POVERTY

WARNING SIGNS: THE SCIENCE AND IMPACTS OF CLIMATE CHANGE

Christian Aid's Time for Climate Justice campaign calls for urgent action to tackle the climate crisis. This campaign is based on clear scientific information about climate change and its effects, as well as our own work with poor people and our understanding of their experience.

It is the poorest people who are on the frontline of climate change: their livelihoods are often dependent on subsistence agriculture, while the places in which some of them live are vulnerable to drought, high winds or rising sea levels. A changing climate adds further risk and unpredictability to lives that are already lived on the edge.

First and worst

Aldo Caico Bellido and his wife Hermogenia live in a remote farming community, high in the Peruvian Andes. Their community depends on mountain glaciers to provide a constant flow of water for drinking, crop irrigation and even energy. But temperatures are getting warmer and the glacier they have relied on for most of their life is shrinking.

Aldo explains: 'Water here is not like before. The river gives life to the districts of Paras and Santa Rosa; today, the river has almost dried up. The river is fed by glacial water. Around six years ago, the glacier used to be very white; not these days.'

With the support of Christian Aid partner Centre for Agricultural Development (CEDAP), Aldo and Hermogenia have learnt better farming and irrigation techniques, but life is still hard. Harvests have decreased and water is an issue in ways it has never been before.

Christian Aid has encountered similar stories of a changing world in many other places where it works. In Kenya pastoralist communities are struggling with droughts that have increased in incidence four-fold over the past 25 years.[1] Communities in Honduras face hurricanes that are significantly more frequent and severe than before, even allowing for natural variations.[2] Farmers in Tajikistan have to cope with much hotter summers and changed patterns of rainfall ruining crops and undermining their livelihoods.[3] And in Bangladesh sea-level rise means poor communities have to travel miles every day to collect water as their local well has been contaminated by salt-water.[4]

Drought, sea-level rise, flooding and storms are all facts of life that poor people are well aware of. But from country to country poor communities tell a story of change – saying that the conditions in recent years are worse than they remember and that the weather is less predictable and more extreme than it used to be.

The climate is changing. Global increase in temperatures is affecting local weather patterns and triggering changes that we are only beginning to understand. But poor people – especially farmers who depend directly on the natural environment – are the least equipped to cope with these changes and are directly suffering because of them.

Assessing the evidence

Observation tells us the world is warming. Global average temperatures, calculated from networks of weather stations around the world, show a persistent warming trend.[5] The Earth's average temperature has increased by 0.75°C over the past 100 years.[6] Eleven of the 12 years from 1995 to 2006 are among the 12 warmest years on record.[7] Indeed, the 10 warmest years from the UK Meteorological Office's 160-year records are all since 1997, while eight of them are after 2001.[8]

Global average temperature trends are calculated by the UK Meteorological Office, which works with the Climatic Research Unit

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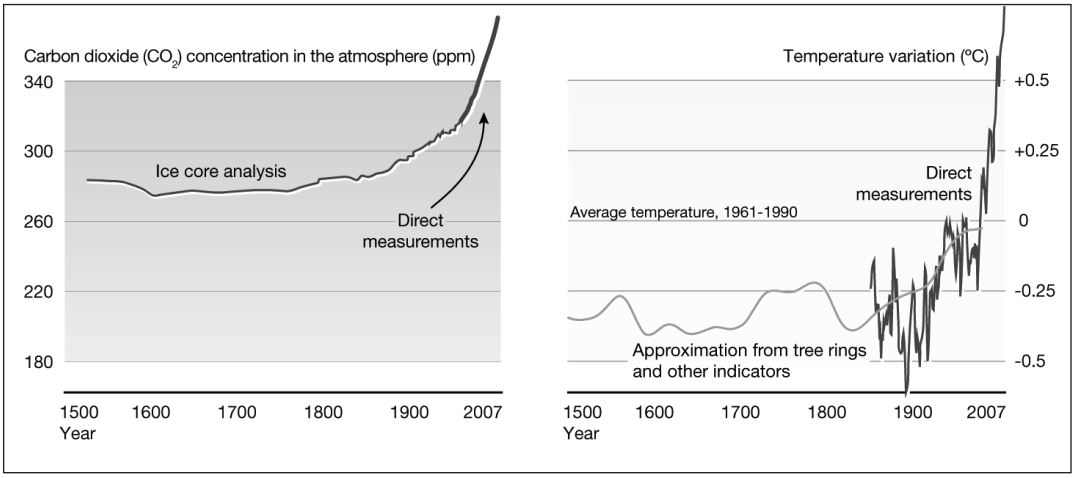

Hugo Ahlenius, UNEP/GRID-Arendal

(CRU) at the University of East Anglia, and in the United States by the Goddard Institute for Space Studies (GISS) at NASA and by the National Oceanic and Atmospheric Administration (NOAA). Each of these three groups uses different methods to collect and process data – but they come out with very similar results and the same long-term warming trend. This trend in surface temperatures has been reflected in similar warming trends in atmospheric and ocean temperatures. Furthermore the impact of increased temperatures can be observed in changes in the environment such as sea-level rise and widespread loss of glaciers and snow cover.[9]

'Forget about making poverty history. Climate change will make poverty permanent.' Nazmul Chowdhury, Christian Aid partner in Bangladesh

Arctic sea ice is particularly useful as an indicator of our changing world and has been described as 'the canary in the coal mine of global warming' by one NASA scientist.[10] The minimum extent of sea ice in the Arctic during the summer has already fallen from around nine million square kilometres in the 1960s to around six million now. This represents a drop of a third in as little as 40 years[11] – the canary has died... Indeed, some scientists have speculated that we could see summers in the Arctic that are completely ice-free in the next few years[12] – a significant shift from the recent consensus that this would only happen 'towards the end of the twenty-first century'.[13]

An even longer view on global temperature can be found by looking at 'temperature proxies'. These are traces left behind in the environment – in tree-trunk rings for example and within Antarctic ice – that scientists can use to reconstruct temperature data. Such data is clearly harder to read and analyse than instrumental data, but scientists can say with certainty that the warming of the past 50 years is unprecedented in the last 1,300 years at least, and probably for several millennia.[14] They can also say that the last time the poles were significantly warmer for a long period, sea levels were 4-6m higher than they are now.[15]

Examining the causes

Scientists have examined various causes for this warming trend: looking at the impact on temperature of natural variations, volcanic activity, changes in solar activity, urban heat effects and more. However the significant cause of the warming trend we have seen is the 'Greenhouse Effect' – a well-understood phenomenon that was discovered in 1824 and first measured in 1859.

Radiation from the sun enters the atmosphere and warms the Earth. The greenhouse effect is where gases – known as greenhouse gases (GHGs) – trap some of that heat and keep the Earth warmer than it otherwise would be. Some greenhouse effect is beneficial – otherwise the world would be much colder and virtually uninhabitable – but as human activity releases more gases into the atmosphere the warming effect increases.

The major greenhouse gases include water vapour, carbon dioxide (CO^2), methane (CH4) and nitrous oxide (N20). Some concentrations of GHGs in the atmosphere are natural but human activity is producing more and more of these gases each year, significantly increasing their concentrations. The human race contributes more carbon dioxide than any other greenhouse gas. From the point of view of human influence, it is the most important of these gases.

There is a natural cycle on Earth by which CO^2 moves in and out of the atmosphere – it is emitted by animals and absorbed by plants, and can be stored in the land and oceans, as well as in fossil fuels such as coal, oil and gas (which were once prehistoric plantlife). But human activity is releasing stores of carbon at a far faster rate than it is being absorbed back into the planet. Every time we burn fossil fuels for energy, cut down forests or dry out wetlands, we contribute more CO^2 to the atmosphere.

Currently the CO^2 concentration in the atmosphere is more than 390 parts per million (ppm)[16] – significantly higher than the pre-industrial figure of around 280 ppm.[17] The present concentration is the highest it

has been for 650,000 years and probably for 20 million years. Human activity also feeds concentrations of other GHGs such as methane, nitrous oxide and others, which are also at elevated levels.

Understanding the change

When scientists explore the potential causes of the Earth's warming trend the only explanation for the changes we are experiencing is that the gases released by human activity are causing significant warming.

In seeking to understand complex systems such as the Earth's climate, scientists have a long tradition of using computer models that allow them to examine the implications of their theories. Such models are tested against real-world data – if they can reproduce how the world has behaved in the past then they can give predictions about how the world might behave in the future.

It is only when human activity is included in these models that they reproduce the warming trend that the world is experiencing.[18]

By running those models against scenarios of further greenhouse-gas emissions in the future, scientists can make predictions of probable further temperature rises. Such predictions indicate that, depending on the level of emissions that humanity contributes to the atmosphere, we will see somewhere between 1.1 and 6.4°C of warming by the end of the century, over pre-industrial levels. Even if we were able to keep atmospheric concentrations of GHGs at today's value, we can expect another 0.3-0.9 deg C of warming because of the effect of existing GHGs in the atmosphere.[19]

While climate science is being developed further every day there are obvious limitations to our knowledge and understanding. The biggest limitations are in understanding how our climate will change in detail, and how that change will manifest itself in the future.

Scientists can confidently predict that increases in global average temperature will cause more unpredictable and extreme weather, change rainfall patterns and melt glaciers, permafrost and other ice, and contribute to sea-level rise and increased numbers of disasters. It is more difficult to make specific predictions about whether a particular country will, for example, see more or less rain, or will experience dramatic warming. But clear trends – such as the drying of parts of Africa – have been identified, and understanding and knowledge in these areas is quickly improving.

Sources of expertise, sources of disinformation

Climate science is an active branch of scientific inquiry where new research is released and debated by a wide community. To help the world understand the broad lines of agreement shared by the majority of climate scientists, the United Nations regularly assembles a panel of almost 3,000 scientists, drawn from research institutions in 190 countries, to assess the body of climate-science knowledge and deliver a clear summary of what is and isn't known. This is the Intergovernmental Panel on Climate Change, or IPCC.

IPCC reports do not include new research; instead they present an analysis of what the science to date shows. In its fourth assessment of climate science, published in 2007 and known as AR4, the IPCC reported that: 'Warming of the climate system is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice, and rising global average sea level.'[20]

This report also confirmed that scientific investigations have revealed the link between GHG levels and global temperatures, saying that human activity is 'very likely' – more than 90 per cent certain – to be the primary cause.[21] The next IPCC report is due in 2015 and will have more analysis to draw on, the vast majority of which supports and strengthens the case that climate change is happening because of human activity.

While the case for climate change is one of the most investigated and mapped subjects in modern science it has not been free of controversy, usually instigated by 'climate-change sceptics' or 'climate-change deniers' – groups and individuals who are intent on spreading doubt about the case for climate change. One such controversy was sparked by the theft and selective publication in 2009 of private emails belonging to the Climate Research Unit, based at the University of East Anglia (UEA) in the UK. The incident did not raise any serious questions about the basic climate science, but there was evidence of the reluctance of UEA scientists to share their data and of hostility from them towards climate-change deniers. Two independent inquiries have clearly supported the science of UEA and found no evidence of misconduct.

Months later, climate-change deniers were making much of a minor error found in AR4, although it did not affect the substance of the publication. The report included a badly sourced and untrue assertion that Himalayan glaciers could disappear by 2035, in the preface to a chapter that went on to lay out a large body of well-substantiated evidence

By agreeing a deal which allows a rise in world temperature over 1.5°C global leaders must accept they are agreeing to a huge human and ecological cost

that glaciers were disappearing, although at a slower rate than the claim implied. The fact that the claim in the preface was untrue makes no impact on the report's main argument, or indeed the case about the potential impact of climate change on glaciers.

These incidents do show however that climate scientists do make mistakes, and these mistakes can detract from the credibility of the story they have to tell. However it is important to acknowledge the existence of a small group of climate-change deniers who are working hard to discredit the science through a mixture of dirty tricks, spin and inaccurate representation of scientific views.

Many of these deniers are funded by fossil-fuel companies, part of a clear strategy to undermine action on climate change. There is growing evidence that oil companies have spent millions funding organisations dedicated to spreading confusion about climate science.[22]

Common challenges to the science – and the truth

'The world isn't warming'
The world is observably warming, in a trend that is clear over several decades. There is also natural variation. For example, according to the UK Meteorological Office, 1998 is the warmest year on record, but when decade-long averages are analysed, 2000-2009 was the warmest decade on record. Similarly, while the winter of 2009/10 was relatively very cold in certain parts of the globe, it was much warmer in others (global-average temperatures showed that 2010 gave us the warmest January on record[23]). It is the long-term global trend that is important, and it is undeniably warming.

'Human activity is not a significant cause of global warming'
Scientists have mapped the effect of other temperature-changing factors such as solar activity, urbanisation and volcanic activity, but it is only when the impact of an increased greenhouse effect due to human activity is factored in that scientists can explain the warming trend we are experiencing. A widespread survey of scientists carried out in 2009 found that 97 per cent of climate scientists believe that human activity is a significant cause of the warming we are experiencing.[24]

'Climate scientists have a vested interest to promote climate change'
This is incredibly unlikely. The nature of how science works and the amount of resources available for challenging climate science encourage scientists to come up with plausible new theories to explain the warming trend – but in decades of peer-reviewed analysis nothing else has stood the test. Climate change really is an 'inconvenient truth' and something that no one has a vested interest in.

'The IPCC's reports are riddled with errors'
The IPCC's latest report is a long summary of complex science, with a large number of authors, commentators and editors. It has been closely read by many people, including those dedicated to undermining it. However, to date, only a couple of minor errors have been identified, and they do not weaken any of the key points made by the report or the core science of climate change.

'Sceptical voices are ignored and drowned out'
The opposite is true. Despite a relatively small number of proponents and a lack of significant scientific backing, the points made by opponents of climate change have been widely discussed and given a high profile. Scientists and others who have closely followed the debate on climate change are understandably frustrated that arguments that were examined and debunked years ago are repeatedly 'unearthed' and presented by climate sceptics.

'Climate change will be beneficial'
Research has estimated that 300,000 people die every year from the effects of climate change even with relatively low levels of warming.[25] Climate change will make the weather more unpredictable and extreme; drought, flooding and forest fires will increase. Poor communities in developing countries will be the least equipped to cope and climate change will mean their suffering increases. Some countries will suffer more than others, and we are likely to see migrations of people away from increasingly inhospitable tropical regions to safer, temperate zones such as Europe.

Better or worse?

There are uncertainties and debate within climate science. But the core case is extremely well-supported, and the uncertainties cut both ways. Climate change could well be more severe than the IPPC's 'most likely' outcome. Recent observations and research have indicated that the IPCC predictions in 2007 may well have been too conservative.

Warning signs can be found in the fact that the world seems to be experiencing

unexpectedly severe warming effects. For example, the Arctic and Antarctic are both warming more dramatically and quickly. than expected, and glaciers and sea ice are disappearing faster than expected.[26]

Recent research has made the case that the analysis used by the IPCC was too cautious. One paper has indicated that sea-level rise may take place two or three times as quickly as the IPCC predicted – potentially reaching six feet by the end of the century.[27]

National Air and Space Association (NASA) scientist James Hansen – one of the first to issue a public warning about the climate crisis – has argued that the IPCC's estimate of how sensitive the climate is to different inputs is too conservative. Hansen and his colleagues have analysed how the world has reacted in the past to high CO^2 levels. They conclude that to prevent dangerous climate change, humanity must aim to reduce global CO^2 concentrations to less than 350 ppm as soon as possible.[28]

One of the key reasons why it is possible the IPPC predictions are an underestimate is that most of the analysis the IPCC has drawn on doesn't take into account the role of 'feedbacks' – as the world warms, a number of climate impacts will take place that will, in turn, cause further climate change. For example, as ice disappears, less solar radiation is reflected back and more is absorbed by the planet, causing more warming; and as permafrost melts, it releases locked-away methane, a green-house gas 23 times more powerful than CO^2.

Understanding of how these feedbacks and others can influence the climate is still at a relatively early stage. Models that do take these feedbacks into account – such as a recent analysis by the UK Meteorological Office – indicate that potential temperature rises predicted for the end of the century could happen up to 40 years earlier than predicted.[29] A plausible worst-case scenario, according to Dr Richard Betts, who led the research,[30] could see a 4°C rise for the world, which would manifest as a 7°C rise or more for much of Africa by 2060.

More worrying still, recent analysis by Massachusetts Institute of Technology of the effect of business-as-usual emissions puts the world on track for total temperature rises of between 4.2°C and 8.1°C by the end of the century, against IPCC predictions of a range from 3.1°C to 7.1°C (above pre-industrial temperatures).[31]

The frontline

Predicting the extent and impact of future climate change is extremely difficult. The world's climate is a complex system that reacts in unstable ways. However scientists can give predicted ranges of outcomes.

Business as usual – ie not taking action to limit our emissions – makes at least a 5°C future very likely. To put this in context, the UK Meteorological Office analysis of a 4°C rise predicts impacts such as:

- crop yields declining for all major cereal crops, causing a 10-20 per cent increase in the numbers of people at risk of hunger
- three billion people exposed to water stress (limited access to fresh water)
- sea-level rise of up to 80cm by 2100, affecting hundreds of millions of people, and much greater sea-level rise after that
- significant increase in drought – one credible analysis[32] suggests that half of all land surface could become subject to moderate drought conditions, and extreme drought might rise from affecting 1 per cent of land surface to around 30 per cent.

These impacts will hit poor people first and worst. These people are the most susceptible to disease, the farmers with the least resources, the inhabitants of the most marginal land. Many of the places where they live will see temperature rises significantly higher than the global average – with 4 degrees of warming globally meaning 7 or 8 degrees for parts of Africa and Latin America, and 5 or 6 degrees in parts of Asia. Aldo and Hermogenia's children, for example, would face a dramatically different world as Peruvian glaciers are predicted to decline by three-quarters in a world that is 4 degrees warmer. Their source of water would disappear.

Even if we manage to keep global warming at a 2 degree increase above pre-industrial levels, we can still expect to see half a billion more people affected by water stress than the present day.[33] Many small island states will be lost to sea-level rise, consistent with this level of warming. This is why over 100 developing countries have called for temperature rises to be limited to no more than a 1.5-degree increase.[34]

Analysis supported by Christian Aid and commissioned by the Pan-African Climate Justice Alliance – a network of organisations, concerned about climate change, from more than 43 countries across Africa – shows that a 2-degree rise could cost African countries twice as much as a 1.5-degree rise.[35] Keeping temperature rises to below 1.5 degrees is a challenge, but the countries that are calling for this argue that they are already seeing problems from climate change that they have not caused, and that the rich countries that are responsible should do everything possible to prevent further damage.

Conclusions

The picture painted by climate science is not yet complete, but it is convincing and, in many ways, terrifying. Climate change hurts and kills poor people – and is threatening ever more damage in the future. There is a high risk that the world will do too little to tackle climate change and little risk that the world will do too much. Work by Lord Nicholas Stern and others also indicates that the cost of not acting to prevent climate change will be much greater than the cost of effectively tackling the problem.

Christian Aid supports those who call for warming to be limited to less than 1.5 degrees or, if possible, lower.

However, at the moment rich countries are not even taking the actions needed to meet a lower target of keeping warming below 2 degrees, even though they have pledged to do so on a number of occasions.
If they allow global temperatures to rise over 1.5 °C, global leaders, especially in the rich world, must accept that they are allowing a huge human and ecological cost. Nazmul Chowdhury, a Christian Aid partner in Bangladesh, has said: 'Forget about making poverty history. Climate change will make poverty permanent.' Millions of lives will be lost, billions of people's livelihoods threatened and the balance of nature disrupted beyond repair. The world would become a less safe and stable place.

The focus must be on the urgent and effective action needed to cut emissions as quickly as possible to cope with the unavoidable impacts of climate change.

Rich countries must take their responsibility seriously and lead the response now: at a minimum this means:

- **cutting their emissions by 40 per cent by 2020**
- **providing new funds of well over €110bn a year to help developing countries adapt to climate impacts and develop cleanly.**[36]

Endnotes

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4 Ibid

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11 See analysis of UK Met office data by *The Guardian*: www.guardian.co.uk/news/datablog/2010/mar/05/arctic-sea-ice-climate-change-visualisation, viewed 12/3/10. Note that other sea-ice data, such as NSIDC, uses different thresholds and definitions, so giving much larger areas covered by sea ice – but with a similar declining trend.

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36 See previous Christian Aid briefings on our recommendations for a fair global deal on climate change.

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Poverty is an outrage against humanity. It robs people of dignity, freedom and hope, of power over their own lives.

Christian Aid has a vision – an end to poverty – and we believe that vision can become a reality. We urge you to join us.

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