Climate Change Impacts

In a nutshell

To address the question of "what are the expected impacts of climate change?" we examined the Fourth Assessment Report by the Intergovernmental Panel on Climate Change (IPCC). (The IPCC, along with Al Gore, won the Nobel Peace Prize in 2007 for its work on synthesizing the research on climate change. We believe it to represent the most authoritative consensus view of current science regarding climate change.) Our reading of this report is that it indicates the following if current carbon emission trends continue and the level of climate change remains within the range that the IPCC considers likely:

- **Climate change would have extraordinarily negative humanitarian impacts** across all of the outcomes we looked at: hunger, flooding, extreme weather, health, biodiversity, and the economy.
- When looking at the range of possible futures outlined in the report, the bulk of the variation (in humanitarian terms) comes from variation in the level of overall economic growth. Under the economic growth scenarios the report considers, it looks like **the world will be substantially better off on average, and in today's low-income countries in particular, in 2100 than today, even after accounting for the negative effects of climate change**; this is the case even under the most pessimistic scenarios regarding economic growth, and more optimistic scenarios regarding economic growth point to even better futures.

  Our best guess based on the evidence we examined is that the effects of economic growth on hunger, flooding, destruction caused by extreme weather, health, and the economy will be positive and outweigh losses from climate change; biodiversity, by contrast, is expected to decline by 2100, with little compensation from economic growth.

We have not addressed low-probability high-impact outcomes, such as methane feedback loops or extremely high climate sensitivity, which are difficult to quantify. In the unlikely event of such occurrences, many or most people might be worse off than today.

Growth scenarios

As discussed below, the impacts of climate change depend a lot on how else the world changes over the coming decades. Accordingly, the IPCC Fourth Assessment Report considers six primary "socio-economic development scenarios," with different projections for population growth, economic growth, and factors related to CO_2 emissions (e.g., degree of transition to clean energy):[1]

- **A1** is the scenario most optimistic about per-capita growth; it projects fast economic growth, slow population growth (7.1 billion people in 2100), and quick catch-up in the developing world. Within this broad scenario, three different possibilities for CO_2 emissions are considered:
  - A1T: Fast transition to clean energy, lower emissions, leading to a 2.4°C ("likely" range 1.4 – 3.8 °C) average temperature increase by 2100.
  - A1FI: Fossil-fuel intensive economy, high emissions,leading to a 4.0°C ("likely" range 2.4 – 6.4 °C) average temperature increase by 2100.
  - A1B: medium emissions, between the above two scenarios, leading to a 2.8°C ("likely" range 1.7 – 4.4 °C) average temperature increase by 2100.

- **A2** is the most pessimistic scenario: slow economic growth, fast population growth (15 billion people in 2100), and slow catch-up in the developing world, with the highest CO_2 emissions of any scenario except A1FI above, leading to a 3.4ºC ("likely" range 2.0 – 5.4 ºC) average temperature increase by 2100.
- **B1** projects medium-fast economic growth, slow population growth (7.1 billion people in 2100), and quick catch-up in the developing world, with the lowest emissions of any scenario, leading to a 1.8ºC ("likely" range 1.1 – 2.9 ºC) average temperature increase by 2100.
- **B2** involves medium-slow economic growth, though higher than in A2 above; medium population growth (10.4 billion people in 2100), and slow catch-up in the developing world. Emissions are at roughly the same level as A1T, which is lower than in any other scenario except B1, leading to a 2.4ºC ("likely" range 1.4 – 3.8 ºC) average temperature increase by 2100.

Broadly speaking, A1 and B1 have faster economic growth and slower population growth than A2 and B2, respectively, while B1 and B2 have lower emissions compared to A1 and A2, respectively.

The following table gives the per-capita income levels for different parts of the world. In the slowest-growth scenario, A2, global GDP per capita in 2100 is approximately 4 times as high as global GDP per capita in 1990, and the developing world has roughly 10x as much (though still only half as much as the OECD—a group of rich countries–had in 1990). Under more optimistic growth scenarios—A1 or B1—the developing world ends up with a GDP per capita in 2100 that is 40-60 times higher than in 1990, and 2-3x higher than the OECD had in 1990.

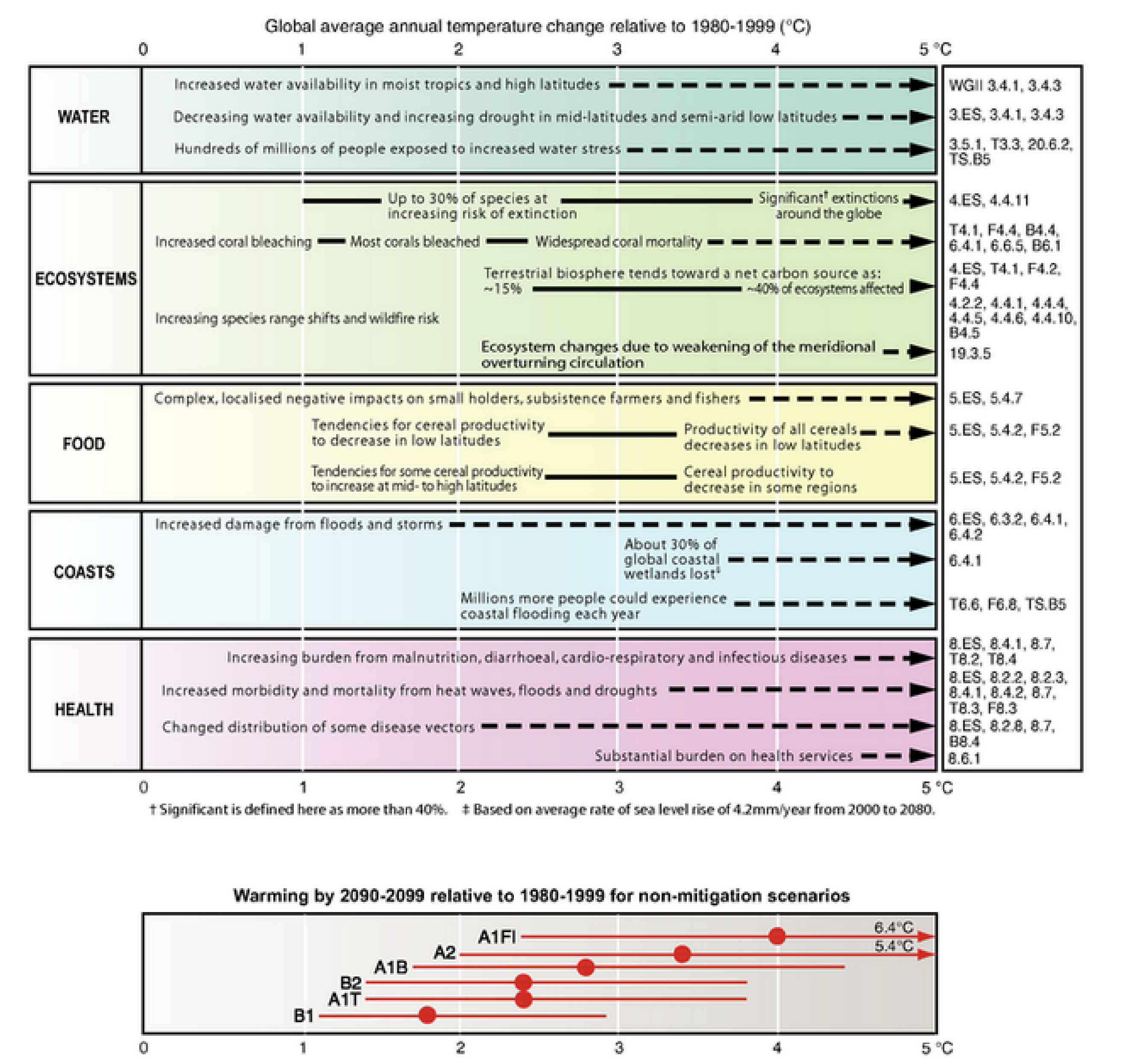
Per-capita income levels in thousands of 1990 US dollars[2]

	1990 [Actual]	2050 A1	A2	B1	B2	2100 A1	A2	B1	B2
OECD as of 1990 (wealthy countries)	17.8-20.6	50.1	34.6	49.8	39.2	109.2	58.5	79.7	61
Developing world	0.7-1.1	15.9	3.9	10.9	8.1	66.5	11	40.2	18
World	3.7-4.0	20.8	7.2	15.6	11.7	74.9	16.1	46.6	22.6

The IPCC Special Report on Emissions Scenarios presents much more detailed information about each of these scenarios.

Specific outcomes of climate change

In order to get a picture of the humanitarian impacts of climate change, we examined the IPCC report's synthesis for policymakers, which provides a visual summary of all of the major effects of climate change discussed in the report:



We struggled to make sense of the humanitarian impact of things like "hundreds of millions of people exposed to increased water stress" and "changed distribution of some disease vectors." Accordingly, we decided to pick the five impacts described in the summaries that seemed most worrisome to us to explore and summarize ourselves in somewhat greater depth.

Crop productivity and hunger in Africa

The IPCC estimates that global warming will have significant negative effects on crop productivity in Africa, across a range of socio-economic growth scenarios. However, more of the variation in projected levels of hunger in Africa is driven by socio-economic growth scenarios than by climate change estimates. Across the scenarios considered, even accounting for the effects of climate change, the proportion of people at risk of hunger declines relative to 2000.

By 2100, the IPCC Second Working Group chapter on Africa reports, "parts of the Sahara are likely to emerge as the most vulnerable, showing likely agricultural losses of between 2 and 7% of GDP. Western and central Africa are also vulnerable, with impacts ranging from 2 to 4%. Northern and southern Africa, however, are expected to have losses of 0.4 to 1.3%" (WGII 9.4.4).

Additionally, the chapter reports that (WGII 9.4.4):

- "the area of arid and semi-arid land in Africa could increase by 5-8% (60-90 million hectares)."
- "wheat production is likely to disappear from Africa by the 2080s"
- "In other countries, additional risks that could be exacerbated by climate change include greater erosion, deficiencies in yields from rain-fed agriculture of up to 50% during the 2000-2020 period, and reductions in crop growth period"
- in South Africa, "crop net revenues will be likely to fall by as much as 90% by 2100, with small-scale farmers being the most severely affected. However, there is the possibility that adaptation could reduce these negative effects (Benhin, 2006)."

However, the picture presented by the chapter on food is considerably more optimistic. Based on models of the climate, economy, and food system, the IPCC reports the following projections regarding the "number of people at risk of hunger," with and without climate change:

Millions of people at risk of hunger 3

	2000	2020		2050		2080	
	[Actual]	Baseline projection	With climate change	Baseline projection	With climate change	Baseline projection	With climate change
A1	824	663	666-687	208	210-219	108	136
A2	824	782	777-805	721	722-730	768-769	742-885
B1	824	749	739-771	239-240	242	90-91	99-102
B2	824	630	640-660	348	336-358	233	221-244

Note that this table gives *absolute numbers of people at risk of hunger*. In three of the four scenarios considered, hunger declines substantially by 2080 relative to 2000, both with and without the effects of climate change; in A2, which features slow economic growth and fast population growth, the number of people at risk of hunger in 2080, taking into account the effects of climate change, is essentially the same as in 2000. Across all scenarios, hunger is expected to decline *as a proportion of the population*.4

The effects of climate change in the table are somewhat smaller than might be expected because the models expect the higher atmospheric concentration of CO_2 to improve crop growth.5

Climate change is predicted to lead to substantially greater levels of hunger than would occur otherwise, but overall hunger is predicted to be far less common - in all scenarios, and including the impact of climate change - than it is today.

Floods due to rising sea levels

The Second Working Group chapter on coastal and low-lying areas reports that climate change is likely to lead to a rise in sea levels and an increased risk of flooding in many areas. Assuming that the only form of increased flood protection over time comes from increases in GDP per capita, millions of additional people are expected to be at risk of flooding due to climate change by 2080. We summarize the results, focusing on Asia and Africa because the IPCC projects 0-1 million people at risk of flooding in each of the other regions by 2020.

Average annual number of coastal flood victims in millions (and sea level rise in meters)6

		1990	2020s				2050s				2080s			
		[Actual]	A1FI (0.05)	A2 (0.05)	B1 (0.05)	B2 (0.06)	A1FI (0.16)	A2 (0.14)	B1 (0.13)	B2 (0.14)	A1FI (0.34)	A2 (0.28)	B1 (0.22)	B2 (0.25)
Asia	No CC	n/a	9-12	14-20	12-17	9-13	0	15-24	2	1-2	0	11-18	0	0-1
	With CC		9-12	14-20	12-17	9-13	0	16-26	2	1-2	1	15-25	0	0-2
Africa	No CC	n/a	1	2-4	1	3-4	0	1-2	0	1-2	0	0-1	0	0
	With CC		1	2-4	1	3-4	0	2-3	0	1-3	2-5	4-8	1	2-4
Global Total	No CC	10	10-14	17-24	13-18	12-17	0-1	16-26	2	3-4	0	11-19	0	1
	With CC	10	10-14	17-24	13-18	12-17	0	18-29	2	3-5	6-10	20-34	2-3	4-6

In all scenarios except A2, the expected absolute number of people flooded per year in the 2080s, including the effects of sea level rise due to climate change, is less than in 1990. In A2, by contrast, population growth leads to increases in flood victims that are exacerbated by climate change, resulting in a doubling or tripling of total annual number of flood victims by the 2080s, relative to 1990. Under A2, the *proportion* of people flooded each year remains approximately steady globally after climate change is accounted for, as global population roughly triples (from 5.3 billion in 1990 to 14.2 billion in the 2080s).[7]

Although the number of people suffering from flooding in A2 is higher than in A1FI, this difference is driven by socio-economic divergence rather than climate change. In 2080, sea level rise under scenario A1FI (34cm) is actually expected to be higher than under A2 (28cm), even though the humanitarian effects are much worse under A2 (essentially because there is a much larger population of very poor people in A2).[8] For Africa specifically, climate change is more of a dominant factor.

Note that the risks discussed here **concern increased flooding risk; they do not involve significant portions of land becoming completely unusable due to being underwater.** The IPCC report does not appear to raise the latter as a major issue; the mention we have seen of this risk in the IPCC report implies that it is primarily a risk over a longer (millennial) time horizon.[9] (This is not to say that there's *no chance* that such changes could occur in the next century, but rather that the IPCC appears to focus on the risk over a much longer time horizon.)

Increasing frequency of extreme weather (e.g. hurricanes, heat waves)

Although extreme weather is discussed in the IPCC's Fourth Assessment Report, the IPCC issued a more recent document, "Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation (SREX)," focused specifically on extreme events, so we referred to that document for information about this outcome.

The IPCC states that it is difficult to attribute any increases in extreme weather to climate change, because extreme climate events are rare,[10] but that there does seem to be evidence that - in most regions - extremely hot days and heat waves will become more frequent while extremely cold days become less frequent.[11]

The change in frequency of extremely hot days depends on the socio-economic scenario modeled (which drives the level of emissions), but under high-emissions scenarios, a day so hot that it would only happen once in every twenty years in 1990 would occur every 2 years in 2100, and the once-in-twenty-years temperatures are expected to rise by about 2 to 5°C.[12]

Other projected impacts include:

- **Precipitation**: "For a range of emission scenarios (A2, A1B, and B1), projections indicate that it is likely that a 1-in-20 year annual maximum 24-hour precipitation rate will become a 1-in-5 to -15 year event by the end of 21st century in many regions. Nevertheless, increases or statistically non-significant changes in return periods are projected in some regions." (SREX 149)
- **Tropical cyclones**: Information about tropical cyclones is relatively sparse in the historical record, but SREX reports that it is likely that the intensity of cyclones (in terms of rainfall and maximum wind speed) will increase while the number of cyclones will remain constant or decline (SREX 163).

- **Droughts**: SREX expresses medium confidence that there have been changes in some regions of the world since 1950 in the pattern of droughts (some positive, some negative), low confidence that climate change has already caused changes in drought patterns in individual regions, and medium confidence that climate change will lead to an increase in duration and intensity of droughts in some regions (including central North America and southern Africa) (pgs 174-175).

Economic and humanitarian losses due to extreme weather events are not well-quantified, but SREX reports high confidence that "[i]ncreasing exposure of people and economic assets has been the major cause of long-term increases in economic losses from weather- and climate-related disasters" (pg 269). In the cases for which SREX presents the most thorough information (primarily in the developed world), it appears that changes in exposure (presumably due to differing patterns of socio-economic development) are generally expected to drive larger changes in economic losses through 2040 than climate change does (SREX 272):

Table 4-3 | Estimated change in disaster losses in 2040 under projected climate change and exposure change, relative to 2000, from 21 impact studies including median estimates by type of weather hazard. Source: Bouwer, 2010.

A. Impact of projected climate change

Study	Hazard type	Region	Estimated loss change [%] in 2040			
			Min	Max	Mean	Median
Pielke (2007)	Tropical storm	Atlantic	58	1,365	417	
Nordhaus (2010)	Tropical storm	United States	12	92	47	
Narita et al. (2009)	Tropical storm	Global	23	130	46	
Hallegatte (2007)	Tropical storm	United States	-	-	22	
ABI (2005a,b)	Tropical storm	United States, Caribbean	19	46	32	30
ABI (2005a,b)	Tropical storm	Japan	20	45	30	
ABI (2009)	Tropical storm	China	9	19	14	
Schmidt et al. (2009)	Tropical storm	United States	-	-	9	
Bender et al. (2010)	Tropical storm	United States	-27	36	14	
Narita et al. (2010)	Extra-tropical storm	High latitude	-11	62	22	
Schwierz et al. (2010)	Extra-tropical storm	Europe	6	25	16	
Leckebusch et al. (2007)	Extra-tropical storm	United Kingdom, Germany	-6	32	11	15
ABI (2005a,b)	Extra-tropical storm	Europe	-	-	14	
ABI (2009)	Extra-tropical storm	United Kingdom	-33	67	15	
Dorland et al. (1999)	Extra-tropical storm	Netherlands	80	160	120	
Bouwer et al. (2010)	River flooding	Netherlands	46	201	124	
Feyen et al. (2009)	River flooding	Europe	-	-	83	
ABI (2009)	River flooding	United Kingdom	3	11	7	65
Feyen et al. (2009)	River flooding	Spain (Madrid)	-	-	36	
Schreider et al. (2000)	Local flooding	Australia	67	514	361	
Hoes (2007)	Local flooding	Netherlands	16	70	47	

B. Impact of projected exposure change

Study	Hazard type	Region	Estimated loss change [%] in 2040			
			Min	Max	Mean	Median
Pielke (2007)	Tropical storm	Atlantic	164	545	355	
Schmidt et al. (2009)	Tropical storm	United States	-	-	240	
Dorland et al. (1999)	Extra-tropical storm	Netherlands	12	93	50	172
Bouwer et al. (2010)	River flooding	Netherlands	35	172	104	
Feyen et al. (2009)	River flooding	Spain (Mad)	-	-	349	
Hoes (2007)	Local flooding	Netherlands	-4	72	29	

This a short time horizon, however, and the types of disasters covered are not the ones that have historically been associated with the largest humanitarian impacts.

Historically, natural disasters have had disproportionate effects on low-income countries, causing higher fatality rates and destroying a greater portion of GDP (pg 265). Between 1970 and 2008, greater than 95% of disaster deaths were in developing countries (pg 265). Between 1980 and 2004, the global economic losses dues to weather and climate disasters (which tend to be mostly in the developed world) have grown faster than the population or the economy, while at the same time the number of lives lost (mostly in the developing world) has declined (pg 269).

It is not clear why the number of lives lost due to extreme weather events has declined. Possible explanations may include "gradual improvements in warnings and emergency management, building regulations, and changing lifestyles (such as the use of air conditioning), and the almost instant media coverage of any major weather extreme that may help reduce losses" (pg 269). We would generally expect these trends to continue due to ongoing economic growth, potentially mitigating some future impacts of climate change due to extreme weather.

Accordingly, we see the research on extreme weather events as fitting the same general pattern as with flooding and crop productivity. Climate change is likely to have substantial negative impacts (especially leading to higher temperature extremes), but difficult-to-assess growth projections dominate our assessment of future vulnerability. Because of a lack of detailed studies, we have much less confidence than we do in the cases of flooding and hunger that the combined effect of growth and climate change on humanitarian effects of extreme weather are likely to be positive.

Adverse effects on health status (e.g., through spreading malaria)

The two best-understood kinds of health effects of climate change appear to be heat and cold deaths and infectious disease (e.g. on malaria or dengue fever). Conforming to the pattern in other outcomes, the expected health effects of climate change are expected to be large, negative, and fall disproportionately on low-income countries (WGII 8.ES), while the effects of socio-economic changes are expected to dominate the effects of climate change in the future (WGII 8.3.2).

Heat and cold deaths

Climate change is expected to increase the number of heat-related deaths, especially amongst the elderly, and reduce the number of cold-related deaths (WGII 8.4.1.3), though quantified estimates are not provided on a global basis - instead, studies of particular areas are cited. For example, in the UK, heat deaths are predicted to rise by ~3000 per year by 2080, while cold deaths are predicted to fall by ~30,000 per year; heat-related deaths in Los Angeles are expected to rise from ~165/year in the 1990s to 319-1182 per year in the 2080s. Note that a heat wave in Europe in 2003 is believed to have caused roughly 35,000 deaths, mostly amongst those over the age of 75 (WGII 8.2.1.1). Heat-related deaths are expected to increase partly because of demographics, due to the higher risk that the elderly face.[13]

Malaria

Regarding malaria, the IPCC says, "trends in population dominate calculations of the possible consequences of climate change" (WGII 8.3.2). van Lieshout et al. 2004, the source cited by the IPCC for global malaria projections, does not separate out the impacts of population growth from climate change. It predicts that, by the 2080s, climate change will lead to (van Lieshout et al. 2004 Table 2):

- regions that are at risk of malaria in *at least one month a year* expanding across all scenarios, to cover between 227 million (scenario A1FI, fast fossil-fuel-intensive economic growth) and 416 million (scenario A2, slow economic growth and fast population growth) additional people.
- varying effects on the size of regions that are at risk of malaria in *at least three months a year*:
    - 100 million additional people (A1FI)
    - 141 million fewer people (A2)
    - 153 million fewer people (B1, medium-fast economic growth, slow population growth, and low emissions)
    - 31 million additional people (B2, medium economic and population growth and medium-low emissions).

Although van Lieshout et al. 2004 does not explicitly compare the effects of population growth and climate change on population at risk of malaria, we can infer that population growth has a bigger impact than climate change. The 2080 population of South Asia alone differs by more than 800 million between scenarios A1 and A2 (Fig 3), and the entire region is at risk of malaria for at least one month per year regardless of the impacts of climate change (Fig 6 and Table

2), implying that population growth is a significantly larger factor in driving malaria vulnerability than climate change is. Also, the authors do not model any changes in capacity over time, so any progress on malaria control that may occur with or without climate change is not included in the projection.

Dengue fever

Regarding dengue fever, there is some confusion due to an apparent misreading of a study (on the part of the IPCC),14 but it appears to us that the authors predict that the total number of people living in regions at risk of dengue fever will go from ~1.5 billion (1990 baseline) to 5-6 billion (2085), with 2 billion of that coming from population growth alone and the remaining 1.5-2.5 billion coming from climate change.15 The authors modeled only one growth scenario, and as with malaria, did not attempt to model the effects of adaptive capacity (e.g., control efforts).

Adaptive capability

A major question regarding all three of the above impacts is that of adaptive capability: improved control efforts, safety measures and care options due to increased wealth. For example, over the last century, the areas at risk of malaria have declined substantially (malaria has been eliminated in the U.S. and Europe, among other places):

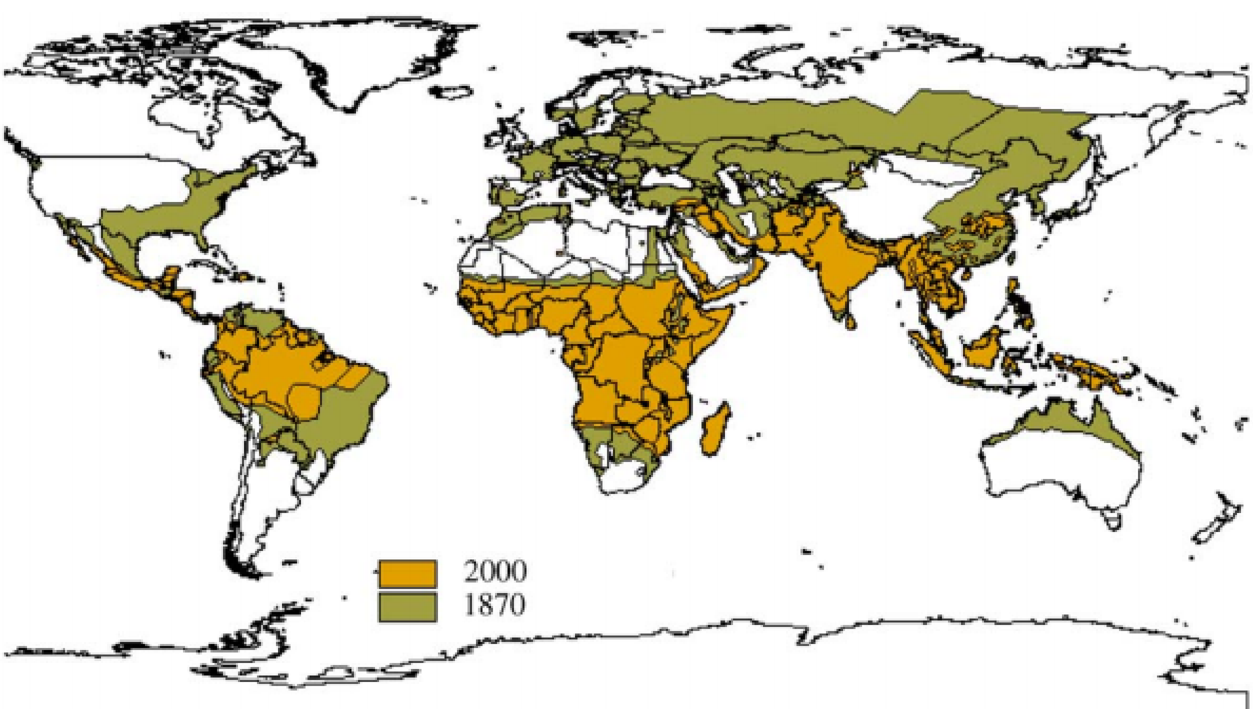


Fig. 1. Current distribution of malaria (Source: WHO, 2002) and the historical distribution (1870).

Absent conclusive evidence in either direction, and based on the track record of malaria control in the developed world, we would expect that the health benefits of economic growth will outstrip the negative health effects caused by climate change.

The IPCC predicts that climate change will lead to a substantial number of species extinctions (e.g. potentially in the region of 20-30% of all species) and substantial loss of biodiversity by 2100 (WGII 4.ES).

The impact of this biodiversity loss on humans is a key uncertainty in our take on the humanitarian impact of climate change. Because species extinction is irreversible, it represents one way in which people living in 2100 could be undeniably worse off than people living today: they may have a smaller pool of animal and plant life on which to draw for research, cultural and economic activity. We are not aware of a good method for assessing the humanitarian value of species that may be at risk.

Note that these estimates of species losses are primarily made using “climate envelope models,” which use climate change models and information about the geographic distribution of species to estimate when the conditions in which they currently reside are likely to cease to exist (i.e. when the “climate envelope” in which they live will be eliminated) (WGII 4.4.11). Many of the expected species losses in these models come from endemic species—ones that are restricted to narrow geographic and climatic areas—which can be especially sensitive to climatic changes.

As a result, we expect that the average humanitarian value of the species at risk are likely to be less than the average humanitarian value of all species (because of their limited populations and ranges). While the total expected loss of species may have enormous value, we are not aware of any attempt to quantify it. The Fourth Assessment Report does point to an estimate of the total value of ecosystem goods and services as approximately equal to the global gross national product, but does not provide an estimate of the value of biodiversity expected to be lost due to climate change (WGII 4.5).

Unlike many of the other impacts we have discussed, biodiversity loss is expected to be driven more by climate change than other socio-economic drivers (e.g. deforestation or land-use changes) over the next century, and the net effects of climate change and socio-economic growth on biodiversity are expected to be negative (WGII 4.4.11).

Economic welfare

In addition to examining the IPCC's projections regarding specific impacts, we also examined its discussion of the overall effect on the world economy. The pattern of results in terms of economic outcomes is roughly similar to the pattern we have observed with respect to most other outcomes: socio-economic growth scenarios have a much larger influence on future welfare than climate change does, and it appears that the net effect of growth and climate change is positive over the ranges considered for both factors.

The chapter of the Fourth Assessment Report that analyzes economic impacts focuses particularly on the estimates from the Stern Review, a 2007 report compiled for the UK government (WGII 20.6.1):

Most recently, Stern (2007) took account of a full range of both impacts and possible outcomes (i.e., it employed the basic economics of risk premiums) to suggest that the economic effects of unmitigated climate change could reduce welfare by an amount equivalent to a persistent average reduction in global per capita consumption of at least 5%. Including direct impacts on the environment and human health (i.e., ‘non-market’ impacts) increased their estimate of the total (average) cost of climate change to 11% GDP; including evidence which indicates that the climate system may be more responsive to greenhouse-gas emissions than previously thought increased their estimates to 14% GDP. Using equity weights to reflect the expectation that a disproportionate share of the climate-change burden will fall on poor regions of the world increased their estimated reduction in equivalent consumption per head to 20%.

A 20% decrease in per capita consumption would be nearly equivalent to the decline experienced by the U.S. during the Great Depression, without the associated recovery.

Although the IPCC does not quote the Stern Review to this effect, the quoted impacts of climate change are taking into account projections out past 2200, a century further into the future than the other projections the Fourth Assessment Report makes. Using a model that takes into account the risk of catastrophe and non-market impacts and worse-than-expected climate change (i.e. everything except equity weights from the quote above), **the Stern review projects a 2.9% reduction in per capita GDP in 2100**.[16] Using the Stern Review's back-of-the-envelope equity weights, that would imply an equivalent loss of welfare in 2100 of about 4%.[17]

What does a 4% loss of GDP per capita really mean? The Stern Review is based on a probabilistic simulation, but it takes a particular socio-economic growth model, SRES scenario A2, which features fast population growth and slow economic growth, as its base (Stern Review pg 154). Of the six major scenarios included in the IPCC Fourth Assessment Report, A2 has the second worst climate change impacts (after only A1FI, the most fossil fuel-intensive fast-growth scenario). A2 also features the worst humanitarian outcomes of the SRES scenarios, with slower convergence of the developing world and slower overall economic growth. **Prior to taking into account climate change, the GDP per capita of the developing world in 2100 under scenario A2 is $11,000; a 4% hit from climate change drops it to $10,560. In 1990, GDP per capita in the developing world was about $1,000.**

All told, on a 2100 time-scale, the variation across socio-economic scenarios dwarfs climate change in terms of their impact on economic outcomes. The four families of scenarios differ by 6 times in the expected level of GDP per capita in 2100. By way of contrast, the impact of climate change in family A2 (the second worst of the six considered by the IPCC) is about 4% of GDP per capita in 2100: this is about 100 times smaller than the variation across the socio-economic scenarios. Even with projected negative impacts of climate change in the range of 4%, the developing world is roughly 10 times wealthier in 2100 than in 1990 in scenario A2, which is the worst scenario in terms of humanitarian growth. In more optimistic growth scenarios, such as A1 or B1, the developing world is 40-60 times richer in 2100 than in 1990 (and 2-3 times richer than the OECD was in 1990).[18]

We would guess that this dominance also holds on a longer time-scale (e.g. out to 2200, as the Stern Review goes), because both economic growth and the impacts of climate change are compounding, but the SRES projections do not go out that far.

Conclusion

Across all of the outcomes we looked at, the effects of climate change are very negative. In the case of three of the effects that we examined (flooding, food, and economic losses), growth scenarios are larger drivers of the outcomes, resulting in net improvements in 2100 relative to 2000 when climate change and growth are both taken into account. In two other cases (extreme weather and health effects) we would guess that a similar dynamic holds—that climate change has large negative effects that are smaller than, and partly determined by, the improvements associated with economic growth—but evidence is weak or unclear. In the case of biodiversity, not only are the effects of climate change unambiguously negative, but there is limited compensation from socio-economic growth, resulting in a net decrease by 2100.

Based on the evidence we have seen, including the effects of socio-economic growth and climate change, we expect that there will be less biodiversity in 2100 than today, but that humanity in general and today's low-income countries in particular will be substantially better off overall.

Sources

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