CLIMATE CHANGE: HEALTH IMPACTS AND OPPORTUNITIES

A SUMMARY AND DISCUSSION OF THE IPCC WORKING GROUP 2 REPORT

THE GLOBAL CLIMATE & HEALTH ALLIANCE

CONTENTS

ILLUSTRATIONS

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EXECUTIVE SUMMARY

The most recent report from Working Group 2 of the Intergovernmental Panel on Climate Change (IPCC-WG2), *Climate Change 2014: Impacts, Adaptation and Vulnerability*, describes in worrying detail, the current and future impacts of climate change; as well as the challenges we face in mitigating further climate change and adapting to its impacts.

This complementary report summarises and interprets over 2600 pages of scientific literature presented by IPCC-WG2, to deliver a concise and robust message about the implications of the report for health.

These impacts of climate change on human health and social wellbeing are varied and occur through many different pathways. They span the full breadth of the immediate and underlying determinants of health, including: the direct impacts of heat and extreme weather events; access to the essentials of life such as clean water, nutritious food and shelter; forced migration, conflict and societal disruption; and loss of biodiversity.

The scale and magnitude of impact will depend on the pattern of future greenhouse gas emissions. This report provides examples of many projections of health impact made by IPCC-WG2, as well as a set of 'key risks' with potentially severe or irreversible adverse consequences, or risks for which there is limited potential to avert through adaptation or mitigation. Among the key risks are:

- Death, injury, ill-health or disrupted livelihoods in low-lying coastal zones and island states.
- Breakdown of infrastructure networks and critical services such as electricity, water supply, and health and emergency services.
- Higher mortality and morbidity during periods of extreme heat.
- Food insecurity and the breakdown of food systems, particularly for poorer populations.

The presence of serious clinical signs and symptoms in a patient necessitates health professionals to take immediate and precautionary action to safeguard life. The IPCC report indicates that the planet is exhibiting a level of serious signs and symptoms that demands immediate and far-reaching action.

In light of this, the Alliance proposes five actions for health professionals across the world:

- Work to reduce the contribution made by health systems to climate change and implement measures to ensure that health systems are climate-resilient and equipped to respond to the growing negative impacts of climate change on health
- Expand research and innovation on the health impacts of climate change, the co-benefits of mitigation and adaptation, and the associated costs or cost-savings
- Create positive synergies between public health improvement, climate protection and equitable development by promoting sustainable diets and food systems; active transport policies and systems; and the expansion of access to reproductive health services
- Engage in public and political advocacy at local, national and global levels to mitigate the risk of further climate change on health
- Build a global partnership of health professionals around population and planetary health to strengthen cooperation and trust across national, cultural, sectoral and geographic divides in support of effective and equitable action on climate change.

The 2009 UCL-Lancet Commission on Climate Change called it the "biggest global health threat of the 21st century". By working together, health professionals can turn it in to one of the most significant health opportunities.

PREFACE

BACKGROUND

The reports of the Intergovernmental Panel on Climate Change (IPCC), set up under the auspices of the United Nations, represent the most authoritative scientific understanding of climate change and climate change. Three scientific working groups have been constituted to cover different areas:

- Working Group 1 (IPCC-WG 1) – The physical scientific aspects of the climate system and climate change.
- Working Group 2 (IPCC-WG2) – The vulnerability of socio-economic and natural systems to climate change, negative and positive consequences of climate change, and options for adaptation.
- Working Group 3 (IPCC-WG3) – Options for mitigating climate change through limiting or preventing greenhouse gas emissions and removing them from the atmosphere.

Last September, IPCC-WG1 published its fifth and most recent report (see Box 1). On March 31st 2014, IPCC-WG2 published its latest report. The report consists of 30 separate chapters.

This document summarises the key issues from that report and their implications for human health and health professionals.

Verbatim quotes from the IPCC-WG2 report are italicised. For the sake of brevity, references found within the report have been excluded. Material taken from other sources are referenced.

Box 1: Key messages from IPCC-WG1 report

Global warming is a well-established phenomenon. Combined land and ocean surface temperature data, as a global average, show an increase of about 0.89°C (0.69 - 1.08) over the period 1901–2012 and about 0.72°C (0.49 -0.89) over the period 1951–2012. Each of the past three decades has been significantly warmer than all previous decades with recorded data.

In presenting these facts, scientists have accounted for the substantial multi-annual variability in the rate of warming, including periods that have exhibited almost no linear trend in rising temperatures. They also explained how the widely reported recent reduction in the surface warming trend between 1998 and 2012 was due to natural changes to the pattern of ocean circulation which transferred heat from the shallower to the deeper parts of the ocean at a faster rate, as well as the cooling effect of volcanic eruptions, and the downward phase of the 11-year solar cycle.

Global warming results from an increase in the amount of solar energy absorbed by the earth-atmosphere system. The primary cause of this increase is the effect of greenhouse gases (GHGs). Scientists have accounted for the effects of other factors that affect the amount of energy retained within this system including the effect of clouds and small particles in the atmosphere; changes to vegetation or land surface properties (e.g. snow or ice cover) which affect the proportion of solar energy reflected back towards space; and the fluctuating intensity of solar radiation.

Carbon dioxide (CO2) is the most important GHG; followed by methane (CH4) and nitrous oxide (N2O). The current atmospheric concentrations of CO2, CH4 and N2O are unprecedented in at least the last 800,000 years. Carbon dioxide concentrations are 40% higher than in pre-industrial times. This is primarily due to fossil fuel combustion, cement production and land use changes (e.g. deforestation).

According to IPCC-WG1, it is *"**extremely likely** that more than half of the observed increase in global average surface temperature from 1951 to 2010" is anthropogenic. The specific contribution of GHGs to global warming "is likely to be between 0.5°C and 1.3°C over the period 1951–2010".*

The effects of global warming and GHG emissions include: changes in climate and rainfall patterns; changes in the frequency and magnitude of extreme weather events; the melting of glaciers and ice sheets; thawing of permafrost; sea level rise; and acidification of the oceans.

THE SCIENTIFIC APPROACH OF IPCC-WG2

An unprecedented level of scientific collaboration underpins the IPCC's reports. In the WG2 report, more than 740 scientists from across the world have been directly involved, as well as 1,729 expert and government reviewers; and the report draws on peer-reviewed evidence produced by thousands more scientists.

Great care has been taken to describe the evidence and scientific basis of conclusions, future projections and policy recommendations. This has included careful description of the degree of 'confidence' in the validity of any finding – based on the type, amount, reliability, quality, and consistency of evidence as well as the degree of agreement amongst scientists. Confidence is expressed qualitatively in terms of being *very high*, *high*, *medium*, *low* and *very low*.

The degree of certainty in a finding or prediction is based on statistical analyses and model results, as well as expert judgment. Certainty is expressed accordingly:

- Virtually certain (99-100% probable)
- Very likely (90-100% probable)
- Likely (66-100% probable)
- About as likely as not (33-66% probable)
- Very unlikely (0-10% probable)
- Unlikely (0-33% probable)
- Exceptionally unlikely (0-1% probable)

Terms used to describe the availability of evidence are: *limited*, *medium* or *robust*; those used to describe the degree of agreement are: *low*, *medium* or *high*.

COMPLEXITY

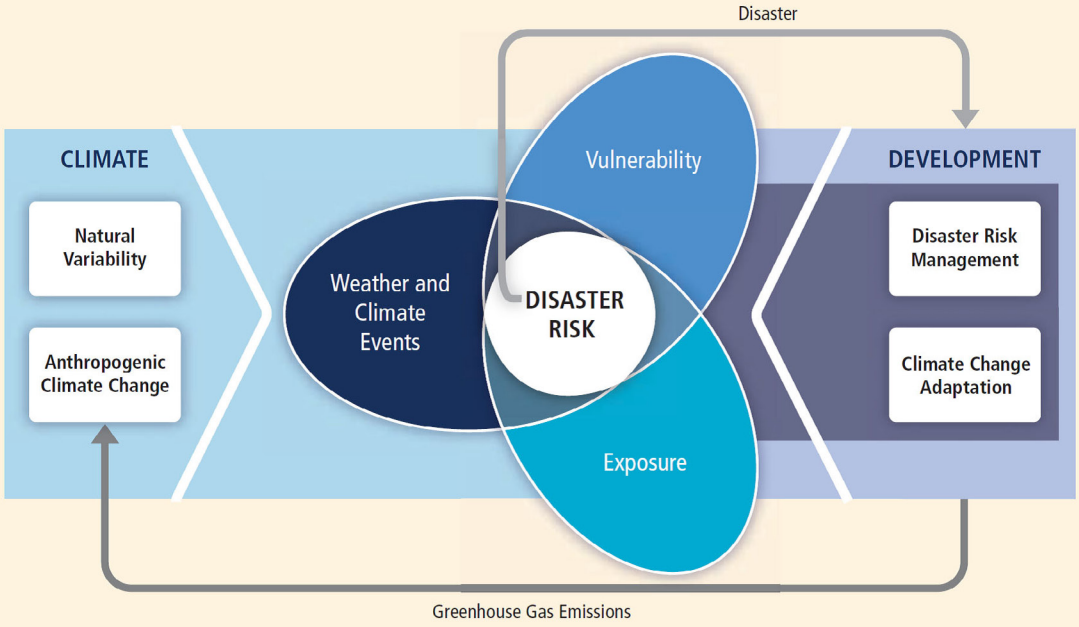
Understanding the human, social and ecological implications of climate change is complex and challenging. And for this reason, some degree of uncertainty is unavoidable.

It involves a study of not just one 'system' but three: the climate system; the biophysical system of the natural environment; and the own social system of humans. Each is complex and multi-dimensional in its own right; they interact with one another.

Estimating the current impact of climate change needs to factor in many variables and pathways. Estimating the future impact of climate change requires the additional accommodation of a wide range of future possible scenarios.

The complex interaction of these variables and factors determines the degree to which different individuals, communities, countries and regions are *exposed* to climate hazards; the degree to which they are *vulnerable* or *resilient* to threats; and the extent to which they are *capable of adapting* to climate change. Figure 1 shows a framework used by IPCC-WG2 to describe some of the key inter-relationships in their report.

Figure 1: The relationship between climate, natural environment and social systems



This complexity makes it difficult to attribute any impact specifically to climate change. In all instances, the impact of climate change is mediated by many other factors and determinants of ecological, human and social wellbeing. In communities and countries which are already insecure or vulnerable, climate change is a 'threat multiplier' of other biophysical pressures (e.g. biodiversity loss, soil erosion, deforestation and pollution) and social stressors (e.g. social inequalities, poverty, gender discrimination, market failures and corruption).

IMPACTS ON HEALTH AND SOCIAL WELLBEING

INTRODUCTION

This section provides an overview of the key evidence regarding the effects of climate change on health and society, at present and in the future. Importantly, impacts *will vary across regions and populations, through space and time, dependent on myriad factors including non-climate stressors and the extent of mitigation and adaptation* (Ch1).

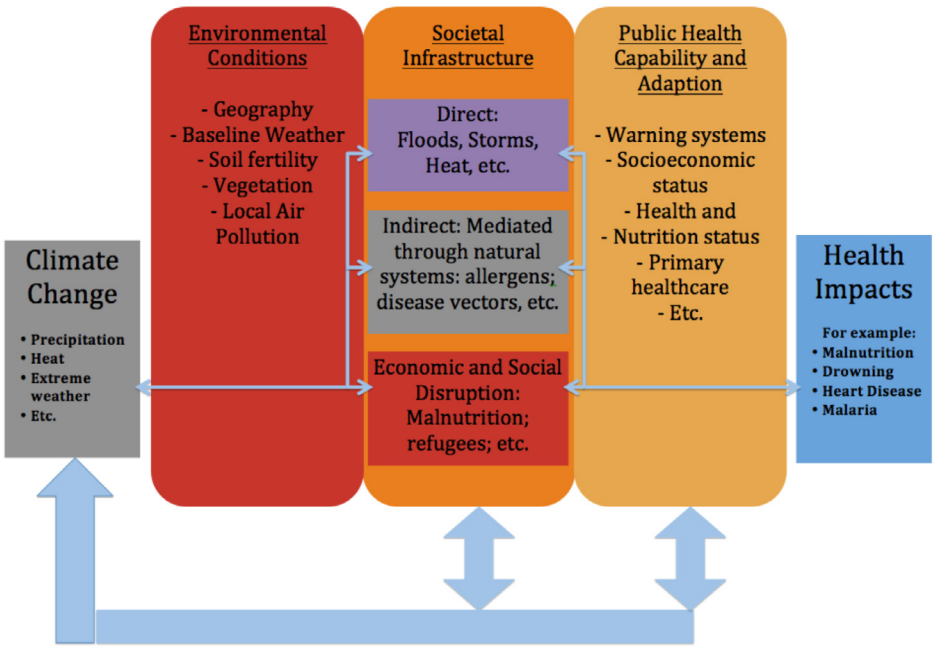
Although in some areas and under certain conditions, climate change may improve health through *modest improvements* in cold-related mortality and morbidity and reduced capacity of disease-carrying vectors, this *will be out-weighed, world-wide, by the magnitude and severity of the negative effects of climate change* (Ch11).

Impacts will be unevenly distributed within and between populations. By and large, the poor and those least responsible for GHG emissions will be most severely affected. However, health is also increasingly affected in wealthier countries.

IPPC-WG2 groups the relationship between health and climate change into three pathways (see Figure 2):

- Direct impacts which relate primarily to changes in the frequency of extreme weather including heat, drought and heavy rain;
- Effects mediated primarily through natural systems, such as changing infectious disease patterns, food and water-borne diseases, and air pollution;
- Effects primarily mediated through human and social systems, such as social disruption, forced migration, conflict, undernutrition and mental stress.

Figure 2: The relationship between health and climate change



[Note: The yellow box indicates the moderating influences of local environmental conditions, and the orange box indicates moderating influences of background socio-economic conditions, public health measures and adaptation actions. The green arrows at the bottom indicate that there may be positive or negative feedback mechanisms between society infrastructure, public health, adaptation actions and climate change itself. For example, some measures to improve health may also reduce GHG emissions, this reducing the extent and pace of climate change.]

KEY RISKS

Of particular importance are a set of 'key risks' identified in chapter 19 of the IPCC-WG2 report. These are broadly defined as risks with potentially severe or irreversible adverse consequences, or risks for which there is limited potential to avert through adaptation or mitigation. In summary, these are:

i. Risk of death, injury, ill-health, or disrupted livelihoods in low-lying coastal zones and small island developing states and other small islands, due to storm surges, coastal flooding, and sea-level rise.

ii. Risk of severe ill-health and disrupted livelihoods for large urban populations due to inland flooding in some regions.

iii. Systemic risks due to extreme weather events leading to breakdown of infrastructure networks and critical services such as electricity, water supply, and health and emergency services.

iv. Risk of mortality and morbidity during periods of extreme heat, particularly for vulnerable urban populations and those working outdoors in urban or rural areas.

v. Risk of food insecurity and the breakdown of food systems linked to warming, drought, flooding and precipitation variability and extremes, particularly for poorer populations in urban and rural settings.

vi. Risk of loss of rural livelihoods and income due to insufficient access to drinking and irrigation water and reduced agricultural productivity, particularly for farmers and pastoralists with minimal capital in semi-arid regions.

vii. Risk of loss of marine and coastal ecosystems, biodiversity, and the ecosystem goods, functions, and services they provide for coastal livelihoods, especially for fishing communities in the tropics and the Arctic.

viii. Risk of loss of terrestrial and inland water ecosystems, biodiversity, and the ecosystem goods, functions, and services they provide for livelihoods.

IMPACTS ON HEALTH AND SOCIAL WELL BEING

The following sub-sections provide a brief description of some of the current and projected impacts of future climate change. Future projections by scientists are made on the basis of various hypothetical future scenarios. The IPCC reports have tended to use four scenarios called Representative Concentration Pathways (RCPs) which are referred into in the subsequent sections. Each RCP represents a different trajectory for future GHG emissions and aerosol concentrations. There RCPs are labelled by number (RCP2.6, RCP4.5, RCP6.0 and RCP8.5) with RCP2.6 assuming a radical *reduction* of GHG emissions starting almost immediately; RCP8.5 assuming more or less unabated emissions; and RCP4.5 and RCP6.0 falling somewhere in the middle.

Water

Water is essential for many daily activities, such as drinking, washing and cooking, so inadequate supply and poor water quality can have dire consequences for health. Currently, about 150 million people currently live in cities affected by chronic water shortages; but by 2050, *unless there are rapid improvements in urban environments, the number will rise to almost a billion.* Increasingly, water scarcity will become a problem for many communities, rural and urban, with climate change acting as *a powerful stressor on freshwater ecosystems in the second half of the 21st century, especially under high-warming scenarios* (Ch3).

This will add to other stressors, including land-use change, pollution and water extraction, with important implications for both the quantity and quality of water that people have access to. Climate change is forecast to *pose risks to drinking water quality (high agreement, medium evidence)* due to a range of factors including temperature, run-off due to heavy rainfall and the impact of both floods and droughts (Ch3).

In most dry subtropical regions, climate change *is projected to reduce renewable surface water and groundwater resources significantly (high agreement, robust evidence*). This is alongside a *likely* increase in the frequency of droughts in currently dry regions (Ch3). Additionally, water security will be impacted by sea level rise in many coastal areas, contaminating freshwater reservoirs (Ch11).

Food and nutrition

IPCC-WG2 states that all aspects of food security are potentially affected by climate change, including food access, utilization, and price stability (high confidence), and emphasises the importance of social, economic and political systems in determining these impacts and their effect on health. Changes in the distribution of weeds, agricultural pests and diseases are also expected under climate change this century, though – as with floods and droughts – their extent is difficult to forecast accurately.

Adverse effects of climate change on crop and food production are already evident in several regions of the world *(high confidence)*. Several cases of rapid food and cereal price increases associated with extreme weather in key food-growing regions, such as Russia and the USA, have been observed in recent years. (Ch7) Climate change is expected to increase the *inter-annual variability of crop yields in many regions (medium confidence)*, with negative economic and health implications, especially for the world's poor.

Without adaptation, local temperature increases in excess of about 1oC – far below the temperature range likely by the end of this century – are projected to have negative effects on yields for the major crops (wheat, rice and maize) in both tropical and temperate regions (medium confidence). (Ch7) It is also projected that *the production of coarse grains in Africa may be reduced by 17-22%* due to climate change in the near-term future.

Climate change is also *affecting the abundance and distribution of harvested aquatic species, both freshwater and marine, and aquaculture production systems in different parts of the world.* With approximately a billion people reliant on fish as their primary source of animal protein, this could have severely negative impacts on nutrition, particularly in coastal regions (Ch7).

According to one estimate, without adequate adaptation, *climate change by 2050 would increase the number of undernourished children under the age of 5 by 20-25 million* (Ch7 p27). Undernutrition is important for health not only because it increases susceptibility to infectious diseases and is already an important contributor to child mortality worldwide, but also increases stunting, anaemia and impaired cognitive development, which could increase dramatically without action to curb emissions (Ch13).

Extreme weather events and heat

Extreme weather events are one of the most obvious ways in which climate change affects human health and are expected to increase, in many cases, in both frequency and severity. These include storms and flooding; drought; extreme heat and forest fires. There is *now higher confidence in the projected increases in droughts, heat waves and floods, as well as their adverse impacts* (Ch1). The risk associated with extreme events is considered *moderate* at recent temperatures but *high* at 1°C warming *(medium confidence)* (Ch19) – yet this is far below the range of temperatures projected for the course of the 21st century.

Floods, storms and forest fires not only affect health directly, causing injuries and deaths and increasing exposure to infectious diseases, but can also destroy homes and communities, sometimes displacing people or ruining their livelihoods. Rapid urbanization has led to the growth of large cities and extreme weather events are often particularly severe for vulnerable communities living in slums or informal settlements, and especially women, children and the elderly. Such risks have *widespread negative impacts on people* and their *health, livelihoods and assets (very high confidence, high evidence)* (Ch8). The effects of extreme weather also include negative impacts on mental health which are often overlooked.

Without action to curb emissions, IPCC-WG2 also warns of negative impacts on human health arising from high temperatures. In some parts of the world, temperatures already exceed the international standard for safe work activity – this may occur on a regular basis in parts of the world during this century (Ch11), leading to ill health and reduced labour productivity. For example, in Australia, one study estimated *that the number of "dangerously hot" days, when core body temperatures may increase by ≥ 2oC and outdoor activity is hazardous, is projected to rise from the current 4-6 days per year to 33-45 days per year by 2070* (Ch11).

Heat is particularly dangerous for urban populations of the elderly, infants, people with chronic diseases, and expectant mothers. Increasing frequency and intensity of extreme heat (including exposure to the urban heat island effect and air pollution) can interact with an inability of some local organizations that provide health, emergency, and social services to adapt to new risks for vulnerable groups, making involvement of the health sector in climate adaptation essential. Globally, and in most countries, the increase in heat deaths is expected to greatly outweigh any reduction in cold deaths associated with warming.

Figure 3a: Projected changes in flood frequency

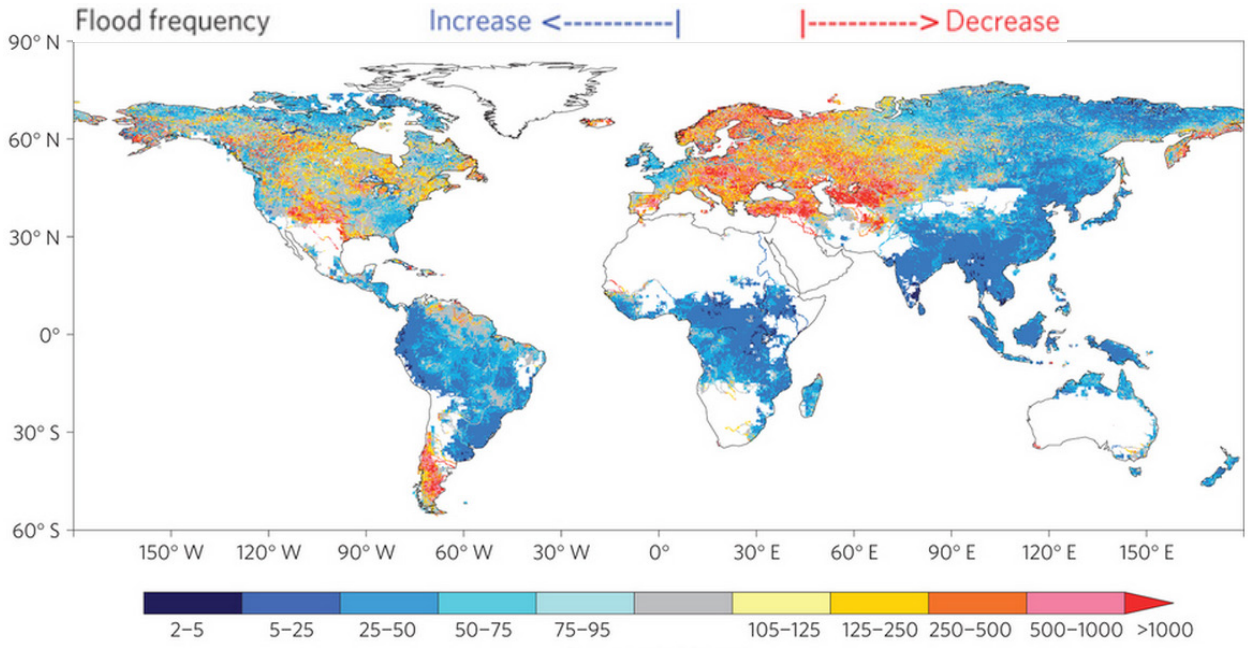
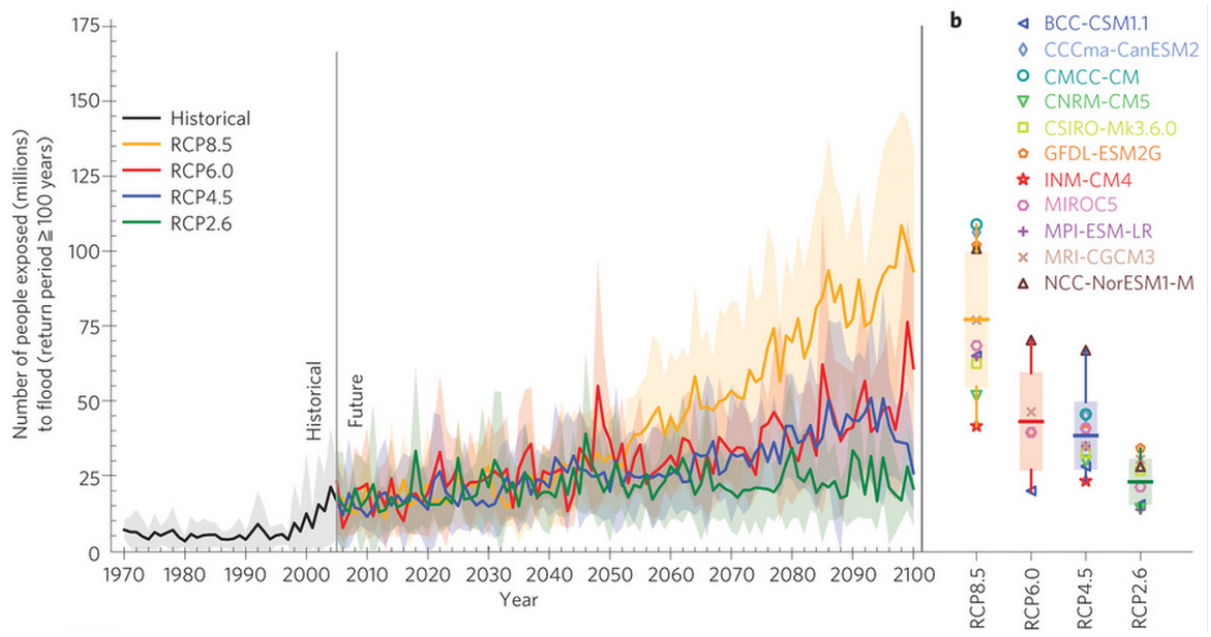


Figure 3b: Number of people (millions) exposed to flooding in the next 100 years.



Air pollution

Climate Altering Pollutants (other than CO2) do not just contribute to climate change, but also contribute to respiratory and cardio-vascular illness. More than 7% of the global burden of disease in 2010 is estimated to be due to inhalation of these air pollutants. Climate change impacts on air quality, particularly in urban areas, *are highly uncertain and may include increases and decreases of certain pollutants*. However, there is *strong evidence that climate change will generally increase ozone in the US and Europe*, although its impact on the largest health-relevant air pollutant, particulate matter, is *highly uncertain*.

Vector-borne Diseases

Climate change is expected to alter and expand the distribution of certain vector-borne diseases. Many – such as malaria, dengue fever, tick-borne encephalitis, hemorrhagic fever with renal syndrome (HFRS), Lyme disease and Japanese encephalitis – are considered 'climate-sensitive' because changing temperatures and rainfall patterns can create new suitable habitats for the insects which spread them. In the case of malaria, the effects of control interventions and socioeconomic development appear to have played a more important role than climate change thus far, but this could change in future. For example, dengue has become much more closely associated with climate change over the past five decades, having increased 30-fold in this period.

Ecosystem changes and loss of biodiversity

Climate change will have many impacts on planetary ecosystems, interacting with various human activities that are also altering ecosystems such as deforestation, agriculture, road building, fishing, mining and the damming of rivers.

According to IPCC-WG2, there is a *high risk* that higher warming scenarios (RCP4.5 and higher) *will result within this century in abrupt and irreversible regional-scale change in the composition, structure and function of terrestrial and freshwater ecosystems, especially in the Amazon and Arctic, leading to substantial additional climate change (medium confidence)* (Ch4).

Current trajectories put us at risk of large irreversible shifts in the spatial distribution of species and the seasonal timing of their activities and behaviours with implications for various 'ecosystem goods and services'. For example, marine ecosystem goods and services that would be affected include: provisioning of food (fisheries and aquaculture); nutrient recycling; production of 02 and removal of CO2; and tourism. In addition, *a large fraction of both terrestrial and freshwater species face increased extinction risk under projected climate change during and beyond the 21st century, especially as climate change interacts with other pressures, such as habitat modification, over-exploitation, pollution and invasive species* (Ch4).

Increased tree death in many places worldwide has also been partly attributed to climate change *(high confidence)*, and has been sufficiently intense in some places to result in forest dieback. This *will become apparent in many regions sooner than previously anticipated (medium confidence); and* is *a major environmental risk with potentially large impacts on climate, biodiversity, wood production, water quality, amenity and economic activity* (Ch4).

For medium- to high-emission scenarios (RCP4.5, 6.0, and 8.5), ocean acidification poses *substantial risks to polar ecosystems and coral reefs* and the combination of acidification and warming of coastal waters will have *significant negative consequences for coastal ecosystems* (SPM) , an especially for coral reefs. Furthermore, the *expansion of oxygen minimum zones and anoxic "dead zones" is projected to further constrain fish habitat* (SPM).

Biodiversity has value in its own right, but its loss also affects health: both for those who depend directly on these ecosystems – for food, water and many other ecosystem services – and also indirectly for their role in climate regulation. Ecosystems have important inter-relationships with local, regional and global climates, and there is accumulating evidence for so-called ecosystem 'tipping points'.

Poverty, Migration and Conflict

Among the most potent mechanisms by which climate change will impact on human health are by making some areas uninhabitable or prone to emergencies and disasters; undermining livelihoods; breaking down social solidarity; precipitating significant population displacement; and triggering conflict over scarce resources.

The combined effects of sea level rise, extreme events and hydrologic disruptions in some areas would increasingly *pose major challenges to vital transport, water and energy infrastructure* (Ch12). Elsewhere, the report notes that risks related to rising sea levels and storm surges, heat stress, inland and coastal flooding, landslides, drought, increased aridity, water scarcity and air pollution are increasing with *widespread negative impacts on people and on local and national economies and ecosystems (very high confidence, high evidence)* (Ch8).

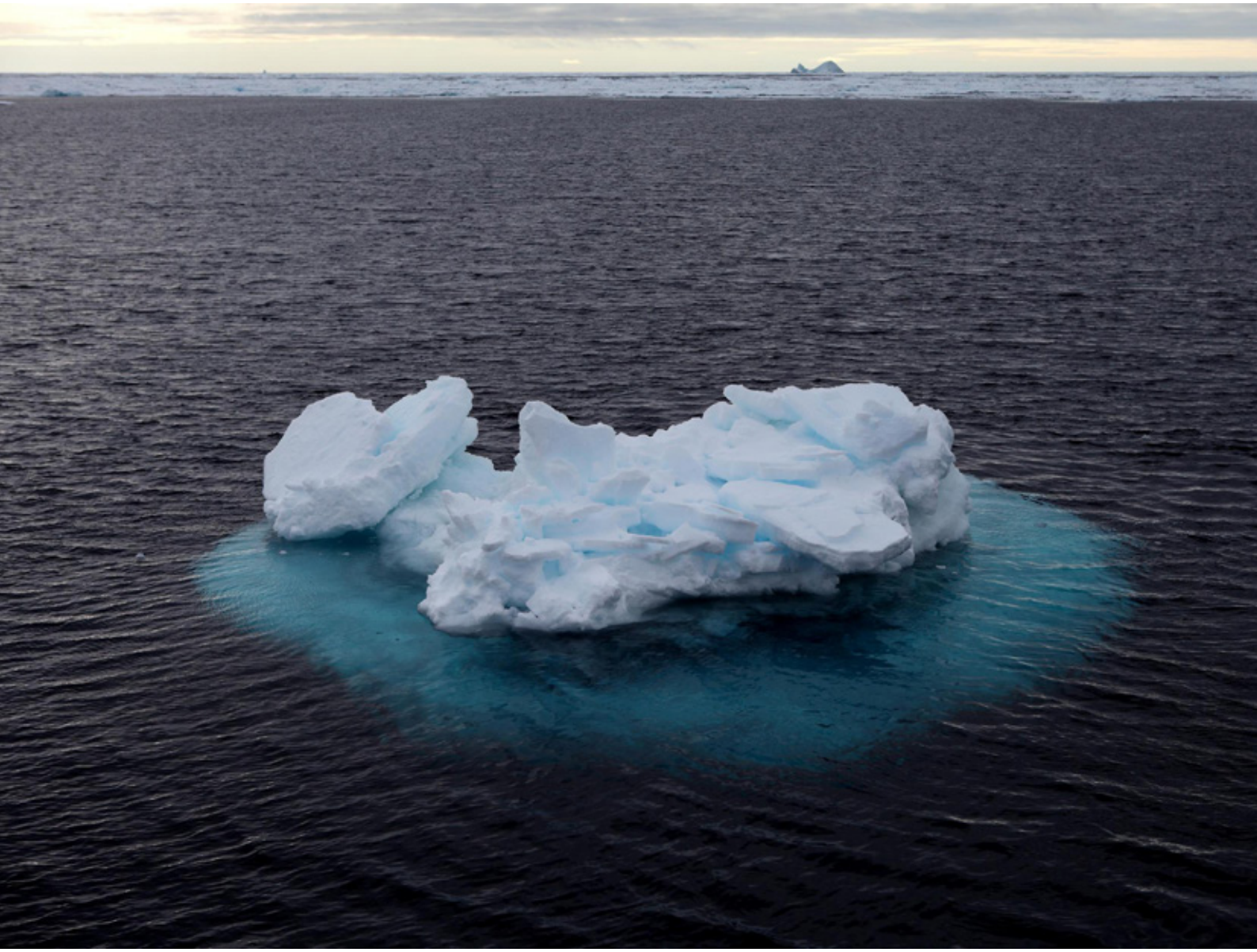
IPCC-WG2 places particular stress on the vulnerabilities of coastal populations who *will increasingly experience adverse impacts such as submergence, coastal flooding and coastal erosion due to relative sea level rise (very high confidence) (Ch5). Cities in Asian megadeltas, where populations are subject to sea level rise, storm surge, coastal erosion, saline intrusion, and flooding, are especially*

exposed to multiple hazards and potential failures of critical infrastructure, generating new systemic risks (Ch19). And developing countries and small island states dependent on coastal tourism *will be impacted directly not only by future sea level rise and associated extremes but also by coral bleaching, ocean acidification and associated reductions in tourist arrivals (high confidence) (Ch5).*

Rural populations in developing countries are also considered especially vulnerable due to the combined effects of climate change and non-climate stressors related to underinvestment in agriculture, problems with land and natural resource policy, and processes of environmental degradation *(very high confidence) (Ch9).*

Although evidence on climate change's effects on conflict and civil unrest is complex and contested, Chapter 19 states that: *in numerous statistical studies, the influence of climate variability on violent conflict is large in magnitude (medium confidence).* The report also notes that climate change will *increasingly shape both conditions of security and national security policies (medium agreement, medium evidence),* with some trans-national impacts of climate change, such as on shared water resources and fish stocks, having *the potential to increase rivalry among states* (Ch12).

Climate-change is projected to slow down economic growth and exacerbate poverty in low income countries and some middle income countries *(Ch13).* The report cites floods, water stress, population growth and 'multiple other deprivations' as important contributors, concluding that *poor people in urban areas in* low-income countries *and* lower middle-income countries *in Africa, Asia, and Latin America may slip from transient to chronic poverty* (Ch13). Poverty would also arise from food price increases that may be precipitated by climate change.



POLITICS, ETHICS AND DECISION-MAKING

Climate change poses serious and urgent threats to human health and social wellbeing. It already contributes to widespread human suffering and economic damage.

The need to respond to climate change is clear, but prioritising between policy alternatives is a more difficult decision. Science can inform us of the threats and risks posed by climate change; and it can indicate how acts of mitigation and adaptation might reduce these. But at some point, selecting an appropriate policy response – especially in the face of some uncertainty – becomes a political and ethical challenge.

POLITICAL AND ETHICAL ISSUES

Unequal burdens and capacities

The risks and threats of climate change and the corresponding capacities for adaptation, vary hugely across countries and different sub-population groups. Lower-income countries are generally more vulnerable to climate change and less able to adapt to its effects. Within countries and communities, the poor, children and the elderly are often more susceptible to the impacts of climate change (Box 2). Gender inequities can also distribute the burden unfairly between men and women.

Some of the variation is the result of geographic factors; but many are the result of an unequal and unfair distribution of economic, social and political resources. The requirement to simultaneously respond to climate change while addressing poverty and the unmet basic rights of billions of people of worldwide poses one the biggest political and ethical challenges facing the global community.

These challenges are accentuated by the fact that climate change could worsen inequalities and injustice *as basic resources such as energy, land, food, or water become threatened*, and lead to *new forms of vulnerability.* Moreover, responses to climate change could worsen inequalities. As one example, IPCC-WG2 describes *increasing cases of land-grabbing and large acquisitions of land or water rights for industrial agriculture, mitigation projects or biofuels that have negative consequences on local and marginalized communities* (Ch 1).

Contested views on historical emissions

A second political and ethical issue is the uneven distribution of responsibilities for historic emissions of GHGs across countries and communities, and the fact that those most threatened by climate change are often least responsible for the causes of climate change. This issue has significantly complicated progress in the UN Framework Convention on Climate Change' negotiations around the reduction of GHG emissions.

The rights of future generations

Another major ethical issue is *inter-generational equity. IPCC-WG2 notes that* inter-generational issues are frequently treated as an economic problem in which the health and lives of future generations are discounted against those of current and living generations. However, others argue that a more ethical framework should give greater or equal value to the rights and lives of future generations.

Differences in culture

Cultural differences across countries, cultures, religions and communities are another set of political and ethical issues. In order to effectively manage climate change, there is a need to accommodate and negotiate between differences in cultural values placed on, for example, nature and biodiversity; social solidarity and equity; and lifestyles and patterns of consumption. There is also a need to accommodate differences in how risk is perceived, tolerated and managed by different societies.

Box 2: Social determinants of vulnerability

For the poor, especially in low and middle income countries, climate change constitutes an additional burden on top of the daily struggles to secure food and water; and to meet basic needs.

For children, climate change will exacerbate existing threats to health such as malaria, diarrhoea and undernutrition which are generally concentrated amongst children. Children are also *generally at greater risk when food supplies are restricted* (Ch11) and at increased risk of climate-related injury or illness related to extreme weather.

For older people, storms, floods, heat-waves and other extreme events pose greater risks compared to younger adults because of their poorer health and mobility, and greater tendency to live alone in some cultures. Older people are also less able to respond to stressors such as heat and air pollution.

COMMUNICATION

The complex nature of climate change and the political and ethical challenges, mean that the *framing* of evidence and information about climate change is important. IPCC-WG2 notes that *socio-cultural and cognitive-behavioural contexts* are *central to decision-making*, and encourages a more sophisticated understanding of the determinants of effective decision-making (Ch2).

For example, it notes that translating knowledge about climate change into necessary action can be blocked four psychological distances: a) temporal (because risks and threats are seen as being in the future); b) geographic (because risks and threats are located elsewhere); c) social (because risks and threats are experienced by other people); and d) uncertainty (because risks and threats are bound by some degree of uncertainty).

Psycho-emotional factors also influence attitudes and actions relevant to climate change. For example, when the a perception of high risk is combined with low adaptive capacity, responses can include fatalism, denial and wishful thinking; while words like 'danger', 'disaster' and 'catastrophe' should be used carefully because they can trigger an emotive reaction, and in certain circumstances, disengagement.

Finally, the importance of clarity in language in communication is noted. Because words like 'adaptation', 'vulnerability', 'risk', and 'sustainability' can carry different meanings across languages, cultures and communities, they can be a source of confusion and misunderstanding. Similarly, the use of different terms to describe the same action can hinder effective communication and decision-making.

ADAPTATION, MITIGATION AND DEVELOPMENT

Climate change is *a severe threat to future sustainable development (high confidence; high agreement; medium evidence)* especially when added to other stresses such as poverty, inequality and environmental degradation (Ch20).

The IPCC-WG2 report includes an assessment of the policies required to help adapt to climate change. But central to this is an understanding that mitigation and adaptation cannot be separated, and that both are essential in ensuring sustainable and equitable development across the world.

The report makes clear that *adaptation is already happening*, but that without mitigation, *a magnitude of climate change is likely to be reached that makes adaptation impossible for some natural systems; while for most human systems it would involve very high social and economic costs (Ch 1)*. Furthermore, delaying the implementation of mitigation policies now will reduce options for effective responses in the future. *In some parts of the world, current failures to address effects of emerging climate stressors are already eroding the basis for sustainable development and offsetting previous gains (Ch20).*

INTEGRATING ADAPTATION AND MITIGATION INTO SUSTAINABLE AND EQUITABLE DEVELOPMENT

The need to combine adaptation and mitigation policies into development policies is highlighted by IPCC-WG2. It calls for strategies and actions that will *move toward climate-resilient pathways while simultaneously helping to improve livelihoods, social and economic well-being, and responsible environmental management (high confidence; medium evidence) (Ch20).*

Adaptation and mitigation have the potential to contribute to or impede sustainable and equitable development, while development strategies and choices have the potential to either contribute to or impede climate change responses. New policy approaches are required to take into account the complex interactions between climate, social and ecological systems.

To date, however, mitigation policies with expected social co-benefits *have had limited or no effect in terms of poverty alleviation and sustainable development*. Furthermore, some mitigation efforts, such as land acquisition for biofuel production, have had *negative impacts on the lives of poor people in many [low and middle income countries]* (Ch13).

Adaptation policies can also have unwanted effects – actions taken in one location or sector can *increase the vulnerability of another location or sector, or increase the vulnerability of the target group to future climate change* (Ch14). For example, *responses to counter increased variability of water supply, such as building more and larger impoundments and increased water extraction, will in many cases worsen the direct effects of climate change in freshwater ecosystems* (Ch4).

Such examples maladaptation arise from bad planning or from decisions that *place greater emphasis on short-term outcomes ahead of longer-term threats, or that discount, or fail to consider, the full range of interactions arising from the planned actions* (Ch14).

However, an abundance of examples and evidence highlighted by the IPCC-WG2 demonstrates that this does not have to be the case. *Adaptation actions can provide significant co-benefits such as alleviating poverty or enhancing development. Many aspects of economic development also facilitate adaptation to a changing climate, such as better education and health, and there are adaptation strategies that can yield welfare benefits, such as more efficient use of water and more robust crop varieties (Ch17).*

Although the framing of adaptation has evolved away from a focus on disaster management towards greater consideration of the wider social and economic drivers of vulnerability and capacity to respond, according to IPCC-WG2, the present literature is still dominated by approaches that focus on defensive infrastructure rather than on human vulnerability. Promoting better connections between climate change actions, development strategies and disaster risk management will partly depend on *the extent to which climate change is viewed as a public safety issue or a development issue (Ch15).*

DRIVING TRANSFORMATIVE CHANGE

Approaches to adaptation and mitigation have tended to focus on what are known as 'no-regret', 'low-regret', and 'win-win' strategies. This emphasises incremental change to reduce impacts while achieving co-benefits.

However, there is increasing evidence that incremental adaptation may not be sufficient to avoid intolerable risks and sustain some human and natural systems (Ch16) and that transformative change is required. Transformation means a change in the fundamental attributes of a system, including altered goals or values.

According to IPCC-WG2, this would imply the need for more fundamental *changes in our perception and paradigms about the nature of climate change, adaptation and their relationship to other natural and human systems* (Ch2), as well as *transformations in political, economic and socio-technical systems (that) can contribute to enhanced climate responses, both for mitigation and adaptation (Ch20).*

CLIMATE AND HEALTH CO-BENEFITS

According to IPCC-WG2, researchers and institutions are turning their attention to the co-benefits associated with adaptation and mitigation. The health co-benefits associated with adaptation and mitigation were not necessarily a central focus of IPCC-WG2, but are central enough human health and well-being to be included in this summary report.

Central to this, is an understanding that many of the drivers of climate change (e.g. fossil fuel burning, over-consumption of meat, poorly designed cities and over-dependence on motorised transport) also contribute to many health problems (e.g. obesity, diabetes, respiratory and heart disease and road deaths). These health gains can be achieved through interventions such as switching to cleaner, low-carbon energy sources; urban planning that promotes active transport (walking and cycling); and reducing red meat and dairy consumption.

Examples of recent research studies on co-benefits of climate change mitigation and public health policies cover the following areas.

CO-BENEFIT CATEGORY	HEALTH BENEFIT	CLIMATE BENEFIT
Reduction of co-pollutants from household solid fuel combustion	Potentially reduce exposures associated with chronic and acute respiratory illnesses, lung cancer, low birth weight and stillbirths, and possibly tuberculosis	Reduces GHG emissions associated with household solid fuel use
Reduction of GHGs and associated co-pollutants from industrial sources, such as power plants and landfills by more efficient generation or substitution of low carbon alternatives	Decrease exposure to outdoor air pollution and reduced risk of cardiovascular disease, respiratory illnesses, lung cancer and preterm birth	Reductions in GHG emissions and other air pollutants
Increases in active travel and reductions in pollution due to modifications to the built environment, including better access to public transport and higher density of urban settlements	Increased physical activity; reduced obesity; reduced non-communicable disease burden; improved mental health; reduced exposure to air pollution; increased local access to essential services; enhanced safety	Reductions of emissions associated with vehicle transport
Low GHG emission diets	Reduced dietary saturated fat in some populations and replacement by plant sources associated with decreased risk of heart disease, stroke and colorectal cancer. Increased fruit and vegetable consumption can reduce risk of several chronic diseases.	Reductions in GHG emissions from energy-intensive livestock systems
Greater access to reproductive health services	Lower child and maternal mortality	Potentially reduced rate of population growth and growth of energy consumption
Increases in urban green space	Reduced temperatures and heat island effects; reduced noise; enhanced safety; psychological benefits; better self-perceived health status	Reduces atmospheric CO2 via carbon sequestration in plant tissue and soil
Reduced deforestation and land degradation	Reduced environmental hazards; possible poverty alleviation and job creation	Carbon sequestration through reforestation

A WAY FORWARD FOR HEALTH PROFESSIONALS

In concluding, this report will depart from the IPCC-WG2, and suggest recommendations to health professionals on what they can do to address the profound impacts of climate change on human health and social wellbeing.

MITIGATE AND ADAPT WITHIN THE HEALTH SYSTEM

GHG emissions from health systems are immense. For example, in 2012, England's National Health Service was responsible for an estimated over 25 million tonnes of CO2e. Through innovative policy and a focus on sustainable procurement, transport, infrastructure and commissioning, health systems can reduce their GHG emissions and set a powerful example for the rest of society. Importantly, many of these interventions have the potential to lead to improved public health and reduced healthcare costs.

Health systems can also take steps to become climate-resilient and increase the adaptive capacity of the populations they serve. Early-warning surveillance systems, infrastructure which can function under the strains of extreme weather, and an adequately trained health workforce which can manage the changing patterns of disease brought on by climate change are just some of the approaches being implemented.

RESEARCH AND INNOVATION

The IPCC-WG2 report highlights the importance of additional research into the co-benefits of mitigation and adaptation policies for health and sustainable development. Whilst the IPCC provides high-quality syntheses and interpretations of the state of research in a variety of areas at a global and regional level, the same level of detail is not readily available at the sub-regional or sub-national level.

MAINSTREAM CLIMATE CHANGE AS A HEALTH ISSUE

Various policy and behavioural interventions have the potential to promote substantial positive synergies between public health improvement, climate protection, and sustainable and equitable development. These include:

- The promotion of sustainable diets and food systems
- The development of more active transport policies and systems
- The promotion of gender equity and the expansion of access to reproductive health services

Health professionals can incorporate such aspects of climate change mitigation and adaptation into their every-day lives and clinical practice, and promote their adoption as public policies in other sectors.

ADVOCATE LOCALLY, NATIONALLY, AND INTERNATIONALLY

Health professionals occupy a privileged role within society, often afforded a high level of trust and respect within society. This credibility comes from an understanding of health and suffering experienced by their patients, and a willingness to 'stand-up' for what is in the public's interest. Insofar as climate change represents a significant and dangerous threat to public health, health professionals have a responsibility to engage in public and political advocacy to mitigate this risk. The health impacts of climate change provide a powerful message for change, and health represents a more tangible and readily understandable concept than abstract indicators such as parts per million CO2e.

BUILD PARTNERSHIPS, BRIDGE DIVIDES

In a previous Lancet Commission, climate change was referred to as "the biggest global health threat of the 21st century". However, the above discussion indicates that there are opportunities to convert climate change into an opportunity for improved health and sustainable development. But this will require a much higher degree of cooperation and trust across national, cultural and geographic divides that currently impede effective and equitable action. By building a global movement around population and planetary health, health professionals have an opportunity and role to play in bridging these divides.

The potential positive synergies available beyond the health sector (eg. with transport, infrastructure, engineering and agriculture) are also immense, and provide impetus for partnerships across all aspects of society. Here too, health professionals have an opportunity and role to help drive ambitious responses to climate change, whilst improving sustainable development and global health.