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Commentary

Is climate change the greatest threat to global health?

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This commentary critically engages with the argument that climate change is the greatest threat to global health in the twenty-first century. A review of climate-health examples suggests that although it is important to be aware of the risk that climate change presents, health status is caused and mediated by multiple exposures. The current evidence suggests the impact of climate change over the next 30 years is not going to be catastrophic for health, and positioning it as the greatest threat – instead of other important factors such as poverty and health inequalities – could obscure the potential of current global health measures and reduce focus on other health risks such as non-communicable diseases and HIV/AIDS. Although climate change mitigation is vitally important to reduce far-future harm, the policymaking community should focus on current interventions that reduce populations' exposure to climate change, boost populations' ability to adapt, and reduce health inequalities.

KEY WORDS: global health, climate change, adaptation, mitigation

Introduction

Research suggests climate change is likely to have a significant impact on global health (Field *et al*. 2014). There is a long history of climate-health research, but the formation of the Intergovernmental Panel on Climate Change (IPCC) in 1988 began to focus attention on the mechanisms and magnitude of climate change impacts on health. Consequently, an explicit chapter on health was first included in the IPCC Fourth Assessment Report in 2007 (Parry *et al*. 2007). There is no doubt that climate change will be an important factor in attempts to meet the health challenges of the future. It is likely that climate change will put more extreme events such as floods, heatwaves and storms beyond the current human coping range for humans and multiply or worsen current health problems (Figure 1).

Despite this, there was a belief that health professionals were less aware of this threat and that framing climate change as a health issue could increase political interest in improving public health. As a result, Costello *et al*. (2009) conducted an invited comprehensive review of the health threats of climate change for *The Lancet*. This review was part of a clear trend which saw a threefold increase in the numbers of papers dealing with climate change published in *The Lancet* (Figure 2). Both the editorial accompanying Costello *et al*. (2009), and its Executive Summary argued that climate change is the greatest threat to global health in the twenty-first century.

In this commentary, we ask whether, on reflection, such a bold assertion – a form of 'climate reductionism' as identified by Hulme (2011) – does more harm than good when trying to improve global health. The most important consideration in this debate is that of time. The impacts of climate change over the next 30 years are not going to be more catastrophic for health than other current threats such as non-communicable diseases (NCDs), in part because of the time lag between greenhouse gas emissions and their impact on the environment.

We argue that since poverty is a primary driver of vulnerability to climate change, policymakers should focus on reducing poverty and inequality, and adaptation measures that reduce populations' exposure to climate change and boost populations' resilience and ability to adapt, thereby expanding the coping range referred to in Figure 1. As these measures correspond closely with conventional public health practices (Frumkin *et al*. 2008), the health research community is better placed to engage in this arena than to join the climate change mitigation debate.

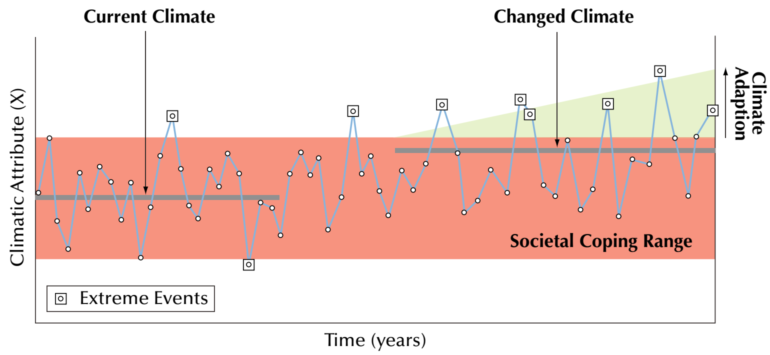

Figure 1 The relationship between climate change, extreme events, society's weather coping range and its adaptability
Source: Adapted from Maslin (2013)

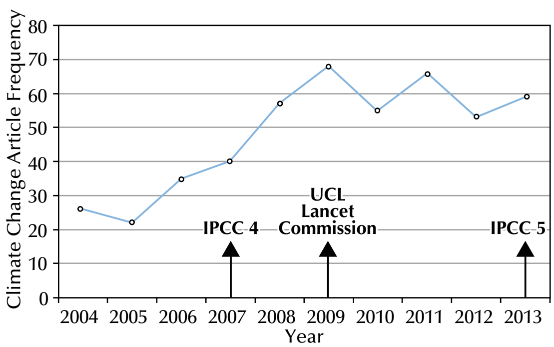

Figure 2 Number of articles published in *The Lancet* per year referring to 'climate change' in the title, abstract or keywords

The article will first define global health before discussing health states highlighted by Costello *et al.* (2009), using case studies to support this argument.

Global health

Koplan *et al.* (2009) define global health by its relationship with international health. Unlike international health, which involves two or more – usually low- or middle-income – countries, a global health issue can be located in just one country if it is of concern to the rest of the world or affected by transnational determinants. Framing the health impacts of climate change in this boundary-less way is spatially problematic (Brown *et al.* 2012), as a global challenge is often deemed to necessitate a global response. Local adaptation is therefore not supported by this definition because the only global response to the impact of climate change on health is to reduce greenhouse gas emissions. Global health comes to enforce a particular spatial and policy bias (see also Randalls 2011).

Beaglehole and Bonita (2010) believe the definition provided by Koplan *et al.* (2009) is 'wordy and uninspiring' and instead propose 'action for promoting health for all'. This commentary adopts this more concise definition, arguing that 'global health' should be about taking action to improve health outcomes regardless of whether this action is a global, national or local process.

The impact of climate change on global health

Climate change can affect global health either directly or indirectly (Figure 3), and both of these are discussed below.

Direct impacts on health

The IPCC suggests that climate change will cause an average global temperature rise of between 2.6 and 4.8°C by 2100 if CO_2 emissions remain unchecked (Stocker *et al.* 2013). There is a high level of confidence that this temperature change will increase the frequency of heatwaves (Meehl and Tebaldi 2004). An increase in the number and length of heatwaves could increase heat-related mortality, mainly due to cardiovascular, cerebrovascular and respiratory disease (Haines and Patz 2004; Patz *et al.* 2005). It will also affect agricultural productivity in the poorest tropical countries by limiting the ability of people to work outdoors (Field *et al.* 2014). However, the definition and impacts of heatwaves are societally mediated with the number of deaths driven by factors other than the severity of the event. This is shown by the example of the 2003 European heatwave, which was well outside the range of expected climate variability (Patz *et al.* 2005), consistent with climate-change modelling, and substantially attributable to human-induced warming (Scott *et al.* 2004). This heatwave caused up to 70 000 premature deaths across Europe (Costello *et al.* 2009). In France there

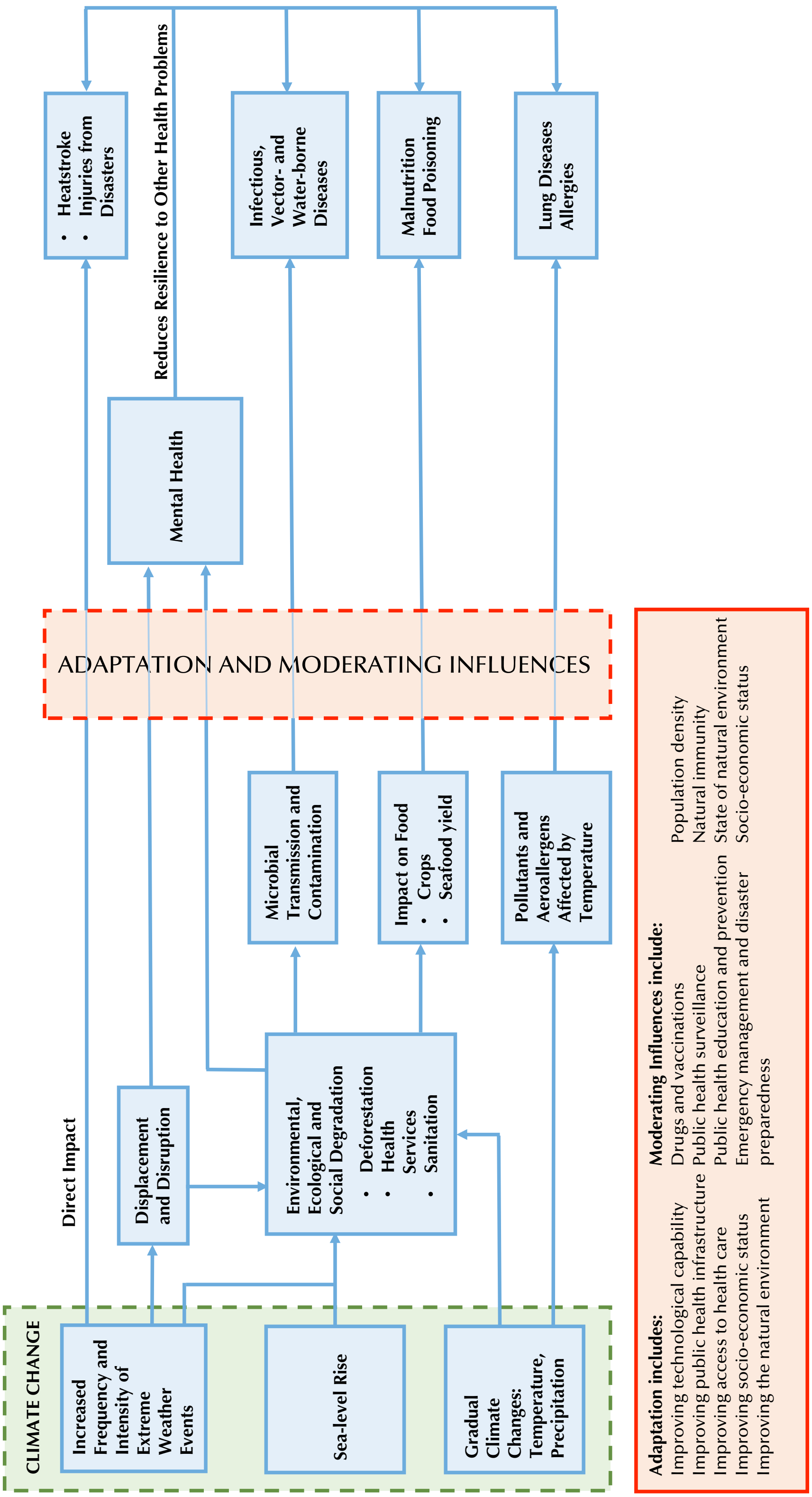

Figure 3 The impact of climate change on health
Source: Adapted from McMichael *et al.* (2006) and Haines *et al.* (2006)

were 14 800 deaths in the first three weeks of August 2003, and in Paris premature deaths increased by 140% (Haines *et al*. 2006).

Many of these additional deaths occurred in vulnerable populations such as the elderly and poor, and could have been avoided had the public health response in France responded to these inequalities. Among other problems, there were no heatwave response plans in place, meaning the disaster was not initially recognised as serious, and there was a shortage of many key workers, including health professionals, due to the holidays. As a result, wide-sweeping policy changes were made in the aftermath of the disaster. These included monitoring temperatures nationally to better predict heatwaves and aid emergency preparations, improved building design and air conditioning for hospitals and retirement homes, increased training for health professionals, an emphasis on responsible media coverage with health recommendations regularly broadcast, and planned regular visits to the most vulnerable members of the population. The positive influence of these policies were seen during the 2006 heatwave. Fouillet *et al*.'s (2008) interrupted time series study adjusted for the slightly lower severity of this second heatwave and concluded that the new policies had reduced net mortality in France by 4400 people (95% confidence interval 4920–3855). This reduction could arguably be further enhanced by changes to the built environment that reduce the urban heat island effect.

Although climate change could multiply or worsen the current impact of heatwaves, this study suggests policies and social changes that increase the resilience of populations to extreme temperatures could cancel out the impact of climate change. This could also be said to be the case for prolonged droughts, floods and storms.

It is worth introducing here the argument made by Marmot *et al*. (2008) in their paper on health inequality. Commenting on behalf of the Commission on Social Determinants of Health, the paper argues that inequality (both between and within countries) is one of the leading causes of poor health. Pearce and Dorling (2009) expand on this viewpoint and argue that global health inequality cannot be addressed by expanding choice as the poorest in society are unlikely to be able to afford the new choices. Applying this to the heatwave context, improving building design and the use of air conditioning to combat heatwaves may only be an option for some neighbourhoods and some countries. If these sorts of measures are viewed as the best way to combat future heatwaves, it is vital these inequalities are addressed.

Indirect impacts on health

The indirect mechanisms by which climate change can affect global health are potentially of greater consequence, but also more complex and difficult to research (McMichael and Haines 1997). This is because the causal mechanisms are convoluted and interlinked with other factors. Disentangling the degree of impact that climate change has on these health states is therefore challenging.

This section explores extreme events and four of the indirect health impacts of climate change identified by Costello *et al*. (2009): vector-borne diseases; food security; water security; and non-communicable diseases.

Vector-borne diseases Climate change is likely to alter the geographical distribution of vectors that cause some infectious diseases (Costello *et al*. 2009). Floods and droughts may affect the breeding sites of disease-carrying vectors, and observational studies have shown even small changes in temperature and precipitation can cause measurable changes to where infectious diseases are prevalent (Haines and Patz 2004). Equally, a number of studies have used future climate models to determine that vectors will be able to survive in new locations (Haines *et al*. 2006). The populations in those areas may be more susceptible to the diseases carried by these vectors, or public health systems may be unprepared to deal with the additional burden.

It is not possible to conclude from this evidence, however, that climate change is the most important control on the spread of vector-borne diseases. First, these climate models are unable to predict changes in vector breeding and transmission at the micro-scale level due to minute changes in vegetation, topography, coastlines, and/or water bodies (Patz *et al*. 2005). Second, future land-use and environmental changes are likely to have a far greater impact on the transmission of vector-borne diseases than climate change. For example, a study investigating the impact of climate change on the health of indigenous populations in Peru found the prevalence of malaria-carrying mosquitos was altered by deforestation and the construction of new infrastructure leading to increased pools of stagnant water (Hofmeijer *et al*. 2013). Perhaps most importantly, a change to potential transmission areas for vectors does not necessarily mean an increase in the number of disease cases. As shown in Figure 4 with the example of malaria, the process of transmission from vectors to humans is dependent on a multitude of demographic, societal and environmental factors.

In addition, the models do not take into account that it is unlikely human responses and resilience to vector-borne diseases will be comparable across the timeframes discussed in these studies, particularly given current research into malaria vaccines and global efforts to reduce infectious disease vulnerability. For example, although a study by Ebi *et al*. (2005, 389) takes care to note that 'a number of other factors will influence whether the future geographic distribution of malaria is different from

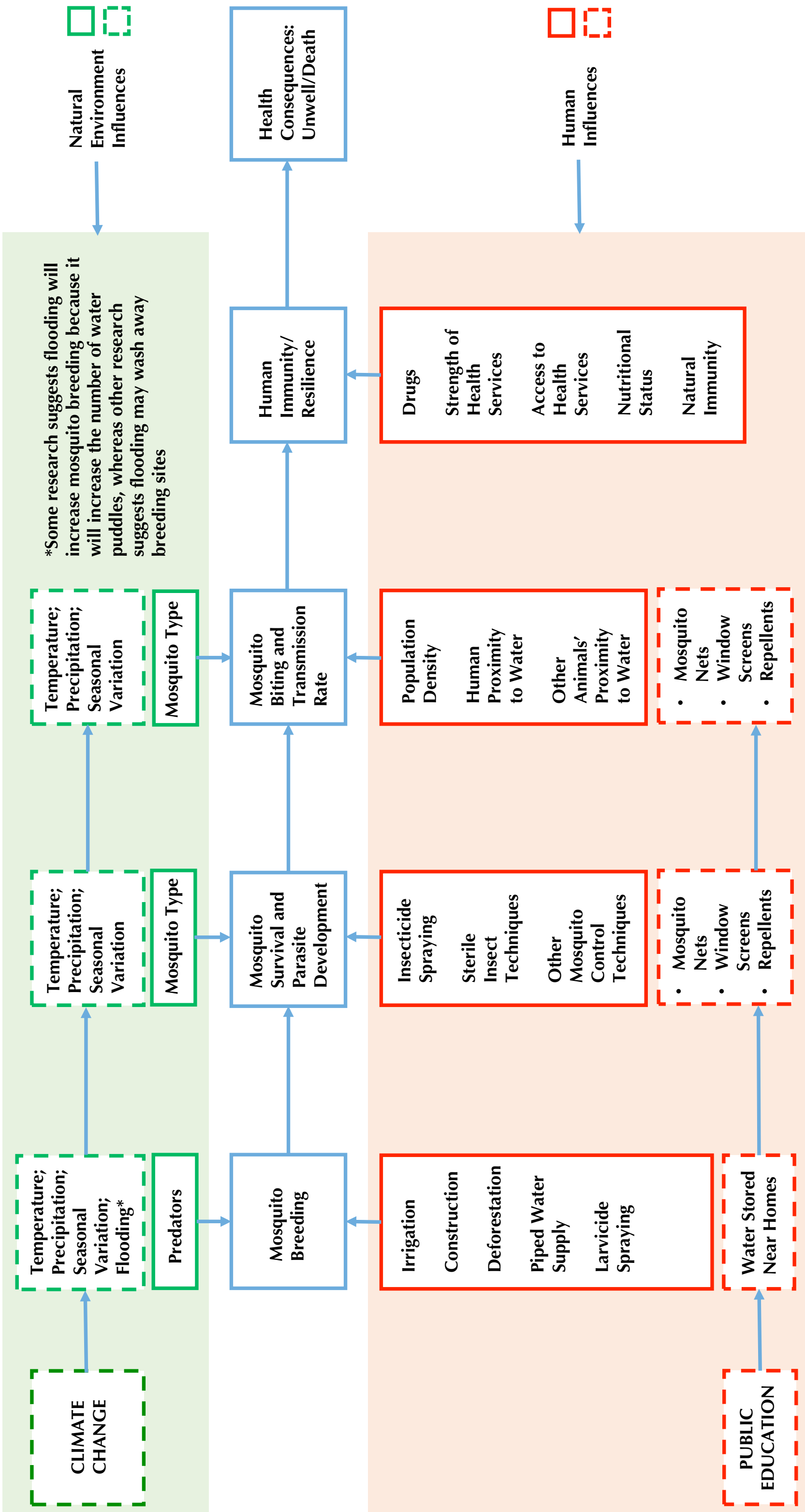

Figure 4 The transmission path of malaria from mosquitoes to humans

today', the results presented still presume no change to human response to malaria for the next century. This is unrealistic given that malaria was prevalent in parts of Europe less than 90 years ago and has now all but disappeared (Evans 1989). Dengue fever was eradicated in the US due to public education, mosquito control programmes, piped water and screened windows (Hopp and Foley 2001).

Even if new drugs or vaccines were developed to combat all vector-borne diseases, however, there is no guarantee these would be distributed according to need. Sparke and Anguelov's (2012) review of the 2009 H1N1 flu outbreak is indicative of how global health inequalities could play out in the future. First, huge global significance was given to the flu virus even though it was less serious than multiple diseases that kill many people in developing countries every day. Sparke and Anguelov (2012, 730) argue this was because it '*might* effect the wealthy [as distinct from] other diseases that *already* effect the poor' (emphasis in original). Future research and technology may therefore be unequally focused on those diseases that affect those who can afford to be treated.

Second, developing nations bought and stockpiled the Tamiflu drug and were given preferential prices, leaving nations that were unable to purchase supplies increasingly vulnerable. In the US, some investment companies received more pills than they asked for, while some health centres were left with shortages. If the same were to occur with new medicines developed for vector-borne diseases, addressing this inequality would be a more important issue than addressing changes in the location of where a disease is prevalent due to climate change.

Given the factors discussed in this section, it is clear climate change cannot be said to be the single greatest threat to the future burden of vector-borne diseases. Focus should instead be placed on simple, local solutions that boost populations' resilience and reduces their exposure to these diseases, as well as measures designed to reduce existing and future health inequalities.

Food security At present, more than 1 billion people are estimated to be suffering from a lack of sufficient dietary energy (Barrett 2010). Climate change could increase this burden by affecting crop yields, food prices and food access (Schmidhuber and Tubiello 2007; Field *et al*. 2014). Increased flooding and droughts may affect crop yields either directly or indirectly through plant diseases and pest infestations (McMichael and Haines 1997). Sea-level rise and increased coastal flooding could lead to salination of farmland (Costello *et al*. 2009). Seafood yields may be reduced through changes in aquatic populations due to warmer ocean temperatures and ocean acidification (Branch *et al*. 2013).

The current reasons for global hunger, however, go beyond climate. For example, irrigation and storage techniques, the maintenance of sustainable ecosystems, and fairer trade and distribution of food are arguably equally as important as climate as causes of future malnutrition (Schmidhuber and Tubiello 2007). While technological development could vastly improve global crop yields and counteract the effects of climate change, the development of new technology could well widen global health inequality. The technologies that enabled the Green Revolution were not equally distributed and caused some communities to be further marginalised (Sparke and Anguelov 2012). Thus we argue that poverty and inequity are central to how and why climatic changes (and policies to avert these) might affect food security.

Purchasing power is very important in determining malnutrition. Evidence suggests extreme events will place landless agricultural labourers at greater risk from losing access to food due to their poor purchasing power (Schmidhuber and Tubiello 2007). Arguably, future economic development will lead to real income rising quicker than food prices (FAO 2006), benefitting those who are currently malnourished, but given that there are currently 3.5 billion people who live on less than \$3.25 per day this will take a long time (Woodward 2013). Food prices have doubled in the last 10 years and experienced very high volatility, but this variation is not due to climate change (Figure 5). In 2008/9 there was a 60% increase in basic food prices and then another 40% rise in 2011/12. It is clear that these peaks were the combined effect of financial speculation in food and rising energy prices particularly oil (Maslin 2014).

Another threat to the food security of the poorest people is the emerging trend of 'land grabs'; acquisitions of land in developing nations by foreign states, private investors or commercial farmers (Borras *et al*. 2011). Examples include Kuwait purchasing

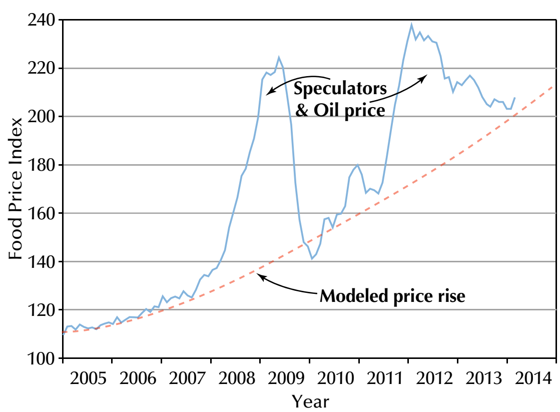

Figure 5 Food Price Index compared with modelled increase due to increased demand and inflation
Source: Adapted from Maslin (2014)

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land in Cambodia for rice farming, India purchasing land in Ethiopia for sugar and biofuel production, and Egypt purchasing land in Sudan for wheat farming (Jarosz 2009; see also Funk 2014). These are attempts to ensure food and fuel production in the face of future global market shock: whether caused by changing climate, population increase, a low quantity of available arable land (for example in China or the United Arab Emirates) or shifts to more meat-based diets (Nally 2014).

Often these deals are struck without the consent of those who currently own, or work on, the land (Borras *et al*. 2011), but they are justified by important actors such as the World Bank on the basis that the land being 'grabbed' will be farmed more efficiently as the new landowners are more likely to use the latest technology (Nally 2014). There is a deep inequity, however, as only those who can afford to buy land are able to secure their future food supply. In Ethiopia, for example, 7.8 million people (10% of the country's population) are chronically hungry and the country is the world's largest recipient of food aid (Nally 2014). Meanwhile, investors profit from buying arable land in the country. Land grabs are another important process contributing to global food security that are not specifically linked to climate change.

This section has shown that food security is a complex issue determined by multiple factors including purchasing power, international markets and speculation driving the relative cost of food, and global market forces precipitating land grabs. In light of this, it is difficult to argue that climate change is solely the greatest threat to global health based on food security as inequity and poverty are particularly important determinants.

Water security The most important threat to human health is arguably access to fresh drinking water. At present there are still 780 million people who do not have regular access to clean safe drinking water (UNICEF 2012). Not only does the lack of water cause major health problems from dehydration but a large number of diseases and parasites are present in dirty water. The impacts of climate change – including changes in temperature, precipitation and sea levels – are expected to have varying consequences for the availability of fresh water around the world. For example, changes in river run-off will affect the yields of rivers and reservoirs and thus the recharging of groundwater supplies. An increase in the rate of evaporation will also affect water supplies and contribute to the salinisation of irrigated agricultural lands. Rising sea levels may result in saline intrusion in coastal aquifers (Costello *et al*. 2009).

Approximately 1.7 billion people – one-quarter of the world's population – live in countries that are water stressed (Parry *et al*. 2007). Rising human populations, particularly growing concentrations in urban areas, are putting great stress on water resources. For example, due to population pressure, four of the 14 aquifers used in Mexico City are overexploited, and throughout Mexico, over 15% of all aquifers are overexploited (CONAGUA 2011). As with the case of food, this water scarcity is combined with a private water grab to protect access to water rights not least in places like the Western United States where the price of water rights has boomed in recent years (Funk 2014). Equity of access to water will be crucial for global health and this involves far more than changing precipitation patterns.

Globally, it is predicted that by 2030 there will be a 40% increase in water demand (Water Resources Group 2012), and a 35% and 50% increase in demand for food and energy respectively, both of which require large quantities of water (National Intelligence Council 2012). Societal decisions about energy and food are likely to be at least as crucial to future water security as environmental changes. More broadly, the scenarios envisaged for future water, food and energy provision contain significant uncertainties (that become critical when used as input into climate models), suggesting that societal changes will be a more significant driver for future health consequences than climatic changes (Maslin 2013).

Extreme events Extreme events, including flooding, hurricanes and drought, disrupt health services and sanitation. Flooding can lead to human or animal waste entering drinking water supplies and spreading water-borne diseases (McMichael *et al*. 2006). Trevejo and colleagues (1998) found in a case-control study that individuals who had walked through flood waters during the 1995 floods in Nicaragua were 15 times more likely to be diagnosed with leptospirosis. Droughts and flooding can lead to population upheaval, which stretches health services.

All of these indirect impacts, however, are mitigated by other factors. The habitation of areas that are at higher risk of being affected by extreme events makes these populations more exposed to disasters. Those adversely affected by Hurricane Katrina, which hit New Orleans in 2005, were more likely to live in the poorer areas of the city (Elliott and Pais 2006). In high-income countries, better adaptation and emergency responses, alongside improving the resilience of poorer communities, could reduce the mortality and morbidity of similar events (Elliott and Pais 2006). This is also true on a global scale, as the floods with the highest mortality have tended to occur where infrastructure is poor and the population has limited economic resources (Ahern *et al*. 2005).

Clearly, although the intensity and frequency of events are significant in determining the severity of subsequent problems linked to sanitation, the vulnerability of the population and the strength of health services is crucial. It is reasonable to argue that if these factors were improved, the impact of extreme events would be greatly reduced.

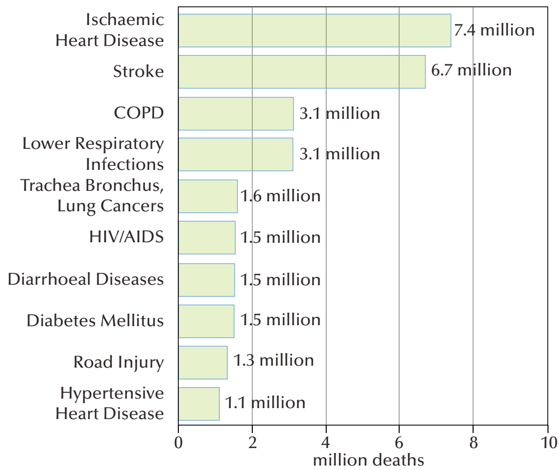

Figure 6 Leading causes of death worldwide (2012)
Source: Adapted from WHO (2014)

Non-communicable diseases Very little research has focused on the impact of climate change on NCDs. Kjellstrom *et al*. (2010) attempted to document some of the causal sequences between climate change and NCDs. They argued that heat exposure and dehydration would exacerbate cardiovascular diseases, renal failure and other kidney diseases. In these cases, however, climate change is exacerbating the disease itself rather than the cause of the disease, so viewing it as the greatest threat to these health conditions is problematic.

Arguably, NCDs could be said to be the greatest independent threat to global health instead of climate change. The current leading causes of death worldwide are all NCDs (Figure 6), and this burden is likely to increase due to ageing populations and adoption of Western lifestyles in developing countries (Herrick 2014). For this reason, existing interventions to reduce NCDs should be a key point of focus for the health research and policymaking community.

Discussion

Climate change is very important for public health officials to consider, as it will undoubtedly have an impact on global health by exacerbating and magnifying current health problems, and by stretching health services. We argue that it cannot be said to be the greatest threat to global health, however, and that this argument risks diverting policymakers for taking action on global health now. Many of the health conditions described in this commentary are affected by multiple factors and it is difficult to attribute causation to climate change. Although exposure to risk factors may be increased by climate change, it is plausible that human society will be more resilient and better adapted in the future. Advances in medical sciences and technology, adaptation and improved emergency response, and other socioeconomic and environmental changes have a large part to play.

Over the next 30 years it is unlikely the impacts of climate change will be catastrophic enough (in most cases) to exacerbate or magnify current health problems beyond the coping range of current adaptations. After that period, however, it is more difficult to be sure that human society will continue to advance sufficiently to cope with the impacts of climate change. For example, the argument that malnutrition will not increase because of future technological and economic development is flawed if the pace of climate change exceeds societal change. Climate change is likely to stretch our ability to cope with all the health impacts mentioned in this commentary.

Moreover, health inequality is a serious issue affecting our ability to overcome many of the health issues we currently face. There is no guarantee that global society will become more equal than it is today and the vulnerability of marginalised populations may increase. For example, given the current rate of 'trickle down', global GDP would have to increase 15 times to lift the world's population up to at least $1.25 per day, which would likely take over 100 years. If we want to be more radical and lift everyone in poverty to $5 per day then it would require global GDP to increase by 170 times, a process taking over 200 years (Woodward 2013). Even if we do develop new health technology including drugs, they are unlikely to be distributed equally (Sparke and Anguelov 2012), and overcoming this type of inequity is perhaps the most serious challenge for global health policy.

We argue that rather than climate change being the greatest threat to global health, there needs to be a clear balance between the key factors affecting global health, including climate change, poverty and health inequalities, as noted in the 2014 IPCC report (Woodward *et al*. 2014) and the 'Closing the gap' study (Marmot *et al*. 2008). We argue that the low resilience or heightened vulnerability of populations (ultimately caused by poverty and health inequalities) should be considered the greatest threats to global health for at least the next 30 years. Public health policies should therefore focus on reducing health inequalities, populations' exposure and sensitivity to climate change, and increase their capacity to be able to cope with this and other future global environmental and social changes. It is important that policies to reduce global greenhouse emissions should continue apace, not least as climate changes after 2050 may be more severe, but this should not be the main focus of the health research and policymaking community. It is more practicable for the health community to boost poverty reduction to enhance resilience to climate change than to tackle climate change mitigation as the solution. Climate stabilisation alone is insufficient to solve global health (contra Friel *et al*. 2008).

Framing climate change as a global health issue was intended to increase political interest in climate change using health as a political attractor (Costello *et al*. 2009), but by doing so we may fail to take action on policies known to improve human health in the short term. Although it is important to be aware of the risk that climate change presents to health, positioning it as the greatest current threat means that key opportunities to improve human health may be missed. Moreover it may even reduce our focus on other major health risks, such as inequality, NCDs and HIV/AIDS.

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