of a planned and sustained policy resulted in an urban renewal campaign over a period of 12 years. This included changes in planning methods, effective public and private management, and a new focus on public participation, with the aim of generating an inclusive, sustainable and just city, transformed from a city for cars into a city for its people.

The mass transport system TransMilenio is considered a cornerstone in this model of urban development. TransMilenio uses a large fleet of high-capacity buses operating in dedicated arterial lanes (84 km of arterial lanes and 512 km of feeder route lanes) offering coverage and accessibility to 536 neighbourhoods, mainly benefiting low-income populations living in the peripheries of the city. The system has an average of 1.66 million daily transit trips and accounts for 26% of all public transportation trips in Bogotá. The TransMilenio buses also include reserved seating, spaces for wheelchairs and pushchairs, and preferential entry doors for pregnant women, people with disabilities, children and older people.

The overall renewal campaign also included infrastructural improvements such as building and renovating cycle paths (354 km) and footpaths, outlawing cars from using the footpaths, closing several streets to cars to convert them into pedestrian areas, creating and renewing green spaces and parks, and improving public facilities.

Data from TransMilenio and the ITSD indicate large and rapid benefits. Using 1998 base year data, the system is estimated to have saved up to 40 minutes per trip, and traffic accidents have been reduced by approximately 50% in the corridors where TransMilenio operates, with a reduction in injuries of more than 80%. There has been a reduction of 3–10 decibels in noise levels in the main arterial corridors. From its inception in 2001 until 2008, the project reduced CO2 emissions by over 1.6 million tons. Particulate matter and nitrogen and sulphur oxides decreased by over 60 000 tons, generating significant health benefits and creating health-care savings estimated at over US$ 428 million between 2006 and 2009. The crime rate also dropped notably over the same period.

The project is considered to have contributed to the social development of the city. TransMilenio is estimated to have generated almost 40 thousand direct jobs (supported by social security and health benefits, and welfare, epidemiological monitoring and disease-prevention programmes) and over 55 thousand indirect jobs. The system has also aimed at balancing the traditional dominance of men in the transport workforce, and prioritized the employment of groups such as single mothers, who comprise 62% of the female workforce. The female participation is currently 24% of the total system workforce, ranging from 2–8% in jobs such as bus driving, to 43% in bus washing, to 70% in fare collection.

This initiative is widely considered to have brought large improvements in health, gender equity and environmental sustainability to the people of Bogotá, and it is internationally recognized as an example for urban renewal.

Source: Adapted from Despacio (2008).

VI Source: Rodriguez Aponte, D. Subgerencia General, TRANSMILENIO S.A. 2010.

Providing opportunities for the use of safe mass transport can reduce levels of ambient air pollution and traffic-related injuries and deaths (von Hilderbrand, 2009).

4.2 Adaptation actions

Adaptation refers to changes in "processes, practices, or structures to moderate or offset potential damages or to take advantage of opportunities associated with changes in climate" and involves adjustments to decrease the vulnerability of communities and regions to the impacts of climate change and variability (IPCC, 2001b). Whereas adaptation was initially considered as a secondary and long-term option if mitigation efforts were not successful, it is now clear that some degree of adaptation is already necessary, particularly in developing countries (UNDP & GGCA, 2009). At the same time, there has been an expansion of approaches to adaptation, from an initial focus on interventions and infrastructure, to a more "development oriented" approach which aims to tackle the underlying drivers of vulnerability, rather than responding only to the symptoms (World Bank, no date).

This kind of second-generation approach helps to build resilience (Box 8) not only to climate change but also to other stressors that affect health and well-being, such as weaknesses in health care, education, social safety nets, and gender equity (World Bank, no date).

Box 8: Resilience to climate change (adaptive capacity)

When referring to human systems, the term "resilience" can be considered a synonym of adaptive capacity (IPCC, 2001b).

Adaptive capacity is the ability of a human or natural system to adapt – that is, to adjust to climate change, including to climate variability and extremes; to prevent or moderate potential damages; to take advantage of opportunities; or to cope with the consequences. The adaptive capacity inherent in a human system represents the set of resources available for adaptation (information, technology, economic resources, institutions and so on) and the ability or capacity of that system to use the resources effectively in pursuit of adaptation.

Source: World Bank (2010).

The following sections describe gender dimensions related to key components of adaptive capacity: coping strategies and local early warning systems.

4.2.1 Coping strategies

Adaptation measures in urban areas can reduce "heat island" effects, improve opportunities for social interaction and physical activity, and increase resilience to flooding. Similarly, improved building standards can reduce energy consumption, provide greater resilience to extreme weather, and reduce opportunities for infectious disease transmission (Campbell-Lendrum & Corvalan, 2007; Bloomberg & Aggarwala, 2008).

Although women and men can be powerful contributors of change in coping with changing climate conditions, the role of women is undervalued or undermined in many societies. There

is a need for women to be fully integrated into climate change adaptation strategies at all levels (Costello et al., 2009).

Case studies in Bangladesh, Ghana and Senegal have highlighted grassroots women's groups developing strategies to cope with issues related to energy and forestry, agriculture, water resources and trade.

FAO, in collaboration with local Indian institutions, conducted a survey on gender responses in coping with variability and long-term changes in climate. According to this survey, men are more likely to report that the weather changes have impacted farm production, while women are more likely to report that such changes have affected health. The study also explored differences in the preferred strategies for coping with long-term weather shifts. The preference to migrate was higher in men (47% of men versus 18% of women), whereas more women would opt to go for wage labour (57.5% of women versus 38% of men). Gender differences were also detected in access to vital information on weather alerts and cropping patterns. According to the farmers' reports, only 21% of women have access to this information, compared with 47% of men. These findings illustrate that gender is a cornerstone in dealing with adaptation strategies of climate change. Gender differences in access to resources and in selecting coping strategies have to be well understood and addressed because they matter both to farmers in their everyday experience of climate variability and to policy-makers in order to provide institutional support and the enabling environment (FAO, 2009).

In Nepal "mountain women" compared to women in the lowlands, and depending on the dominant culture within which they live, have a greater say in decision-making and have greater overall independence. The constant migrations of men mean that these women must be more involved in managing household and community resources. The women are able to maximize use of their available natural resources. Their knowledge helps in the survival and care of their families and permits adaptation in extreme situations such as conflicts, natural disasters and displacements. Unfortunately, their knowledge and skills are still not acknowledged and valued (WEDO, 1998). Box 9 shows another example of empowerment of rural women.

Box 9: Good practices: Bolivia – democratizing knowledge for rural empowerment

The Bolivian high-altitude plains are a harsh, arid, cold climate for agriculture, and innovative methods are needed for survival. An initiative started in October 2006 and concluded in July 2008, supported by Interccoperation, aimed to use traditional knowledge of climate prediction for better decision-making in agricultural production and risk management. This has helped to strengthen the capabilities in disaster risk management, monitoring bio-indicators of climate and weather-related hazards.

The programme was gender-sensitive, and the inclusion of women's expertise in the initiative was vital for transferring agricultural success into stable livelihoods, through women's traditional skills and roles in crop and seed storage, and in accessing markets. Women had the knowledge to design strategies for risk management and were able to assist other women farmers. They not only transferred knowledge but also helped to build up analytical capabilities of farming women.

The following lessons were learned from this experience: Agricultural risk management is a task for both women and men in rural contexts and empowerment can be achieved for women if they are recognized as knowledge managers.

The result is that farmers now lose less food because of climate threats. Also men and women are now capable of defeating frosts in the altiplano. In 2 years, more than 100 sound technologies and good practices were developed or reintroduced from traditional knowledge.

Source: Adapted from UNISDR (2008).

4.2.2 Early warning systems and hazard management

Case studies related to gender and natural disaster showed that women make an important contribution to disaster reduction, usually informally through participating in disaster management and acting as agents of social change. Women's resilience and women's networks are particularly important in household and community recovery (IPCC, 2007b).

After the 1999 Orissa cyclone, most of the relief efforts were targeted at or through women, giving them control over resources. Women received relief kits, including house-building grants and loans, resulting in improved self-esteem and social status. Similarly, following a disastrous 1992 flood in Pakistan in the Sarghoda district, women were involved in the reconstruction design and were given joint ownership of their homes, promoting their empowerment (Confalonieri et al., 2007).

After Hurricane Mitch in 1998, La Masica, Honduras surprisingly reported no deaths (Box 10). A disaster agency had provided gender-sensitive community education on early warning systems and hazard management 6 months earlier. Women were able to assume responsibility for continuously monitoring the early warning system, a role traditionally performed by men. As a result, the municipality was able to evacuate the area promptly when Hurricane Mitch struck (Buvinic et al., 1999).

Box 10: La Masica: Good practices in emergency preparedness

The municipality of La Masica in Honduras, with a mostly rural population of 336 people, stands out in the aftermath of Hurricane Mitch because, unlike other municipalities in the northern Atlantida Department, it reported no deaths. This outcome can be directly attributed to a process of community emergency preparedness that began about 6 months before the disaster.

The project involved the establishment of networks of local organizations in charge of risk and disaster management, coordinated through the municipality and the Municipal Emergency Commission. Networks were trained in the geographical mapping of hazards and use of an early warning system, and undertook an assessment of vulnerabilities differentiated by gender. Gender lectures were given and, consequently, the community decided that men and women should participate equally in all hazard management activities. When Hurricane Mitch struck, the municipality was prepared and evacuated the area promptly, thus avoiding deaths. Women participated actively in all relief operations. They went on rescue missions, rehabilitated local infrastructure such as schools, and, along with men, distributed food. Women also took over from men who had abandoned the task of continuous monitoring of the early warning system.

This experience shows that preparedness is an important step in saving lives. The engagement of women from the start, on an equal footing with men, contributed to the success in saving lives. In addition, and likely because of their active role, women reported a very low incidence of depression. In fact, contrary to repeated findings in the literature on disasters, the community assessed the psychological situation and concluded that help was required for men rather than for women to restore their capacity to contribute to the community.

One of the most important gains at La Masica was the empowerment of women and the community's recognition of women's capabilities and contributions. As a token of recognition, a new sign in the mayor's office reads: "Everything is easier with the cooperation of women."

Source: Buvinic et al. (1999).

Table 1 summarizes possible gender impacts of climate change and gender adaptive strategies, and provides recommendations for possible policy interventions to safeguard health, especially of women. The table reflects the gaps in data that can strengthen more specific and targeted interventions.

Table 1: Gender, adaptive strategies and interventions

Impact of climate change	Gender dimensions (examples)	Gender-sensitive adaptive strategies (examples)	Possible interventions beneficial to both women and men (examples)
Increase in infectious diseases	Women constitute the majority of those who take care of the sick (both as household caregivers and as front-line health workers) Women often lack, or have less access to, health services	A gender perspective must be incorporated into infectious disease analysis and research to target policies and programmes Collected data must be disaggregated by sex, age, socioeconomic status, education, ethnicity and geographical location, where appropriate An understanding of gender and its implications for health and health-seeking behaviour should be incorporated into training of health professionals and development of health-sector responses	Ensure better availability and access to, and support by, health systems for both women and men, but especially for women, given their caregiving roles Support outreach activities, using gender-sensitive information, education, and communication strategies and materials for advocacy and training Promote childcare facilities and other approaches to support women's caregiving role, while trying to transform related gendered roles and norms
Scarcity of water **Salination of water** **Increase in arsenic** **Flooding**	Health problems, especially for women and girls who have to walk long distances to fetch water Increase in work burden, which implies less time to access health-related resources such as education and economic resources	Promote water-saving practices that take into account the different uses and roles related to water for women, girls and men Address salination and arsenic contamination of water, proposing specific actions that consider the different patterns of exposure and impacts on women and men Counter social stigma attached to the effects of arsenic poisoning on women and men	Ensure affordable drinking water, taking into account the different roles and needs of women and men Empower women and facilitate their equal participation in management of water resources at national, regional and grassroots levels Appropriate technologies for assuring potable water closer to where families live Strengthen forestation and water-harvesting mechanisms, considering the different roles, needs and impacts on women and men Promote women's rights to own land and ownership of land use certificates Effective implementation of water policies that consider women's and men's different needs and roles for water use, provision and consumption Ensure equitable access to resources also in relation to payments for environmental services
Mortality through extreme weather events	Socioeconomic status, age and social gendered norms influence the risk of injury and death Women are vulnerable due to gender norms that dictate acceptable proper behaviours (e.g. not learning how to swim, not going out alone) Men's vulnerability because of gender norms that promote risk-taking	Provide safe shelters and homes for both women and men Training on gender-sensitive disaster risk reduction and early warning systems Promote programmes that facilitate men to seek help for psychosocial problems Empowerment of women to strengthen their capacity to question and change harmful behavioural norms that put them at risk in the case of extreme events	Gender-sensitive disaster preparedness Gender-sensitive early warning systems Ensure women's participation on equal basis in all policy and programme cycles Target women and men differently in communication campaigns and health-promotion strategies, taking into account their gender norms and roles Adopt strategies at all levels of programming to change norms and practices that prevent women or men from appropriate responses and coping mechanisms in situations of natural disasters

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Impact of climate change	Gender dimensions (examples)	Gender-sensitive adaptive strategies (examples)	Possible interventions beneficial to both women and men (examples)
Disruption of human security force migration	Increase of violence at household level Harassment and loss of privacy in shelters Harassment in relief queues	Build strong and supportive networks for both women and men Promote gender-sensitive training to eliminate violence against women, girls and boys Capacity building within the health system to ensure early detection of domestic or sexual violence Involve women in management of shelters and distribution activities	Policy initiatives in the health, education, finance and labour sectors to be conceived as a part of a cohesive national/international violence prevention effort that includes women, girls, men and boys Implement appropriate health services that respond to the specific needs of women and men based on their respective needs, roles and capacities Design effective referral systems for cases of domestic violence Design referral system for cases of sexual harassment
Decreased income-generating and credit opportunities after extreme weather events	Women working in informal sector are also affected Increase in household expenses Out-migration of males Feminization of poverty, especially in urban/peri-urban areas Risk of malnutrition related to loss of income	Save on expenses or money for lean periods for both women and men Promote alternative income-generating activities	Proper and accessible credit facilities, both formal and informal, for women Establish market linkages that consider different patters of consumption of women and men Vocational training for women and men Promote social security and other safety nets among people working in the informal sector, both women and men
Change in agricultural production **Decrease in fishery stocks**	Increase of work burden Calories/micronutrients deficiencies	Involve women and men in conservation of biodiversity	Training on agricultural extension for both women and men Better nutrition supplements for needy families Marketing facilities Land rights for women
Other indirect health impacts following extreme weather events: **Increased burden of work and responsibility, especially on women and girls** **Increased anxiety, fears and intra-household tension** **Increased rates of suicide among men in cases of drought**	Suicide rates are higher, due to weaker or non-existent and effective social networks, among men Greater social responsibility on women to cater for family needs such as water and food	Promote programmes that facilitate men to seek help for psychosocial problems Empower women to enhance their capacities to look after themselves and their families and specifically to use available social and other networks to cope with increased burdens and tensions	Target women and men differently in post-disaster relief, taking into account gender norms, roles and relations

5. Conclusions, gaps in understanding and issues for urgent action

Preparations for, and responses to, climate change need to be sensitive to gender dimensions of health care (including mental) and health-seeking behaviours.

Policies to promote mitigation activities that have strong co-benefits in health and other development needs provide a potential political bridge across the "development gap" between rich and poor countries.

Adaptation strategies need to take into account women's and men's relative and different capacities, power, social resilience, vulnerabilities and resources, because gender norms, roles and relations can either enable or constrain adaptive capacities.

IPCC acknowledges that disasters affect men and women differently on a number of levels, including economically, socially, psychologically, and in terms of exposure to risk and risk perception. However, there remains a general lack of research on sex and gender differences in vulnerability to, and impacts of climate change especially health-related impacts.

Addressing the social and gender dimensions of climate change poses many challenges that are not insurmountable. It requires gender mainstreaming in climate change response activities, sustainable and equitable development, a clear focus on adaptation and mitigation, a strong commitment of resources, and empowerment of individuals to build their own resilience.

Equity and social justice cannot be achieved without recognizing the differences in vulnerability and strengths of women and men, and the various factors that contribute to vulnerability. Recognizing these differences is a necessary and important component of any prospective attempts to address the gendered health consequences of climate change. Gender-sensitive research is needed to better understand the health impacts of climate change in general and extreme events in particular. There is an urgent need to collect, analyse and report relevant data disaggregated by age and sex; and, depending on the context, other stratifiers should be included to enable thorough gender analysis. There is a need for the development of gender-responsive and accessible health services that reach the poorest populations, thereby addressing particular health needs of women and men throughout their entire life-cycle.

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PUBLIC HEALTH AND ENVIRONMENT

In this paper, available information on the differential links between climate change and the health of women and men has been collated and analyzed. The overall aim is to provide a framework for gendered health risk assessment and adaptation/ mitigation actions in relation to climate change.

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