

Chapter 2

Climate Change, Health and Future Well-Being in South Asia

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Abstract About one fifth of the world's population live in South Asia. There are many reasons to be concerned about the impacts of climate change on this region, many parts of which experience apparently intractable poverty. The health problems caused by climate change in South Asia have been conceptualised here as three tiers of linked effects. In this framework, primary health effects are considered the most causally direct impacts of climate change. They include increased mortality and morbidity during heatwaves and 'natural' disasters worsened by climate change. Secondary effects include those resulting from ecological changes that alter the epidemiology of some infectious and chronic diseases. Tertiary effects refer to impacts on health of large-scale events with complex, multidimensional economic and political causation, including migration, famine and conflict.

Urgent action, both preventive and adaptive, is needed. India, an emerging great power, and the dominant nation in South Asia, must lead urgent and intense engagement with this overarching issue. Transformation of its energy system would improve population health, constitute regional leadership and be significant at the global level.

Keywords Climate change • Energy • Health inequality • South Asia • Sustainability

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2.1 Introduction

South Asia, defined geographically as the region of Asia that includes Afghanistan, Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan and Sri Lanka, holds 1.6 billion people, almost one quarter of the world's current population. Recent population projections suggest that by 2050, the population of South Asia will approximate or exceed 2.2 billion people (International Institute for Applied Systems Analysis 2012). Despite the perception of global economic growth and rising prosperity, 45 % of the world's poor people (living at or below \$2 a day) reside in South Asia; over one third of the world's poor lives in India alone (Sumner 2012).

Scenarios describing the effects of climate change are detailed elsewhere in this book, but the most recent estimates, detailed in the Intergovernmental Panel on Climate Change's (IPCC) fifth assessment report, suggest that by 2100:

- Global mean surface temperatures are likely to rise by between 1.4 and 5.5 °C, compared to the average temperature between 1850 and 1900. Already the world has warmed by about 0.85 °C compared to that baseline (IPCC 2013).
- Extreme rainfall events are very likely to become more intense and more frequent in tropical regions (IPCC 2013).
- The sea level is likely to rise by between 0.26 and 0.82 m (depending on the scenario) compared to the period 1986–2005 (IPCC 2013).

Data on the predicted impacts of climate change in South Asia are limited. The IPCC models suggest that there is likely to be an increase in mean temperatures in South Asia – this represents both an increase in winter temperatures and an increase in the frequency of extremely hot days and nights during the summer. Rainfall patterns are also likely to change: models suggest an increase in the frequency of extreme precipitation events, but an overall decrease in mean annual rainfall (IPCC 2013).

As the impact of climate change deepens, the people of South Asia are vulnerable due to a combination of factors. These include aspects of the region's physical and human geography, including high population densities, large areas lying close to sea level (particularly in the Maldives and coastal Bangladesh, including the Sundarbans, the delta which extends into India) and agricultural dependence on major rivers, fed by Himalayan glaciers vulnerable to melt. This vulnerability is exacerbated by high levels of poverty and income inequality and by poorly functioning national institutions and governance structures. It is important to recognise that the human toll from the increased disasters expected from climate change can be reduced by good governance and large-scale cooperation. In South Asia, the response to some disasters has greatly improved. For example, in Bangladesh in 1970 Cyclone Bhola (a category 3 storm, a classification in which the strongest category, a measure of maximum wind speed, is 5) killed at least 300,000 people (Cash et al 2013), but category 4 Cyclone Sidr in 2007 caused fewer than 3,500 deaths (Paul 2010). However, other governance structures remain weak, as shown by the belated and inequitable response to the 2005 earthquake in Pakistan (Yasir 2009).

2.1.1 Primary, Secondary and Tertiary Effects

The health impacts of climate change can be conceptualised in many ways. This chapter uses a framework that groups these impacts into ‘primary’, ‘secondary’ and ‘tertiary’ effects (Butler and Harley 2010; Butler 2014a, b). Primary effects are the most direct and obvious; these include changes in mortality and morbidity due to increased heatwaves and also include the most direct effects (e.g. trauma or drowning) of extreme weather events worsened by climate change, such as floods or cyclones. Secondary health effects are more indirect; they include the impact of changes in the ecology and the environment such as in the epidemiology of vector-borne diseases (VBDs) or of atopic conditions. Tertiary effects refer to the health impacts of complex, large-scale events that occur at a societal level, examples of these include conflict, famine and migration. Tertiary effects also include other ways that climate change may affect overall human well-being, for example, by impacting on economic growth or by causing extinction of other species (Thomas et al. 2004; Selwood et al. 2014).

There is, of course, overlap between the primary, secondary and tertiary effects of climate change – this is particularly true during ‘natural’ disasters – where there are direct primary health effects (such as death by drowning during flooding), but also potential secondary and tertiary effects as a result of responses to disasters, including diarrhoeal diseases, internal displacement and migration. Furthermore, all kinds of effect are mediated by economic, social and governance factors, from the presence or absence of heat alerts and storm warning signals to the quality of primary health care and the capacity of governments to respond to refugee crises.

Although high-quality data that specifically predict the health impact of climate change in South Asia are limited, the primary and secondary health effects have been well modelled in the global context. The tertiary effects are undoubtedly harder to model and quantify, not least as their causal attribution is so challenging and debated. However, we are far from the first health authors to recognise that climate change, beyond a threshold of warming of perhaps as little as 1.5 °C, may be associated with large-scale economic collapse, mass migration and resource scarcity, with consequences including conflict (Costello et al. 2009; Watts et al. 2015; King et al. 2015).

Given the complexity of the climate and of societal responses to climate change, the likelihood and timelines of these tertiary effects will be disputed. For example, the war in Syria is increasingly recognised as in part caused by climate change (Gleick 2014; Kelley et al. 2015). If so, we could consider it a tertiary effect. The risk of these catastrophic outcomes is real and must be taken into consideration in cost-benefit analyses and when planning adaptation responses (Weitzman 2009). Avoiding a ‘catastrophic’ outcome is also central to the most recent Lancet commission on climate change (Watts et al. 2015).

2.1.2 The Position of the Indian Government on Climate Change

Genuine global engagement with the issue of climate change will precipitate intense attempts to lower carbon emissions and their replacement by alternative paradigms that promote genuine and equitable economic growth, at the same time reducing pressure on natural resources. However, India has long argued against specific emission reduction targets for countries in the developing world, with the justification that climate change is a result of historical emissions from industrial activity in developed countries (Ministry of External Affairs 2009). It does however need to be acknowledged that India has pledged that it will not allow its per capita GHG emissions to exceed the average emissions of the developed world, even as it pursues its socio-economic development objectives. But as a regional power and aspiring global superpower, India has the potential to divest itself from the carbon-intensive development pathways of industrialisation and urbanization pursued by the developed world and, instead, adopt an alternative path, especially involving large-scale provision of renewable energy. This will not only benefit population health in India but create a vision for other developing countries, by allowing populations to lower the rate of climate change increase and, at the same time, continue on a path towards socio-economic growth, and for societies to adapt in ways that will minimise adverse health impacts.

India is a largely vegetarian society. As the carbon footprint of meat is so high, Indians can also make an important contribution to slowing the rate of climate change through maintenance of this ancient tradition (McMichael et al. 2007). On the other hand, many people in South Asia are deficient in zinc and iron and may benefit from more animal products in their diet. But they will also benefit from improved sanitation, handwashing and the treatment and prevention of parasitic conditions, such as of hookworm.

2.2 Primary Health Effects in South Asia

As mentioned, these include health impacts as a result of changes in temperature and exposure to ‘natural’ disasters, such as forest fires, floods and storms.

2.2.1 Changes in Temperature

Climate change in South Asia is predicted to lead to an increase in the frequency and duration of summer heatwaves, but also an increase in mean winter temperatures (IPCC 2013). The overall direct impact on health may be mixed – warmer winter temperatures may lower mortality and morbidity in some areas (Hashizume et al. 2009),

but heatwaves may also increase illness and mortality. High temperatures cause ill health through heatstroke, which can progress to death, and also through an increase in the mortality from cardiovascular and respiratory illness (Basu and Samet 2002). Some other conditions, such as multiple sclerosis, are worsened by heat. Whilst multiple sclerosis is uncommon in India, there may be other conditions that are worsened, perhaps, most obviously gastroenteritis. These risks are exacerbated by growing urbanization and the urban heat island effect, the phenomenon whereby cities show a higher mean temperature than surrounding farmland due to the building materials used and human activity within cities.

Models assessing the relationship between temperature and mortality in Delhi reveal a 3.9 % increase in cardiac and respiratory mortality and 4.3 % increase in mortality from all other causes, for every 1 °C rise in temperature (McMichael et al. 2008). The impact of heatwaves in South Asia has already been documented, such as a heatwave in the Indian state of Andhra Pradesh in 2006 that is estimated to have killed over 600 people (IPCC 2012). Heatwaves in 2015 in India and Pakistan have been widely reported in the media as causing over 3,000 deaths. Such media estimates are likely to be conservative, as they are largely based on hospital admissions. Many people are likely to have died in these heatwaves before reaching a hospital in South Asia.

A more recent study found that a heatwave in Ahmedabad, Gujarat, lasting for about a week, was associated with an increase in all-cause mortality of 43 % compared to a similar time of the year without a heatwave (Azhar et al. 2014). Heatwaves disproportionately affect the poorest and most marginalised in a society – the elderly (particularly elderly women), manual labourers and those who work outdoors (Kovats and Akhtar 2008; Kovats and Hajat 2008). High temperatures in India consistently above 30–32 °C have been linked with a significant increase in rural mortality thought to be mediated through lower rural incomes, due to lowered crop yields (Burgess et al. 2011). This could also be conceptualised as a risk factor of a tertiary health impact, potentially causing large-scale food insecurity.

2.2.2 *Natural Disasters*

Models suggest that the frequency of tropical cyclones is unlikely to rise, but that their intensity may increase, with more extreme precipitation (IPCC 2013). Heavy precipitation and tropical cyclones interact with rising sea level to cause primary health effects through flooding and secondary effects through an increase in diarrhoeal disease. Longer-term impacts of tropical cyclone include destruction of farm crops and salinisation of coastal soils and water supplies (IPCC 2014a), leading to the tertiary health effects of forced migration and internal displacement.

Cyclone Nargis, which killed over 130,000 people in Myanmar (not part of South Asia as we have defined it, but in close proximity) in 2008, is an example of the devastating impact that natural disasters can wreak, particularly in countries that are densely populated in coastal regions, with poor-quality building infrastructure

and vulnerable populations. The impact of Nargis was exacerbated by seawater surges, which led to extensive damage to Myanmar's rice crop and salinisation of land. Over 50,000 acres of previously fertile delta land was temporarily considered unfit for planting (Webster 2008).

2.2.3 *Flooding*

Flooding can be caused by increased precipitation, sea level rise or glacier melt. Models suggest that climate change in South Asia is likely to result in longer monsoon seasons, with more heavy precipitation (IPCC 2013). Sea levels rise as a result of thermal expansion of the oceans, melting of ice sheets and loss of glacier mass. Models suggest that, by 2100, global sea level is likely to have risen by between 0.26 and 0.97 m (IPCC 2013). Another effect of climate change relevant to South Asia is the melting of Himalayan glaciers (IPCC 2013). In the short term, this is associated with increased water flows in the rivers supplied by Himalayan glaciers, such as the Ganges and Brahmaputra. Large coastal cities in South Asia (such as Mumbai, Dhaka and Chittagong) face risks of flooding from sea level rise, from rapid increases in river flows, and flooding caused by blocked, poorly maintained drains and sewers overwhelmed by heavy rainfall (Tanner et al. 2009).

Flooding causes ill health directly, through trauma and drowning. More significantly, it harms water and sanitation infrastructure and is associated with increased diarrhoeal disease and VBDs (Githeko et al. 2000). Urbanization, and rapid population growth without sufficient investment in sanitation infrastructure, has left South Asian megacities particularly vulnerable (Kovats and Akhtar 2008). Floods already pose a major health problem in parts of South Asia: flooding in Dhaka in 2004 inundated the whole eastern part of the city; two million people experienced drinking water that was more contaminated than normal. Flooding in Dhaka in 1998 is estimated to have resulted in 5,000 excess cases of diarrhoea (Alam and Rabbani 2007).

2.3 **Secondary Health Effects in South Asia**

The secondary effects of climate change on health include how changes in the environment and ecology can bring about changes in disease epidemiology. This includes increases in water-borne illnesses caused by flooding and temperature rise and shifts in the geographical distribution of VBDs. Importantly, climate change is only one of many factors which shape the incidence and impact of infectious diseases. Non-climatic factors (other than humidity, temperature and rainfall) which interact with and which complicate the epidemiology of climate change include migration, changes in land use, drug and insecticide resistance and eradication efforts (Reiter 2008). Furthermore, although climate change is predicted to increase transmission windows of malaria overall in South Asia, it will likely reduce it in some areas.

2.3.1 *Diarrhoeal Disease*

Climate change is likely to result in an increased incidence of diarrhoeal disease in South Asia, through two separate mechanisms. The first is that natural disasters (particularly flooding) can damage water and sanitation infrastructure resulting in contamination of drinking water supplies with infective faecal material (ten Veldhuis et al. 2010). Models suggest that in the WHO South-East Asian Region D (which comprises Bangladesh, Bhutan, North Korea, India, Maldives, Myanmar and Nepal), there may be an excess incidence of 40 million cases of diarrhoea per year, by 2030, as a result of climate change (Ebi 2008).

Another mechanism is the association of climate change with warmer sea temperatures. Some organisms (e.g. the *Vibrio cholerae* bacteria, which cause cholera) are naturally found in coastal water bodies and are concentrated in plankton. Warmer sea temperatures are associated with an increased rate of bacterial reproduction and are also associated with phytoplankton blooms (Lipp et al. 2002). As a result, the likelihood of transmission of cholera to humans is increased, either through drinking infected water or through eating shellfish which concentrates the organism.

2.3.2 *Leptospirosis*

Leptospirosis is a bacterial disease, carried by animal hosts, passed to humans through direct contact with infected animals or through exposure to the urine of infected animals. Several outbreaks of leptospirosis have been associated with flooding in India, through multiple hypothesised mechanisms, by bringing humans in closer contact with the bacteria and its animal hosts, through damage to sanitation infrastructure and by increasing rodent populations. In addition, rising temperatures mean that spirochaetes (the organisms which cause leptospirosis) can persist longer in the environment, also enhancing transmission risk. The incidence of leptospirosis is likely to increase in urban megacities, with their poor water and sanitation infrastructure, and where there are large numbers of animal reservoirs (such as rats) in close proximity to humans (Lau et al. 2010).

2.3.3 *Vector-Borne Diseases*

Changes in temperature can affect the rates of reproduction and survival of infectious organisms and insect vectors, thus affecting rates of transmission of vector-borne diseases and causing diseases to spread to new areas (Patz et al. 2005). There are six major vector-borne illnesses in South Asia (malaria, dengue, chikungunya, filariasis, Japanese encephalitis and visceral leishmaniasis). Of these, malaria has the most impact, killing over 55,000 people in South Asia in 2010 (Murray et al. 2012).

Malaria is transmitted by the *Anopheles* mosquito, an insect vector which is highly sensitive to changes in temperature. As climate change results in higher temperatures (and warmer winters), transmission windows are predicted to increase in North India, and malaria is predicted to spread to new parts of previously low-risk countries, such as Bhutan and Afghanistan. In fact, malaria has already re-emerged in parts of North Afghanistan. Climate change is one potential risk factor for this, amongst intensified rice growing and insufficient chemical vector control (Faulde et al. 2007). In addition, the development stages of *Anopheles* mosquitoes are highly temperature dependent, as is the growth and maturation of the parasite within the mosquito. The abundance of potentially infectious mosquitoes increases with warmer temperatures, up to a threshold of around 30 °C (Beck-Johnson et al. 2013). As a result of climate change, malaria transmission is predicted to extend by 2–3 months in the northern Indian states of Punjab, Haryana and Jammu and Kashmir, although its transmission windows will decrease in South India as temperatures exceed 40 °C (Dhiman et al. 2010).

The *Aedes* mosquito, a vector for the virus which causes dengue fever, is similarly sensitive to changes in temperature and humidity. A 2–4 °C rise in temperature is predicted to increase dengue transmission windows in North India (Dhiman et al. 2010); as a result of climate change and population growth, the global population at risk of dengue is predicted to rise from 1.5 billion people in 1990 to 4.1 billion people by 2055 (Hales et al. 2002).

Evidence on the effect of climate change on other VBDs is more limited. Chikungunya, a viral disease transmitted by insects including the *Aedes* mosquito, has recently spread from its origin in Africa to affect parts of Southern India, Sri Lanka and Indian Ocean islands, including Reunion, Mauritius, Madagascar and the Maldives. Like all VBDs, its aetiology is complex, also involving human mobility and even trade, such as of tyres and plants in which vectors or their eggs sometimes survive and thus accidentally migrate (Gould and Higgs 2009). Similar to dengue, as temperatures rise, transmission windows for chikungunya are likely to increase in North India (Dhiman et al. 2010). Visceral leishmaniasis, a parasitic disease spread through a climate-sensitive sandfly vector, is also re-emerging in parts of Nepal and Northern India (Dhiman et al. 2010). Whilst this is likely to be principally due to a lagged resurgence in vector populations following the reduced use of insecticides, climate change is a plausible contributing factor.

2.4 Tertiary Health Effects in South Asia

The tertiary effects of climate change occur at the intersection of climate, politics and ecology and may include large-scale societal shifts (Butler and Harley 2010). They do not fit easily into traditional quantitative models. Whilst the most speculative of the three classes of effect we have used, they may also be the most important,

as realisation grows that the interaction between humans and ecosystems must be viewed through the lens of interdependent complex adaptive systems, even though outcomes can be difficult to predict (Folke et al. 2002).

The complex nature of tertiary effects may lead to a series of positive (reinforcing) feedback loops, with drastic consequences at a population level. Changes in temperature and rainfall patterns are likely to harm agriculture and food production. Sea level rise, and an increased frequency of extreme precipitation events, may worsen flooding and land inundation, contributing to forced human migration (Bowles et al 2014), such as the potential for the Sundarbans population to be compelled to migrate to West Bengal or Bangladesh (Daigle 2015). Migration and limited availability of natural resources may lead to conflict. Movement of people into internally displaced persons' (IDP) and refugee camps can be associated with localised land degradation, more food insecurity and increased scarcity of natural resources. In turn these events can be associated with further conflict. All of these indirect effects are influenced by social, economic and demographic pressures, in conjunction with climate change (McMichael 2013).

2.4.1 Food Insecurity

Energy undernutrition is directly estimated to kill 190,000 people in South Asia each year, 50,000 of them under the age of five (Global Burden of Disease 2010). The indirect effects of chronic undernutrition are much greater, including an increased susceptibility to infectious diseases (Rao and Beckingham 2013). In total, including indirect effects, undernutrition is currently estimated to result in almost a million deaths each year of children under the age of five in South Asia (Black et al. 2008).

Existing food insecurity is likely to be exacerbated by climate change, although there is a high degree of regional and crop variation. Extreme weather events are likely to dramatically reduce access to food, and temperatures above 30 °C have a large negative impact on crop yields. By contrast, elevated atmospheric CO₂ is likely to improve some crop yields in the short term, although how this interacts with other factors, including ocean acidification, is unknown (IPCC 2014b). In South Asia, higher temperatures are predicted to reduce the yield of rice production (IPCC 2014b). This impact is likely to be exacerbated by a reduction in water availability, as rainfall patterns change and as glacier melt leads to long-term reduction in river flows, particularly in the Indus and Brahmaputra River basins (IPCC 2013; Immerzeel et al. 2010). Overall, in South Asia, one estimate is that crop yields will decrease by 5–30 % by 2050, leading to an additional 5–170 million people at risk of undernutrition (Schmidhuber and Tubiello 2007). The IPCC projects that by the middle of the twenty-first century, the largest number of food-insecure people will be located in South Asia, partly caused by reductions in sorghum and wheat yields (IPCC 2014b).

As discussed previously, the eventual impact on food security is very difficult to predict as human factors, including population growth, economic growth and income inequality, are likely to have a greater overall influence on food security than climate change alone (IPCC 2014b).

2.4.2 *Migration*

Many effects of climate change are likely to contribute to migration in and from South Asia. Large-scale extreme weather events, including flooding and tropical cyclones, are likely to lead to sudden but temporary human movements, with the possible return of displaced people. By contrast, gradual and long-term climatic shifts, including sea level rises, increased competition for natural resources and land degradation, may result in more permanent internal and external migration of populations (Walsham 2010). As with all tertiary effects, migration is not easy to model, with multiple economic, political, social and cultural drivers influencing vulnerability and individual decisions to migrate. In South Asia, climate change-influenced and driven migration will occur in the context of ongoing population growth and rural-to-urban migration driven by a perception of greater economic opportunities.

A sea level rise of 1 m (towards the upper end of the current IPCC estimates for 2100) would impact at least five million people across South Asia, mostly in Bangladesh and Sri Lanka (Dasgupta et al. 2007). Even worse, however, these projections of sea level rise do not factor in possible feedbacks to the climate system such as from methane and CO₂ release from the melting tundra. Sea level rise may directly displace people through loss of land mass, but can indirectly displace people through saltwater intrusion and degradation of agricultural land (Walsham 2010). In Bangladesh, this may lead to internal migration to urban slums in cities such as Dhaka or Chittagong or attempted external migration to nearby India, despite the fence that currently marks the entire land boundary. Land degradation and difficulty with agricultural harvests is estimated to have already led to the emigration of 12–17 million people from Bangladesh to India, before the fence was fully constructed (Reuveny 2007).

Long-term migration is likely to be exacerbated by the short-term impact of natural disasters, including flooding from heavy precipitation and high-intensity tropical cyclones. Bangladesh is currently affected by annual inland monsoon floods, which can cause internal displacement. Severe flooding in 2007 affected around three million households (Walsham 2010). By 2050, climate change is modelled to lead to an additional 1.9 million people affected by areas newly inundated in monsoon floods (Sarraf et al. 2011).

Indian Ocean island nations are also particularly vulnerable to the health impact of climate change. The Maldives – a nation consisting of 1,200 individual islands, which lie 0–2 m above sea level – has long been considered one of the countries most vulnerable to climate change. Ongoing sea level rise as a result of climate

change may result in widespread inundation of the nation (Church et al. 2006), requiring the whole population to emigrate.

The health impact of migration is varied and disproportionately affects the poorest and most vulnerable in a society. The wealthiest people are able to migrate proactively, whereas the poorest either lack the financial capital to move away from natural disasters, or are forced to move into temporary and makeshift shelter in the aftermath of disasters (The Government Office for Science 2011a). The act of migration itself is associated with impacts on health during the travel phase, which include trauma, undernutrition and increased transmission of infectious disease. It is also associated with negative health outcomes in the destination phase, including impacts on mental, reproductive and child health (Zimmerman et al. 2011). This is particularly exacerbated if populations are forced into IDP camps, refugee camps or other ‘temporary’ accommodation, which can be associated with transmission of infectious diseases and an increase in gender-based violence.

2.4.3 *Conflict*

Climate change may be associated with conflict through a variety of mechanisms, including instability following extreme weather events, competition over scarce natural resources such as water or a breakdown of international and national social and political systems (The Government Office for Science 2011b; Kelley et al. 2015). Direct empirical evidence for a causative link between climate change and conflict is limited, and no one suggests that climate change is a single driver causing conflict. The problem is significant enough that the British and American militaries (amongst others) are considering climate change as part of their long-term contingency planning. South Asia is particularly vulnerable to potential conflict, as a region with existing ethnic, religious and political tensions that have led to a number of international military engagements over the last 50 years. In addition, India and Pakistan have nuclear capabilities, and large areas of Afghanistan and Northern Pakistan are already outside state control.

At a local level, extreme weather events can drive short-term migration of people into internally displaced persons’ (IDP) camps or refugee camps. These place increased strains on local environmental resources, including water supplies, and can lead to conflict between indigenous and migrant communities (Reuveny 2007).

Competition over scarce natural resources can also lead to conflict; within South Asia, one particularly scarce natural resource is likely to be water, due to glacier melt and variation in monsoon rainfall. As population growth, urbanization and economic growth continue in South Asia, demands and stresses for the water supply are likely to be increased. The major Himalayan rivers traverse national boundaries (the Brahmaputra River originates in Tibet, China), and management of water across national boundaries represents another potential flashpoint for conflict, particularly as India and China are both planning large-scale river diversion projects

(UCL Hazard Research Centre and Humanitarian Futures Programme, King's College London 2010). Silt from the Brahmaputra River may be reduced this century by its proposed damming and even diversion of part of its water to eastern China (Matthew 2013). That would not only reduce soil fertility in Bangladesh but also increase the delta's vulnerability to sea level rise. Numerous other dams have been built or are planned along other rivers, especially in India; some of these are already reducing silt flow to the Sundarbans (Matthew 2013).

Also, as legitimate states fail, the opportunity for non-state actors rises, with distinct motivations. For example, there is evidence that extremist organisations provided aid in remote areas of Pakistan after the 2008 earthquake – this legitimises their role and further erodes state influence (The Government Office for Science 2011b).

2.4.4 *Economic Instability*

Globalisation has resulted in complex interconnected supply chains; individual countries are less self-sufficient and therefore increasingly vulnerable to external events. Disrupted supply chains can directly affect health, by limiting the supply of necessary medicines and vaccinations. Economic harm and worsening poverty also hurt health, both physical and mental.

The economic impact of extreme weather events is hard to fully assess. The disruption to banking and financial systems can be very large – floods in Mumbai in 2005 caused a temporary closure of the Stock Exchange (IPCC 2012). However, probably an even larger economic impact is felt in the informal economy – where the disruption of everyday market buying and selling can affect the livelihoods of millions of people.

2.4.5 *Mental Health*

Climate change is likely to have adverse mental health effects at each of the three levels of the framework that we have proposed. Any severe physical illness is likely to have an adverse mental health effect, even if just anxiety. Extreme weather events and natural disasters can lead to mental ill health, including acute traumatic stress in the short term and post-traumatic stress disorder, depression, anxiety disorders and drug and alcohol abuse in the long term (Fritze et al. 2008). Survivors of disasters can also be harmed through seeing others killed or hurt, by the loss of family members and livestock and droughts (Hanigan et al. 2012).

Some VBDs can lead to cognitive and psychiatric disturbances (e.g. cerebral malaria or post-viral fatigue and depression). Primary care services across South Asia are already stretched, and if overall demand for health services increases, mental health is likely to be further ignored. The tertiary impacts of climate change on

mental health are likely to be the greatest, through a variety of levers, including resource scarcity, extreme weather events and widespread social and community disruption. Mental scars arising from the witness or experience of violent conflict can easily be transmitted for generations.

Involuntary migrants face many risks, including trafficking and other forms of exploitation. Some will languish in camps for years. Populations at the greatest risks of climate change-influenced migration are likely to be amongst the most marginalised and socially excluded. Additionally, people with existing mental illnesses (whether diagnosed or not) are amongst the most vulnerable during natural disasters and forced migrations.

Crop failure and indebtedness are already associated with thousands of farmer suicides and other forms of stress in India, particularly in Andhra Pradesh, Karnataka, Kerala and Maharashtra (Gruère et al. 2008; Sarkar and van Loon 2015). As discussed in the section on food security, climate change is likely to be associated with reduced crop yields in South Asia and, as a result, may worsen rural mental health, including suicides.

2.5 Conclusion

Climate change is already harming the health of people in South Asia – both physically and mentally and through a range of different direct and indirect mechanisms. But these effects are likely to become far worse as the environmental impact of anthropogenic activity, including from climate change, intensifies this century.

Although this chapter used a primary, secondary and tertiary framework to describe the health impact of climate change, it is stressed that these effects are interconnected, and impacts may be multiplicative. For example, high temperatures cause a primary health impact through heatstroke; they may also worsen labour productivity and also lower crop yields. These effects are also interconnected with more general societal trends – economic migrants from South Asia already face poor living conditions, including poor shelter, inadequate sanitation and possible conflict with host communities. These existing vulnerabilities will exacerbate any migration or conflict caused by climate change.

As always, the health impacts of climate change cause the greatest harm to the poorest and most vulnerable members of a society – these are people who may live in urban slums with poor access to clean water and sanitation, people who are already most susceptible to undernutrition and food insecurity and people who cannot afford to migrate proactively away from areas prone to natural disasters. Poor women and girls are at the greatest risk. These people are dependent on state responses for adaptation, as they lack the financial capacity and political power to take individual action.

India is currently publicly reluctant to support mitigating its own carbon emissions, believing that developed countries must pay the price for their historical emissions. This position, whilst understandable, allows India to avoid engagement

with climate change as a political and social issue. However, India, whilst continuing to expand its coal use, is also promoting an aggressive expansion of renewable energy (Kalra and Wilkes 2015).

Following this lead, many South Asian governments are reluctant to curtail their own carbon-dependent economic growth. True global leadership on the issue would allow South Asian governments to pursue a path of ‘green growth’, demonstrating an alternative to the current damaging economic paradigm. A number of policies, such as decentralised solar power generation, can allow for economic growth and improvements in peoples’ quality of life, whilst mitigating overall carbon emissions. There is a significant opportunity for South Asian governments to use their strengths in research on technology development to become world leaders in carbon-neutral development policies.

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