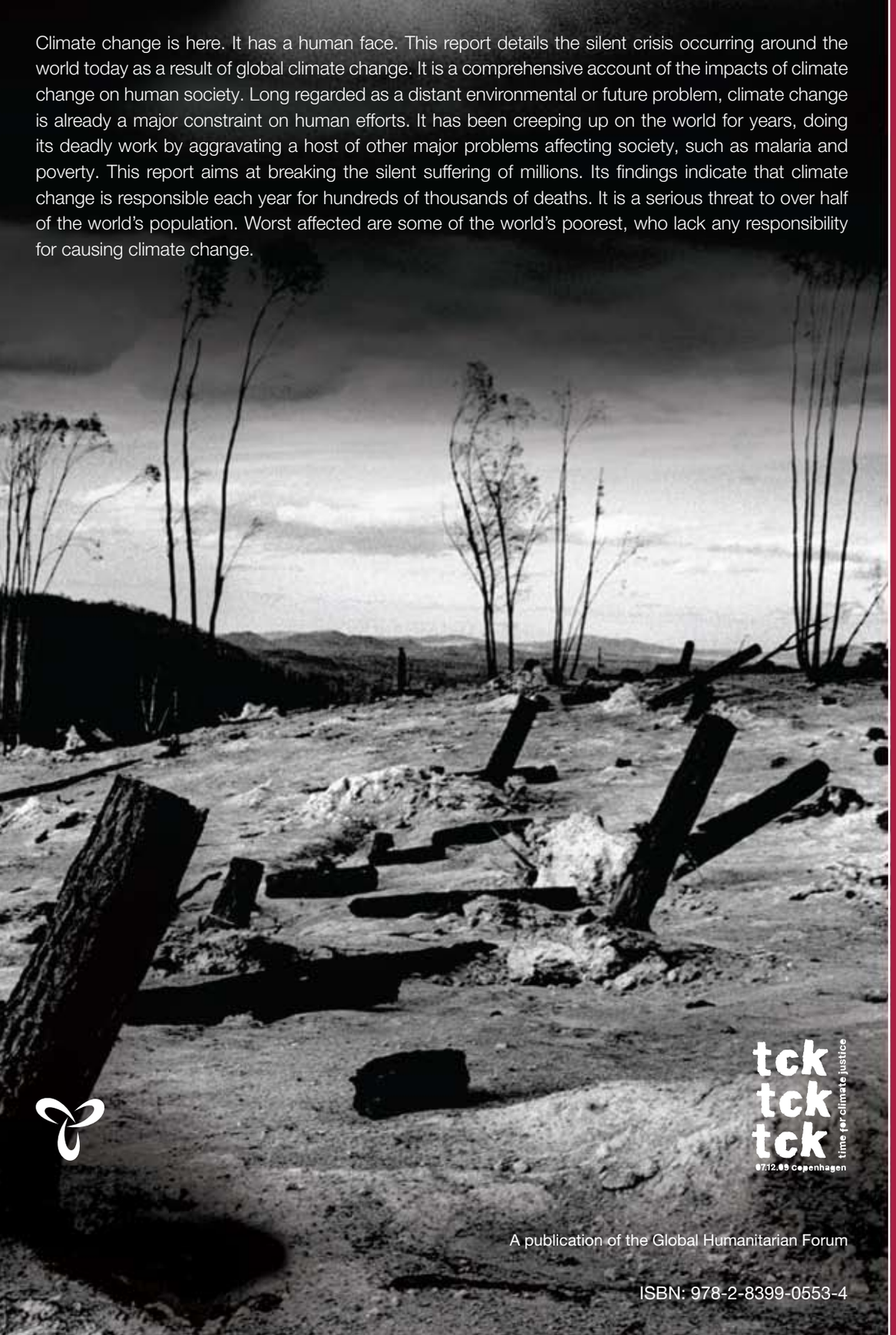
Climate change is here. It has a human face. This report details the silent crisis occurring around the world today as a result of global climate change. It is a comprehensive account of the impacts of climate change on human society. Long regarded as a distant environmental or future problem, climate change is already a major constraint on human efforts. It has been creeping up on the world for years, doing its deadly work by aggravating a host of other major problems affecting society, such as malaria and poverty. This report aims at breaking the silent suffering of millions. Its findings indicate that climate change is responsible each year for hundreds of thousands of deaths. It is a serious threat to over half of the world's population. Worst affected are some of the world's poorest, who lack any responsibility for causing climate change.



tck tck tck time for climate justice
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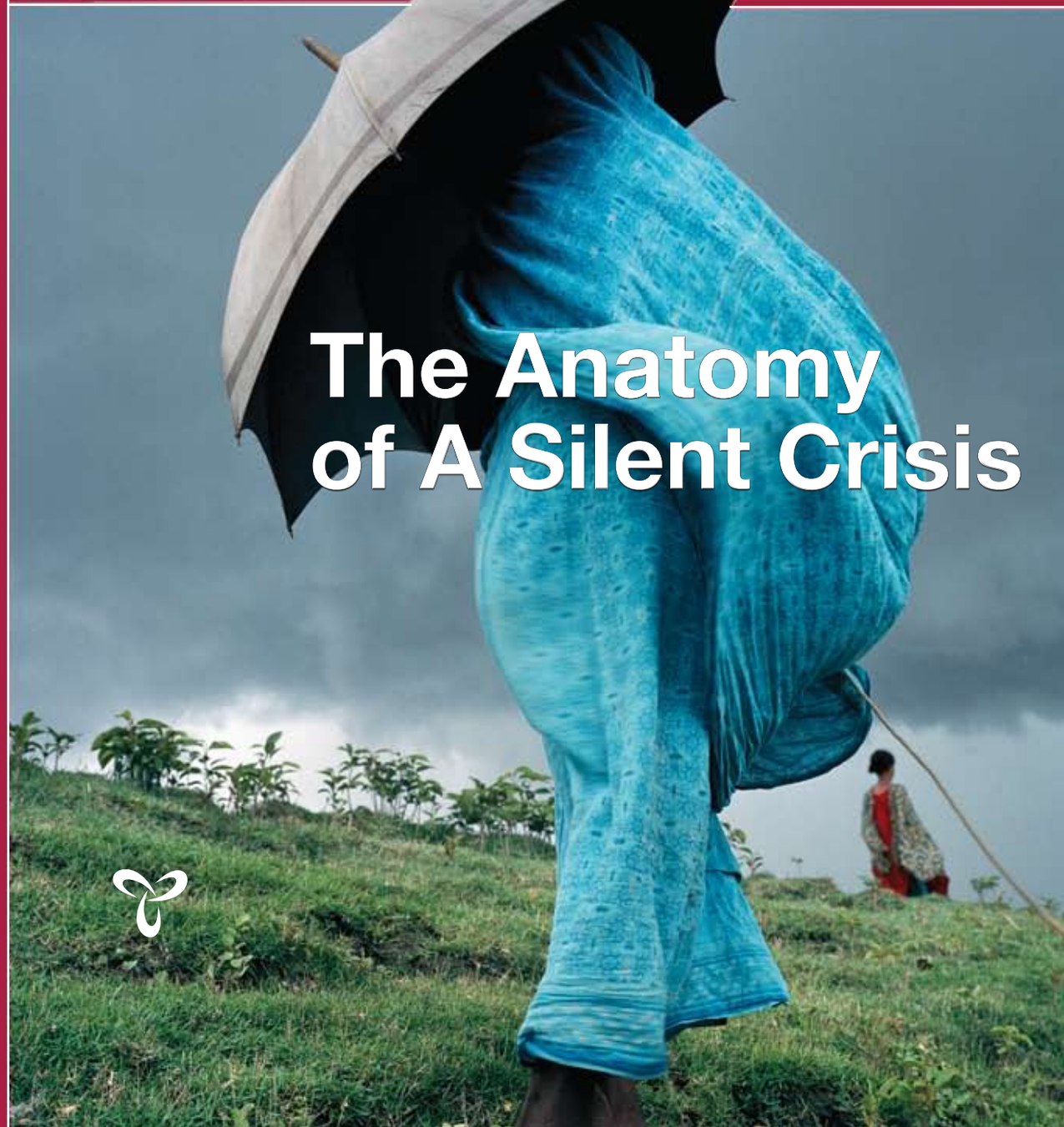
The Anatomy of A Silent Crisis

Human Impact Report
Climate Change

Global Humanitarian Forum Geneva



The Anatomy of A Silent Crisis

Introduction

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Cover Picture:
Laurent Weyl, Collectif Argos. 'Elderly woman looking after her cow on top of a large dyke.'
Sea-level rise and changing monsoon patterns have changed the landscape where she grew up.
District of Satkhira, 'Bangladesh: Le grand debordement'

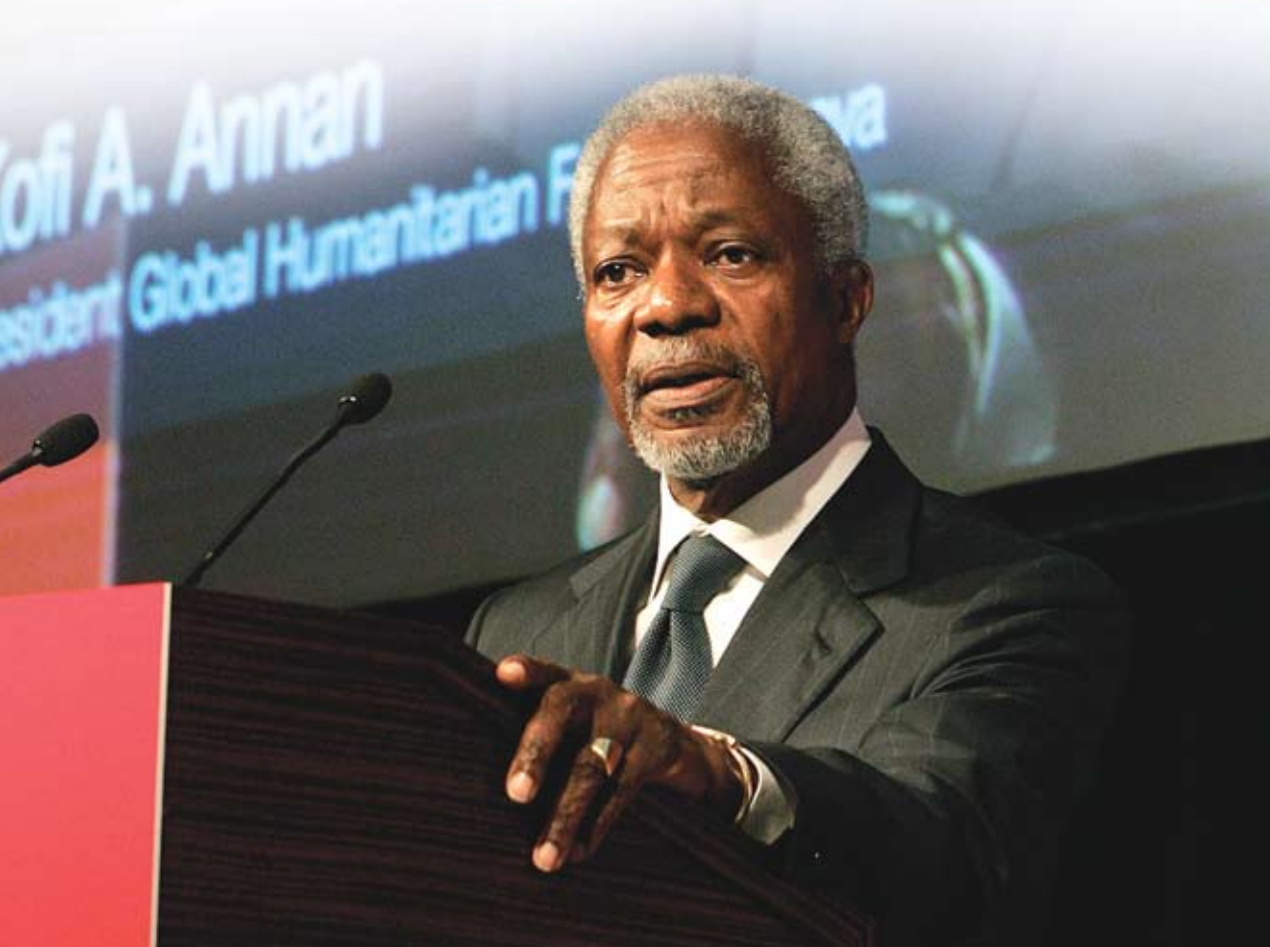
Introduction

Kofi A. Annan, President of the Global Humanitarian Forum

Today, millions of people are already suffering because of climate change.

The deathly silence of this crisis is a major impediment for international action to end it.

This report tries to document the impact of climate change on human life globally. Science is only beginning to address the human impact of climate change. However, dozens of research organizations and experts contributing to this report can agree on the widespread damage it causes. We feel it is the most plausible account of the current impact of climate change today.



Without describing the full picture of the challenge, we cannot expect our response to match its scale. And we can no longer hold back from speaking out on the silent suffering of millions worldwide.

Polls already show that people worldwide are concerned about climate change. Communities on the climate frontlines already see and feel the change. But awareness about the impacts of climate change is low, particularly among the poor. In industrialized countries, climate change is still considered a solely environmental problem. It is seen as a distant threat that might affect our future. A viewpoint reinforced by pictures of glaciers and polar bears — not human beings.

And yet Australia is witnessing a full decade of drought. Large tracts of the United States are exposed to stronger storms and severe water shortages — leading to crop loss, job loss, fires, and death.

We testify here to the human face of this dangerous problem. The first hit and worst affected by climate change are the world's poorest groups. Ninety-nine percent of all casualties occur in developing countries. A stark contrast to the one percent of global emissions attributable to some 50 of the least developed nations. If all countries were to pollute so little, there would be no climate change.

The effects of pollution driven by economic growth in some parts of the world are now driving millions of people into poverty elsewhere. At the same time, decades-old aid pledges continue to go unmet. The Millennium Development Goals are endangered. And the poor lack capacity to make their voices heard in international arenas, or attract public and private investment. For those living on the brink of survival, climate change is a very real and dangerous hazard. For many, it is a final step of deprivation.

Where does a fisherman go when warmer sea temperatures deplete coral reefs and fish stocks? How can a small farmer keep animals or sow crops when the water dries up? Or families be provided for when fertile soils and freshwater are contaminated with salt from rising seas?

Climate change is an all encompassing threat, directly affecting the environment, the economy, health and safety. Many communities face multiple stresses with serious social, political and security implications, both domestically and abroad. Millions of people are uprooted or permanently on the move as a result. Many more millions will follow.

New climate policy must empower vulnerable communities to cope with these challenges. It should support the wider drive for a dignified existence for all, in harmony with the environment as well as in safety from it.

This report has been realized at the last possible moment. It is being issued just six months prior to the meeting of nations at Copenhagen, Denmark, in December 2009. Copenhagen will conclude negotiations begun nearly two years ago for a new international climate agreement to succeed the Kyoto Protocol after 2012.

Even the most ambitious climate agreement will take years to slow or reverse global warming. A global carbon economy has been the basis of all productive efforts since centuries. Emissions are still steadily increasing, and the world population is set to grow by forty percent by 2050.

If we do not reverse current trends by close to 2020, however, we may have failed. Global warming will pass the widely acknowledged danger level of two degrees, since there is an approximately 20 year delay between emission reductions and the halting of their warming effect. This report clearly demonstrates that climate change is already highly dangerous at well below one degree of warming. Two degrees would be catastrophic.

Weak political leadership as evident today is all the more alarming then. It is not, however, surprising, since so few people are aware of just how much is at stake. That we are already this far into the most important negotiations ever for the future of this planet without a clear idea of the full impact of climate change on human society speaks volumes in itself. In this respect, I hope that the report will change political attitudes, spur public debate and more research.

Copenhagen needs to be the most ambitious international agreement ever negotiated. The alternative is mass starvation, mass migration, and mass sickness. If political leaders cannot assume responsibility for Copenhagen, they choose instead responsibility for failing humanity. In 2009, national leadership goes beyond the next elections, and far beyond national borders.

To do justice to the basic needs of people around the world, Copenhagen must produce an outcome that is global, safe, fair and binding. Such an agreement is in the interests of every human being alive today. Achieving a just accord is also our shared responsibility. An agreement seen to be unjust would struggle to achieve worldwide ratification.

We live in a global village and we each have a responsibility to protect our planet. Isn't it logical and equitable, therefore, to insist that those who pollute have a duty to clean up? Pollution by some affects us all. Every one of us needs to understand that pollution has a cost, and this cost must be borne by the Polluter. Least responsible for greenhouse gas emissions are the world's poorest communities who suffer most from climate change. This is fundamentally unjust. If efforts to build a global framework to address climate change are to succeed and endure they must be based on the principles of fairness and equity. People everywhere deserve climate justice. And everywhere people must stand up and demand exactly that from their representatives. A fair and just approach would facilitate agreement at the UN Climate Conference in Copenhagen later this year. We cannot afford to fail.

Climate change is a truly global issue. Its impacts, while skewed, are indiscriminate and threaten us all. People everywhere deserve not to suffer because of climate change. People everywhere deserve a future for their children. People everywhere deserve to have leaders who find the courage to achieve a solution to this crisis.

We will not get there by shaming and blaming. We must go beyond piecemeal changes to alter the very structure of the global economy. This will only be feasible if we manage to force a global price on carbon that is more representative of its costs to society, calculated at over 1 trillion dollars per year today according to this report's findings. Taking these costs into account would redirect resources, exponentially multiplying possibilities for taking a greener path.

Indeed, that transformation is likely to prove the greatest opportunity for new economic growth since the advent of the industrial revolution. Renewable clean energy in particular would benefit the poor most, because of health, social and access reasons. It could also help springboard development: remembering, in particular, the 1.6 billion people on this planet who lack access to any modern forms of energy whatsoever.

When it comes to dealing with climate change, everybody must contribute according to their fair share of responsibility for the problem. No nation has the right to pollute. But we must be reasonable in our demands. And the poor urgently need protection to persevere and support to lead a dignified existence.

The role of this report is to document the greatest ongoing silent crisis of human history. When reading these pages it must not be forgotten that solutions exist: we can take preventative measures, we can adopt greener practices, and we can provide a dignified existence for all. We can contain climate change and end the suffering it causes.

But nobody can do it alone. Even if the United States or China — the world's largest polluters in total emissions — were to stop polluting today, if others are not on board, climate change will continue to menace human society. Together, we can multiply the possibilities for overcoming it, and lessen the burden on everyone. But we must act now.

Humanity is facing a rare challenge. But it is a common challenge. There are no sides in the fight for climate justice.

I urge people everywhere to unite for climate justice and ensure that their leaders sign up to a fair, global and binding agreement in Copenhagen.

CONTENTS

Executive summary 1

Background 5

1 The human impact of climate change — Already serious today 6

2 Critical areas of human impact 22

3 The world's poorest — Most vulnerable yet least responsible .... .58

4 A global challenge — Goals missed 66

5 Conclusion 77

Notes on report methodology 83

Glossary and abbreviations 93

End notes 97

Bibliography 112

Acknowledgments 117

Biographies of advisory panel 119

List of figures

Figure 1 — Comparing human impact of climate change today with other global challenges ...11
Figure 2 — The impact of climate change is accelerating over the next 20 years 14
Figure 3 — Physical vulnerability to weather-related disasters and sea level rise 16
Figure 4 — Comparing economic losses with other important economic outcomes.....19
Figure 5 — The links from increased emissions to human impact 23
Figure 6 — The world map reflecting mortality related to climate change 31
Figure 7 — Areas vulnerable to climate-related water challenges 43
Figure 8 — Stages of climate change impact on security 54
Figure 9 — Socio-economic vulnerability to climate change around the world 59
Figure 10 — Physical and socio-economic vulnerability to climate change.....60
Figure 11 — Share of burden of disasters.....61
Figure 12 — The world map reflecting carbon emissions 63
Figure 13 — Threats to Millennium Development Goals due to climate change.....68
Figure 14 — Climate change agenda linked to disaster and development policies 75

List of case studies

Bangladesh — A nation at ground zero of the climate change crisis 17
Hurricane Katrina — Massive economic losses.....21
Uganda — A drought-plagued country 26
Indonesia — Seasonal variation in rainfall results in widespread hunger 27
Ethiopia — Drought, flooding and diarrhoea outbreaks 32
European heat wave — 2003 summer hottest in 500 years 33
Tanzania — Subsistence farmers required to switch to less lucrative crops. 38
Ecuador — El Niño phenomenon severely destroying livelihoods 39
Morocco — Vulnerable to drought.....44
Mexico City — Running out of water.....45
Ghana — A metaphor for those driven from home by desertification.....50
Small island developing states — Powerless against rising seas 51
Climate change in the dry land belt — An ecological time bomb 56
South Asian region — Melting of the Himalaya glaciers and risk of conflict.....57
Mali — Building adaptive capacity brings hope to a vulnerable drought-ridden nation 72
Arctic communities — “Canary in the coalmine” and climate change adaptation 73

Laurent Weyl, Collectif Argos. 'Tuvalu: Polynesian requiem.' Rare are the fishermen who dare go fishing on stormy days. Those who dared to face the elements are patiently awaited by housewives and mothers whose meal depends on the success of the expedition. Tuvalu

Executive summary

The anatomy of a silent crisis

Science is now unequivocal as to the reality of climate change. Human activities, in particular emissions of greenhouse gases like carbon dioxide are recognized as its principle cause. This report clearly shows that climate change is already causing widespread devastation and suffering around the planet today. Furthermore, even if the international community is able to contain climate change, over the next decades human society must prepare for more severe climate change and more dangerous human impacts.

This report documents the full impact of climate change on human society worldwide today. It covers in specific detail the most critical areas of the global impact of climate change, namely on food, health, poverty, water, human displacement, and security. The third section of this report highlights the massive socio-economic implications of those impacts, in particular, that the worst affected are the world's poorest groups, who cannot be held responsible for the problem. The final section examines how sustainable development and the Millennium Development Goals are in serious danger, the pressures this will exert on humanitarian assistance, and the great need to integrate efforts in adapting to climate change.

Based on verified scientific information, established models, and, where needed, on the best available estimates, this report represents the most plausible narrative of the human impact of climate change. It reports in a comprehensive manner the adverse effects people already suffer today due to climate change within a single volume, encompassing the full spectrum of the most important impacts evidenced to date.

The findings of the report indicate that every year climate change leaves over 300,000 people dead, 325 million people seriously affected, and economic losses of US$125 billion. Four billion people are vulnerable, and 500 million people are at extreme risk. These figures represent averages based on projected trends over many years and carry a significant margin of error. The real numbers could be lower or higher. The different figures are each explained in more detail and in context in the relevant sections of the report. Detailed information describing how these figures have been calculated is also included in the respective sections and in the end matter of the report.

These already alarming figures may prove too conservative. Weather-related disasters alone cause significant economic losses. Over the past five years this toll has gone as high as $230 billion, with several years around $100 billion and a single year around $50 billion. Such disasters have increased in frequency and severity over the past 30 years in part due to climate change. Over and above these cost are impacts on health, water supply and other shocks not taken into account. Some would say that the worst years are not representative and they may not be. But scientists expect that years like these will be repeated more often in the near future.

Climate change through the human lens

Climate change already has a severe human impact today, but it is a silent crisis — it is a neglected area of research as the climate change debate has been heavily focused on physical effects in the long-term. This human impact report: climate change, therefore, breaks new ground. It focuses on human impact rather than physical consequences. It looks at the increasingly negative consequences that people around the world face as a result of a changing climate. Rather than focusing on environmental events in 50-100 years, the report takes a unique social angle. It seeks to highlight the magnitude of the crisis at hand in the hope to steer the debate towards urgent action to overcome this challenge and reduce the suffering it causes.

The human impact of climate change is happening right now — it requires urgent attention. Events like weather-related disasters, desertification and rising sea levels, exacerbated by climate change, affect individuals and communities around the world. They bring hunger, disease, poverty, and lost livelihoods — reducing economic growth and posing a threat to social and, even, political stability. Many people are not resilient to extreme weather patterns and climate variability. They are unable to protect their families, livelihoods and food supply from negative impacts of seasonal rainfall leading to floods or water scarcity during extended droughts. Climate change is multiplying these risks.

Today, we are at a critical juncture — just months prior to the Copenhagen summit where negotiations for a post-2012 climate agreement must be finalized. Negotiators cannot afford to ignore the current impact of climate change on human society. The responsibility of nations in Copenhagen is not only to contain a serious future threat, but also to address a major contemporary crisis. The urgency is all the more apparent since experts are constantly correcting their own predictions about climate change, with the result that climate change is now considered to be occurring more rapidly than even the most aggressive models recently suggested. The unsettling anatomy of the human impact of climate change cannot be ignored at the negotiating tables.

Climate change is a multiplier of human impacts and risks

Climate change is already seriously affecting hundreds of millions of people today and in the next twenty years those affected will likely more than double — making it the greatest emerging humanitarian challenge of our time. Those seriously affected are in need of immediate assistance either following a weather-related disaster, or because livelihoods have been severely compromised

by climate change. The number of those severely affected by climate change is more than ten times greater than for instance those injured in traffic accidents each year, and more than the global annual number of new malaria cases. Within the next 20 years, one in ten of the world's present population could be directly and seriously affected.

Already today, hundreds of thousands of lives are lost every year due to climate change. This will rise to roughly half a million in 20 years. Over nine in ten deaths are related to gradual environmental degradation due to climate change — principally malnutrition, diarrhoea, malaria, with the remaining deaths being linked to weather-related disasters brought about by climate change.

Economic losses due to climate change currently amount to more than one hundred billion US dollars per year, which is more than the individual national GDPs of three quarters of the world's countries. This figure constitutes more than the total of all Official Development Assistance in a given year.

Already today, over half a billion people are at extreme risk to the impacts of climate change, and six in ten people are vulnerable to climate change in a physical and socio-economic sense. The majority of the world's population does not have the capacity to cope with the impact of climate change without suffering a potentially irreversible loss of wellbeing or risk of loss of life. The populations most gravely and immediately at risk live in some of the poorest areas that are also highly prone to climate change — in particular, the semi-arid dry land belt countries from the Sahara to the Middle East and Central Asia, as well as sub-Saharan Africa, South Asian waterways and Small Island Developing States.

A question of justice

It is a grave global justice concern that those who suffer most from climate change have done the least to cause it. Developing countries bear over nine-tenths of the climate change burden: 98 percent of the seriously affected and 99 percent of all deaths from weather-related disasters, along with over 90 percent of the total economic losses. The 50 Least Developed Countries contribute less than 1 percent of global carbon emissions.

Climate change exacerbates existing inequalities faced by vulnerable groups particularly women, children and the elderly. The consequences of climate change and poverty are not distributed uniformly within communities. Individual and social factors determine vulnerability and capacity to adapt to the effects of climate change. Women account for two-thirds of the world's poor and comprise about seven in ten agricultural workers. Women and children are disproportionately represented among people displaced by extreme weather events and other climate shocks.

The poorest are hardest hit, but the human impact of climate change is a global issue. Developed nations are also seriously affected, and increasingly so. The human impact of recent heat waves, floods, storms and forest fires in rich countries has been alarming. Australia is perhaps the developed nation most vulnerable to the direct impacts of climate change and also to the indirect impact from neighbouring countries that are stressed by climate change.

The time to act is now

Climate change threatens sustainable development and all eight Millennium Development Goals. The international community agreed at the beginning of the new millennium to eradicate extreme hunger and poverty by 2015. Yet, today, climate change is already responsible for forcing some fifty million additional people to go hungry and driving over ten million additional people into extreme poverty. Between one-fifth and one-third of Official Development Assistance is in climate sensitive sectors and thereby highly exposed to climate risks.

To avert the worst outcomes of climate change, adaptation efforts need to be scaled up by a factor of more than 100 in developing countries. The only way to reduce the present human impact is through adaptation. But funding for adaptation in developing countries is not even one percent of what is needed. The multilateral funds that have been pledged for climate change adaptation funding currently amount to under half a billion US dollars.

Despite the lack of funding, some cases of successful adaptation do provide a glimmer of hope. Bangladesh is one such example. Cyclone Sidr, which struck Bangladesh in 2007, demonstrates how well adaptation and prevention efforts can pay off. Disaster preparation measures, such as early warning systems and storm-proof houses, minimized damage and destruction. Cyclone Sidr's still considerable death toll of 3,400, and economic damages of $1.6 billion, nevertheless compare favourably to the similar scale cyclone Nargis, which hit Myanmar in 2008, resulting in close to 150,000 deaths and economic losses of around $4 billion.

Solutions do also exist for reducing greenhouse gas emissions, some even with multiple benefits. For instance, black carbon from soot, released by staple energy sources in poor communities, is likely causing as much as 18 percent of warming. The provision of affordable alternative cooking stoves to the poor can, therefore, have both positive health results, since smoke is eliminated, and an immediate impact on reducing emissions, since soot only remains in the atmosphere for a few weeks.

Integrating strategies between adaptation, mitigation, development and disaster risk reduction can and must be mutually reinforcing. Climate change adaptation, mitigation, humanitarian assistance and development aid underpin each other, but are supported by different sets of institutions, knowledge centres, policy frameworks and funding mechanisms. These policies are essential to combat the human impact of climate change, but their links to one another have received inadequate attention.

A key conclusion of this report is that the global society must work together if humanity is to overcome this shared challenge: nations have to realize their common interest at Copenhagen, acting decisively with one voice; humanitarian and development actors of all kinds have to pool resources, expertise and efforts in order to deal with the rapidly expanding challenges brought about by climate change; and in general, people, businesses, and communities everywhere should become engaged and promote steps to tackle climate change and end the suffering it causes.

Background

Context

This report aims at filling a void in both the general public's understanding of climate change and in the senior policy-makers' toolbox. It provides a consolidated volume specifically focused on the adverse impacts of climate change on human society. The report appears at a critical time for global policy on climate change — just over six months prior to the United Nation's Climate Change Conference in December 2009 in Copenhagen, where negotiations for a post-Kyoto international climate agreement are set to be finalized. Its aim is simple: to stimulate an informed public, political and policy debate and, hopefully, to put human life in the center of the long-overdue response to climate change. This current, comprehensive reference guide to the impact of climate change on human society today and over the next two decades is meant to provide an essential basis for any such debate. To date, the human impact of climate change has been a rather neglected area of research. Indeed, this report attempts to set out the detrimental effects people already suffer today due to climate change, as well as the far greater impacts it will have on the lives of the next generation. As such, the report is an attempt to fill an important gap in our collective knowledge and represents a plausible narrative of the human impact of ongoing climate change.

Objectives

The key objectives of this report are to:

- Shed more light on the human impact of climate change: The report focuses on the human impact rather than the physical effects. It looks at the increasingly negative consequences that people around the world face as a result of a changing climate.
- Clarify the current status of human impact: The report presents evidence demonstrating how climate change already affects human beings significantly today and how emissions released today will alter people's lives over the next 20 years.
- Document the full impact of climate change on human society in one comprehensive volume: The report attempts to encompass the full spectrum of the human consequences of climate change. It draws on leading scientific research in the field, but also includes well established estimates where complete data has not been available.
- Highlight adaptation funding gaps for developing countries and the need for cooperation and alignment: The report provides an overview of adaptation funding needed. It represents a call for action of increased cooperation and alignment between sustainable development, disaster risk reduction and adaptation.

1 The human impact of climate change — Already serious today

Human impact of climate change is irrefutable, even if difficult to measure precisely

Evidence that climate change is a present reality is unequivocal

Global warming *is* occurring and human-driven emissions of carbon dioxide and other greenhouse gases, as well as land-use change, are primarily responsible. Given current trends, temperature extremes, heat waves and heavy rains are expected to continue to escalate in both frequency and intensity, and the earth's temperature and seas will continue to rise. These conclusions lie at the heart of a 2007 report issued by the Intergovernmental Panel on Climate Change (IPCC), the world's foremost scientific body for the study of climate change. The IPCC was set up to provide an authoritative international statement of scientific understanding of climate change. Its reports are written by a team of authors nominated by UNEP and WMO member states or accredited organizations and are based on consensus and input from hundreds of international experts.

> "There is a very human tendency to wish away such dire prognostications and even to question the underlying science. But the science is now quite firm. People need to be told how it will affect them in their country and why they need to worry about it now rather than at some later time."
>
> Nitin Desai — Member, Prime Minister's Council on Climate Change, India; Distinguished Fellow, The Energy and Resources Institute (TERI)

This report draws attention to the serious human impact of climate change already visible today

Climate change affects human health, livelihoods, safety, and society. To assess the human impact of climate change, this report looks at people hit by weather-related disasters such as floods, droughts and heat waves as well as those seriously affected by gradual environmental degradation such as desertification and sea level rise. The report covers both the human impact of climate change today and over the next 20 years as this clearly demonstrates the acceleration of human impacts of climate change in the near-term.

The human impact is difficult to assess reliably because it results from a complex interplay of factors

The human impact is still difficult to assess with great accuracy because it results from a complex interplay of factors. It is challenging to isolate the human impact of climate change definitively from other factors such as natural variability, population growth, land use and governance. In several areas, the base of scientific evidence is still not sufficient to make definitive estimates with great precision on the human impacts of climate change. However, data and models do exist which form a robust starting point for making estimates and projections that can inform public debate, policy-making and future research. This report, based on the most reliable scientific data, presents estimates of the number of people seriously affected, lives lost and economic losses due to climate change. These numbers give the clearest possible indication of the order of magnitude of the human impact of climate change today and in the near future. A significant and conscious effort has been made to neither over-state nor under-state the human impact of climate change within the constraints given. Recognizing that the real numbers may be significantly lower or higher than suggested by these estimates, they should be treated as indicative rather than definitive.

Intensified research on the human impact of climate change is imperative

The need to continue to press for increased precision in estimates presents a rallying cry for investment in research on the social implications of climate change. There are particularly three areas requiring more research:

- The attribution of weather-related disasters to climate change, as no consensus estimate of the global attribution has yet been made;
- Estimate of economic losses today, as the current models are forward looking;
- Regional analysis, as the understanding of the human impact at regional level is often very limited but also crucial to guide effective adaptation interventions.

The true human impact is likely to be far more severe than estimated in this report

The estimates in this report are very conservative for four main reasons:

- The climate change models used as the basis for this report's estimates are considered credible, but are based on IPCC climate scenarios which have proven to be too conservative. Recent evidence suggests that important changes in climate are likely to occur more rapidly and be more severe than the IPCC assessments made nearly two years ago. In many key areas, the climate system is already moving beyond its traditional patterns.[1] The estimates may also be considered conservative as potential large scale tipping point events, such as the rapid melting of the Greenland ice sheet and the shutdown of the Gulf Stream, which would have dire consequences have not been included in the estimation for this report as they are unlikely to happen within the next 20 years. However, it is important to note that critical tipping points have already been crossed, including the loss of the Arctic summer ice in 2007 and the devastating forest fires in Borneo, which may be a combined effect of deforestation and climate change.

> "Climate change is happening more rapidly than anyone thought possible. Should humankind stop worrying about global warming and instead start panicking? My conclusion is that we are still left with a fair chance to hold the 2°C line, yet the race between climate dynamics and climate policy will be a close one."
>
> Hans Joachim Schellnhuber — Founding Director, Potsdam Institute for Climate Impact Research (PIK); Member, Intergovernmental Panel on Climate Change (IPCC)

- The most powerful consequences of climate change arise when a chain reaction magnifies the effects of rising temperatures. Think of a region suffering from water scarcity. That scarcity reduces the amount of arable land and thereby aggravates food security.[2] The reduced crop production results in loss of income for farmers and may bring malnutrition. Health issues arise that could further diminish economic activity as family members become too weak to work. With time, worsening environmental conditions combined with financial instability may force populations to migrate. Migration can then become a catalyst for social unrest if increased population density in the place of refuge causes resource scarcity.
- Population growth exacerbates the impact of climate change by increasing human exposure to environmental stresses. For example, as population grows, more people are expected to live near the coast and the amount of resources such as food available per person declines.
- Climate change aggravates existing problems. Many people today are not resilient to current weather patterns and climate variability, which is to say that they are unable to protect their families, livelihoods and food supply from the negative impacts of seasonal rainfall leading to floods or water scarcity during extended droughts. Climate change will multiply these risks. For example, as the international community struggles to reduce hunger-related deaths, a warmer, less predictable climate threatens to further compromise agricultural production in the least developed countries, thereby increasing the risk of malnutrition and hunger.

Credible scientific evidence is crucial in determining the effects of climate change, but delay and underestimation of its impact is also risky

Global data on climate change has many gaps and uncertainties. As a result estimates may not capture the full range of potential indirect impacts and chain reactions. Scientists will often be inclined or forced to make conservative estimates when confronted with such uncertainties.

Overall human impact of climate change today

Several hundred million people[3] are seriously affected by climate change today, with several hundred thousand annual deaths[4,5,6]

The definition of "being seriously affected" by climate change includes someone in need of immediate assistance[7] in the context of a weather-related disaster or whose livelihood is significantly compromised. This condition can be temporary, where people have lost their homes or been injured in weather-related disasters, or permanent, where people are living with severe water scarcity, are hungry or suffering from diseases such as diarrhoea and malaria. A couple of examples can illustrate the significance of this number. The impact of climate change today affects 13 times[8] the number injured in traffic accidents globally every year and more people than the number of people who contract malaria annually[9], which it incidentally is also suggested to increase.

An estimated 325 million people are seriously affected by climate change every year. This estimate is derived by attributing a 40 percent proportion of the increase in the number of weather-related disasters from 1980 to current to climate change and a 4 percent proportion of the total seriously affected by environmental degradation based on negative health outcomes.[10]

Climate Impact Witness

Tulsi Khara, India has lived all her 70 years in the world's largest delta, where the Brahmaputra and Ganges rivers meet and flow into the Bay of Bengal.

"We are not educated people, but I can sense something grave is happening around us. I couldn't believe my eyes — the land that I had tilled for years, that fed me and my family for generations, has vanished. We have lost our livelihood. All our belongings and cattle were swept away by cyclones. We have moved to Sagar Island and are trying to rebuild our lives from scratch. It wasn't like this when I was young. Storms have become more intense than ever. Displacement and death are everywhere here. The land is shrinking and salty water gets into our fields, making them useless. We feel very insecure now."

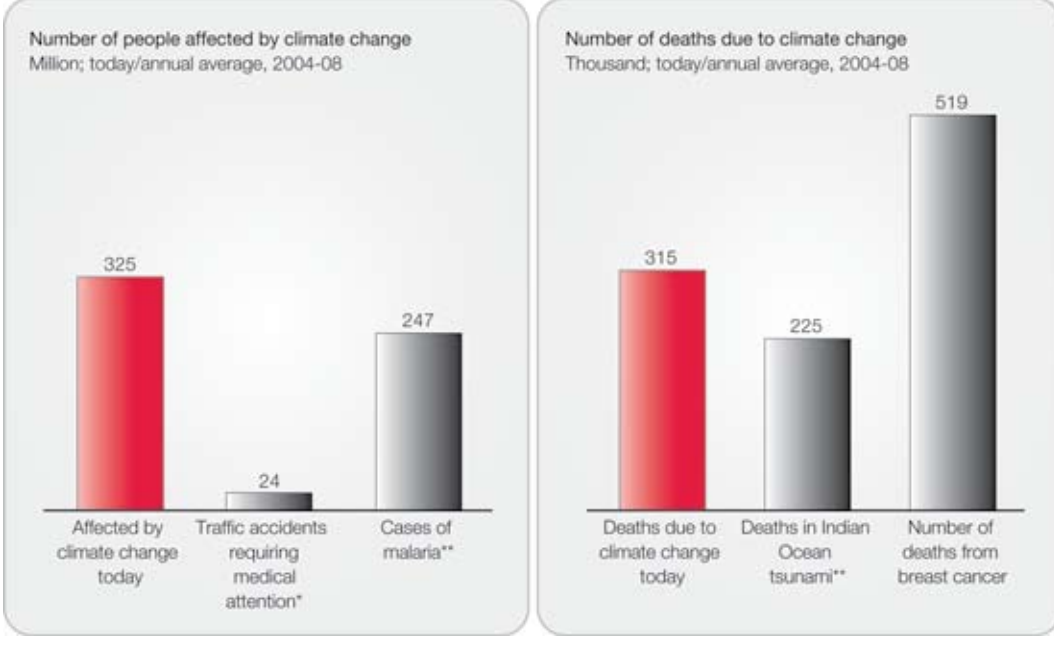
Source: WWF India and Vissa Sundar

The 40 percent proportion is based on an analysis of data provided by Munich Re on the past trend of weather-related disasters, as compared to geophysical (i.e. non climate change related) disasters over time.[5] It compares well to a 2009 scientific estimate of the attribution of climate change to droughts.[11] It is assumed that the 40 percent increase due to climate change based on frequency of disasters can be applied as an approximation for the number of people seriously affected and deaths. The 4 percent proportion is based on a study by WHO[4] which looks at health outcomes from gradual environmental degradation due to climate change.[12]

Application of this proportion projects that more than 300,000 die due to climate change every year—roughly equivalent to having an Indian Ocean tsunami annually.[13] The number of deaths from weather-related disasters and gradual environmental degradation due to climate change — about 315,000 deaths per year — is based on a similar calculation, (i.e. an attribution of 40 percent from weather-related disasters that translates into 40 percent of the death burden from weather disasters due to climate change and 4 percent of current death burden from disease[14]). Over 90 percent of the death toll relates to gradual onset of climate change which means deterioration in environmental quality, such as reduction in arable land, desertification and sea level rise, associated with climate change. As for the number of seriously affected, the basis for the estimations of deaths is negative health outcomes.

Figure 1 below shows the impact of climate change today compared to other global challenges.

Figure 1 — Comparing human impact of climate change today with other global challenges



* 2004 **2006

Source: WHO World Malaria Report, 2008; WHO. (2004): "The global burden of disease: 2004 update."; McMichael, A.J., et al (2004): "Chapter 20: Global Climate Change" in Comparative Quantification of Health Risks. WHO; Munich Re; CRED database; Dalberg analysis

In its Fourth Assessment Report, the IPCC found that weather patterns have become more extreme, with more frequent and more intense rainfall events and more intense heat waves and prolonged droughts. The rhythm of weather has also become more unpredictable with changes in the timing and location of rainfall.[15,16] In addition to the increased severity of weather events, the sheer number of weather-related disasters (storms, hurricanes, floods, heat waves, droughts) has more than doubled over the last 20 years.[17] Today, the world experiences over 400 weather-related disasters per year. They leave a frightening toll in their wake: almost 90 million people requiring immediate assistance due to personal injury, property loss, exposure to epidemics, disease or shortages of food and fresh water.[18]

The main gradual changes are rising earth surface temperatures, rising sea levels, desertification, changes in local rainfall and river run-off patterns with increased precipitation in high latitudes and decreased precipitation in sub-tropical latitudes, salinisation of river deltas, accelerated species extinction rates, loss of biodiversity and a weakening of ecosystems. The impact of this gradual change is considerable. It reduces access to fresh and safe drinking water, negatively affects health and poses a real threat to food security in many countries in Africa, Asia and Latin America. In some areas where employment and crop choices are limited, decreasing crop yields have led to famines. Desertification and other forms of land degradation have led to migration. Furthermore, the rise in sea levels has already spurred the first permanent displacement of small island inhabitants in the Pacific, i.e. Kiribati and Tuvalu.[19] Gradual environmental degradation due to climate change has also affected long-term water quality and quantity in some parts of the world, and triggered increases in hunger, insect-borne diseases such as malaria, other health problems such as diarrhoea and respiratory illnesses. It is a contributing factor to poverty, and forces people from their homes, sometimes permanently. Intuitively, if someone is affected by water scarcity, poverty or displacement, this also translates into health outcomes and food insecurity. Typically, climate change today mostly affects areas already seriously suffering under the above mentioned factors. Likewise, health outcomes and food insecurity lead to displacement and poverty which might result in competition for scarce resources and strains on mostly already limited government capacity to deal with deteriorating conditions and might ultimately lead to conflict. Therefore health outcomes and food security are taken as the basis for all climate change related impacts. Using this approach, the update of WHO Global Burden of Disease study shows that long term consequences of climate change affect over 235 million people[20] today.[4,21]

Those seriously affected by climate change are expected to more than double within 20 years, and lives lost every year are expected to increase by at least two thirds[22]

The same calculation as above is used to project past weather disaster trends into the future.[23] Projecting past trends into the future assumes a constant number of people seriously affected or dying per disaster — i.e. factors such as population growth are not taken into account. By the year 2030, the lives of 660 million people are expected to be seriously affected, either by natural disasters caused climate change or through gradual environmental degradation.[24] This is,

as an example, almost twice the number of people expected to suffer from diabetes in 2030.[25] And while experts today worry about a projected explosion of diabetes cases by more than 50 percent over next 20 years, there is little awareness that the number of people seriously affected by climate change actually is expected to increase at double that rate.

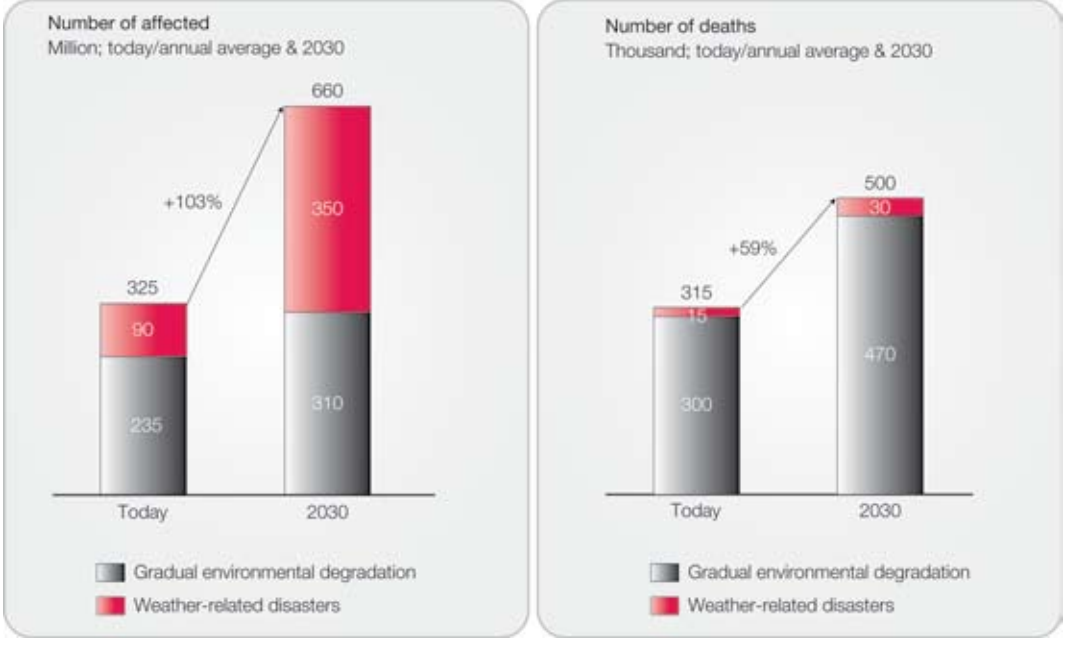
The number of deaths from weather-related disasters and gradual environmental degradation due to climate change is expected to jump to about 500,000 people per year.[26] This is about equal to those who annually die of breast cancer, which has the fifth largest mortality rate among cancers and is the number one leading cause of cancer deaths among women.[27] The underlying assumption is that population growth and continuous efforts to alleviate the burden on health and livelihoods will cancel each other out.

The outlook for the future is not encouraging, with more frequent, more severe and more prolonged weather-related disasters on the horizon. Linear projections suggest that by 2030, the number of weather-related disasters recorded in a single year will be approximately three times higher than the average occurrence rate during the 1975-2008 time span.[28] This is suggested in a 2008 report on the Humanitarian Consequences of climate change by the Feinstein Center. If these projections prove correct, weather-related disasters due to climate change could affect about 350 million.[29]

Global warming is expected to increasingly impact food security, water availability and quality, and exact a toll on public health, spurring chronic disease, malaria prevalence, and cardiovascular and respiratory diseases.[16,30,31] Rising sea levels, which affect relatively few people today, are expected to impact large populations in the future and desertification is projected to accelerate with 40 percent of the earth's land becoming dry or semi-arid regions[32] which is detrimental given that arid and semi-arid climates comprise over one quarter of the land area of earth.[33] Glaciers will continue to melt at an ever accelerating pace. Changes in local rainfall and river run-off patterns are expected to trigger increased water supply in high latitudes but reduced amounts in sub-tropical latitudes. About 310 million people could be seriously affected by these changes due to climate change by the 2030.[34]

Figure 2 below shows the strong increase in the number of seriously affected and deaths due to climate change over the next 20 years.

Figure 2 — The impact of climate change is accelerating over the next 20 years



Source: WHO. (2004): "The global burden of disease: 2004 update."; McMichael, A.J., et al (2004): "Chapter 20: Global Climate Change" in Comparative Quantification of Health Risks. WHO; CRED database; Webster, M., et al. (2008): "The Humanitarian Costs of Climate Change." Feinstein International Center; Munich Re; Dalberg analysis

Vulnerability assessment

More than one third of the world's population are physically vulnerable to climate change[35]

Currently over 2.8 billion people live in areas of the world prone to more than one type of the physical manifestations of climate change: floods, storms, droughts, sea level rise. Physical vulnerability to climate change is used to mean that an individual is vulnerable if they face a medium to high risk of experiencing at least two of these events. The figure below shows the areas which are most physically vulnerable to climate change. (In Section 3 below, please note that, when secondary socio-economic factors are included, over 4 billion people could be considered as vulnerable to climate change and, of these, over half a billion as extremely vulnerable.)

Those most vulnerable live in the semi-arid dry land belt countries, sub-Saharan Africa, South and Southeast Asia, Latin America, Small island developing states and the Arctic

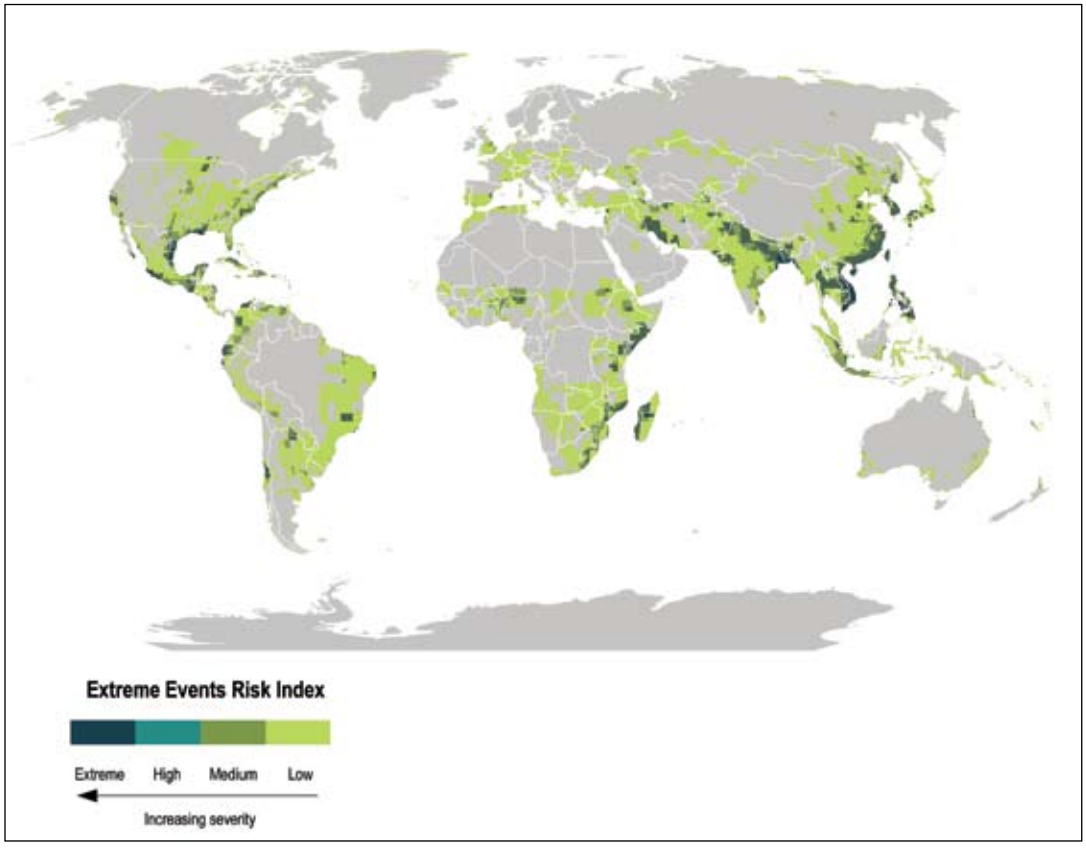
People living in low-lying areas, the semi-arid dry land belt along the Sahel that separates Africa's arid north from more fertile areas, easily flooded regions on the Equator, and glacier regions are most likely to be affected. The following countries and regions are considered the most vulnerable to climate change:

- The semi-arid dry land belt countries because of overall vulnerability to droughts from the Sahara/Sahel to the Middle East and Central Asia. (The most affected countries include Niger, Sudan, Ethiopia, Somalia, Yemen, and Iran, all the way to Western/Northern China.)
- Sub-Saharan Africa because of vulnerability to droughts and floods. (The most affected countries include Kenya, Uganda, Tanzania, Nigeria, Mozambique, and South Africa.)
- South and Southeast Asia because of the melting Himalayan ice sheets, droughts, floods and storms. (The most affected countries include India, Pakistan, Bangladesh, southern and eastern China, Myanmar, Vietnam, Philippines and Indonesia.)
- Latin America and parts of the US because of water shortages and floods. (The most affected countries include Mexico, Andean countries like Peru and Brazil.)
- Small island developing states because of sea level rise and cyclones. (The most affected countries include the Comoros islands, Kiribati, Tuvalu, the Maldives and Haiti.)
- The Arctic region because of the melting of ice caps.

The region at most immediate risk of droughts and floods is sub-Saharan Africa. Droughts are most probable in Burkina Faso, Mozambique, Rwanda, Somalia and Tanzania, while Malawi, Mozambique, Nigeria, Somalia, Sudan and Tanzania are considered especially prone to floods. Flooding is also likely in South Asia (Afghanistan, Bangladesh and Nepal). The most storm-prone areas are along the coasts of East Africa (Mozambique, Madagascar) and South Asia (Bangladesh) as well as along the Southeastern and central areas of the US.[36,37]

The map below shows area of natural vulnerability to floods, storms, droughts and sea level rise. It does not show areas vulnerable to extreme temperature events.

Figure 3 — Physical vulnerability to weather-related disaster and sea level rise*



* "Climate Vulnerability Index" designed and prepared by Maplecroft
Source: Center for Hazards and Risk Research, Center for International Earth Science Information Network, Columbia University , International Bank of Reconstruction/World Bank, United Nations Environment Programme. Global Resource Information Database Geneva.

Case Study

Bangladesh — A nation at the frontline of the climate change crisis

Bangladesh is the most vulnerable country in the world to tropical cyclones and the sixth most vulnerable to floods.[38] More than 68 million people[39] have been directly affected over the last eight years, and millions of lives and livelihoods are threatened by frequent weather-related disasters. With low-lying lands, coastline areas and floodplains occupying 80 percent of the country, Bangladesh is highly exposed to both disasters and sea level rise. Of its 155 million inhabitants, half live below the poverty line and over a third suffers from malnutrition and hunger.[40]

A Bangladeshi rights group estimates that some 30 million people[41] in Bangladesh are already exposed to climate change through extreme weather, rising sea levels and river erosion.[42] Since 2000 the country has experienced more than 70 major disasters. Tropical cyclones, local storms, floods and droughts, have killed 9,000 people[39] and caused damages of more than $5 billion. One-fifth of the country is flooded every year, and in extreme years, two-thirds of the country has been inundated.[40] To demonstrate the magnitude of the problem, agricultural production losses due to flooding in 2007 are estimated at 1.3 million tons. Although agriculture accounts for only 20 percent of GDP, over 60 percent of people depend on its products. Losses of both food and cash crops are common occurrences, which seriously disrupt the economy, precipitating unplanned import requirements. In 2006-07, agri-food imports represented approximately $1.9 billion (8 percent of total imports). In addition to food security, weather-related disasters due to climate change cause outbreak of disease such as diarrhoea that killed 20 percent of the children under 5 years of age in 2000.[43] Poverty and environmental degradation have caused migration from rural to urban areas. Although 75 percent of its population currently is rural, Bangladesh already has one of the highest population densities in the world and migration into urban areas is increasing by over 2 million people each year.

Over the next 30 years, the population is expected to grow to 200 million and, although greater success in disaster management has significantly reduced the lives lost in recent years, the numbers are still very high and the potential for economic and infrastructural damage remains very significant.

Key Sources: OECD, UNDP and World Bank

> "In our globalizing world, the agenda is set by economics. It is therefore essential that the macroeconomic policy-making, as also the practices of government and multilateral lending and credit institutions and export credit agencies, must continue to take the environmental dimension into account."
>
> Klaus Töpfer — Executive Director, United Nations Environment Programme (1998-2006)

Overall economic impact of climate change

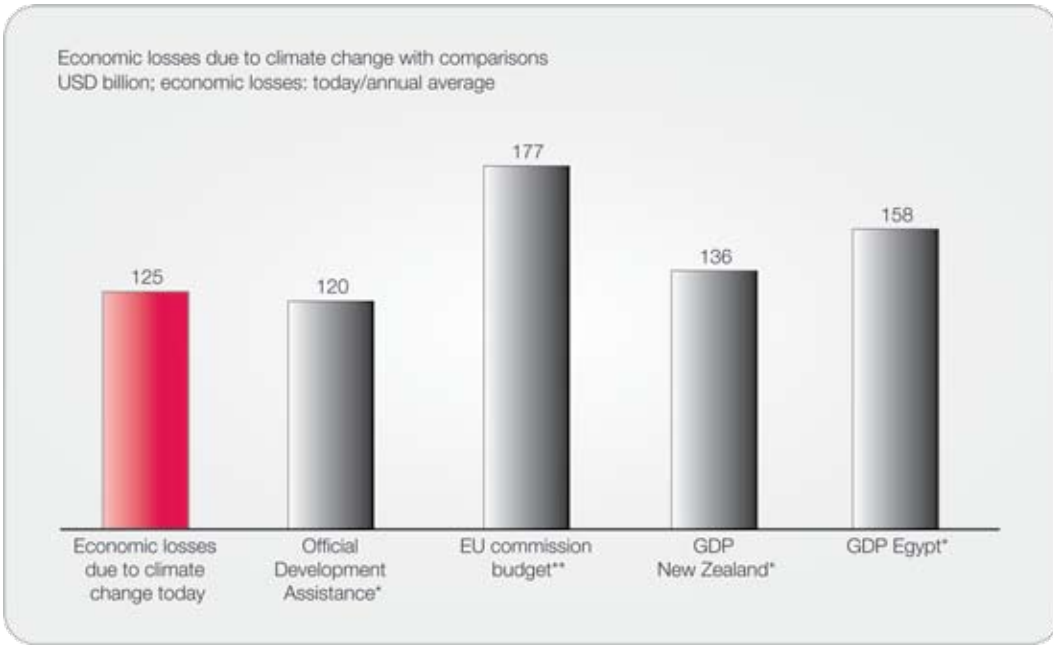
Current economic losses due to climate change are significant — estimated at more than a hundred billion US Dollars annually

Based on an update of the model by the report team used in the Stern review,[44] the economic costs and benefits of climate change add up to an economic loss of about $125 billion today, which is a mean value. In 2006, Nicholas Stern published a report, which estimated the long term economic costs of climate change, but also shows values for today. This report's estimate is based on this model,[45] but includes an update of critical assumptions, which are further explained in "Notes on report methodology" in the appendix. The initiation of adaptation—steps to reduce the effects of climate change has been delayed until 2010 amid criticism that the Stern model assumed too early investment in adaptation in developing countries. Furthermore, Nicholas Stern has acknowledged that the model does not fully capture the effect of weather-related disasters.[44] This is supported by Professor Ross Garnaut's 2008 report, commissioned by the Australian government, on the impacts of weather-related climate change effects in Australia.[46] Therefore, additional losses from natural disasters caused by climate change have been included in the model.[47] The new results obtained are higher than in the original Stern model and in line with Stern's recent recognition that the Stern review underestimated the degree of damages and the risks of climate change.[48] For equity purposes and based on expert recommendations, the weight on poorer countries have been increased in this report to correct for income differentials, i.e. similar incomes across countries is assumed.

To put these economic losses into perspective, $125 billion — the mean value of the calculation — is higher than the individual GDPs of 73 percent of the world's countries,[49] the same as the total annual Official Development Assistance (the amount of humanitarian and development aid that flows from industrialized countries into developing nations), which was at about $120 billion in 2008[50] and higher than Afro-Asian trade which is expected to reach $100 billion in 2010.[51] These losses are also more than four times higher than the average estimated annual adaptation funding gap for developing nations.[36,52] The losses include asset values

destroyed by weather-related disasters and sea level rise, lost income due to reduced productivity, and the costs of reduced health or injury. Figure 4 below shows the economic losses compared to other economic outcomes.

Figure 4 — Comparing economic losses with other important economic outcomes



*2008 **2009
Source: OECD. (2008): "Development Aid at its highest level ever in 2008." ;Felix, A, IPP media. (2008): "Experts predicts Afro-Asian trade to exceed USD 100 billion by 2010. "; CIA World Factbook, 2008; European Commission. (2008): "Financial Programming and Budget"; Stern Review; Dalberg analysis

The $125 billion losses are estimated using a global model which is based on ranges of projected losses from a comprehensive base of research. Property losses from weather-related disasters and economic losses due to reductions in agricultural yield constitute a significant part of these losses, but, it is difficult to separate out each input from the model. However, estimates from experts on property losses due to weather-related disasters and cereal production losses provide an idea of the magnitude of these two areas. According to Munich Re the average economic losses due to weather-related disasters amounted to around $115 billion per year between 2004 and 2008. A 40 percent climate change attribution would give losses of $46 billion. It is estimated that climate change could impact global cereal production by 50 million tons in 2020.[30] 50 million tons translate into roughly $10 billion losses for cereal farmers.[53] For example, climate change is projected to cost corn growers in the United States alone over $1.4 billion annually in the near future, and has already cost corn growers globally $1.2 billion since 1981.[54] If losses in all other agricultural sectors like fruits, vegetables, livestock (cattle, chickens, dairy etc) and cash crops like cotton and tobacco were taken into account, this would more than double this figure.[55]

In this report's model results, almost 90 percent of the $125 billion losses stem from two regions: India plus South East Asia, and Africa plus the Middle East.[56] In India and South East Asia, the mean impact of climate change reduces GDP by almost 1.4 percent. In Africa and the Middle East the figure is over 0.7 percent. Such statistics carry major implications for the growth of these regions.

Economic losses due to climate change are expected to more than double in the next 20 years

Estimated future economic losses could amount to more than USD 340 billion[56] by 2030, i.e. the mean value obtained in the model used in this report. Only 30 countries in the world currently have a GDP higher than this number.[57] It is also almost double the EU commission budget for 2009.[58]

The social cost of climate change is over US Dollars 1 trillion[59]

Carbon dioxide resides over hundreds if not thousands of years in the atmosphere. In fact recent studies show that after 100 years almost 30 percent of the original CO_2 still remains in the atmosphere, after 1000 years about 20 percent.[60] Therefore, the carbon emitted today has long lasting implications and the social cost will be far higher than the impact felt today. The USD 1 trillion social cost of climate change is conservative as it is based on the assumption that the CO_2 emitted today will only reside 100 years in the atmosphere. The Social Cost of Carbon Dioxide (SCCO2) is a monetary indicator of the global damage done over time by the emission of one extra ton of carbon today, discounted to present value. In cost-benefit analyses of projects to control greenhouse gas emissions, the $SCCO_2$ is employed to measure the financial value of the damages avoided, and therefore the benefit of the mitigation project. The larger the $SCCO_2$, the more attractive is investment in greenhouse gas emissions reductions. The carbon dioxide emitted globally in 2004, for example, carries a social cost of over $1300 billion,[61] a figure greater than 2 percent of global GDP in 2008.[48]

Case Study

Hurricane Katrina — Massive economic losses

This short case study on Hurricane Katrina illustrates the massive economic losses that weather-related disasters can cause. Whereas an individual hurricane event cannot be attributed solely to climate change, it can serve to illustrate the consequences of weakening ecosystems as the intensity and frequency of such events increase in the future.

Over 1,800 people lost their lives during Hurricane Katrina and the estimated economic losses totalled more than $100 billion.[62,63] Across the US Gulf Coast region, there were 1.75 million private insurance claims amounting to USD 40 billion.[64] Katrina exhausted the federally-backed National Flood Insurance Program, which had to borrow $20.8 billion from the US Government to fund residential flood claims. In New Orleans alone, while flooding of residential structures caused $8 to $10 billion in losses, of which $3 to $6 billion in losses were uninsured. Of the flooded homes, 34,000 to 35,000 carried no flood insurance, including many that were not in a designated flood risk zone.[62,63]

Key Sources: IPCC and Munich Re

2 Critical areas of human impact

Links between climate-induced physical changes and human impact

Climate change damages human habitat

Increased temperatures produce rises in sea level, melt glaciers, increase unpredictable weather events and change rainfall patterns. They also bring more frequent, more intense weather-related disasters. Most of the observed increase in global average temperatures since the mid-20th century is very likely linked to the rise in green house gas emission—emissions generated by human activities.[65] These physical changes manifest themselves through gradual environmental degradation such as desertification and weather-related disasters such as floods.[65] In the future, potential large scale tipping-point events such as the rapid melting of the Arctic and Greenland ice sheets, a retreat of the Amazon and the Boreal forests or a shutdown of the Gulf Stream would each have a potentially enormous impact on global climate patterns. However, as these events are unlikely to occur within the next 20 years, their potential influence is not included in this report.

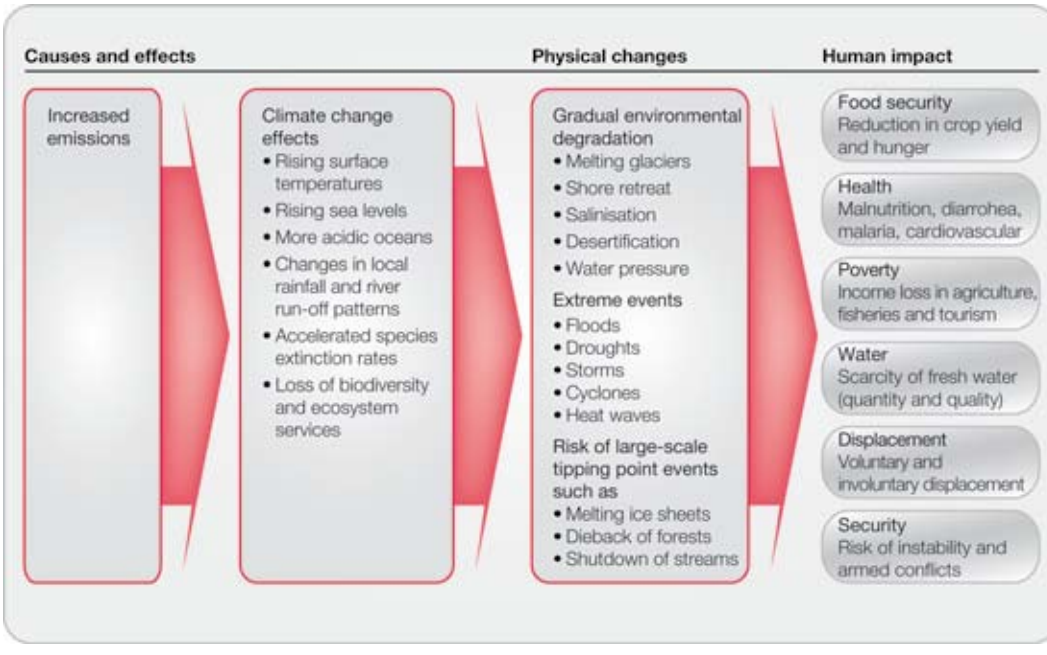
Through a complex set of effects, climate change impacts human health, livelihoods, safety, and society

This report seeks to identify the most reliable evidence measuring the human impact of events that can be attributed directly to climate change. Climate change impacts on people in the following ways:

- Food security: More poor people, especially children, suffer from hunger due to reduced agricultural yield, livestock and fish supply as a result of environmental degradation.
- Health: Health threats like diarrhoea, malaria, asthma and stroke affect more people when temperatures rise.
- Poverty: Livelihoods are destroyed when income from agriculture, livestock, tourism and fishing is lost due to weather-related disasters and desertification.
- Water: Increased water scarcity results from a decline in the overall supply of clean water and more frequent and severe floods and droughts.
- Displacement: More climate-displaced people are expected due to sea level rise, desertification and floods.
- Security: More people live under the continuous threat of potential conflict and institutional break down due to migration, weather-related disaster and water scarcity.

Figure 5 below demonstrates how the causes of climate change, when linked to the resulting physical changes, impact people today and in the future. The framework shows how increased emissions physically alter the environment in a way that has human consequences.

Figure 5 — The links from increased emissions to human impact



Source: Dalberg analysis

Food security: Climate change leads to hunger

Climate change reduces food security — especially in the poorest parts of the world where hunger is already an issue

Weather-related disasters destroy crops and reduce soil quality in some of the world's poorest regions. Increased temperatures, decreased rainfall, water shortages and drought reduce yield and livestock health. Desertification eats away at the amount of arable land and the quality of the soil. In the world's oceans, climate change and coral reef destruction reduce fish stock. The impacts are particularly severe in developing regions such as South Asia, Sub-Saharan Africa and the dry land belt that stretches across the Sahara and the Middle East all the way to parts of China.[66,67,68,69]

While warmer temperatures are leading to more favourable agricultural conditions and increased yield in some parts of North America and Russia, the global impact of climate change on overall food production is negative.[69] The damage is especially severe in the world's poorest areas, where subsistence farmers get hit twice by the less favourable growing conditions.

First, many may not have enough crop production to feed their families. Second, the shortfall of their own crop may likely force them to buy food at a time when prices are high due to reduced global crop yields and population growth.

Over 900 million are chronically hungry today—many of them due to climate change

In 2008, the Food and Agriculture Organization of the United Nations estimated that more than 900 million are afflicted with hunger, or about 13 percent[70] of the global population.[71] Of those suffering from hunger, 94 percent[72] live in developing nations.[73] Most are subsistence farmers, landless families or people working in fishery or forestry. The remainder live in shanty towns on the fringes of urban areas. A quarter of the hungry are children.[73]

Climate change is projected to be at the root of hunger and malnutrition for about 45 million people, as a result of reduced agricultural yields of cereals, fruits, vegetables, livestock and dairy, as well as the cash crops like cotton and fish which generate income.[34] For example, drought hurts crops in Africa where over 90 percent of farmers are small scale and about 65 percent of people's primary source of income is agriculture.[74]

By 2030, the number of hungry people because of climate change is expected to grow by more than two thirds

Within 20 years, the number of hungry people as a result of climate change is projected to almost double to 75 million.[75] The reason for this increase is that the effects of climate change become more pronounced as temperatures rise. Within the same 20 years, climate change is projected to reduce global food production by approximately 50 million tons.[76] That, in turn, could force up global food prices by 20 percent.[76,77]

In some parts of Africa climate change is expected to reduce yield up to 50 percent by 2020.[78] Historical evidence shows that higher food prices cause an immediate and direct jump in hunger levels. During the 2008 food crisis, the number of hungry people in the world increased by 40 million, primarily due to increased food prices.[71]

Climate Impact Witness

Joseph Kones, Kenya is a farmer in Mara Basin who has seen gradual climate change over the last 20 years.

"When I was young, we used to have regular rains, but now it rains any time of the year. These changes started about 20 years ago. Food production in the area has gone down because people are not sure when to plant and even when they plant, they may not get rains at the right time. Farming in our area is not only for our food, we depend on agriculture for income too. Some people have even had to resort to food donations from the government, something that has not happened since I was born."

Source: WWF EARPO

Case Study

Uganda — A drought-plagued country

Perpetual droughts have plagued Uganda since the 1960s, usually occurring every 5 to 10 years. However, drought frequency and intensity is rapidly worsening as the country experienced drought seven times between 1991 and 2000.[79,80] For example, the Karamoja region has suffered from extreme drought for two straight years.[81] According to the UN World Food Programme, Uganda is on the edge of a humanitarian catastrophe as drought reduced agricultural output by as much as 30 percent in some areas in 2008.[79,82] Drought compounds food shortages, and food production is now lagging behind population growth rates.[83] This will likely lead to an impending crisis in the near future unless more food becomes available.

Over 80 percent of Uganda's 31 million people rely on rain-fed subsistence farming, and agriculture accounted for over 33 percent of national GDP in 2002-2003.[83] Over 40 percent of deaths among Uganda children are due to malnutrition, largely a result of food shortages from chronic drought.[83] Additionally, more than 38 percent of children younger than 5 are stunted and 23 percent are underweight, which has long term implications on productivity.[83] It is estimated that each child stunted by hunger and malnourished stands to lose 5-10 percent in lifetime earnings.[84] Therefore, the long term impact of climate change-linked hunger in Uganda is expected to be enormous.

Key Sources: UNESCO, WFP and Relief Web

Case Study

Indonesia — Seasonal variation in rainfall results in widespread hunger

Food insecurity is nothing new to the 4 million residents of the Indonesian province of East Nusa Tengarra, but climate change and rising food prices are making the situation even worse.[85] Climate experts have linked the effects of El Niño Southern Oscillation to increased seasonal variation in rainfall, which leads to increased drought frequency and reduced rice yields.[86] This has dramatic implications for the 115 million poor Indonesians who rely predominantly on rice production for their food and income.[87] An estimated 13 million children suffer from malnutrition in Indonesia today as many residents face failed crops due to drought and are unable to afford to buy food.[85]

Climate change is predicted to lead to a 2-3 percent increase in annual rainfall.[88] But the additional rains come and the least favorable times. In fact, there are drier conditions and delayed monsoon rainfall for most of the year, followed by a condensed and even wetter three month rainy season in all of Indonesia.[89] In 2008, severe drought reduced food supply and food prices increased by as much as half.[86] In East Nusa Tengarra, the number of deaths from malnutrition doubled compared to 2007 and more than half of all children under five years of age show signs of stunted growth, a 15 percent increase from 2007.[85]

Key Sources: International Medical Corps, FSE Stanford University and World Bank

Health: Climate change increases the spread of diseases globally

Climate change threatens to slow, halt or reverse progress towards reducing the spread of diseases and aggravates already enormous health problems, especially in the poorest parts of the world

Current weather conditions heavily impact the health of poor people in developing nations[90], and climate change has a multiplying effect. A changing climate further affects the essential ingredients of maintaining good health: clean air and water, sufficient food and adequate shelter. A warmer and more variable climate leads to higher levels of some air pollutants and increases transmission of diseases through unclean water and contaminated food. It compromises agricultural production in some of the least developed countries, and it increases the hazards of weather-related disasters. Therefore global warming, together with the changes in food and water supplies it causes, can indirectly spurs increases in such diseases as malnutrition, diarrhoea, cardiovascular and respiratory diseases, and water borne and insect-transmitted diseases.[91] This is especially worrisome because a massive number of people are already impacted by these diseases — for example upwards of 250 million malaria cases are recorded each year and over 900 million people are hungry today.[92]

Climate change has contributed to the reappearance of Lyme disease in the US and Europe, a disease once thought extinct in those regions.[91] In areas where malaria is common, particularly warmer and wetter areas, people are able to build up a certain degree of natural resistance. However, as climate warms, the mosquitoes carrying malaria move into new areas, such as traditionally colder, mountainous regions where people have less natural resistance leading to even more severe malaria epidemics.[93]

Climate Impact Witness

Mbiwo Constantine Kusebahasa, Uganda is a farmer at the foot of the Rwenzori Mountains. He has seen the glaciers on the mountains recede, rainfall become erratic, and temperatures increase.

"When I was young, this area was very cold. Now the area is much warmer. Before the 1970's, we did not know what malaria was. The mosquitoes that spread malaria are thriving due to the higher temperatures. At present, there are many cases of malaria in the Kasese area."

Source: WWF

Climate change is responsible for several hundred million additional people suffering from health problems and several hundred thousand lives lost

Every year the health of 235 million people is likely to be seriously affected by gradual environmental degradation due to climate change. This assumes that climate change affects malnutrition, diarrhoea and malaria incidences.[34]Furthermore, within the next year over 300,000 people are expected to die from health problems directly attributable to climate change.[34]

Malnutrition is the biggest burden in terms of deaths. Climate change is projected to cause over 150,000 deaths annually and almost 45 million people are estimated to be malnourished because of climate change, especially due to reduced food supply and decreased income from agriculture, livestock and fisheries. Climate change-related diarrhoea incidences are projected to amount to over 180 million cases annually, resulting in almost 95,000 fatalities, particularly due to sanitation issues linked to water quality and quantity. Climate change-triggered malaria outbreaks are estimated to affect over 10 million people and kill approximately 55,000.[34]

By 2030, climate change is expected to increase the number of people suffering by more than one third and lives lost by more than one half

In 2030, approximately 310 million people are expected to suffer from the health consequences related to more pronounced gradual environmental degradation and temperature increase due to climate change. This, in turn, is projected to increase disease levels to a point where half a million people could die from climate related causes.[94] In the future, weather-related disasters are likely to have an even more profound impact on health quality when they cause floods, heat waves and droughts. Although numerous interventions are underway to combat hunger, improve sanitation and reduce diseases like malaria; the percentage of cases attributable to climate change rises in the future and population growth may counteract progress towards disease reduction.

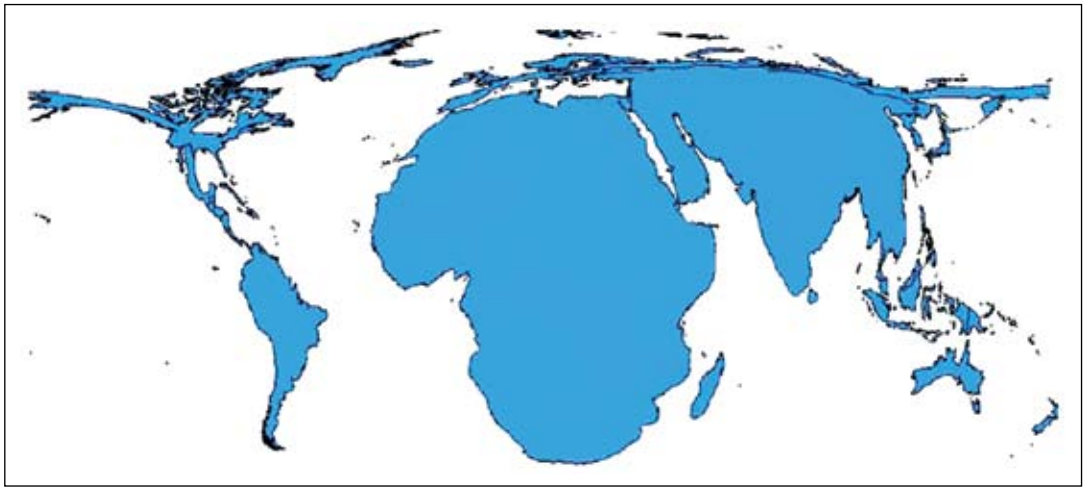
Developing countries — especially their children, women and elderly — are most severely affected

Over 90 percent of malaria and diarrhoea deaths are borne by children aged 5 years or younger, mostly in developing countries.[21] Other severely affected population groups include women, the elderly and people living in small island developing states and other coastal regions, mega-cities or mountainous areas.[36,95] These groups are the most affected due to social factors like gender discrimination, which can restrict women's access to health care, and age-based susceptibility as children and elderly often have weaker immune systems. Additionally, people living in certain geographic areas are more affected due factors such as high exposure to storms along coastlines, inadequate urban planning etc. Almost half the health burden occurs in the population dense Southeast Asia region with high child and adult mortality, followed by losses in Africa (23 percent) and the Eastern Mediterranean (14 percent).[91] Africa is also hit

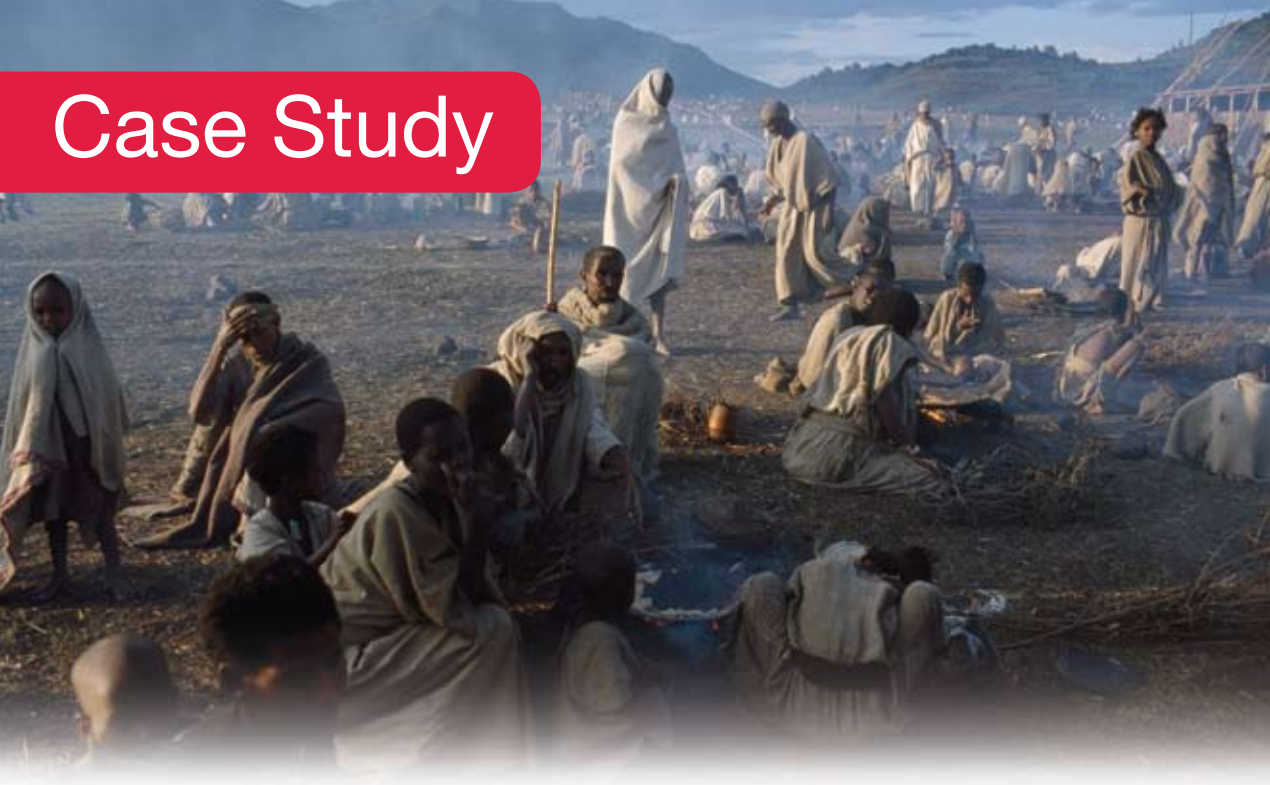
particularly hard by malaria and other insect-borne diseases. Overall, the per capita mortality rate from vector borne diseases (diseases like malaria that are transmitted by insects) is almost 300 times greater in developing nations than in developed regions.

The figure below is a startling illustration that shows the disproportionate degree to which developing nations suffer from almost the entire health burden related to climate change.

Figure 6 — The world map reflecting mortality related to climate change



Source: Climate Change and Global Health: Quantifying a Growing Ethical Crisis, 2007, Jonathan A. Patz, Holly K. Gibbs, Jonathan A. Foley, Jamesine V. Rogers, and Kirk R. Smith



Case Study

Ethiopia — Drought, flooding and diarrhoea outbreaks cause death and suffering

As seasonal rains stop falling, drought sets in and severe food shortages prevail across many parts of Ethiopia, affecting approximately 25 million of the 78 million Ethiopians.[96] Approximately 100,000 children are believed to suffer acute malnutrition,[96] and over 46 percent[97] of the population is malnourished.[98] Over the past two decades, five major droughts have occurred in this country, leaving many families unable to recover and pushed to the brink of survival.[98] Agriculture accounts for over half of GDP and employs more than 80 percent of the labour force, but less than 1 percent of farming land is irrigated and drought quickly brings food shortages.[98] Weakened by food shortages, people are more susceptible to diseases like diarrhoea. Dehydration caused by diarrhoea kills approximately 20,000 children every year in Ethiopia, and 40 percent of the population does not have access to improved water sources such as piped water, protected springs or hand-pumps.

When it finally does rain, it pours and further deaths and suffering result. Rain variability and severity is increasing in many areas, triggering some of the worst floods in Ethiopia's history during 2006.[98] For example, flash floods in Dire Dawa, the second largest city in Ethiopia, killed almost 250 people and displaced thousands.[98] This increases the risk of diarrhoea. Over 400 people died during an outbreak of acute diarrhoea in 2006.[98] The problem is likely to only worsen in the future and further add to the disease burden in Ethiopia.

Key Sources: Red Cross and Oxfam

Case Study

European heat wave — 2003 summer hottest in 500 years[91]

As average global temperature and climate variability increase, heat waves are becoming more common and more intense throughout the world. Heat is associated with excessive mortality in several ways: Dehydration and heat stroke are primary. It can also precipitate cardiovascular collapse and cerebrovascular and respiratory distress.

In 2003, a heat wave in Europe killed 35,000 people in five countries. The majority of deaths occurred in persons aged 75 or older. There was also an upsurge of respiratory illness and high ozone levels. The heat wave strained water supplies, farmers, and energy suppliers. Livestock and crop losses alone amounted to over $12 billion. The cost of monitoring and preparations in subsequent years was estimated to be $500 million annually.

It has been estimated that anthropogenic warming has increased the probability to four fold of a weather-related disaster such as the 2003 European heat wave. The likelihood is projected to increase 100-fold over the next four decades.

Key Sources: IPCC and Epstein 2006

Poverty: Climate change increases poverty

Climate change and the cycle of poverty

Because the poor tend to live in geographical and climatic regions that are naturally most vulnerable to climate change, their capacity to adapt is easily overwhelmed by the impact of the changing conditions. They have the least assets to rely on in the event of a shock — whether it be a weather-related disaster, a bad harvest or a family member falling ill. These factors build on each other and create a perpetuating cycle of poverty that is difficult to break. Safety net structures like insurance are also largely unavailable to the world's poor. Many are subsistence farmers, fishermen, or have jobs in the tourism industry—vocations highly dependent on natural resources such as the ocean, forests and land for their livelihoods. Climate change compounds existing poverty by destroying livelihoods. Specifically, rising temperatures, changing rainfall patterns, floods, droughts and other weather-related disasters destroy crops and weaken or kill livestock. Rising temperatures and acidic oceans destroy coral reefs and accelerate the loss of fish stock.[99] Loss of biodiversity, weather-related disasters such as hurricanes, disease outbreaks and sea level rise have strong negative impacts on tourism. The Coral Reef Alliance estimates that coral bleaching can result in billions of dollars in losses due reduced biodiversity, coastal protection and income from reef fisheries and tourism.[100] $6-7 million losses are projected in the next 10 years if coral does not recover in the Philippines based on the net present value of the local diving industry.[111]

Climate change drives poverty through a vicious circle of reduced crop yield and resulting lower income, which leaves fewer resources for the following year's planting season. About 60 percent of developing nations' workforce, about 1.5 billion people, are employed in agriculture, livestock, fisheries and tourism.[102] Most of the farmers live on bare minimum production and losing a small amount of their yield pushes them even further into poverty. Fishermen and those employed in tourism lose income or become unemployed.

The loss of biodiversity is worrisome not only due to its direct impacts on people's livelihoods, but also due to the intrinsic value of biodiversity and its pivotal role in building the poor's resilience to climate change. A vicious cycle evolves as climate change fundamentally alters ecosystems and reduces species diversity. For example, species diversity assists in strengthening the ability for cod or lobster fishing resources to sustain stress and shocks. Ecosystem self regulating processes are pivotal, such as the creation of natural carbon sinks which remove carbon dioxide from the atmosphere. Increased landscape diversity with varied plant species and natural coastline barriers like mangrove forests can protect coastal inhabitants and their belongings from climate shocks like coastal storms and soil erosion. Having an assortment of traditional seeds to help identify more drought resistant crop varieties is increasingly critical to survival in drought-prone areas. There is great cause for concern as the IPCC estimates that 20-30 percent of global species are likely to be at risk of extinction this century.

Climate Impact Witness

Alizeta Ouedraogo, Burkina Faso lives in a Sahel country where 90 percent of its inhabitants are farmers.

"As far as my own family is concerned, the crops are always bad, and we don't have enough food. My mother is very poor because of the drought."

"For the community, it is even more serious since everything is bought with money from agricultural products. Every year, there is a food shortage. Children quit school because they cannot afford supplies and school fees. Girls sometimes prostitute themselves and may end up with an unwanted pregnancy or a sexually transmitted disease. People do not go to health centres, and some contract diseases caused by a lack of hygiene."

Source: UNICEF

Climate change is expected to reduce the earning potential of the next generation because it decreases family income and increases the number of hungry children. Economists estimate that every child whose physical and mental development is stunted by hunger and malnutrition stands to lose 5 to 10 percent in lifetime earnings.[73] As incomes drop, poor families might be forced to send their children to work to bring in extra income. Consequently, climate change affects educational opportunities and thereby income potential of the next generation.

More than ten million[103] people have fallen into poverty today because of climate change

The majority of people suffering from the impacts of climate change are already extremely poor. Currently about 2.6 billion people — two thirds of them women — live in poverty (below $2 a day) with almost 1 billion living in extreme poverty (less than $1 a day).[104] About 12 million additional people are pushed into poverty because of climate change. They are situated mainly in India and South East Asia as well as in Africa and Latin America.

By 2030, double as many is expected to be pushed into poverty due to climate change[105]

By 2030, over 20 million less people would live in poverty in a world without climate change.[106] This figure may be an underestimation as it, among other things, does not account for future population growth projections. This is primarily due to reduced income from lower crop yields coupled with increased food prices. In some countries, the implications of widespread poverty from such a cycle are particularly worrisome. In Ethiopia, the World Bank estimates that water variability may increase poverty by 25 percent.[44]

Eléonore Henry de Frahan, Collectif Argos. 'China: the anger of the yellow dragon.' To counter desertification, the government launched the "Green Great Wall." The objective aims at planting vast stretches of trees and shrubs from the periphery of Beijing to the borders of the Inner Mongolia. China

Case Study

Tanzania — Subsistence farmers required to switch to less lucrative crops

Climate change is reducing rainfall in many areas, increasing variability in water supply, raising average and extreme temperature and increasing wind.[107,108]

Many small farmers in Tanzania therefore have opted to stabilize income at a lower level.[109] They have switched to traditional safer but less lucrative crops which are less sensitive to such increases in variability but give lower returns, such as cassava, sweet potato and millet.[107,110]

The average return of sweet potatoes per hectare is at least 25 percent less than that for the crops they produced earlier like maize, but more than 75 percent of farmers now grow sweet potato and some even on up to 30 percent of their land.[110] Wealthier households appear to have less need for the stabilizing "safety net" effect of switching to higher levels of low risk and return crops. On average, these households allocate only 9 percent of their land to sweet potato.[110] Such adaptive responses to climate change are necessary in many parts of the world, but disproportionately impact the poorest families.

Key Sources: DFID and OECD

Case Study

Ecuador — El Niño phenomenon severely destroying livelihoods

Californian surfers may revel in the warmer water temperatures brought on by El Niño, but this feeling is not shared elsewhere around the world. El Niño[111], affected by climate change-induced rising temperatures, has ruined livelihoods, led to lost lives and impaired national economies.

The El Niño phenomenon occurs at irregular intervals of two-seven years and has usually lasted one or two years historically. It causes sea temperatures to increase off the South American coast. For example, El Niño has occurred in seven of the past ten years. If we look further back in time, El Niño was recorded only three times between 1950 and 1960.[112] This natural occurrence has global repercussions as it shifts Pacific weather patterns which can cause droughts and flooding and also alter the regional burdens of vector-borne diseases like malaria and dengue in regions as far away as Africa and India.[78,113]

Over the last 20-30 years, El Niño frequency, duration and intensity have increased.[114] In Ecuador, the associated cost of direct damages to agriculture, fisheries and livestock associated with the 1997/98 El Niño equaled 4.7 percent of its agricultural GDP.[115] This equates to USD 112 million in lost earnings, mainly due to infrastructural damage, crop losses and unemployment of farm workers; resulting in an 11 percent increase in poverty in the most severely affected municipalities.[115]

Key Sources: Inter-American Development Bank and IPCC

> "Humanity will face major water challenges in the next few decades in certain regions of the world related to the impacts of climate change and rapidly growing human demands for water. However, the picture may be less bleak than widely portrayed — if overall water resources are managed better, future food crises could be significantly reduced."
>
> Johan Rockström — Executive Director, Stockholm Environment Institute (SEI) and Stockholm Resilience Centre

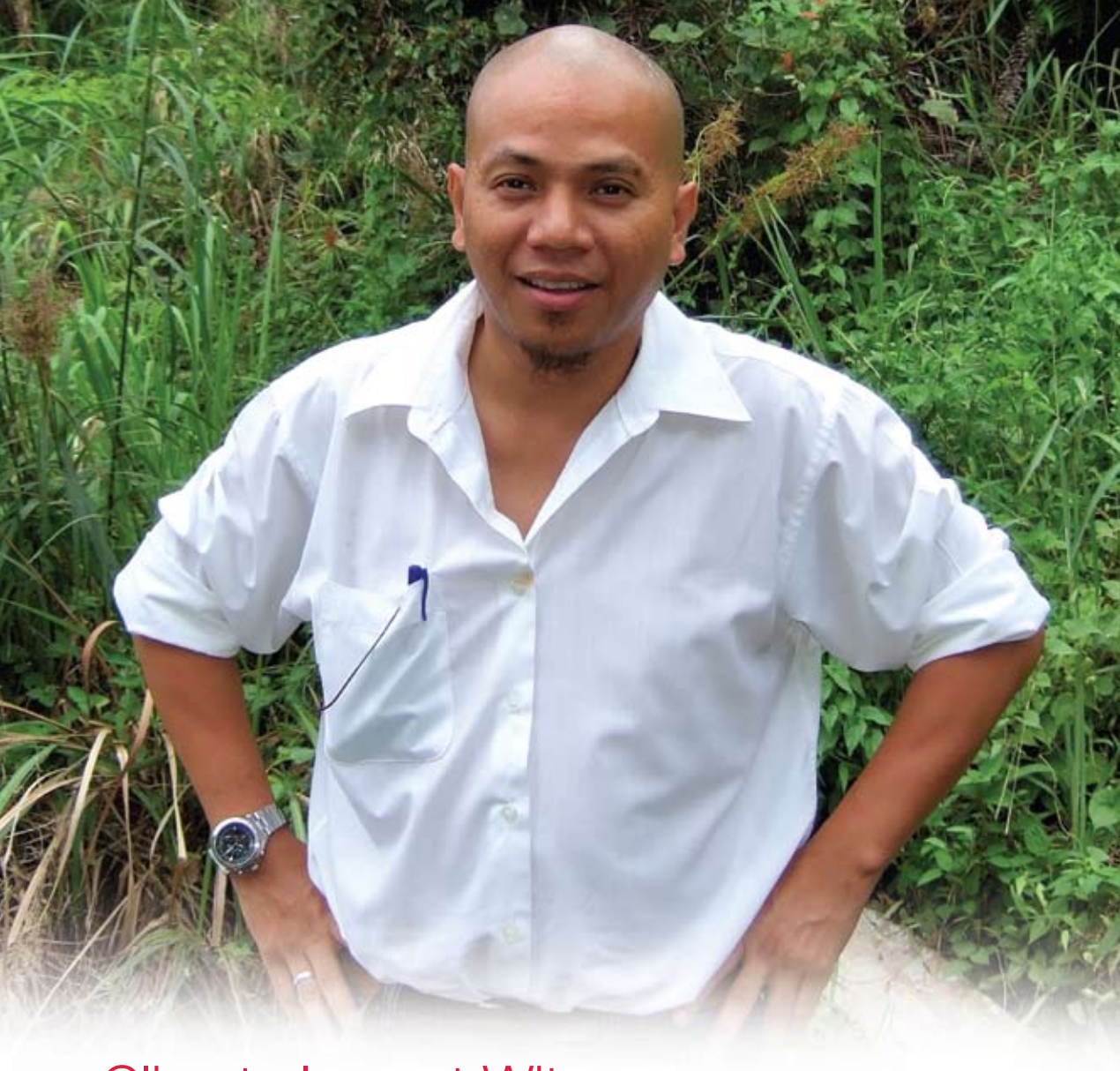
Water: Climate change exacerbates already shrinking fresh water availability

Freshwater supply and quality are strongly affected by climate change

As the climate warms, it changes the nature of global rainfall, evaporation, snow, stream flow and other factors that affect water supply and quality.[116] Freshwater resources are highly sensitive to variations in weather and climate. Climate change is projected to affect water availability. Growing evidence suggests that it speeds up the water cycle, which can bring longer droughts and more intense periods of rain.[117,118] This makes wet regions even wetter and arid areas drier.[118] In areas where the amount of water in rivers and streams depends on snow melting, warmer temperatures increase the fraction of precipitation falling as rain rather than as snow, causing the annual spring peak in water runoff to occur earlier in the year.[116] This can lead to an increased likelihood of winter flooding and reduced late summer river flows.[117] Rising sea levels cause saltwater to enter into fresh underground water and freshwater streams. This reduces the amount the amount of freshwater available for drinking and farming. Warmer water temperatures also affect water quality and accelerate water pollution.[116]

Climate change makes water scarce and unfit for human consumption today and exacerbates unsustainable water use by farming sector in many water scarce regions

Over 1.3 billion people worldwide are "water stressed,"[119] meaning they are facing extreme water scarcity.[120] Chronic shortages of freshwater are likely to threaten food production, reduce sanitation, hinder economic development and damage ecosystems.[121] Because of this, water scarcity and reduced quality pose problems that threaten the very survival of those affected. For example, changes in water quantity and quality directly affect food availability. Too little water decreases food



Climate Impact Witness

Jerome Robles, Malaysia has been witness to changing rainfall patterns resulting in landslides and flooding, destroying homes, lives and livelihoods.

"There does not seem to be a distinct monsoon season anymore. The rain is more frequently, random and certainly more intense. I wonder whether the more intense rains could be a result of global warming. Long gone are the days when children are able to play in the rain like I used to. Now we are afraid of flash floods and strong winds which normally accompany the intense rains."

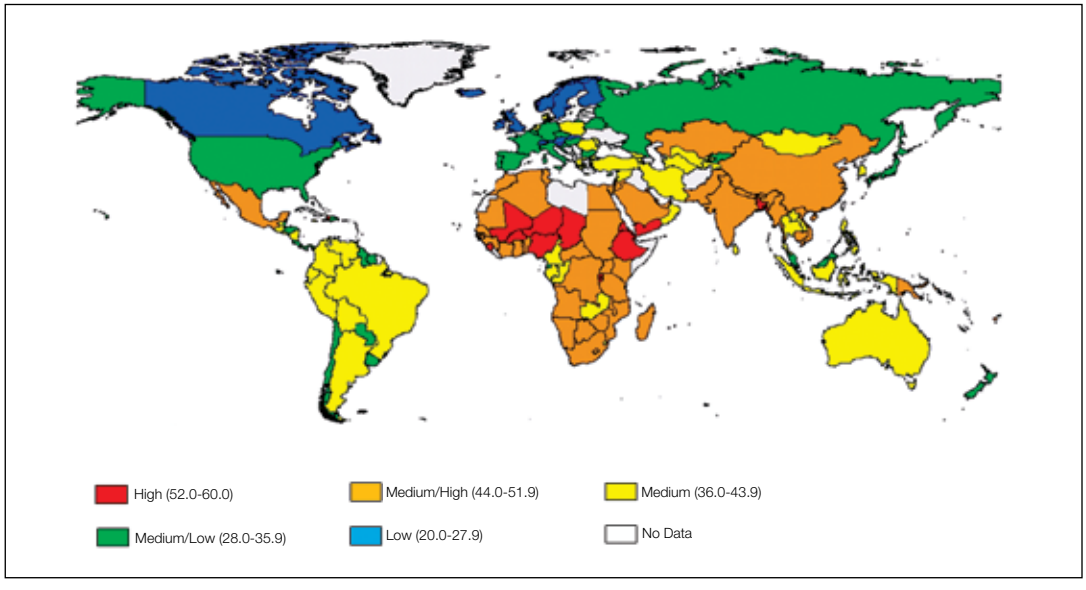
Source: WWF International and Jeremy Robles

security because it limits the water available for farming which can cause crops to wilt and therefore increased vulnerability of poor rural farmers. About 70 percent of the world's runoff water withdrawals are used to irrigate farmlands — this total rises to almost 95 percent in developing countries.[122] While the daily drinking-water requirement per person is 2-4 litres, about 2,000 — 5,000 litres are needed to produce a person's food each day.[122] This means that meeting the Millennium Development Goal target of halving hunger would require the equivalent of the world's current water use in irrigation unless current water practices are improved.[123] This suggests that securing adequate water supply is a critical factor in stabilizing food security which is at high risk due to climate change.

Less than one fifth of water is used by industry, though this value rises in developed nations signifying its importance particularly in sectors like energy that employ power plants or oil refineries.[122] This leaves about 10 percent of water for domestic or municipal purposes like sanitation.[118] Access to safe drinking water and securing adequate amounts of water for hygiene are crucial to meet basic health needs. Poor people in rural and urban areas often have extremely limited access to safe water for household uses. For example, an average slum dweller may only have access to about 5-10 litres daily, while a middle- or high-income individual living in the same city may use about 50-150 litres per day.[124] An estimated 2.3 million people die every year from diarrhoeal diseases because of inadequate water and sanitation.[21,125] International agencies and national policy-makers have been successful in reducing diarrhoeal deaths through efforts to improve safe water supply and health care access, but these gains may be thwarted if water scarcity increases due to climate change. At the same time increased variability and excessive water brings floods that destroy crops, overwhelm existing levees and displace millions of people every year. Climate change causes more violent swings between floods and droughts, which are hard for people to cope with absent improved storage capacity like more cisterns along with levees and dams to protect people.[118] Increased water scarcity is a principal route through which climate — change stresses will manifest themselves by impacting the availability of safe drinking water, irrigation and urban water supply — all critical components of development and poverty reduction. Thus, taking account of the changes that climate change may have on global and regional water supply is particularly pressing.

Climate change exacerbates water quality and availability in regions that are already struggling hardest with water scarcity: Africa, South West Asia, the Middle East and the Mediterranean.[126] In other regions, such as South Asia, climate change increases the variability of water supply, leading to floods during some parts of the year and droughts in others.[16,127] These problems add to the vulnerability of populations in these regions whose existence is already precarious.[127,128] The map below illustrates areas that are currently impacted by water problems today due to a combination of climatic and social factors[129] which reflect global change.[128,130]

Figure 7 — Areas vulnerable to climate-related water challenges*



*Climate Vulnerability Index developed by Dr. Caroline Sullivan, Southern Cross University, NSW, Australia
Source: Sullivan, C.A. (2009 forthcoming) Global Change, Water Resources and Human Vulnerability. Paper presented at MODSIM, 2009.

By 2030, hundreds of millions of people are expected to be hit by deteriorating water quality and availability due to climate change

Hundreds of millions more people are projected to become water stressed by the 2030s due to climate change.[120,126] Although future population growth, increasing food demands and unsustainable agricultural practices place the largest pressures on the world's finite freshwater resource, climate change exacerbates water scarcity and adds new risks to farming systems.[118] The subtropics and mid-latitudes are expected to generally become drier including: Central and Southern Africa, the Mediterranean, the Middle East, Northwest Pacific including China, Central- and South America.[126] Africa will be hit particularly hard due to longstanding periods of drought and its weak capacity to adapt to more difficult conditions. Rainfall has decreased by 4 percent on average each decade since the 1970s in Western Africa and 2.4 percent per decade in tropical rainforest regions.[131] Complicating the picture, in some dry areas like Morocco, seasonal rain showers will likely become more intense, which can produce unusually severe and damaging flooding.

Climate change is expected to produce more water annually in some parts of the world — above all in South Asia.[120,126] In fact, over 90 percent of those projected to experience decreased water stress live in South Asia.[126] However, even here, changing water supply patterns could end up having a negative effect. For example, increases in water quantity seem likely to occur during the wet season leading to flooding, and may not alleviate dry season problems if this extra water is not stored.[16,86] The Indonesia case study in Food Security (above) illustrates this phenomenon.

Case Study

Morocco — Vulnerable to drought

To some, water-related climate change might sound like an abstract phenomenon, but to Moroccans its impact is both real and immediate. On the edge of the Sahara, where water has always been a precious and limited resource, climate change is accentuating the problem, making water even scarcer due to decreasing rainfall and increasing droughts. Water scarcity not only threatens food production but also has undercut the government's progress in increasing access to safe drinking water and improving sanitation.

On average a major drought has occurred every 11 years for the past 100 years. However, over the past 30 years, drought frequency, intensity and duration have increased.[132,133] Overall annual water supply has decreased by 15 percent between 1971 and 2000, particularly in southern and south-eastern Morocco. By 2020, average annual rainfall is projected to decrease by 4 percent compared to 2000 levels, a development that could lead to cereal yields falling between 10 percent in normal years and by half in dry years.[133] Climate change also increases seasonal variability and extremes leading to more flooding.[134] For example, 44 people died in two separate floods in northern and central Morocco in November 2008 and February 2009.[135] Approximately 1.0 percent to 1.5 percent of Moroccan GDP is lost annually due to the lack of access to water and sanitation.[136]

Between 20-30 percent of the government's budget is spent on water management projects, such as irrigation and water pipes and results are impressive: In 2005 56 percent of the population in rural Morocco had access to safe drinking water as compared to 15 percent in 1995.[136] However, per capita water availability is expected to be reduced by half in the next 40 years[137] which may reverse this great progress.[136]

Key Sources: World Bank and WHO

Case Study

Mexico City — Running out of water

Hearing about the water crisis in the Sahara desert may not be surprising, but did you know that fast growing urban areas, particularly mega-cities like Mexico City, Dhaka, Lima, and Addis Ababa are also vulnerable to water problems.[130,138] In Mexico City water problems induced by climate change — particularly decreased rainfall and increased variability — are compounded by human factors, such as overexploitation, fast-growing populations, especially in squatter communities, and outdated basic services that lead to sewage overflows and flooding after heavy rains.[139,140,141]

In 2009 Mexico City has begun to completely shut down its water supply from an overexploited basin, which normally provides 25 percent of total supply, for three days each month during dry season.[138] This results in more water being drawn from other sources like groundwater.[139] As a result, underground resources are being severely depleted. The city's freshwater supply is currently at a 16 year record low level.[138] With precipitation in Mexico City projected to fall by 5 percent by 2020, water availability is likely to worsen in the future. During the same time period, temperature will likely increase by 1.2 degrees Celsius.[142] Mexico City has 18.6 million inhabitants, the 10th largest city in the world.[141] Safeguarding access to clean water and thereby the health of residents is a critical goal in itself. However, it is also important to remember that assuring the availability of reliable supplies of water for agriculture and industrial purposes is also crucial for economic stability in a city that produces 35 percent of Mexico's total annual GDP.[141]

Key Sources: Jiménez, B., UNDP and Climatico

Displacement

Climate change displaces people

Climate change causes displacement of people in several ways, the most obvious—and dramatic—being through the increased number and severity of weather-related disasters which destroy homes and habitats forcing people to seek shelter or livelihoods elsewhere. In the long term, such environmental effects of climate change as desertification and rising sea levels gradually doom livelihoods and force communities to abandon traditional homelands for more accommodating environments. This is currently happening in areas of Africa's Sahel, the semi-arid belt that spans the continent just below its northern deserts. Deteriorating environments triggered by climate change can also lead to increased conflict over resources which in turn can displace people.[143,144]

However, the links between the gradual environmental degradation of climate change and displacement are complex: When individuals decide over time to leave, it is impossible to single out the influence of climate change in these decisions from other factors, such as poverty, population growth or employment options. According to the UN High Commissioner for Refugees, it will become increasingly difficult to categorize any displaced people by separate causes, which may include any combination of conflict, economic, environmental, climate or other factors. Neither the UN Framework Convention on Climate Change nor its Kyoto Protocol, an international agreement on climate change, includes any provisions concerning specific assistance or protection for those who will be directly affected by climate change. The current terminology is the following:

- Refugee: Under the 1951 United Nations Convention Relating to the Status of Refugees and later expanded through a 1967 Protocol relating to the Status of Refugees, a refugee is a person who "owing to well-founded fear of persecution for reasons of race, religion, nationality, membership of a particular social group or political opinions, is outside the country of his nationality and is unable or, owing to such fear, is unwilling to avail himself of the protection of that country, or who, not having a nationality and being outside of the country of his former habitual residence as a result of such events, is unable or, owing to such fear, is unwilling to return to it".[145]
- Internally Displaced People: While there is no legal definition a widely recognized United Nations report, "Guiding Principles on Internal Displacement", uses the following definition: Persons or groups of persons who have been forced or obliged to flee or to leave their homes or places of habitual residence, in particular as a result of or in order to avoid the effects of armed conflict, situations of generalized violence, violations of human rights or natural or human-made disasters, and who have not crossed an internationally recognized State border.[146]
- Migrant: International migrants are those who leave their country to settle in another country, voluntary or involuntary and temporarily or permanently. Voluntary migrants normally leave their country in search of a higher standard of living and quality of life elsewhere, typically referred to as economic migration. Involuntary migrants include victims of human trafficking, whose special situation is addressed by a number of international legal instruments.[147]

Climate Impact Witness

Jyotsna Giri, India had a small farm on Lohachara Island in West Bengal. Fifteen years ago she had to move to a refugee colony on a neighbouring island when the sea claimed her home and farm.

"I still remember that fateful day, when I lost everything. When we approached Lohachara Island, I suddenly noticed that my sheep were all drifting in the river. I found that half of my house was washed away by the river. Slowly the entire island got submerged."

Source: WWF India

Climate displaced people is the term used in this report describing people who predominantly involuntarily are forced to move or are displaced, either permanently or temporarily, because of climate change, through its impacts and shocks. It is possible to estimate the numbers of Climate Displaced People in global terms, since, for instance, a correlation can be made between the great increase in the number of severe weather events — much of which can be attributed to climate change — over the last decades, and the number of additional people that these events displace. It is, however, virtually impossible to single out individual people or even scenario specific situations as being attributable to climate change. This means that the definition of Climate Displaced People carries almost no practical application today. It is however, a useful estimative indicator of the additional burden that climate change is placing on the international community, on existing legal frameworks of protection and assistance, and on local communities in areas where climate impacts are most acute.

Today there are about 26 million Climate Displaced People[148]

Today about 350 million people can be considered displaced[143] — some temporarily, some long-term. They include over 150 million people involuntarily displaced—people forced from their homes by weather-related disasters, gradual environmental degradation such as desertification and sea level rise or due to development projects, such as the construction of dams, mines, roads, factories, plantations and wildlife reserves. Environmental pressures also have an impact on the number of voluntary long-term migrants whose numbers have risen from 75 million in 1965 to over 200 million today. These are people who leave voluntarily and live outside their home country for at least a year, with improved economic condition being the main reason for leaving.[143]

An estimated 26 million of the 350 million displaced worldwide are considered climate displaced people.[149] Of these, 1 million each year are estimated to be displaced by weather-related disasters brought on by climate change.[150] These populations are mostly temporarily forced displacement within national borders, but also include temporarily forced and voluntary displacement across international borders.[151] For example, torrential rains that struck Uganda during the summer of 2007 caused the country's worst floods in 30 years and displaced over 60,000 people.[39] Cyclone Nargis hit the Irrawaddy Delta in southern Myanmar and displaced 800,000 people.[152] About 25 million people are displaced quietly, far from the news headlines, due to more gradual environmental change related to climate change[153], mainly by desertification, but also by rising sea levels. The displacement is often gradual, beginning with voluntary movements (in- and outside the country) and in some cases ending in forced displacement by realities of the climate. There are also cases where areas are being prohibited for habitation by authorities leading to either internal or across border and forced or voluntary displacement.[154] These 25 million people come from sub-Saharan areas of Africa, including the Sahel and the Horn of Africa,

but also include populations from China, and India.[155] In West Africa, a creeping desertification is in progress, with 1,350 square miles of Nigerian land turning into desert each year, uprooting farmers and herdsmen and causing internal migration towards coastal areas. In Burkina Faso, desertification is the single largest cause for migration to fast growing urban centres. The UN housing agency estimates that about one in three African slum dwellers could be considered environmental refugees, who have fled advancing deserts and failing farms.[156]

In the next 20 years the number of Climate Displaced People could more than triple

The IPCC and the Stern review speak of 150 million and 200 million permanently displaced due to rising sea-levels, floods and droughts in 2050. These are widely disputed estimates[155], but give an order of magnitude that shows that by 2030, the number of Climate Displaced People could at least triple. They migrate because they are driven from their homelands by weather disasters or gradual environmental degradation that generates economic migration.[44,155] These people leave a variety of different topographies, including small islands, low lying coastal areas, arid and semi-arid areas, forested areas and areas liable to forest decay. Regions prone to natural disasters, drought and desertification, high urban atmospheric pollution are also hit. The most seriously affected countries include island states, several African nations, China, India, Bangladesh, Egypt and the delta areas and coastal zones of several countries.[143]

It is not possible to say with certainty who will be Climate Displaced People in 2030, but vulnerability to displacement both to weather-related disasters and gradual environmental degradation is already enormous and it is growing with over 2.8 billion people vulnerable to weather-related disasters and sea level rise today. Furthermore, the poor are typically the most exposed—especially to the effects of more frequent and more intense weather-related disasters. Almost 160 million people currently living in low lying areas are believed to be at risk of flooding from storm surges.[143] Even more people are vulnerable to gradual environmental degradation through desertification and rising sea levels: Arid and semi-arid areas currently cover about 40 percent of earth's land surface and are home to more than 2 billion people. It is estimated that 135 million people — the combined populations of France and Germany — are at risk of being displaced by desertification. The problem is most severe in sub-Saharan Africa, the Sahel and the Horn of Africa. In sub-Saharan Africa alone, some 60 million are estimated to move from desertified areas to northern Africa and Europe by 2020. The World Bank estimates that sea levels rising a single meter would displace 56 million people in 84 developing countries. In Bangladesh alone, 20 million would be affected.[143]

Case Study

Ghana — A metaphor for those driven from home by desertification

In a survey of 203 internal migrants from north-west Ghana, the vast majority mentioned environmental reasons for leaving their homes.[157] The respondents — settler farmers living in rural areas of Brong Ahafo Region in Central Ghana — said they decided to migrate because of scarcity of fertile land, unreliable rainfall, low crop yields and/or food security problems. A minority mentioned non-environmental reasons for migrating — lack of non-farm income opportunities, family conflicts, witchcraft, cattle theft and the desire for personal independence. The survey suggested that districts receiving less rainfall tended to experience greater outward migration. The same was true of districts with less vegetation and higher population density. High rural population density caused scarcity of land for farming, one of the prime motives for migrating mentioned by the survey respondents. The survey demonstrated climate change is not the only factor that influences the decision to migrate, but that it is one of a bundle of issues that contribute to deteriorating economic and political conditions.

Key Sources: EACH-FOR and UNCCD

Case Study

Small island developing states — Powerless against rising seas

Small islands, whether located in the tropics or higher latitudes, have characteristics that make them especially vulnerable to sea-level rise. In the Caribbean and on Pacific islands, more than half the population lives within 1.5 km of the shore. In most cases, these small islands have few viable answers to the threat facing them and the cost of options that are available are prohibitively expensive for nations with only modest GDPs. Where adaptation isn't feasible, migration is the main alternative.[158]

The small islands of Tuvalu, Kiribati and the Maldives are particularly vulnerable to gradual sea level rise and storm surges.[158] Tuvalu, in the South Pacific Ocean, is the lowest-elevated state, with a peak elevation of less than 4.5 meters above sea level. Frequent saltwater flooding, accelerated coastal erosion and increasing difficulty growing vegetables and plants are day-to-day challenges. The people of Tuvalu have reluctantly accepted the idea of relocation, and have started moving to New Zealand, under the terms of a negotiated migration scheme.[159]

Forced displacement is the ultimate human consequence of sea level rise. Before reaching that stage, sea-level rise will likely exacerbate inundation, erosion and other coastal problems, threaten vital infrastructure, settlements and facilities, and thus compromise the socio-economic well-being of island communities and states.[158]

Key Sources: IPCC and EACH-FOR

Security: Climate change threatens security

Climate change contributes to violent conflict

Conflicts are typically extremely complex with multiple inter-dependent causalities, often referred to as 'complex emergencies.' Climate change has the potential to exacerbate existing tensions or create new ones — serving as a threat multiplier. It can be a catalyst for violent conflict and a threat to international security.[160,161] The United Nations Security Council held its first-ever debate on the impact of climate change in 2007.[162] The links between climate change and security have been the subject of numerous high profile reports since 2007 by leading security figures in the United States, United Kingdom and the European Union.[163,164,165] The G77 group of developing nations also considers climate change to be a major security threat which is expected to hit developing nations particularly hard.[166]

> "We sink or swim together. Climate change can be a threat to peace and stability. There is no part of the globe that can be immune to the security threat."
>
> Rajendra K. Pauchauri — Chairman, Intergovernmental Panel on Climate Change (IPCC);
> Director General, The Energy and Resources Institute (TERI);
> Director, Yale Climate and Energy Institute

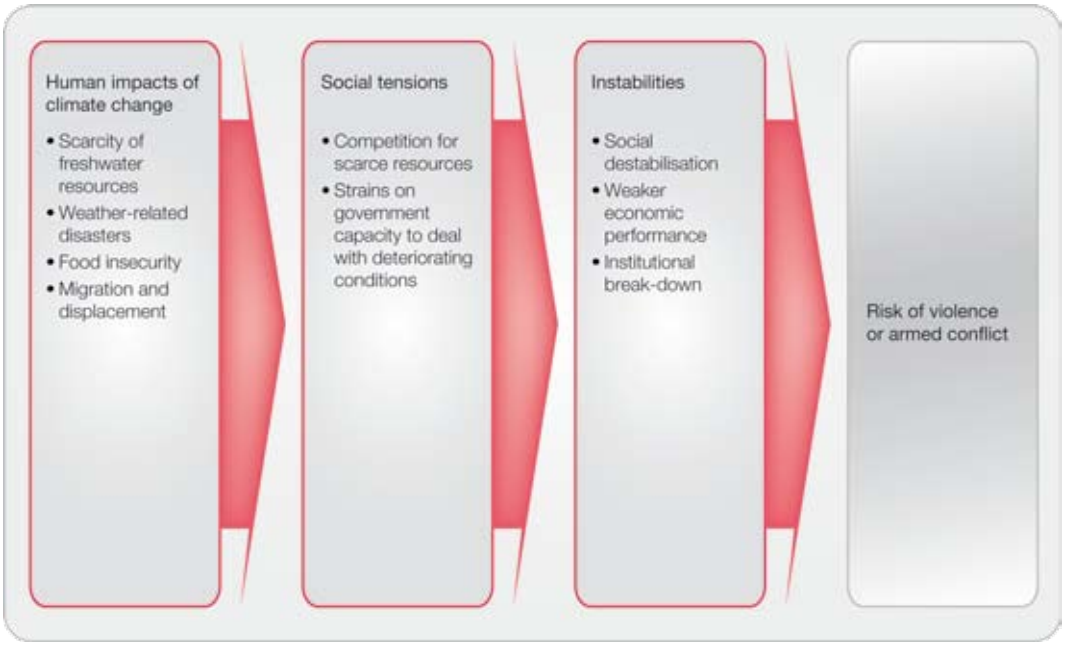
The links between the human impact of climate change and the threat of violence and armed conflict are particularly important because multiple destabilizing conditions are affected simultaneously.[163] Below are three examples of how climate change causes instabilities that can lead to or drive violent conflict:

- Climate change intensifies negative environmental trends like desertification, soil salinisation and water scarcity; all of which contribute to resource scarcity. Mainly it reduces the supply of food, fresh water for people and livestock, agricultural produce, and farmer livelihoods. These conditions can trigger increased competition for food, land and water, creating situations with a propensity to conflict. This occurs particularly in areas where governments are not able to provide support or alternative sources of income. Today such situations can be seen for instance in some dry land belt countries which are home to more than 2 billion people.[167] Examples include fighting between pastoralists and farmers in the Oromia and Ogaden regions of Ethiopia, inter-clan fighting in Somalia, and increased fighting during drought periods in northern Nigeria.[168]
- Weather-related disasters often cause destruction and put immense pressures on local resources. The risks are particularly high when communities are not able to protect and provide sufficiently for their populations.[161] Developed nations are not immune to this threat. In the aftermath of Hurricane Katrina when about 100,000 New Orleans residents were trapped in the flooded city there were reports of fighting, looting and rape.[169]

- Sea level rise and sinking land may cause disputes over remaining areas. People displaced by these physical changes need to identify new locations to re-establish their livelihoods either in neighbouring areas or far away. Social tensions and the potential for violence could increase where the arrival of climate displaced populations causes competition for scarce resources or where they are not welcomed in new communities.

The figure below illustrates the links through which the human impact of climate change contributes to social tensions and instabilities that raise the risk of violence or armed conflict.

Figure 8 — Stages of climate change impact on security



Source: Dalberg analysis

Evidence of climate change related conflict is inconclusive today

It has been argued that 2 out of 5 people in the world today, or 46 countries with a combined population of 2.7 billion, are vulnerable to the effects of climate change on security because of current and recent wars coupled with social and institutional instabilities.[170,171] 23 countries are in Africa, and more than one-third in Asia and the Middle East. Already today, over 40 percent of intra-state conflicts are linked to natural resource issues.[172] As climate change intensifies, it can generate new resource conflicts over water and food, and increase resource issues as a driver of conflict. This should be seen in the context of existing instabilities in post-conflict situations. Evidence shows that conflicts linked to natural resources are twice as likely to relapse within

the first five years compared to non-resource related conflicts.[173] For example, the potential for armed conflict over water resources is often seen as an imminent threat to security as 263 river basins are shared by two or more countries,[174] and water supply is fast depleting in many of these water reservoirs in areas like Middle East and Central Africa. However, past predictions of large scale water wars have not come to pass and increased cooperation has instead prevailed.[175] Most shared water resources are managed peacefully through cross-border engineering and diplomacy with increased security collaboration, i.e. UN peacekeeping reform, and resource sharing agreements like the over 200 water treaties negotiated in the last 50 years.[176] In fact, many processes associated with global warming, have occurred during a time when the world has witnessed a dramatic reduction in the frequency and severity of armed conflict.[175] The main reasons for this include the end of the Cold War; increased international cooperation to prevent and stem conflict; rapid economic growth in parts of the world once rife with conflict, such as areas of Eastern Europe; and United Nations peacekeeping operation reforms.

Future conflict or cooperation?

Based on historical precedent, resource sharing and cooperation have been the rule, not the exception, but what is in store for a future impacted by climate change remains in the hands of humankind. The number of people vulnerable to the effects of climate change to security is projected to increase.[171] These people live in countries that are not currently unstable but there are concerns about their capacity to maintain stability in the face of increased human impact from climate change, often due to factors such as recent transitions out of dictatorship and war, and economic development challenges.

Climate change is linked to a range of threats to international peace and security that are subject to increasing attention and study. Three examples of these are energy, terrorism and Arctic exploration:

- The majority of global oil reserves and production is located in the regions that are most vulnerable to climate change: the dry land belt countries from the Sahel through the Middle East to Central Asia. Large oil-importers, such as the United States, China and Europe, regard energy insecurity as an important threat and are concerned over potential regional instabilities caused by climate change. There are fears that conflicts may disrupt supply from energy producing countries and further intensify global competition for energy resources.[176]
- Climate change has also been linked to terrorism because it can serve as a threat multiplier for instability in the most volatile regions of the world which are vulnerable to civil unrest and the growth of extremist ideology.[163]
- As polar ice caps are melting, new coveted waterways are opening up in the Arctic along with increased access to new mineral deposits and natural resources. This may ignite international territorial disputes, exemplified by the outcry after Russia planted a flag in a seabed below the North Pole in 2007.[164]

Case Study

Climate change in the dry land belt — An ecological time bomb for human security in the Middle East

The dry land belt encompasses 41 percent of the world's landmass including the Sahara, the Middle East and Central Asia, and is to home over 2.3 billion people.[167,177] The combination of a fragile ecosystem, environmental degradation, scarce water supply and high population growth rates creates a poverty trap and an enormous threat to human welfare.[177] The Middle East is already a politically volatile region where the demand for water is fast outstripping diminishing supplies. Water scarcity due to climate change could heighten tensions between countries sharing water resources. It could also increase internal instability as it becomes harder for governments to provide for their people — one more area of potential conflict for extremists to exploit.

Lebanon is a country whose history is heavy with conflict. Today, long-simmering tensions surround the question of how to equitably divide one its most precious natural treasures: its water. In the Bekaa Valley, an historic feud over irrigation and water diversion is being re-ignited between Muslim and Christian families.[178,179] Nationwide, demand for water is expected to increase by over 80 percent in the next fifteen years and population is projected to grow from 4 to 7.6 million.[179] On top of this, climate change, including expected rises in summer temperatures of 1.2 degrees centigrade[179] are projected to boost irrigation needs by over 18 percent.[180] The energy and water ministry is currently implementing a 10-year water strategy aimed at sustainable water resource management. Nonetheless, experts warn that where there is a history of conflict, climatic changes can become a trigger for renewed hostilities.

Key Sources: Integrated Regional Information Networks, Lebanese Agricultural Research Institute and NASA

Case Study

South Asian region — Melting of the Himalaya glaciers and risk of conflict

As temperature rises globally, glaciers around the world are melting at an alarming and ever accelerating rate. This is of concern not only for the world's ski goers. A far bigger worry are projections that this melting will play havoc with the supply of fresh water, causing increased flooding in the medium term, then water scarcity in the long term. And, as water becomes scarce, the risk of conflict over water resources emerges as a climate-induced security concern. The use of dams upstream as a reaction to changing water supply is a particularly volatile issue that also carries an extremely high price tag.

For example, the Himalaya glaciers,[181] the largest body of ice outside the poles, may completely disappear as early as 2030 as about 7 percent of its ice is melting away each year.[182] The Himalayas supply water to 2 billion people in Asia feeding into 6 major rivers (Ganges, Brahmaputra, Indus, Mekong, Yellow and Yangtze) that run through China, India, Pakistan, Bangladesh, Tibet, Nepal, Burma, Thailand, Laos, Cambodia and Vietnam.[183,184] The Ganges River flows through Northern India and Bangladesh and alone supplies a population of over 407 million people with water.

Key Sources: IPCC and Institute for Public Policy Research and Woodrow Wilson International Center for Scholars

3 The world's poorest — Most vulnerable to climate change yet least responsible

Poverty increases vulnerability to climate change

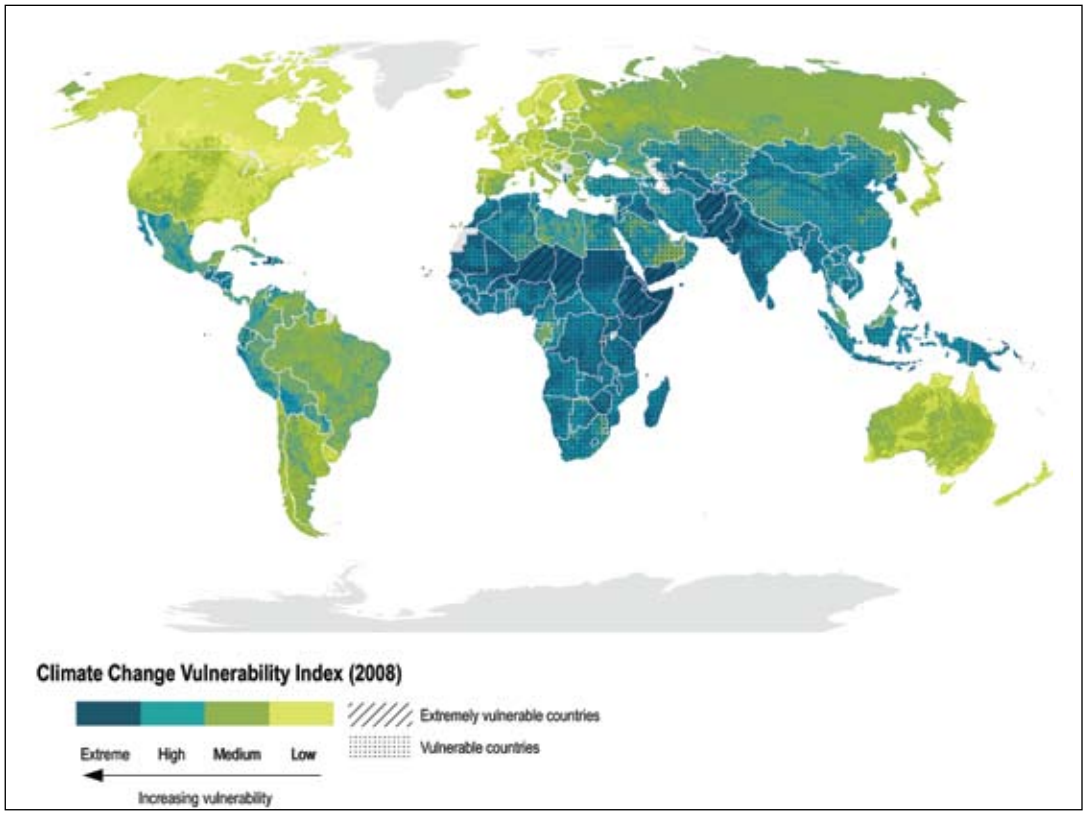
Those most vulnerable to the human impact of climate change are exposed to both the physical changes and the socio-economic implications. Section 1 introduced the 2.8 billion people in the world who are most vulnerable to the physical changes caused by climate change and the regions of the world in which they live. Physical changes include weather-related disasters and gradual environmental degradation, which are already occurring faster and more intensely in developing countries than in developed countries because of warmer starting temperatures and increased proximity to the Equator.

Socio-economic vulnerability to climate change is a measure of how well individuals and communities are able to respond and adapt to the human impacts of climate change. 4 billion people — 60 percent of the world's population[185], are vulnerable to climate change today in socio-economic terms. The global poor, with incomes of less than $2 per day (40 percent of global population), have very limited resources to respond and adapt to climate change without assistance. People with incomes between $2 and $10 have some capacity to respond but they are still likely to be vulnerable if confronted with the impacts of climate change. Those relying on natural resources for their livelihoods such as farmers, fishermen and low-wage earners in tourism will be particularly vulnerable to income losses due to climate change. The level of social development and local infrastructure also significantly determines the vulnerability of communities and their capacity to adapt. People living without access to affordable health care, water, electricity and paved roads are more likely suffer severe human impact than those who have access to these basic services.[186] Broad lack of access to insurance in developing countries further magnifies the vulnerabilities. Insurance is a mean for people to help them find their own way out of a crisis and this cover against risks can help people escape poverty.

The map on next page helps illustrate the areas where the people who are most vulnerable to climate change in socio-economic terms live.[185] Worst affected regions include the Sahara, the coastline of Eastern Africa, all of South Asia, and many small island states. Africa is the most vulnerable region — 15 of the world's 20 most vulnerable countries are African. By contrast,

developed nations are the least vulnerable — in particular Scandinavia, Canada and the United States — both because of their lower exposure to the physical impact of climate change and the greater investment in climate change adaptation, like coastal protection and advanced warning systems.[187]

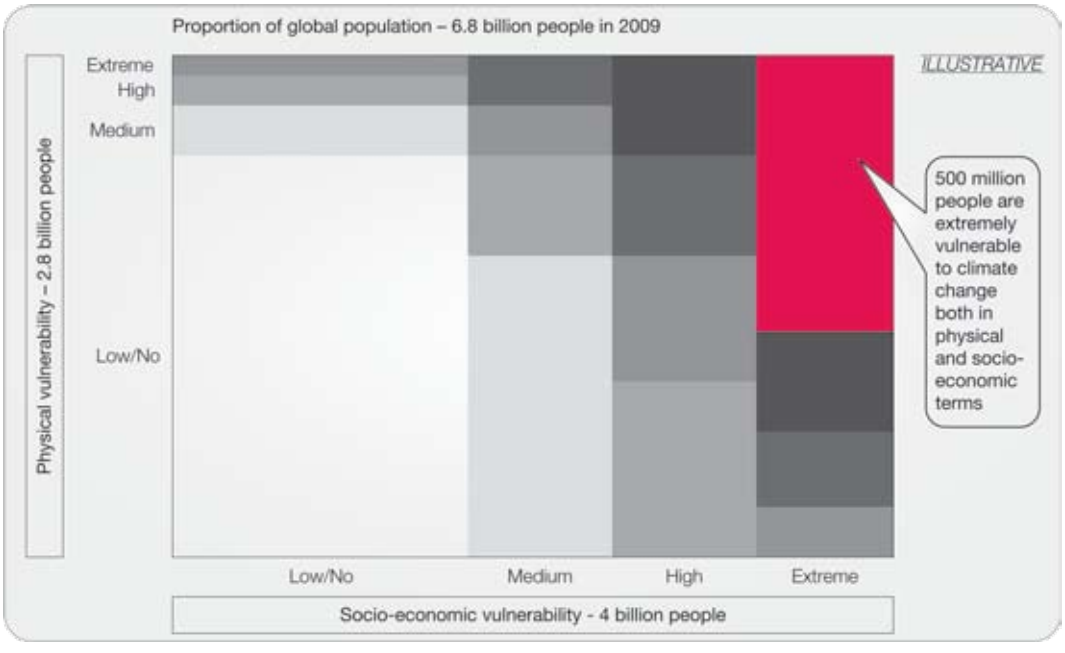
Figure 9 — Socio-economic vulnerability to climate change around the world



Source: Climate change vulnerability index, Maplecroft, 2008.

Particular attention must be given to the approximately 500 million people who live in countries that are extremely vulnerable to climate change due to the physical location of their homes and social circumstances.[185] The figure below illustrates how physical and socio-economic vulnerability coincides. The extremely vulnerable people are typically poor and live in least developed countries that are prone to more than one type of weather disaster, i.e. floods, droughts and storms; as well as gradual environmental degradation like sea level rise or desertification. The ten most vulnerable countries are Comoros, Somalia, Burundi, Yemen, Niger, Eritrea, Afghanistan, Ethiopia, Chad and Rwanda. These ten most vulnerable nations have experienced almost 180 storms or floods during the last 30 years. In these same countries, 11 million were affected by drought in 2008 alone while 85 million have been affected by droughts in last 30 years.[39]

Figure 10 — Physical and socio-economic vulnerability to climate change



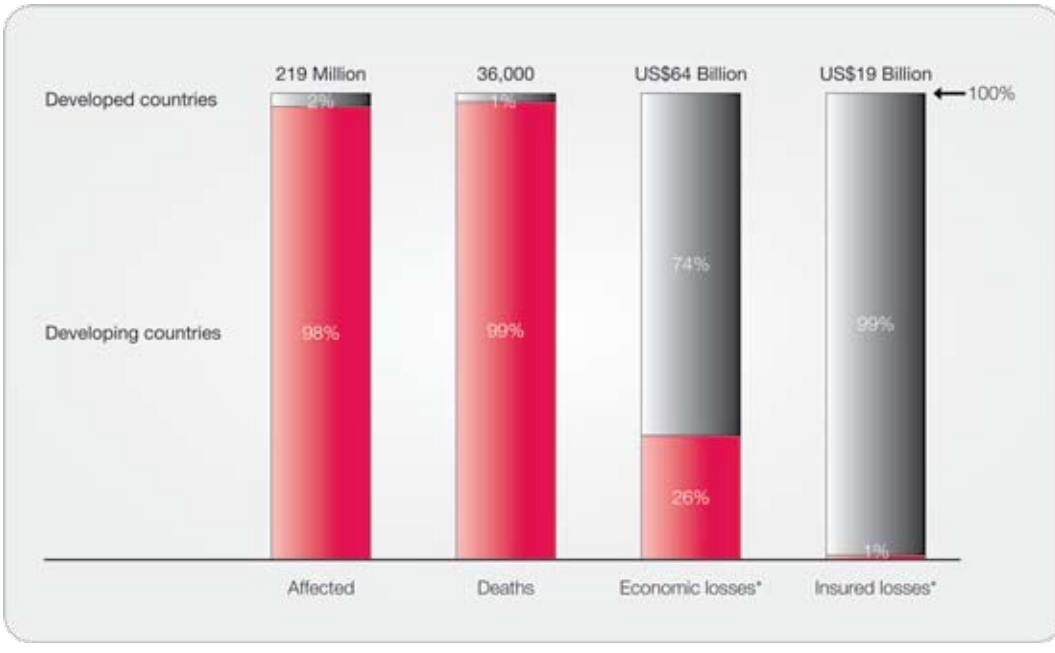
Source: Maplecroft climate vulnerability indices; Dalberg analysis

Adaptation can reduce overall vulnerability, in particular among the world's poorest. This can be through policies of investing in early warning and evacuation systems to prepare people for storms, or assisting farmers to modify the crops grown and the timing of planting and harvesting. The good news is that there are some success stories of poor countries reducing vulnerability to the impacts of climate change. Bangladesh, one of the countries most naturally vulnerable to climate change, has taken steps over the past few years to become better prepared, and thus, less vulnerable. These steps helped reduce mortality in Bangladesh during Cyclone Sidr in 2007 which killed approximately forty times fewer people than a similar scale cyclone in 1991 (3,400 deaths versus 138,000) and that is despite the subsequent population increases over the intervening period.

Poor countries suffer the vast majority of human impact of climate change

To illustrate how unevenly the human impact of climate change is distributed, figure 11 shows some basic statistics on the burden of disasters. 98 percent of those affected in disasters between 2000 and 2004 and 99 percent of disaster casualties in 2008 were in developing countries.[36,188] Unequal access to property insurance is another example of how people with low incomes are more exposed to the impacts of climate change. Less than 3 percent of the insured property losses[189] from disasters are in low and lower middle income countries. Low-income households consider their biggest risk to be the incapacitation of the main breadwinner[190] which means that a disaster constitutes one of the greatest risks they encounter.

Figure 11 — Share of burden of disasters



*Low income countries and lower middle income countries
Source: Watkins, K. (2007): "Human Develop Report 2007/2008 Fighting climate change: Human solidarity in a divided world." United Nations Development Programme, p.8; International Strategy for Disaster Reduction Statistics, (2009); Munich Re and PIK (2008).

Gradual environmental degradation due to climate change, such as changing rainfall patterns, also disproportionately hurts the poor. This is particularly the case when crop yields are reduced and farmers are forced to change to more drought resistant crops that provide less income. This economic impact is unevenly distributed with more than 90 percent[191] of the $125 billion in annual economic losses due to climate change occurring in developing countries.[192]

Climate change exacerbates existing inequalities faced by vulnerable groups particularly women, children and elderly

The consequences of climate change and poverty are not distributed uniformly within communities. Individual and social factors such as gender, age, education, ethnicity, geography and language lead to differential vulnerability and capacity to adapt to the effects of climate change. Climate change effects such as hunger, poverty and diseases like diarrhoea and malaria, disproportionately impact children, i.e. about 90 percent of malaria and diarrhoea deaths are among young children.[21] Furthermore, in times of hardship young girls are particularly likely to be taken out of school to care for sick relatives or earn extra income. The elderly have weakened immune systems making them more susceptible to diseases and changing weather conditions, especially heat waves, along with being highly vulnerable to weather-related disasters due to reduced mobility. Roughly 60 percent of Hurricane Katrina victims were 65 years or older.[193]

> "It is a matter of social justice. If we care about injustice and inequality, we must care about climate change. Climate change exacerbates existing inequalities including the different vulnerabilities of men and women."
>
> Barbara Stocking — Chief Executive, Oxfam GB, Oxford, England

Climate change exacerbates gender inequalities. Women account for two-thirds of the world's poor.[194] 70-80 percent of agricultural workers are women. They are also largely responsible for water collection and often serve as the primary caretaker in a household.[195] As a result, climate change impacts like decreased farm yields and water supply disproportionately impact women by reducing their livelihoods, impairing food provision and increasing their household workload. 75 percent of deaths in climate disasters are female,[196] due to factors like an inability to swim that leads to drowning during floods; constricting dress-codes inhibiting fast movement; and behavioural restrictions forbidding women from leaving the house without male relatives.[197] Women are also more vulnerable to climate related displacement and conflict, with women representing the majority of climate displaced people.[198] This vulnerability and inequality often relegates women to the worst paid, least regulated jobs and can place them at higher risk of sexual exploitation.[198]

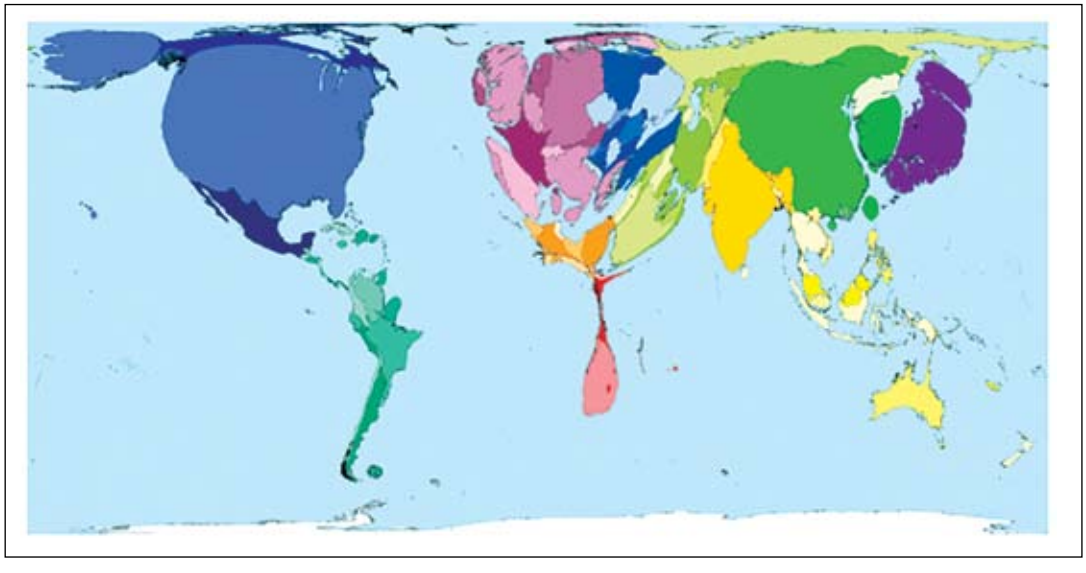
A global justice concern: Those who suffer most from climate change have done the least to cause it

The global pollutants that contribute to climate change do not adhere to national or regional boundaries. They impact people regardless of where they were produced and by whom. The world's poorest have not benefited from the decades of economic growth that have accelerated global warming. The poor are also only responsible for a small part of the emissions that contribute to climate change — yet they suffer the majority of the human impact of climate change. These contrasting realities of responsibility and human impact of climate change raise significant concerns of global justice.

Carbon dioxide emissions are considered by far the number one cause of global warming.[65] Figure 12 on next page illustrates the imbalances between carbon emissions in the North versus the South.

> "The countries least responsible for global warming — the poorest developing nations — will be the most affected by its consequences. In the cruel calculus of disasters, the poorer the community, the greater its vulnerability to natural hazards and the more difficult its recovery."
>
> Margareta Wahlström — United Nations Assistant Secretary-General, Disaster Risk Reduction

Figure 12 — The world map reflecting carbon emissions*



*Annual aggregate national CO_2 emissions 2000
Source: SASI Group (University of Sheffield) and Mark Newman (University of Michigan), 2006

The United States — emitting over 20 percent of total global carbon emissions, joined by Russia, Japan, Germany, Canada and United Kingdom, were among the top 10 emitters of carbon globally in 2004.[199] This picture looks very similar when accounting for emissions over the last decade.[200] In comparison, the 50 Least Developed Countries released less than 1 percent of total emissions.[199,201] Looking at the top per capita emitters; the US is joined by developed nations like Italy, France, and Luxemburg, along with a few oil-rich countries like Kuwait or the United Arab Emirates.

Incidentally, the 20 least vulnerable countries to climate change (emitting 39 percent of global carbon in 2004) are all developed nations with Uruguay as the sole exception.[202] In comparison, the top 20 countries most vulnerable to climate change in 2004, 15 of which are in Africa, collectively emitted less than 0.7 percent of total carbon emissions.[202] Altogether African countries emitted only 4 percent of all carbon — 2.6 percent if South Africa is excluded. The same is true for small island states. Haiti is extremely vulnerable to climate change yet emits only 0.01 percent of total carbon emissions. The Comoros Islands off the East African coast release one of the smallest amounts of carbon in the world but is rated as the country which is the most vulnerable to climate change.

Difficult climate justice issues: high growth, deforestation and black soot

Developed nations bear the most responsibility for climate change, but there is an increasing number of cases where low and middle income countries also contribute significantly to climate change. The top 20 emitters of carbon included large and rapidly industrializing nations like China, India, Republic of Korea, Mexico, South Africa, Indonesia, and Brazil.[200] These countries often have rich natural resources and are experiencing fast economic growth. Often they find it difficult to achieve sustainable policies as they do not always have access to appropriate and affordable technologies. These are countries where climate justice issues are becoming particularly acute but also sensitive — being both large emitters and highly vulnerable to climate change.

Deforestation is another activity which raises significant climate justice issues. While fossil fuel usage is the largest single contributor to global carbon emissions producing climate change (coal alone accounts for roughly 20 percent of global emissions),[203] deforestation also plays a major role, accounting for over 25 percent of global emissions.[204] A majority of deforestation is carried out by slashing and burning (54 percent) and the remainder constitutes of cattle ranching (5 percent), heavy logging (19 percent) and the growing palm oil industry (22 percent), an industry projected to grow due to its use in biofuel production.[205,206] In just one day, deforestation generates as much CO_2 as 8 million people flying from London to New York.[204]

As of 2003, two billion tons of CO_2 were linked to deforestation activities that led to the destruction of 50 million acres — an area roughly the size of England, Wales and Scotland.[204] Rapid deforestation prioritizes immediate economic output in favour of natural wealth preservation. This has also been the case historically: 500 years ago almost half of the United States, three-quarters of Canada and almost all of Europe were forested.[207] The majority of remaining forests globally are located in high growth nations such as Brazil, Indonesia and China but also in developing countries such as the Democratic Republic of Congo.[208] In 2004, almost 1 percent[209] of global carbon emissions were generated by clearing and burning the Amazon rainforest.[199,210] Deforestation depletes natural resources permanently and leaves the land exposed to environmental disasters, including those associated with climate change.

Poverty can be a driver of practices that contribute to climate change. Black carbon from the soot released from cooking stoves is one example. Under-ventilated fireplaces and primitive cooking appliances not only have negative health impacts almost exclusively born by women, from smoke inhalation and respiratory illnesses, but also hurt the environment. While carbon dioxide is the number one cause of climate change — responsible for about 40 percent of warming — black carbon from soot is fast emerging as a large contributor to climate change, causing as much as 18 percent of warming.[211] These findings are so recent that they were not covered in the 2007 Intergovernmental Panel on Climate Change report.[65] Nevertheless, soot from fireplaces in tens of thousands of villages in developing countries is the primary contributor to black carbon.[212] Often those who depend on these cooking stoves to prepare staple foods do not have access to affordable alternatives.
A solution of this difficult situation would also have a global benefit. Providing affordable alternatives could have a fast impact on curbing global warming, as unlike CO_2 which lingers in the atmosphere for years, soot only remains for a few weeks.[213]

4 A global challenge — Goals missed

Climate change — a global problem

The poorest are hardest hit but climate change is a global problem

Even though over 90 percent of all weather-related disasters take place in developing countries, developed nations are also affected — increasingly with devastating effects. The human impact of recent heat waves, floods, storms and forest fires in Europe, the United States and Australia have been shocking. The 2003 heat wave in Europe killed 35,000 people[91] and Hurricane Katrina that hit the US Gulf Coast in 2005 caused economic losses in excess of USD 100 billion.[62,63] California's $35 billion farm industry, which is the source of half of all US fruit, vegetables and nut production, is highly vulnerable to climate change — particularly to drought which reduces the water supply needed to grow crops.[214] A drought emergency was declared in California in early 2009 to prevent the loss of 95,000 agricultural jobs and economic losses of up to $3 billion for the year.[214] California is also exposed to extreme coastal storms which could affect some 480,000 people and cause damage to homes, businesses, power plants, ports, and airports estimated at over $100 billion over the next year.[215]

Australia is perhaps the developed nation most vulnerable to the direct impacts of climate change and also to the indirect impact from neighbouring countries that are stressed by climate change.[46] Temperature has increased by three-quarters of a degree Celsius in the past 15 years in Australia and rainfall has decreased — leading to water scarcity and drought.[216] The multi-year drought since 2001 in South-eastern Australia is the worst in the country's recorded history.[216] It is estimated that GDP was reduced by 1 percent in 2002-2003 as a result, claiming 100,000 jobs.[217] In 2003, grain output decreased by 50 percent, millions of sheep and cattle died and over 80 percent of dairy farmers were impacted.[217] Partly due to the same multi-year drought, wheat prices in Australia jumped 42 percent from 2007 to 2008.[218]

Development goals and humanitarian relief at risk

Climate change significantly impacts the international community's development assistance and humanitarian relief efforts. The human impact of climate change is expected to have a real cost both in terms of lost progress towards development goals and increased costs of assistance.

> "Environmental sustainability is central to the Millennium Development Goals. MDG-7 includes a call to 'integrate the principles of sustainable development into country policies and programs and reverse the loss of environmental resources'."
>
> Jeffrey Sachs — Director, The Earth Institute, Columbia University , New York; Quetelet Professor of Sustainable Development and of Health Policy and Management, Columbia University; Special Adviser to the UN Secretary-General on the Millennium Development Goals

Climate change threatens sustainable development, especially the Millennium Development Goals (MDGs)

Climate change slows — and in the worst cases reverses — progress made in fighting poverty and diseases. Unless adaptation to climate change is funded through additional channels, the growing impact of climate change is expected to consume an increasing share of development aid. In fact, the OECD estimates that as much as 50 percent of development assistance is exposed to climate risks.[219] Official development assistance alone amounted to $120 billion in 2008. This amount is already insufficient to reach international development goals and the exposure to climate risks further threatens its value.

The incremental risks associated with climate change increase the costs of achieving flagship human development goals like reduced childhood mortality and improved nutrition. Climate change may be particularly detrimental to development assistance for the world's most vulnerable groups and communities.

Climate change poses a threat to all of the eight Millennium Development Goals. For example, the impact of climate change on poverty, access to natural resources such as water, and diseases such as malaria have direct implications for the achievement of several of the MDGs. These goals represent the commitment of the international community to reducing extreme poverty. They were adopted as the United Nations Millennium Declaration in September 2000 by United Nations member states and leading development institutions. The declaration set out a series of time-bound targets — the Millennium Development Goals with a deadline of 2015 — such as halving the levels of world hunger and poverty. Figure 13 lists some of the most important areas where climate change may work against reaching these goals.

Figure 13 — Threats to Millennium Development Goals due to climate change

MDGs	Threat to MDGs
Goal 1: Eradicate extreme hunger and poverty	• More frequent and intense weather-related disasters threaten livelihoods, regional food security is undermined and vulnerability of poor people increases • Water scarcity further aggravates the problem as vase amount of fresh water is required to half hunger. • Without the effects of climate change, about 10 million fewer people would live in poverty today. • The number of malnourished is expected to increase due to climate change.
Goal 2: Achieve universal primary education	• Loss of livelihoods means more children will be engaged in income-earning activities and the displacement and migration of families will make education a low priority. • Infrastructure, such as schools are destroyed. For example, in 1998, Hurricane Mitch destroyed one-quarter of all of Honduras' schools.
Goal 3: Promote gender equality	• Women make up two-thirds of world's poor and are more adversely impacted by disasters. • Additional burdens are placed on women's health as additional work and chores increase stress levels
Goals 4, 5, and 6: Reduce child mortality, improve maternal health and combat HIV/AIDS, malaria and other diseases	• Women and children are particularly vulnerable to extreme weather events. For example, 90 percent of victims in the cyclone in Bangladesh in 1991 were women and children. • Children and pregnant women are particularly susceptible to vector- and water-borne diseases, malnutrition and diarrhoea, all of which are expected to grow due to climate change. About 90 percent of the deaths occur in children under 5.
Goal 7: Ensure environmental sustainability	• Climate change causes fundamental alterations in ecosystems, such as losses of coral reefs, for example • Climate change has reduced biodiversity. IPCC estimates that 20-30 percent of global species are likely to be at risk of extinction this century. • Climate change changes the quality and quantity of natural resources. For example, 20 million people in six countries in West and Central Africa rely on Lake Chad for water, but the lake has shrunk by 95 percent in the last 38 years.
Goal 8: Develop a global partnership for development	• Investment in adaptation and mitigation is crucial and requires close cooperation and coordination. • The lack of adequate investment for adaptation acts as a significant drag on humanitarian assistance and development.

Cost of humanitarian relief is expected to grow exponentially in the next 20 years

Climate change also threatens the ability of the international community to deliver humanitarian relief. The financial requirements for humanitarian assistance are projected to increase by up to 1600 percent over the next 20 years, in large part due to climate change.[28] Already today, the funds available for disaster preparedness and disaster relief are inadequate. Bilateral funds for disaster relief amount to less than $10 billion per year,[220] leaving many disasters with little or no support.

Only a very small proportion of global humanitarian assistance goes into disaster preparedness even though this is a crucial and worthwhile investment. Some experts estimate that for every dollar invested in disaster preparedness, six dollars could be saved in reconstruction costs.[221] Ultimately, the ability of individual households to protect themselves against the physical and economic shocks of disaster is the best way to assure survival.

Costs of adaptation to climate change

Climate adaptation refers to individual or governmental action to reduce present adverse effects or future risks of climate change. This activity will be critical to coping with the human impact of climate change in the future. However, to date, investments have been very limited.

Many new plans and adaptation projects in developed countries

Many developed nations have already realized that ignoring climate change is too costly and is taking action by means of insurance solutions and state funding. Here are some recent prominent examples:

- The Netherlands has an overall budget of $3 billion to protect against flooding.[36]
- Australia is investing more than $13 billion[222] to counter the impact of climate change.[223]
- The UK government is discussing whether to invest $42 billion to upgrade the Thames Flood Barrier to protect London from rising sea levels.[223]
- On the US California coastline, a $14 billion investment topped up with annual maintenance fees of $1.5 billion is suggested to combat climate change related to sea level rise and increased storms to shore up levees and build sea walls.[215]

Adaptation needs to be scaled up 100 times to avert worst outcomes

Developing nations have also realized the enormity of the climate change challenge, but the commitments to invest funds in climate adaptation in developing countries amount to very little. The multilateral funds that have been pledged for climate change adaptation across developing countries currently amount to about $400 million.[226] This amount is less than the German state of Baden-Württemberg is planning to spend on strengthening flood defense.[36] The funds needed for adaptation in developing countries stand in sharp contrast to this current level of commitment. Experts and aid agencies estimate that the true cost of adaptation in developing countries ranges from $4 to $86 billion annually[225] with an average of $32 billion annually.[36,52] The African Group, comprising more than 50

nations, has estimated that $67 billion is needed annually from 2020 onwards for adaptation efforts in developing countries like building stronger defenses against rising sea levels and developing drought-resistant crops.[226] It is important to note that adaptation financing estimates are supplemental to existing overseas development aid needs related to broader sustainable development and mitigation efforts. For example, African nations further project that $200 billion annually is necessary to curb rising greenhouse gases by improving energy efficiency and switching to renewable energy sources each year from 2020 onwards.[226] While these costs are high, the cost of adaptation is far less than the cost of inaction. The Stern Report estimated the cost of ignoring climate change at more than that of the two World Wars and the Great Depression, or 5-20 percent of GDP.[44]

There are a few cases that provide a glimmer of hope. The United Nations Framework Convention on Climate Change's National Adaptation Programmes of Action provides a process for Least Developed Countries to identify priority climate change adaptation activities.[227] Samoa has been hailed for their 2005 NAPA and implementation efforts — expected to cost $2 million, aimed at reducing vulnerability to increase resilience through close collaboration with local communities.[228] As over 70 percent of Samoa's population and infrastructure are located in low-lying coastal zones, Samoan focus areas include: coastal ecosystems, coastal protection, community water supply, forests, health and climate related diseases, early warning systems, agriculture, and disaster risk reduction.

Bangladesh is an example of a state that has successfully invested in disaster preparedness to reduce the detrimental impacts of climate related disasters. It is among the countries most naturally vulnerable to climate change but numerous steps have been taken over the past few years to become better prepared, and thus, less vulnerable. Efforts have paid off — Cyclone Sidr hit the low lying, densely populated coastal areas of Bangladesh in 2007, but disaster preparation measures such as early warning systems and storm-proof houses kept the death toll to 3,400 and limited the economic damages to $1.6 billion.[229] In comparison, the highly populated delta region of the Ayeyarwady River in Myanmar was not prepared for Hurricane Nargis in 2008 and the human consequences were over forty times greater — 146,000 people died, over 2 million people became homeless and damages equalled around $4 billion.[230] In August 2005, Hurricane Katrina caught many in New Orleans by surprise and caused damage in the range of $100 billion.[62,63]

> "Climate change impacts are affecting the poorest groups of people the most, so building resilience through community-based adaptation in vulnerable and poor communities is crucial."
>
> Saleemul Huq — Senior Fellow, Climate Change,
> International Institute for Environment and Development (IIED), London

Climate Impact Witness

Pablo Huerta Mandez, Peru is a farmer on the Andean slopes. To make better use of its limited water supply, the community has built a concrete reservoir costing USD 1,500. With this, and a new drip irrigation system, they use 1/7 of the water they used to.

"But it barely rains, now. Year by year it's less and less. I've farmed here for 10 years and there is more heat, which affects the plants and causes plagues. If the weather continues like this, maybe people will only be able to cultivate half their land. The flow might decrease, and water might dry out because of the heat. We're very worried about climate change. The drip irrigation is very useful, and more profitable. It prevents erosion, and we have seen an improvement in our crops. We have a better income and larger harvests."

It is this more efficient use of water which is helping farmers cope with less water, and which farmers across Peru will need to adopt as the impact of climate change becomes increasingly apparent.

Source: Oxfam

Case Study

Mali — Building adaptive capacity brings hope to a vulnerable drought-ridden nation

Mali is a drought-ridden, semi-arid Western African nation with high agricultural dependence[231] — a country highly vulnerable to climate change.[223,233] Home to some 12 million people, agriculture and livestock generate approximately 40 percent of GDP in Mali and employ over 50 percent of the workforce.[232] Despite being one of Africa's major cotton exporters, Mali is one of the world's poorest nations as approximately two-thirds of its population lives below the poverty line.[234,235]

In the 1970s Mali's economy was severely impacted by frequent droughts resulting in heavy agricultural losses and negative impacts on livestock and human health.[233] In response, a regional program was launched to combat drought by strengthening weather and water services by enhancing weather collection, local training and telecommunication capacity.[236] Weather, crop and water data is collected, processed and used to create weather bulletins which are then disseminated in the community via radio, newspapers and television.[232,233] These notices relay early warning information on rainfall, pestilences and disease, along with advice on optimal timing for planting, crop selection, fertilizer application, etc.

The results have been hugely successful as food security has increased substantially. Since this program's inception, yield has increased by approximately 20 percent and replanting has decreased from 40 percent to 5 percent.[233] The cotton industry saved millions of dollars from advanced warning of out-of-season rainfall in 2002 alone.[233] Addition social benefits include reduced rural to urban migration and more effective use of pesticides. Adaptive capacity has thus been tremendously strengthened by combining indigenous knowledge and coping capacity with weather information, technology and training.[237]

Key Sources: AGRHYMET and UNFCCC

Case Study

Arctic communities — "Canary in the coalmine" and climate change adaptation

While global leaders debate how to reduce emissions and some still question if climate change is real, hundreds of thousands of indigenous people in the Arctic must draw on ancestral resilience to adapt to climate change in a rapidly changing world.[238,239] The 600 residents of Shishmaref located on a small Alaskan island have witnessed it creep into every aspect of daily life, as rising seas and fierce ocean-based storms have eroded land beneath their homes and ice has become softer making every day activities like travel, hunting and fishing perilous.[240,241] Shishmaref residents have raised awareness of their town's plight, but their predicament is far from unique as nearly 90 percent of Alaska's 213 indigenous villages could face similar challenges in the near future due to habitual flooding and erosion.[242] The voices from the Arctic sound an early warning of larger global changes in the near future — the canary in the coalmine.

The Alaskan government has acknowledged that the impacts of climate warming in Alaska are already felt — including coastal erosion, increased storm effects, sea ice retreat and permafrost melt.[243] A state-wide Climate Change Sub-Cabinet was formed in 2007 to build knowledge and develop comprehensive adaptation policies. The citizens of Shishmaref are taking a lead role in adaptation and have already begun relocation plans as staying on the island has been deemed to be too risky — the cost is estimated at $180 million.[240] Over 160 additional Alaskan rural communities have been identified to be at risk of serious erosion.[243] Emergency action plans are being developed, shoreline defenses are being erected, and increased coordination between local, state and national efforts are underway.

The interconnectivity of man and nature is something that indigenous people have long understood and a key element of successfully adaptation to a rapidly changing environment. For example, as ice becomes less stable due to a warming climate, traditional dogsleds able to sense when a path is unsafe may provide a safer alternative to snowmobiles.[244] Indigenous people comprising about 6 percent of the global population thus have a powerful role to play in a warming world as native traditions can provide useful tools to adapt to climate change.[244]

Key Sources: Shishmaref Alaska Erosion and Relocation Coalition, Alaskan government and UNESCO

The link between adaptation, sustainable development and disaster risk reduction

Integrating strategies — Mutually reinforcing versus mutually destructive

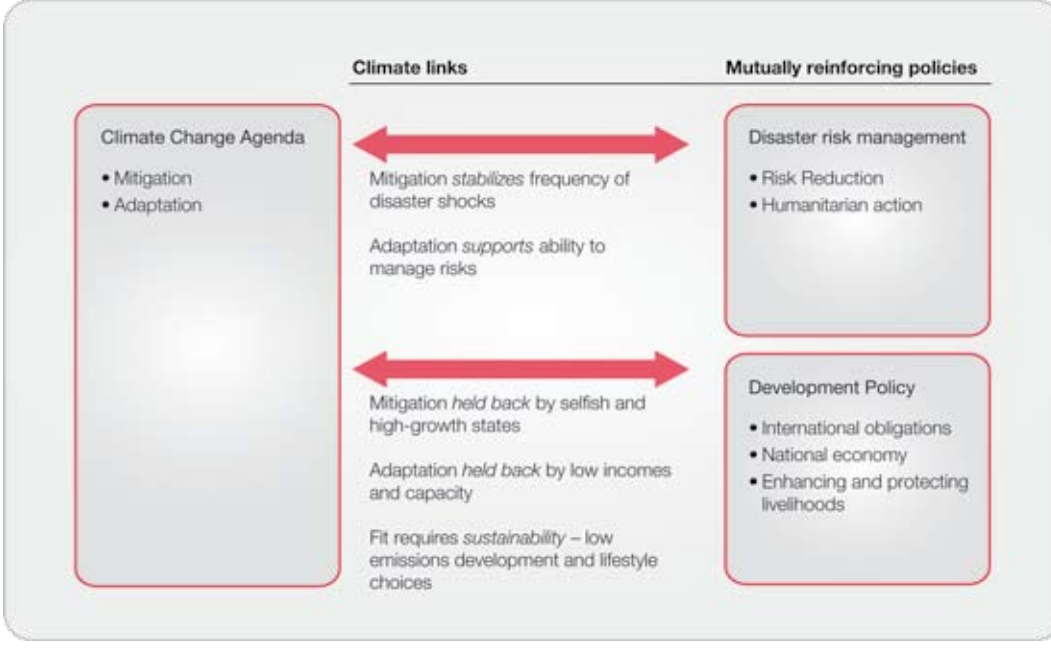
There are significant benefits to incorporating climate adaptation in development planning. When development programmes help build resilience and reduce vulnerability to climate change it reinforces the objectives of long term poverty reduction. For example, the government in the Pacific Ocean island of Kiribati has worked with donors to integrate climate change risk assessments of sea level rise and storms into national planning, working through high-level ministerial committees.[245] Such efforts are also urgently needed in the Himalayas where there is a close link between rising temperatures and the melting glaciers that increase the risk catastrophic flooding. Such floods are especially dangerous because they can occur with no advance warning. A range of development activities, from the design of hydropower facilities to an overhaul of rural development and settlement policies, are needed to adapt to such impacts.[245] In the area of rural development, agricultural planning and crop choice are critical to reduce vulnerability to climate change. In Africa over 90 percent of farmers are small scale and about 65 percent[246] of the population have agriculture as their primary source of income — a sector that is very vulnerable to climate change.[246]

> "I have seen, first hand, in growing numbers of natural disasters the following bitter, heartbreaking reality: those who now struggle hardest to survive did nothing to cause climate change, whereas we in the industrialized North who polluted the most are affected the least. We have a moral obligation to make it right by investing massively in the survival of the most vulnerable"
>
> Jan Egeland — Director, Norwegian Institute of International Affairs; UN Under-Secretary-General for Humanitarian Affairs and Emergency Relief Coordinator (2003-2006)

Climate adaptation also offers significant benefits in promoting disaster preparedness. The longer term development prospects of communities hit by natural disasters depend crucially on their capacity to cope with emergencies. This is both the case for disaster risk reduction and post disaster relief. An example of this would be supporting island states in the Caribbean to prepare for more severe and frequency hurricanes. There is a range of interventions that can contribute to this, including early warning systems, evacuation plans, hurricane shelters and construction guidelines to "hurricane proof" houses. Local knowledge can guide building of relatively low cost, traditional wooden houses that are better able to withstand hurricanes, if built correctly. The Mainstreaming Adaptation to Climate Change programme in the Caribbean was initiated in 2002 to promote integration of adaptation and climate risk management strategies into water resource management, tourism, fisheries, agriculture and other areas.[36] The programme is linked explicitly to the Millennium Development Goals and brings together a range of previously fragmented activities.[245]

The figure below illustrates how the climate change adaptation and mitigation agenda, disaster management, and national development policy all reinforce each other. As can be seen, there are both positive and negative influences from one to the other, evidence of the need to coordinate such measures.

Figure 14 — Climate change agenda linked to disaster and development policies



Source: Adapted from Schipper and Pelling 2006; GECHS: "Disaster Risk Reduction, Climate Change Adaptation and Human Security", 2008

Links neglected between adaptation, development and risk reduction[36]

There are many and very substantial barriers to effective introduction of adaptation strategies. Adaptation, development assistance and disaster risk reduction have similar objectives and face similar challenges.[219] But these different areas of activity have historically been regarded and financed separately. Cooperation can be challenging.

In most countries adaptation is not treated as an integral part of national programmes, even in areas heavily impacted by climate change like health and agriculture. A significant proportion of development aid is directed at activities potentially affected by climate change. But often little or no attention is paid to the impact of climate change — even in climate sensitive sectors. Good policies must more effectively link to the climate change agenda — whether it is taking into account future stream flow when building a bridge in Nepal or investing in health system strengthening in Ethiopia without considering how climate change affects mosquito breeding and malaria risk. The OECD estimates that 17-34 percent of development aid investment goes into sectors at risk of climate change impacts without addressing climate change issues.[36] In some countries such as Nepal, the figure is higher than 50 percent.[245] Analysis of government plans and strategies in climate-sensitive sectors indicates that such documents generally pay little or no attention to climate change.[247,248,249,250] Even when climate change is mentioned, guidance on how to account for it is generally lacking.[245]

There are several structural and practical reasons why mainstreaming climate adaptation within development activities has been difficult.[245] One explanation of the difficulty in promoting climate adaptation in national programmes is that climate change expertise is still mostly the domain of environmental departments in government and donor agencies. When these experts have limited influence on government priorities and input into sector guidelines and programmes, climate remains a secondary concern. Add to this a lack of hard data and the general difficulties in promoting preventative measures directed at probable but not certain events — and promotion of climate adaptation becomes a formidable task.

Climate adaptation activities also have to navigate fragmentation between the agencies that provide humanitarian assistance and those that are more concerned with a longer term development agenda. As these are often different institutions, knowledge centres and funding mechanisms, the common risk management agenda can easily be ignored.[248] The consequence can be that climate adaptation activities struggle to strike the balance between long term and short term objectives. For example, there are concerns that the widely promoted adaptation measure of switching to drought-resistant seeds cause increased malnutrition if the new crops provide fewer nutrients. Development projects to build human settlements in mangrove areas can increase exposure to climate change. On the other hand, development projects that build water cisterns for storage and drainage runoff systems can be effective at reducing climate risks but are not identified as investments in risk reduction and adaptation.

5 Conclusion

Walter Fust, CEO/Director-General, Global Humanitarian Forum

An opportunity for change

Kofi Annan spoke of the need for international solidarity for a just deal in Copenhagen. The necessity for such a deal is as unequivocal as the change in the global climate system itself. However, since we imply the restructuring of an entire global economy along a low-carbon path, we cannot avoid long-term timescales. Even an ambitious agreement will have trouble reducing the growth in greenhouse gas emissions causing climate change prior to 2020. That means the world must brace for more severe climate change and more severe impacts of that change. The international community is already struggling to deal with its vast humanitarian mandate just as the world's poorest groups are already struggling to survive. How can we bear more?

Climate change needs to be seen as an opportunity. The scale of the problem at hand, and the urgency with which we must tackle it, is precisely the opportunity to galvanize calls for reform and innovation. We need to question the capacity of the entire system with which we plan to respond to climate change, and the slow and abrupt disasters it causes.

Preparing for greater climate impacts

Given the staggering account laid out in this report, the desperate urgency of Copenhagen has never been more apparent.

Copenhagen is set to address the global situation post-2012. Before then, and after then, we are only predicting expansion of emissions, at least for a number of years. Copenhagen will have to enact a full circle change in the direction of human activities in a space of less than ten years, and bring human society to less than 20 percent of current emissions in less than forty years. An extremely ambitious project given the entire planet is involved, including all of the major economies of the world If Copenhagen fails totally or is postponed, the level of ambition will only increase because we cannot push back the date for contracting emissions. Since a high ambition climate deal in Copenhagen is already going to be a major challenge, it is clear that Copenhagen could well be the last chance for avoiding global catastrophe. Yet the earth's atmosphere will increase in temperature to very close to two degrees regardless of how ambitious Copenhagen is. The impacts associated with 0.74 degrees of warming today — the widespread suffering accounted for in this report — would pale in comparison to the devastation of two degrees. No matter what, therefore, the suffering documented in this report is only the beginning.

It can be said that climate change is the antithesis of sustainable development. Sustainable development aims at increasing economic prosperity, safeguarding the environment and improving social equity. As it stands, climate change will impact heavily on the economy — the per year equivalent of the GDP of three quarters of the world's countries already today, according to this report — and is causing millions of people to enter poverty once more. It will cause massive degradation to the environment and human habitat worldwide, including glacial and ice-cap melting, desertification, coastal flooding and soil salination, in addition to much, much more.

Above all, climate change affects the world's poorest first and foremost. 99 percent of all casualties occur in developing countries. The billions already living on the edge of survival have nowhere to turn when climate change levels its additional burden. Social impacts are diffuse and diverse, people living on two meals a day may be forced to get by on one, basic nutrition or health care are neglected, children may be taken out of school, or women forced into prostitution. In sum, social inequities will become entrenched globally. So climate change undermines the key principles of sustainable development, constituting a serious threat to socio-economic progress worldwide.

Redefining sustainable development

Nevertheless, it is entirely possible to improve the ability of communities to cope with these changes, and take preventative measures that minimize if not avert disasters. The trouble is the scale and scope of the challenge, and the architecture and financial means available to the broader humanitarian community for addressing these concerns.

Since climate change will only intensify, it is imperative that the concept of sustainable development as we know it today is redefined. Resilience in the face of climate change must be added as an additional pillar to the concept of sustainable development. Development must not only be sustainable, but also climate-proof. That redefinition will not come for free. Substantial resources must be spent on adaptation to climate change. But these resources will safeguard past investments in development that have been sourced over decades mainly from public coffers. Much of this public money is at great risk today.

There are many reasons why a comprehensive report on the human impact of climate change is only available in mid-2009. Our lack of ability to understand and account for the risks mirrors our inability to analyze threats and map these same risks. Climate change is shifting the ground from underneath us. Farmers who once relied on traditional knowledge, handed down over generations, for choosing when to plant and when to harvest are now at the mercy of erratic rainfall patterns or dry spells. Floods follow droughts follow floods. And while climate change benefits from the world's largest scientific body, the Intergovernmental Panel on Climate Change, our understanding of the impacts is still limited. Phenomenal gaps in research exist. Climate change was always considered a theoretical future problem, until now. In which directions will the deserts expand? At what point will sea-level rise cause salt to permeate the soil destroying its natural fertility? We cannot answer these questions, and yet we must if we are to plan ahead and minimize suffering.

So while this report is based on the best available scientific evidence, its estimative nature in a number of respects mean that it cannot possibly comply in all regards with the rigours of full-scale scientific enquiry. But we have to begin to piece together the information available to us into a plausible narrative of what is actually occurring. If we continue to ignore the trends, we will only find ourselves ill-prepared. That would be a terrible error in judgement, given that this report suggests that we are clearly dealing with the single greatest emerging humanitarian threat ever encountered.

Integrating humanitarian and development work

While this knowledge is the basis of all effective policies, that is only the beginning of the challenge. The policies themselves demand adequate financial means in order to be realized. That also requires the greatest urgency, given the half a billion people who live at extreme risk today — a number set to increase substantially in coming years.

Part of a redefinition of development must include an integration of development and humanitarian efforts. The humanitarians and the development actors must conduct risk analysis together. Prevention and preparedness needs to take into account the socio-economic, cultural and environmental parameters of each community affected. Both groups also need to undertake serious capacity-building within their institutions in order to ready for greater climate shocks, to better manage risks rather than continually operating in reaction mode, and to prepare for working together to tackle climate change. All actors must innovate and drive for effective solutions rather than administering concerns.

Investment in prevention is also critical no matter where the resources are drawn from. There is a complementarity between multi-lateral and bi-lateral approaches to aid work. Discussions about which is more effective will take us nowhere. Both will be needed, and the combination must be extremely well coordinated. We can better spend the over 100 billion dollars of Official Development Assistance (ODA), in ways that will minimize the 125 billion dollars of annual losses indicated by this report as a consequence of climate change.

Humanitarian actors have a great interest in preventative work since the alternative is an increasing number of humanitarian disasters. While development actors have an incentive to protect past efforts already damaged or at risk. Unfortunately, prevention continues to be difficult to sell. People continue only to react to disasters and lack the political foresight to invest in prevention. We can do better if we fuse the two systems of actors. Today there are separate institutional, budgetary and governance structures for development and humanitarian work. This hinders rapid-reaction and the evolution of priorities to overcome new, emerging and growing challenges. Integration would dramatically increase flexibility in facing increasingly complex and multiple stress situations that blur the boundaries between relief and development.

Beyond the Paris Declaration

All actors involved in efforts to improve the state of the world must endeavour to go beyond the 2005 Paris Declaration of Aid Effectiveness, towards a true integration of efforts. Again, multilateral and bilateral approaches are complementary and should not polarize. Otherwise the international community and local actors stand no chance in dealing with the additional burdens of climate change. And while adaptation can safeguard ODA, greatly minimizing the threat on investments, it should not be derived from ODA. ODA still falls far short of the 0.7 percent of GDP promise. Further reducing that margin by attributing a proportion of the money currently allocated towards adaptation would cause internationally recognized development goals to suffer another setback. Even as in some regions, such as Sub-Saharan Africa, we are clearly not meeting our targets, particularly for the Millennium Development Goals. The international community would simply be committing itself to not fulfilling long-standing promises once more. There has to be a substantial additionality of financial means for adaptation.

It is crucial that climate change adaptation also ranks in the first 3-5 priorities of National Poverty Reduction Strategies, so as to ensure adequate attention from donors. But the whole framework needs to be expanded for adaptation needs. Local development of Strategies and National Adaptation Programmes for Action requires additional funds, and should include full community participation.

Equitable climate policies

The poorest countries also require additional capacity in order to attract investment, public and private. Emissions transfer schemes, such as the Clean Development Mechanism, continue to benefit mainly emerging economies, where the need for new jobs, technology and investment is not as great. These schemes should not be linked to national economic interests, and corporate supply chains. Such linkages create effectively another form of tied aid. It has to be untied and remain untied with respect to economic and other interests. Copenhagen has a clear mandate to fill the shortfall in additional financing, providing for adaptation, including reliable assistance to those countries worst affected. In order to reorganize the global economy towards a low-carbon path, Copenhagen is likely to generate some sort of global pricing system on emissions. It must go for mechanisms and sanctions, including a globally accepted solution on taxing CO_2.It is imperative, however, that the effects of such a pricing system do not create yet another burden for the poor. What will effectively act as a global price on carbon, will also act as a regressive tax, similar to value-added taxes, since the additional costs of pollution will eventually be passed on to consumers. The increased costs will have the greatest effect on the world's poorest groups, where individuals will have to forgo a larger proportion of their income otherwise spend on basic nutrition and health needs. Any climate policy must also compensate for these effects through financial redistribution, or risk further exacerbating inequities yet again.

Multiple responses to climate and energy policies

Technology transfer for adaptation as well as clean development is also key. Energy poverty afflicts close to one third of the population of this planet, who benefit from no form of modern energy supply whatsoever — instead relying on the burning of soot and dung. This has huge ramifications for human health, triggering respiratory diseases over time, as well as carbon emissions. Providing decentralized renewable energy for the poor would be a revolution. It would lead to a rapid contribution to reducing emissions — up to 18 percent of warming being due to black carbon from soot. It would bring modern energy to places far beyond the existing grid and likely energize the Millennium Development Goals. The benefits would be of particular importance to women and children, who spend hours of their day gathering firewood, often at great risk, and inhaling hazardous smoke while cooking. It will also be necessary to revisit the research agenda to provide access to suitable technologies beyond wealthy countries. There is, for instance, no reason why research undertaken in developed countries using public money could not be made accessible to everyone.

Dealing with mass displacement of people

If we do not act, ultimately, people will either die or they will move. Millions of people are already on the move today because of climate change. What are termed here Climate Displaced People are often difficult to identify down to the individual. Climate change is a generalized phenomenon. It is rare that an impact, such as a storm or a flood, can be entirely blamed on climate change. Most low-elevation territory is reclaimed through a combination of sea-level rise and ordinary geological subsidence, although climate change greatly accelerates this process. So if a cyclone hits, it would be impossible to say if one particular individual is a climate displaced person or not. This report attributes 40 percent of extreme weather-related events to climate change, based on their steady increase over the last 30 years. That itself is an average, which would vary greatly from situation to situation, if applicable at all to that specific a level. But globally we can say with some degree of confidence that around 40 percent of those displaced because of extreme weather events are in fact Climate Displaced People. We count over 26 million Climate Displaced People today. That is likely to triple by the 2020s. It does not, however, include those economic migrants who might also be attributed to climate change, since varied climate shocks can and do act as drivers of such migration. There is little protection or assistance available under international law today for these vast numbers of people. In fact, the international community struggles with existing populations of Internally Displaced People and official Refugees. Protection for Climate Displaced People is particularly weak when the crossing of national borders is involved. They will also encounter legal lacunas, such as when a low-elevation state is entirely submerged by rising-seas. These shortcomings will soon become crippling for the international community, given the sheer numbers of people involved.

A strengthened global community

There is a particular need today for a new solidarity around the concept of climate justice. Every person on this planet has a number of reasons to call for climate justice. Action to tackle climate change and protect those people and communities most at risk is overdue — as told by the story of this silent crisis. Climate change should not be allowed to become another social ill we oblige ourselves to be accustomed to, if simply because it will intensify so quickly that the international community risks being completely unarmed and overwhelmed.

We cannot ignore the stark truth that the poor are suffering the brunt of a problem they have not caused. And we cannot turn a blind eye to the suffering we are accepting on behalf of our children and grandchildren if we do not act, — suffering we would not stand for ourselves. We must have a global deal that will prevent catastrophe, and protect lives and investments already at extreme risk. In the interim, however, climate change will intensify, and all efforts will be needed to prepare the broader humanitarian community for the more severe impacts of climate change that we no longer have the power to avert.

The Global Humanitarian Forum itself, who is at the origin of this report, strives to establish a stronger community of actors from across the global society. It aims, in particular, to bring together stakeholders from different sub-communities to better deal with key humanitarian concerns, including climate change.

The unique challenge of climate change requires a unique response which is itself an opportunity for integrating a fragmented international humanitarian and development system. That endeavour will should not only enable us to better combat climate change, but also to reap benefits that will ring true for wideranging humanitarian challenges of today and tomorrow.

Notes on report methodology

A. Overall framework — Definitions and section guide

Types of Climate Change	Description	Climate Change attribution	Indicator:		
			Affected	Deaths	Economic losses
Weather-related disasters	Droughts, floods, extreme temperature events, cyclones	Percentage of weather-related disasters that can be attributed to climate change	People requiring immediate assistance during a period of emergency; it can also include displaced or evacuated people	Annual deaths from weather disasters due to climate change	Benefits — costs of climate change in a given year
		EXPLAINED IN SECTION B			
Gradual environmental degradation	Sea level rise, desertification, salinization	Percentage of burden that can be attributed to climate change	People temporarily or permanently compromised in their livelihood because of hunger, lack of access to fresh water, poverty, disease, displacement, or conflict	Annual deaths related to gradual environmental degradation due to climate change	
			EXPLAINED IN SECTION C		EXPLAINED IN SECTION D

B. Attribution of weather-related disasters to climate change

Basic reasoning behind methodology

The frequency and intensity of weather-related disasters is often associated with climate change in public debate and common perceptions. In its Fourth Assessment Report, the IPCC found that weather patterns have become more extreme, with more frequent and more intense rainfall events, more intense heat waves and prolonged droughts. However, there is not yet any widely accepted global estimate of the share of weather-related disasters that are attributable to climate change. A range of regional studies will be discussed at the end of this section; but these are hard to generalize to the global level. While there are many connections between physical linkages from the physical changes caused by climate change to weather-related disasters, there are also significant challenges in estimating the attribution. First of all, natural variability and socio-economic factors have an impact on the frequency and scale of natural disasters. This means that the increase in weather-related disasters over the past decades cannot be entirely attributed to climate change.

The attribution estimates in the Human Impact Report rely on a simple but powerful approach to separating climate change from factors not related to climate change. The natural variability of disasters is best taken into account by considering as long a period of available reliable data as possible. Factors other than natural variability are also considered. Geophysical disasters, such as earthquakes, are also subject to natural variability but they are clearly not impacted by the climate. The trend in such disasters can be considered as a proxy for factors not related to climate, for example the quality of monitoring of disasters. A comparison of the trend in weather-related disasters to the trend geophysical disasters can provide an indication of the share of weather-related disasters attributable to climate change. If climate change is causing an increase in weather-related disasters we would expect the trend in weather-related disasters to exceed the trend in geophysical disasters.

Approach applied

The approach of comparing the trends in weather-related and geophysical disasters is based on an analysis of loss-generating events in the publication Journal of Flood Risk.[5] The article states that by “Assuming the socio-economic driving factors behind loss-generating events to be the same for all causes, the difference is likely to be due to climate change”. The validity of the approach has been reviewed with a number of experts. While it is a rough approach, particularly on shorter time series, it is seen as comparatively strong. Alternative analyses of number of affected, recorded losses of property and insured losses are associated with greater uncertainty than the frequency of events.

Key indicators

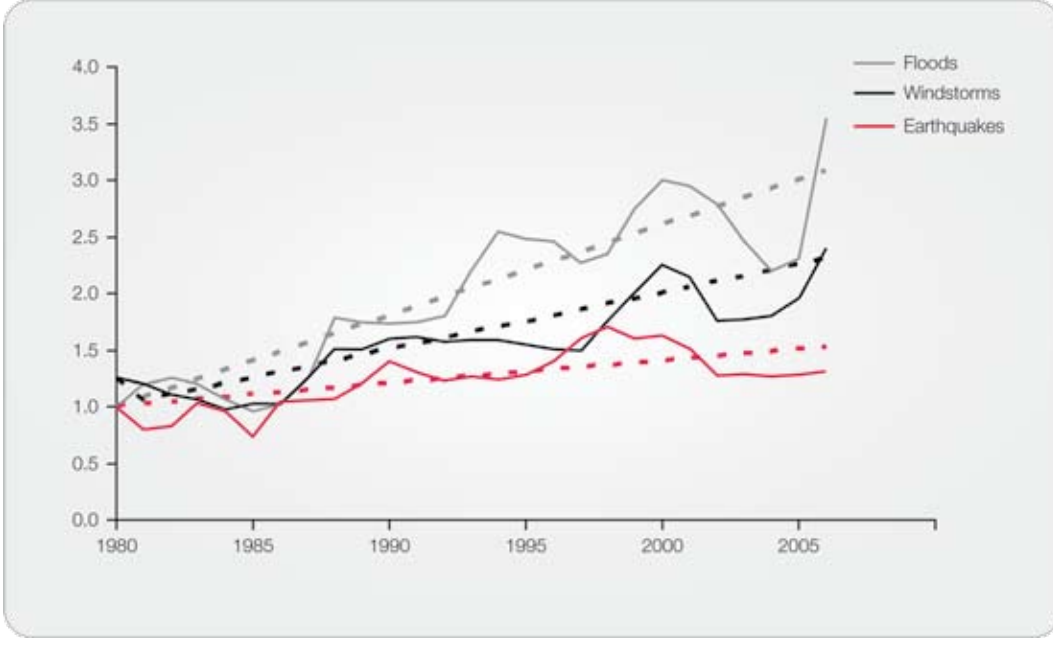
- Numbers of loss-generating events — floods, windstorms, earthquakes.
- Trend in loss-generating events — floods, windstorms, earthquakes.
- Share of weather-related disasters attributable to climate change.

Assumptions and calculations

- Calculations are performed on a data set with the recorded frequency of loss-generating events (natural disasters such as floods, windstorms, earthquakes).
- The analysis is performed on data provided by Munich Re in 2009. Replicating the analysis using the CRED database yields similar results.
- The time series is over the 25 years between 1980 and 2005 which is a period frequently chosen in analyses because there is robust data for this period and it is the period when it is assumed that climate change has started to have an impact. The IPCC suggests a very high likelihood of climate change since 1990 while individual studies have indicated points between 1960 and 1990. The analysis is not highly sensitive to changing the starting point by a few years.
- The number of disasters provide a good basis because there is a clear link between frequency of weather-related disasters and climate change, and data reliability is good.

The figure below provides an overview in the trends in different types of weather-related disasters between 1980 and 2005.

Relative number of loss events from floods, windstorms and earthquakes, 1980-2005



Source: Flood insurance from clients to global financial markets, W. Kron,Geo Risks Research, Munich Reinsurance Company, 2009.v

The share of weather-related disasters attributable to climate change in 2005 is calculated by comparing the number of weather-related disasters (floods and windstorms) with what the number would be if growth rate had been similar to earthquakes. The gap between the trend value for weather-related disasters and the trend value for earthquakes is attributed to climate change. For example, with 97 floods in 1980 and 307 percent growth over the period yields 298 floods in 2005. However, if the number wof floods had only increased at the rate of earthquakes, namely 152 percent, the predicted number of floods would only have been 148 floods in 2005. The difference, 150 floods, is attributed to climate change, a 50 percent attribution (i.e. 150/298). The full calculation is contained in the table below:

Resulting "attribution" estimates used in Human Impact Report

		Flood	Storm	Earthquake	**SUM OF FLOODS AND STORMS**
1980	in percent (normalized)	100%	100%	100%	
	Actual number of disasters	97	138	67	
2005	in %	307%	223%	152%	
	Number of disasters on trend line	297.79	307.74	101.84	605.53
"Attribution" estimate	Hypothetical value if trend had been like earthquake trend (no climate change scenario)	147.44	209.76	101.84	
	Difference (Trend line value — No climate change value)	150.35	97.98	0	248.33
	Estimated share of weather-related disasters attributable to climate change in 2005, percent	50.49	31.84	0.00%	**41.01%**

The resulting estimate is a 40 percent attribution of weather-related disasters to climate change in 2005. The corresponding attribution for 2030 is 50 percent.

The report applies the attribution of disasters to climate change in estimating numbers of people seriously affected by climate change, deaths and economic losses.

Resulting projections of "seriously affected" and "deaths" used in Human Impact Report

Year	Global attribution	Number of people affected	Number of deaths	Sources	Assumptions
2010	40 percent of weather-related disasters	87 million (40 percent of 219 million people affected on average between 2000 and 2008 by droughts, temperature extremes, floods, storms, wildfires)	14,500 (40 percent of 36,000 deaths on average between 2000 and 2008 due to droughts, temperature extremes, floods, storms, wildfire)	• Munich Re • Baines and others for comparison	No climate change before 1980 All non-climate change related factors are equally reflected in the geophysical trend The climate change attribution to the number of events can be used as a proxy for the attribution of climate change in terms of number of affected/ deaths/ economic losses
2030	50 percent of weather-related disasters	351 million (50 percent of 702 million people affected if we assume a 320 percent increase from today as in the latest Feinstein Center Report)	29,000 (50 percent of 58,000)	• Munich Re • Baines for comparison • Feinstein Center	See above Deaths increase only half as fast as the number of people affected

Validation and context

The attribution estimates compare well to the sectoral and regional estimates that have been published. For instance, Baines 2009 estimates that 37 percent of drought is due to climate change,[251] and Dorland et al.,[252] Leckebusch et al., 2007,[253] Hanson et al., 2004[254] come up with similar proportions for regional studies.

The assumption that the frequency of events translates into a proportional number of people affected and number of deaths may be viewed as conservative:

- The overall proportion of people affected by weather-related disasters is significantly greater than for earthquakes. The intensity of floods and storms may also increase due to climate change.
- A number of factors may worsen consequences of natural disasters independent of climate change. Some of these factors should affect the outcome of weather disasters but not geophysical disasters. Examples include: more people living in coastal regions exposed to hurricanes and cyclones; and more people live in conditions of poverty and among dense populations in communities with low resilience to the effects of disasters.

C. Gradual environmental degradation due to climate change

Basic reasoning

Gradual environmental degradation due to climate change has a range of human impacts, including water stress, food insecurity, poverty and displacement. Several of these are linked to measurable health outcomes. Some of these have been linked to the effects of climate change, particularly malnutrition, diarrhoea and malaria. It is these health outcomes that are used as the basis for estimating the human impact of climate change in terms of seriously affected and deaths. These are certainly not the only human impacts of gradual environmental degradation due to climate change but they represent a reliable starting point for estimation.

Poor health outcomes frequently have a dynamic effect by exacerbating other areas of human development, including poverty and security. These effects are difficult to measure and current scientific research does not do this in detail and reliably enough to apply in global estimates. It is evident that populations that are vulnerable to the human impact of climate change often live in regions that are already affected by general development challenges and often also complex emergencies.

Model and approach applied

The estimates used in the Human Impact Report of the health outcomes that can be attributed to gradual environmental degradation due to climate change are based on the Global Burden of Disease Study by the World Health Organization. The study uses existing models that describe observed relationships between climate variations, either over short time periods or between locations, and a series of health outcomes. These climate — health relationships are extrapolated and linked to climate change projections and compared to a 1961-1990 baseline, as the climate are assumed to be more significant after this period. This, in turn, allows for estimation of the likely future health consequences of gradual environmental degradation due to climate change.

The results of the study are presented in terms of climate change risk factors per region — i.e. the factor by which climate change is increasing the underlying disease burden. A risk factor of 4 percent means that 4 percent of the overall disease burden (total number of cases) can be attributed to climate change. The WHO model is widely regarded to be the only model that provides a global estimate of the impact of the health consequences of climate change. It is a widely acknowledged model, and during the course of consultations, a majority of experts have indicated this as the most reliable study.

Key indicators

- Climate change risk factor for malnutrition — i.e. the percentage by which climate change increases the risk of malnutrition
- Climate change risk factor for diarrhoea — i.e. the percentage by which climate change increases the risk of diarrhoea
- Climate change risk factor for malaria — i.e. the percentage by which climate change increases the risk of malaria

Assumptions and calculations

- The risk factors, which are computed for lives lost, are also applied for the number of people affected. The original study describes climate change induced disease burden in terms of number of lives lost and disability adjusted life years, (DALYs — a time-based measure combining years of life lost due to premature death and disability, see further details in Glossary). To estimate the number of people affected, this report applies the same risk factors to the number of people seriously affected by disease, such as people who contract malaria, people suffering from malnutrition, and the number of diarrhoea incidences.
- The total number affected is assumed to equal the number of cases in a given year. For each of the three health impacts, this means that: (1) The total number of people affected by malnutrition is assumed to be equal to the malnourishment cases over one year, (2) Recorded malaria cases are assumed to equal the total number affected by malaria each year, and (3) The number of people affected by diarrhoea is assumed to equal the diarrhoea incidence in a given year.
- Any overlaps, whereby the same individual suffers from multiple cases of diarrhoea or malaria (incidence equals the number of new cases per year) are not accounted for, as several cases can occur in one individual within a year. Reliable global data on the average number of cases in individuals is not available particularly for adult populations who are also significantly affected by these diseases. On the other hand, incidence does not take into account individuals who suffer from long term effects due to their illness. In general this leads to the conclusion that incidence is a better measure of those “affected” than alternatives like the number of deaths.
- Overlaps could also occur if an individual is afflicted by more than one of the three health impacts (malnutrition, diarrhoea or malaria) within a given year. Any overestimation that this may lead to is assumed to be offset by potential underreporting of overall disease levels, possible underestimation of climate change risk factors and having the health impacts account for all impacts of gradual environmental degradation.
- All health consequences measured refer to the gradual impact of climate change and no major additional gradual onset impacts are left out.
- The global disease burden is kept constant as it is assumed that future population growth will counteract intervention gains.
- The climate change scenario used is the mid range of the HadCM2 global climate model (i.e. one of several alternative global climate models) used previously by the IPCC.

Resulting "global burden" estimates used in Human Impact Report

		Global burden independent of climate change		Climate change risk factors, percent (range)	Climate change (Burden * Risk factor)		Assumptions
		Cases, million[21]	Deaths, million		Affected, million	Deaths, '000	
2010	Malnutrition	960	3.85	4- 5	45	154	Socio-economic adaptation reduces risk factors in developed countries
	Diarrhoea	4600	2.35	4	182	94	
	Malaria	247	1.35	4-4.5	11	54	
	TOTAL			**4-4.1**	**238**	**302**	
2030	Malnutrition	960	3.85	7-8	75	269.5	Biological adaptation only for extreme temperature events
	Diarrhoea	4600	2.35	4-5	216	94	
	Malaria	247	1.35	7.7-8	19	108	
	TOTAL			**5.3-6.2**	**310**	**471.5**	

D. Economic costs of climate change using updated Stern Model

Basic reasoning

Emission and climate change can be linked to economic effects but it requires a sophisticated and complex model. The most comprehensive such model is the so-called Stern Model (PAGE 2002) which uses emission scenarios to predict global greenhouse effects and counteracting cooling. The temperature effect of climate change by region is the difference between global warming and regional cooling. Based on regional temperature effects, the damages and benefits from warming are estimated for an economic and a non-economic sector. The net damage or benefit translates into regional income loss or benefit which is evaluated in terms of an annual percentage loss or benefit of income by region. Adaptation to climate change counteracts damage from warming and regional income loss.

Model and approach applied

PAGE 2002 is a consensus model which means that it seeks to rely on the best available scientific research and to ensure that the range of its variables is always within the bounds of existing studies. PAGE 2002 is one of very few attempts to estimate the global economic costs of climate change. The strong reputation it enjoys, its comprehensive structure, the consensus-driven nature and the ease with which assumptions can be updated in the model, make it the most suitable model to apply for estimates in the Human Impact Report.

The PAGE 2002 model is based on a top-down approach with the following key components:

- It relies on aggregate data on population and on economic growth for 8 regions in the world.
- The basic inputs include emissions policy, adaptation and mitigation scenarios.
- There is not a break-down per economic sector: The model does not give results for water or agriculture or other independent sectors.
- Impact in the model is the sum of three components: Economic loss, non-economic loss and cost of discontinuous events (i.e. tipping point events).

Key indicators

- Economic losses — i.e. benefits minus costs of climate change.
- Social cost of carbon — i.e. the monetary indicator of the global damage done over time by the emission of one extra ton of carbon today.
- Reduced growth rate — i.e. how much lower is GDP growth because of climate change.

Assumptions defined under expert guidance

For the purpose of the estimates for the Human Impact Report, a number of assumptions have been updated to reflect recent research findings. The original model dates back to 2002. The updating of assumptions has been carried out under the guidance of the expert who is in charge of PAGE 2002. The key assumptions include:

- Discount rate increased to [0, 0.75, 1.5] from a constant of 0.1 to lower discount impact (in line with recommendations by Prof. Hope).
- Increased equity weights to correct for income difference in developing countries. Therefore changed marginal utility to [0.5;1.25;2] from a constant of 1 (in line with recommendations by Prof. Hope, see Hepburn and Cameron).
- Updated tipping point scenarios to account for more realistic values: Threshold lowered to [1;3;6] degrees (from [2;5;8]). Risk increased to [10;20;30] percent (from [1;10;20]), Loss lowered to [1;5;10] of GDP (from [5;10, 20]) (in line with recommendations by Lenton and other tipping point experts).
- Assumed that no adaptation takes place before 2010 — changed value to 0 (in line with recommendations by Prof Hope).
- Weather-related disasters attributable to climate change are underrepresented in the model. We therefore changed the mean value of the impact of a 2.5 degree increase in temperature from 1.3 percent of GDP to 2.53 percent of GDP and set the Min value at 0.5 percent of GDP and the max at 2.53 percent. (Based on experts indications that the Min value was too low, and that extreme events were underrepresented in the model, found no indication that the Max value in the model was too high). See calculation below.

The A2 IPCC climate scenario was used for estimation. The A2 scenario is one of the more aggressive scenarios described in the model. The A2 storyline and scenario family describes a very heterogeneous world. The underlying theme is self-reliance and preservation of local identities. Fertility patterns across regions converge very slowly, which results in continuously increasing population. Economic development is primarily regionally oriented and per capita economic growth and technological change more fragmented and slower than other storylines. Temperature increase in the period 2090-2099 vs. 1980-1999 is assumed between 2 to 5.4 degrees Celsius with a likely value of 3.4 and sea level rise 0.23-0.51m.

Resulting "economic cost" estimates used in Human Impact Report

	Result 2010 – Mean	Result 2030 – Mean	Comment
Economic losses (from economic and non-economic sectors)	125.8 billion USD (90% confidence interval: 4.1, 951.1)	340.8 billion USD	Note that the PAGE 2002 model does not give a value for 2030 (value extrapolated from 2020)
Social cost of carbon	1.350 billion USD (300, 3450)	Not calculated	Note that the model output is the cost per tonne (this cost applied 2004 emissions level)
Reduced growth rate	0.23 percent of global GDP (90% confidence interval: 0.007, 1.73)	0.43 percent of global GDP	Note that the PAGE 2002 model does not give a value for 2030 (indication is average of 2020 and 2040 results)

Estimate of impact on poverty used in Human Impact Report

According to World Bank 2005 statistics, roughly 2.6 billion people live on less than $2 per day. Stern 'Economics of Climate Change',[44] indicates that experts have suggested a 2 percent poverty reduction for a 1 percent increase in GDP. Using this relationship, we assume that a 0.23 percent loss of global GDP results in a 0.46 percent increase in poverty that could otherwise have been averted. The same approach is used to estimate the value for 2030 with the additional assumption that the overall number of poor people stays constant.

Glossary and abbreviations

Glossary

Adaptation: In this report, adaptation refers to individual or governmental actions to reduce adverse effects or future risks associated with climate change. The IPCC defines adaptation as the "adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities."

Affected persons: Persons affected by climate change have seen their livelihoods compromised temporarily or permanently by climate change.

Attribution of climate change: Effort to scientifically ascertain mechanisms responsible for relatively recent changes observed in the Earth's climate, i.e. variations in temperature, weather-related disasters and disease levels. The dominant mechanisms include manmade activities which increase greenhouse gases, release aerosols, and cause land surface changes like deforestation.

Climate Change Vulnerability Indicator (CCVI): Developed by Maplecroft, the CCVI is an attempt to quantify and map vulnerability to the impacts of climate change at the sub-national level. 'Vulnerability' is defined as a combination of factors that influence the capacity of individuals, communities, economies and societies to reduce the risks from changes in patterns of natural hazards and impacts on ecosystem services as a result of climate change. The CCVI does not attempt to predict changes to patterns of natural hazards or ecosystems as a result of climate change. Six groups of climate change vulnerability factors make up the CCVI: economy; natural resources and ecosystems; poverty, development and health; agriculture; population, settlement and infrastructure; and institutions, governance and social capital. A sub-index was developed for each group and these were combined to form the CCVI. The natural resources and ecosystems and agriculture sub-indices are weighted twice as heavily as the others in the overall CCVI.

Climate Displaced People: Climate displaced people is the term used in this report describing people who predominantly involuntarily are forced to move or are displaced, either permanently or temporarily, because of climate change, through its impacts and shocks. It is possible to estimate the numbers of Climate Displaced People in global terms, since, for instance, a correlation can be made between the great increase in the number of severe weather events — much of which can be attributed to climate change — over the last decades, and the number of additional people that these events displace. It is, however, virtually impossible to single out individual people or even scenario specific situations as being attributable to climate change. This means that the definition of Climate Displaced People carries almost no practical application today. It is however, a useful estimative indicator of the

additional burden that climate change is placing on the international community, on existing legal frameworks of protection and assistance, and on local communities in areas where climate impacts are most acute.

Development aid: Aid to support the economic, social and political development of developing countries. The aim is to alleviate poverty in the long run.

Disability-adjusted life year: This time-based measure combines years of life lost due to premature death and years of life lost due to time lived in states of less than full health. The DALY metric was developed in the original Global Burden of Disease 1990 study to assess the burden of disease consistently across diseases, risk factors and regions.

El Niño: Global ocean-atmosphere phenomenon which occurs if sea surface temperature rises by more than 0.5°C across the central tropical Pacific Ocean. Some experts suggest that El Niño frequency, duration and severity are increasing due to global warming.

Food security: Refers to the availability of food and people's access to it. A household is food secure when its occupants do not live in hunger or fear of starvation.

Global burden of disease study: Comprehensive regional and global assessment of mortality and disability conducted by the World Health Organization. It can be viewed as the gap between current health status and an ideal situation in which everyone lives into old age free of disease and disability. Causes of the gap are premature mortality, disability and exposure to certain risk factors that contribute to illness, such as climate change.

Gradual environmental degradation: Deterioration in environmental quality, such as reductions in arable land, desertification, sea level rise, etc., associated with climate change.

Humanitarian aid: Material or logistical assistance provided for humanitarian purposes, typically in response to humanitarian crisis. The aim is to alleviate suffering in the short term.

Mitigation: Actions taken to lower greenhouse gas emissions targeted at reducing the extent of global warming. This is distinct from adaptation which involves taking action to minimize the effects of global warming.

Semi-Arid Dryland Belt: The dry land belt encompasses 41 percent of the world's landmass including the Sahara, the Middle East and Central Asia, and is home to over 2.3 billion people.

Social Cost of Carbon Dioxide ($SCCO_2$): Monetary indicator of the global damage done over time by the emission of one extra ton of carbon today, discounted to present value.

Tipping point: Threshold points in which climate systems change abruptly, i.e. the shutdown of the Atlantic Gulf Stream, (which would cool the North Atlantic particularly Nordic countries and the United Kingdom) or the collapse of Greenland ice sheets, (which would dramatically increase sea level).

Vulnerability — Physical vulnerability to climate change: Refers to people who live in areas of the world that are prone to more than one type of the physical manifestations of climate change: floods, storms, droughts, sea level rise etc.

Vulnerability — Socio-economic vulnerability to climate change: Incorporates the capacity of individuals, communities, economies and societies to adapt to climate change impacts and avoid suffering from long-term, potentially irreversible losses in wellbeing and stability. Six factors of climate change vulnerability are included: economy; natural resources and ecosystems; poverty, development and health; agriculture; population, settlement and infrastructure; and institutions, governance and social capital. See Climate Change Vulnerability Indicator for further discussion.

Water stress: Expression denoting that a person does not have sufficient access to adequate amounts of water. Water-stress occurs if the annual per capita water availability falls below 1,000 cubed meters per year.

Weather-related disaster: Natural disasters that are dependent on weather patterns, such as floods, droughts and heat waves. Geophysical disasters such as earthquakes are not included in this category.

Abbreviations

CCVI	Climate Change Vulnerability Indicator
CO_2	Carbon Dioxide
CRED	Centre for Research on the Epidemiology of Disasters
DALY	Disability-adjusted life year
DFID	UK Department for International Development
EACH-FOR	Environmental Change and Forced Migration Scenarios
FAO	Food and Agriculture Organization of the United Nations
GDP	Gross Domestic Product
IPCC	Intergovernmental Panel on Climate Change
ISDR	International Strategy for Disaster Reduction
MDGs	Millennium Development Goals
NASA	US National Aeronautics and Space Administration
OCHA	Office for the Coordination of Humanitarian Affairs
ODA	Official Development Assistance
OECD	Organisation for Economic Co-operation and Development
$SCCO_2$	Social Cost of Carbon Dioxide
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNFCCC	United Nations Framework Convention on Climate Change
UNHCR	Office of the UN High Commissioner for Refugees
UNICEF	United Nations Children's Fund
WFP	United Nations World Food Programme
WHO	World Health Organization
WWF	World Wildlife Forum

End Notes

1 These parameters include global mean surface temperature, sea-level rise, ocean and ice sheet dynamics, ocean acidification, and weather related disasters.

2 Food Security refers to the availability of food and people's access to it. A household is food secure when its occupants do not live in hunger or fear of starvation.

3 Report team calculation — see "Notes on report methodology" for further explanation.

4 McMichael, A.J., et al (2004): "Chapter 20: Global Climate Change" in Comparative Quantification of Health Risks. *World Health Organization*.

5 Kron, W. (2009): "Flood insurance: from clients to global financial markets.", *Journal of Flood Risk Management*, 2 68-75, Geo Risks Research, Munich Reinsurance Company, Koeniginstrasse, Munich, Germany.

6 CRED and ISDR (2008): "2008 Disasters in Numbers." International Strategy for Disaster Reduction and Centre for Research on the Epidemiology of Disasters, p.1-2.

7 Based on definition by Centre for Research on the Epidemiology of Disasters (CRED) database.

8 WHO estimates that 24.3 million people were seriously injured in road traffic accidents and required medical attention in 2004. WHO. (2004): "The global burden of disease: 2004 update." *World Health Organization Health statistics and health information systems*, p.28. http://www.who.int/healthinfo/global_burden_disease/2004_report_update/en/index.html.

9 WHO estimates that 247 million cases of Malaria were recorded in 2006. WHO. (2008): "World Malaria Report 2008." *World Health Organization*. http://apps.who.int/malaria/wmr2008/.

10 Attribution of climate change includes efforts to scientifically ascertain mechanisms responsible for relatively recent changes observed in the Earth's climate, i.e. variations in temperature, weather related disasters and disease levels. The dominant mechanisms include manmade activities increasing greenhouse gases, aerosols, and land surface changes like deforestation.

11 Dr. Baines from the University of Melbourne estimates that 37% of drought is caused by climate change in 6 regions of the world. Baines, P. (2009): "The attribution of causes of current decadal droughts." *University of Melbourne* and Fogarty, D. (2009): "Global warming 37 pct to blame for droughts-scientist." Reuters, March 25. http://www.reuters.com/article/latestCrisis/idUSSP141565.

12 The calculation and the assumptions are detailed in "Notes on report methodology."

13 The Indian Ocean Earthquake in 2004 killed over 225,000 people.

14 Includes Malnutrition, Diarrhoea, and Malaria. Please refer to "Notes on report methodology C."

15 Tin, T. Dr. (2007): "Climate Change: Faster, Sooner, Stronger. An Overview of the Climate Science Published Since the Fourth IPCC Assessment Report". *World Wildlife Foundation*, WWF and Allan, R., and Soden, B. (2008): "Atmospheric warming and the amplification of precipitation extremes." Science. September 12, Volume 32, Number. 5895, DOI: 10.1126/science.1160787.

16 Kundzewicz, Z.W., et al. (2007): "Freshwater resources and their management." Climate Change 2007: Impacts, Adaptation and Vulnerability, Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, M.L. Parry, et al. Eds., Cambridge University Press, Cambridge, UK, 173-210.

17 International Strategy for Disaster Reduction Statistics, (2008) and Munich Re Statistics, (2009).

18 According to CRED, 219 million on average required assistance between 2000 and 2008 and 40% is attributed

to climate change based on assumptions described in "Notes on report methodology." Centre for Research on the Epidemiology of Disasters Database, (2009).

19 Barnett, J. and Adger, N. (2001): "Climate dangers and Atoll countries." *Tyndall Centre for Climate Change Research*, Working Paper 9. http://www.tyndall.ac.uk/publications/working_papers/wp9.pdf.

20 Comprehensive regional and global assessment of mortality and disability conducted by the World Health Organization. It can be viewed as the gap between current health status and an ideal situation in which everyone lives into old age free of disease and disability. Causes of the gap are premature mortality, disability and exposure to certain risk factors that contribute to illness, such as climate change. Please refer to "Notes on report methodology C."

21 WHO. (2004): "The global burden of disease: 2004 update." *World Health Organization Health statistics and health information systems*. http://www.who.int/healthinfo/global_burden_disease/2004_report_update/en/index.html.

22 Based on and adapted from CRED and ISDR (2008), McMichael, A.J., et al (2004) and Kron, W. (2009). Please see "Notes on report methodology" to describe the estimation in more detail.

23 A 320% increase in weather related disasters today is assumed based on Webster, M., et al. (2008). A 50% climate change attribution from weather related disasters is assumed in 2030. Webster, M., et al. (2008): "The Humanitarian Costs of Climate Change." *Feinstein International Center*, December, p.19.

24 Total estimate consists of the total number of people affected by gradual environmental degradation and weather-related disasters attributable to climate change. Please see "Notes on report methodology" to describe the estimation in more detail.

25 The total number of people with diabetes is projected to rise from 171 million in 2000 to 366 million in 2030. *International Diabetes Federation*. (2009). "Diabetes Prevalence." International Diabetes Federation. http://www.idf.org/home/index.cfm?node=264 and Wild, S., et al. (2004): "Global prevalence of diabetes". Diabetes Care, Volume 27, Number 5, May. http://www.who.int/diabetes/facts/en/diabcare0504.pdf.

26 For deaths due to weather related disasters, this assumes a 160% increase in the number of deaths for a 320% increase in the number of disasters. For deaths due to gradual environmental degradation see WHO. (2004): "The global burden of disease: 2004 update." *World Health Organization Health statistics and health information systems*, p.56. http://www.who.int/healthinfo/global_burden_disease/2004_report_update/en/index.html

27 WHO (2004) estimated that 519,000 people died from breast cancer in 2004.

28 Webster, M., et al. (2008): "The Humanitarian Costs of Climate Change." *Feinstein International Center*, December, p.19.

29 This value is obtained applying a 50% attribution of climate change, which is based on the difference in the trend increase in the frequency of weather related disasters and geophysical disasters. We use Munich Re (2009) trend calculations and extrapolate the linear trend to 2030. The calculation is explained in "Notes on report methodology".

30 Parry, M., Rosenzweig, C., and Livermore, M. (2005): "Climate Change, Global Food Supply and Risk of Hunger." Philosophical Transactions of the Royal Society, 360, 2125-2138.

31 WHO. (2008): "Protecting Health From Climate Change". The World Health Organization-World Health Day 2008. http://www.who.int/world-health-day/toolkit/report_web.pdf.

32 Grinsted, A., Moore, J.C., and Jevrejeva, S. (2009): "Reconstructing sea level from paleo and projected temperatures 200 to 2100 AD." *Climate Dynamics*, 10.1007/s00382-008-0507-2, January 6, p.1. and UFL. (2009): "A White Paper on the Impacts of Climate Change on Drylands." *Department of Geography-University of Florida*, p.3. http://www.clas.ufl.edu/lueci/southworth/Climate-Change-Class/chien/CWKAO_White%20paper1.pdf.

33 Warner, T. (2004). "Desert Meteorology". Cambridge University Press, Cambridge, p.595.

34 Please refer to "Notes on report methodology C."

35 Maplecroft, (2009) and McCarthy, M. (2008): "Why Canada is the best haven from climate change." *UK Independent*. July 4. http://www.independent.co.uk/environment/climate-change/why-canada-is-the-best-haven-from-climate-change-860001.html.

36 Watkins, K. (2007): "Human Develop Report 2007/2008 Fighting climate change: Human solidarity in a divided world." *United Nations Development Programme*.

37 Ehrhart, C. (2008): "Humanitarian implications of climate change mapping emerging trends and risk hotspots." *CARE*, p.2..

38 Government of Bangladesh. (2008): "Bangladesh climate change strategy and action plan." *Government of Bangladesh*. http://www.foshol.org/IUCN_BCCSAP_2008/IUCN_BCCSAP_2008_part2.pdf.

39 CRED database, (2009).

40 Agrawala, S., et al. (2003) "Development and climate change in Bangladesh: Focus on coast flooding and sundarbans." OECD. http://www.oecd.org/dataoecd/46/55/21055658.pdf.

41 The Equity and Justice Working Group Bangladesh claims that approximately 30 million people in 19 of 64 districts along the southern coastline have already been exposed to climate change. The Inter-governmental Panel on Climate Change had previously estimated that about 22 million Bangladeshis would become refugees due to climate change impacts by 2050.

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43. World Health Organization Statistical Information System, (2009).

44. Stern, N., et al. (2006): "Stern Review: The Economics of Climate Change." *HM Treasury*, Chapter 6, http://www.hm-treasury.gov.uk/stern_review_report.htm.

45. Please refer to "Notes on report methodology D."

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47. The model is based on an aggregate value for economic and non-economic losses due to climate change at a 2.5 degree increase in temperature compared to pre-industrial times. See "Notes on report methodology D." for further description.

48. Fortson, D., (2008). "Stern warns that climate change is far worse than 2006 estimate." *The Independent*, April 17. http://www.independent.co.uk/news/business/news/stern-warns-that-climate-change-is-far-worse-than-2006-estimate-810488.html.

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52. WRI. (2009): "Annual Adaptation Costs in Developing Countries." *World Resources Institute*. http://www.wri.org/chart/annual-adaptation-costs-developing-countries.

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55. World Resources Institute Earth Trends (2003) states that cereal production in South Africa and Sub-Saharan constitute 40% of total agricultural production, with remainder including roots and tubers, pulses and meat. International commodity unit prices (2001-2003) for cattle: US $1,183 and cow milk: US $269.

56. Based on the geographical representation in the Stern model. The model does not give results for 2030. We use the mean value for 2020 and project it linearly to 203

57. CIA World Factbook Database, (2007).

58. European Commission. (2008): "Financial Programming and Budget." *European Commission*. http://ec.europa.eu/budget/budget_detail/current_year_en.htm.

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60. Inman, M. (2008). "Carbon is forever". Nature Reports Climate Change. http://www.nature.com/climate/2008/0812/full/climate.2008.122.html

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One of the worst firestorms in Australia's history swept through the western suburbs of Canberra on January 18, 2002, resulting in the deaths of four people, and the destruction of 503 homes.The remains of a forest on the western suburbs outskirts.

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