

# A Perspective Paper on Adaptation as a Response to Climate Change

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## **COPENHAGEN CONSENSUS ON CLIMATE**

### A Perspective Paper on Adaptation as a Response to Climate Change

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## ABSTRACT

This paper sets out the case for adaptation as a core aspect of the global policy response to climate change. The paper argues that adaptation is now unavoidable. There are no realistic mitigation policies that restrict warming to a level that does not require substantial adaptation.

In fact, the adaptation needs over the next few decades are already predetermined by the amount of warming that is already in the pipeline. A choice between adaptation and mitigation only exists in the long term, but the paper argues that this is not a trade off policy makers will make explicitly. Adaptation and mitigation choices are made by different actors.

The paper highlights the powerful nature of adaptation, which can go a long way to reverse the worst impacts of climate change. The net benefits of basic adaptations, such as coastal defence and adjustments in agricultural practices, are often substantial. This is particularly the case in developing countries, where there are well-documented “adaptation deficits”, that is, a limited ability to deal even with current climate events. In developing countries adaptation and development go hand in hand.

Adaptation is made more difficult by uncertainty about the exact nature of the expected change. This affects the timing and sequencing of adaptation action and puts a premium on adaptations that yield early benefits and/or increase the flexibility of systems to react to unexpected change.

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The Copenhagen Consensus Center has commissioned 21 papers to examine the costs and benefits of different solutions to global warming. The project’s goal is to answer the question:

*“If the global community wants to spend up to, say \$250 billion per year over the next 10 years to diminish the adverse effects of climate changes, and to do most good for the world, which solutions would yield the greatest net benefits?”*

The series of papers is divided into Assessment Papers and Perspective Papers. Each Assessment Paper outlines the costs and benefits of one way to respond to global warming. Each Perspective Paper reviews the assumptions and analyses made within an Assessment Paper.

It is hoped that, as a body of work, this research will provide a foundation for an informed debate about the best way to respond to this threat.

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## INTRODUCTION

The policy debate on climate change distinguishes two generic response options. The first (and more prominent) option is mitigation. Mitigation addresses the *causes* of climate change by reducing the emission of harmful greenhouse gases. The second response is adaptation. Adaptation deals with the *consequences* of climate change and seeks to reduce the vulnerability of human and natural systems to a shift in climate regime.

This perspectives paper sets out the case for adaptation, complementing and building on the assessment paper by Bosello, Carraro, and de Cian.<sup>1</sup> Both the assessment paper and this perspective paper aim to answer the same question: *What is the role of adaptation in the international policy response to climate change?* Bosello et al approach the question from a modelling point of view, using an integrated assessment model that explicitly includes both adaptation and mitigation. This paper seeks to extract answers from the wider literature, rather than through bespoke modelling work.<sup>2</sup>

The paper is structured as a set of six theses that I believe are central to the adaptation debate and can help to frame the question at hand. The paper deals with each of them in turn. The six theses are:

1. A minimum level of adaptation is now unavoidable
2. Adaptation and mitigation are complements, but making the trade off is hard
3. Adaptation can have massive net benefits
4. Adaptation goes hand in hand with development
5. The timing and sequencing of adaptation action matters
6. Uncertainty matters

## A MINIMUM LEVEL OF ADAPTATION IS NOW UNAVOIDABLE

The need to adapt to climatic conditions has been a feature of human life since the beginning of time. It is an ongoing challenge that affects the way we live, how we design our infrastructure and how we produce our goods and services. Adaptation is not a new activity introduced as a consequence of climate change. What climate change forces us to do is to re-adjust our economies and our behaviour to reflect the new climate realities. Adaptation to climate change is a challenge not because the concept is new but because of the scale and speed of the adjustments required is unprecedented and because the exact nature of the anticipated changes remains highly uncertain.

<sup>1</sup> F. Bosello, C. Carraro and E de Cian (2009), *Adaptation to Climate Change: The Role of Market and Policy-driven Responses*, Assessment Paper for the Copenhagen Consensus on Climate Change, Fondazione Eni Enrico Mattei, draft, July.

<sup>2</sup> The paper draws heavily on S. Agrawala and S. Fankhauser (2008), *Economic Aspects of Adaptation to Climate Change. Costs, Benefits and Policy Instruments*. Paris: OECD; S. Fankhauser (2009), "The costs of adaptation", in *Wiley Interdisciplinary Review Climate Change*, forthcoming; and S. Fankhauser, J. B. Smith and R. Tol (1999), Weathering Climate Change. Some Simple Rules to Guide Adaptation Investments, in: *Ecological Economics*, 30(1): 67-78.

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Yet much of that change is already in the pipeline. Global mean temperatures today are already about three quarters of a degree warmer than in pre-industrial times, and even if carbon emissions completely ceased today the warming trend would continue for many decades. In other words, the mitigation measures currently discussed will determine the climate (and adaptation needs) towards the end of the century. The adaptation needs over the next couple of decades are already pretty much set.

Even over the longer term it looks pretty certain that the world will have to adapt to climate change of at least 2oC. There are few realistic policy scenarios that entail equilibrium warming of less than that. Both a 2oC world and the temperature changes already committed to will require considerable adaptation.

Short-term adaptation needs (up to 2015 – 2030) have been costed at anywhere between US\$ 4 billion to over US\$100 billion a year. These numbers are crude and at best indicative, however. At the low end, they almost certainly underestimate true adaptation needs. At the high end they also include “social adaptation” activities that could arguably be part of baseline economic development.<sup>3</sup>

### ADAPTATION AND MITIGATION ARE COMPLEMENTS, BUT MAKING THE TRADE-OFF IS HARD

While the short-term need for adaptation is pretty much predetermined, there is policy flexibility in the longer term. At least conceptually, policy makers may choose between different combinations of adaptation and mitigation. From an economic point of view the policy choice is an intertemporal optimisation problem. An imaginary global social planner seeks to minimise the costs of climate change through a judicious mix of mitigation policies and adaptation action.

For example, the social planner may decide to limit the overall temperature increase to 2oC (mitigation) and invest in items like flood protection, coastal defense and drought-tolerant cultivars to limit the negative impacts of 2oC warming (adaptation). There would be some residual damages, for example, the loss of certain coastlines and lower agricultural yields because this cannot be avoided at reasonable cost. If the social planner chooses right the combined costs of mitigation, adaptation and residual damage are kept as low as possible.

The paper by Bosello et al. is firmly in this vein. It is the basic approach most economists would apply to the problem, although it is well-recognized that more complex frameworks should also consider reasons for concern other than net costs, such as the unfair distribution of impacts, the risk of tipping points, excessive climate variability and the threat to unique natural systems.<sup>4</sup>

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<sup>3</sup> Fankhauser et al, *op. cit.*

<sup>4</sup> See J. Smith et al. (2001), “Lines of Evidence for Vulnerability of Climate Change: A Synthesis”, in: IPCC, *Climate Change: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Third Assessment Report of the IPCC*, Cambridge: CUP. The original IPCC analysis was recently updated in J. Smith et al. (2009) “Assessing Dangerous Climate Change through an Update of the Intergovernmental Panel on Climate Change (IPCC) ‘reasons for concern’”, in: *Proceedings of the National Academy of Science of the United States of America*, 106(11): 4133–4137.

Integrated models that include both adaptation and mitigation policies are still fairly novel, and they provide new and interesting insights. However, they are too stylized and not yet robust enough to allow firm policy conclusions. Very little is known, for example, about the shape of the climate change damage function. Similarly, most adaptation estimates are point estimates. We do not know how adaptation costs vary as a function of temperature rise, and to what extent there are limits to adaptation.

Moreover, policy decisions about adaptation and mitigation are often not made by the same people. Mitigation decisions are reached globally in international negotiations, backed up subsequently through national legislation. Adaptation decisions are made, more often than not, at the local level (e.g., municipal governments) and by private agents (households and firms), perhaps incentivized by national policy. These people are “climate takers” in the sense that global emissions are outside their control. Their own greenhouse gas output has no noticeable impact on total emissions.

In practice, therefore, no explicit choice, or trade off, will be made between the optimal levels of mitigation and adaptation.

## ADAPTATION CAN HAVE MASSIVE NET BENEFITS

Much of what we know about the costs and benefits of adaptation comes from case studies of particular sectors or countries. A recent survey carried out by the OECD found that our knowledge about adaptation at the sector level is growing, but information it is unevenly distributed.<sup>5</sup> Outside coastal zones and agriculture our knowledge base is still limited.

Nevertheless, the available evidence shows that adaptation is very powerful for dealing with moderate amounts of warming at least. For example:

- In agriculture there is broad evidence that low-cost adaptation measures like changes in planting dates, cultivars, fertilizer use and management practices can reduce the impact on crop yields by often more than half, relative to the no-adaptation case (see Chart 1).
- Coastal protection is one of the few sectors where adaptation costs (usually sea walls and beach nourishment) and adaptation benefits (avoided land loss, flooding) are routinely compared. The resulting benefit-cost ratios are not always reported, but one study, on coastal protection in the European Union, suggests benefit / cost ratios of 1.1 – 2.6 by 2020, rising to 4.3- 6.5 by 2080.<sup>6</sup>
- In the health sector, it has been estimated that preventing some 133 million climate-related deaths from malaria, malnutrition and diarrhoea would cost around \$3.8 – 4.4 billion, or less than \$33 per life saved.<sup>7</sup> This is several thousand times lower than

5 Agrawala and Fankhauser, *op. cit.*

6 Commission of the European Communities (2007). *Commission Staff Document. Accompanying document to the Communication of the Commission to the Council, the European Parliament, the European Economic and Social Committee and the Committee on the Regions on Limiting Global Climate Change to 2 degrees Celsius. Impact Assessment.* SEC (2007) 8. [http://ec.europa.eu/environment/climat/pdf/ia\\_sec\\_8.pdf](http://ec.europa.eu/environment/climat/pdf/ia_sec_8.pdf).

7 UNFCCC (2007). *Investment and Financial Flows to Address Climate Change.* UN Framework Convention on Climate Change, Bonn.

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people's willingness to pay to avoid this kind of risk, although "value of statistical life" estimates for developing countries are rare and notoriously controversial.<sup>8</sup>

Since the focus of many of these studies is on low-cost adaptation, high benefit / cost ratios are not unexpected. The question is how the return on adaptation changes as we move up the adaptation cost curve and start to implement more expensive measures. A recent McKinsey study<sup>9</sup> in eight countries confirms benefit / cost ratios will eventually drop below one. There is a limit to cost-effective adaptation. However, the study also found that in the eight cases considered well over 50% (and in one case as much as 95%) of expected impacts may be avoided through cost-effective adaptation.

However, while cost-effectiveness is a key consideration, it is not the only concern in the allocation of adaptation funding. The equitable distribution of funds is equally important. In particular, developed countries have an obligation, acknowledged in the UN Framework Convention on Climate Change, to support adaptation in developed countries that are particularly vulnerable to climate change. Providing sufficient adaptation funding to developing countries is a key concern that goes well beyond cost-effectiveness considerations.

## ADAPTATION GOES HAND IN HAND WITH DEVELOPMENT

Since adaptation to the prevailing climate is nothing new it is often difficult in practice to delineate where "normal" socio-economic development ends and adaptation to anthropogenic climate change begins. Socio-economic trends over the coming decades – population growth, economic expansion, the deployment of new technologies – will both shape and be shaped by our vulnerability to climate conditions.

This is particularly the case for developing countries, where there is a well-documented adaptation deficit – that is, insufficient adaptation to the current climate. Poor people and poor countries are less well prepared to deal with current climate variability than rich people and rich countries. There is evidence that development indicators like per capita income, literacy and institutional capacity are associated with lower vulnerability to climate events.<sup>10</sup> This has led authors like Schelling to conclude that good development is one of the best forms of adaptation.<sup>11</sup>

More broadly, we can think of adaptation as a "pyramid of needs", where certain development conditions have to be fulfilled before it makes sense to move to the next response level. McGray et al distinguish four levels in the development – adaptation continuum:<sup>12</sup>

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8 See for example D. Maddison and M. Gaarder (2002). "Quantifying and Valuing Life Expectancy Changes due to Air Pollution in Developing Countries" in D.W Pearce, C. Pearce and C. Palmer, *Valuing the Environment in Developing Countries*, Cheltenham: Edward Elgar. The value of a statistical life measures people's willingness to pay to avoid (or willingness to accept compensation for) a small increase in the risk of dying. 10,000 people accepting \$500 to face a 1:10,000 risk results in one statistical death compensated at \$5,000,000.

9 McKinsey (2009). *Shaping climate-resilient development. A framework for decision-making*. Report of the Economics of Adaptation Working Group, draft (July).

10 I. Noy (2009); "The macro-economic consequences of disaster;" *Journal of Development Economics*; No. 88; (221-231).

11 T. Schelling (1992). "Some Economics of Global Warming". *American Economic Review* 82(1): 1-14.

12 H. McGray, A. Hamill, R. Bradley, E.L. Schipper and J-O. Parry (2007); *Weathering the Storm. Options for Framing Adaptation and Development*. World Resources Institute, Washington DC.

- Policies to reduce vulnerability to stress more broadly (whether climate-related or not), including core human development objectives like education, health, sanitation and poverty eradication;
- Creation of “response capacity”, such as resource management practices, planning systems and effective public institutions;
- The management of current climate risks, including flood and drought prevention, disaster preparedness and risk management.
- Policies specifically addressing anthropogenic climate change, such as accelerated sea level rise and an increased incidence of extreme weather events.

Although only the last of these sets of activities is “adaptation to climate change”, strictly defined, effective strategies (and spending decisions) to reduce climate vulnerability have to address the entire pyramid and recognize synergies between the different levels.

## THE TIMING AND SEQUENCING OF ADAPTATION ACTION MATTERS

While some impacts can already be felt, climate change is essentially a long-term problem. The worst effects are not expected to materialize for a couple of decades. This makes the timing and the sequencing of response measures an important part of adaptation decisions.

In deciding the optimal timing for adaptation, decision makers will compare the net present value of adaptation now with the net present value of adaptation at a later stage. The two present values consist of adaptation costs (incurred either now or later) plus a stream of climate costs (say, the costs of flooding), which is reduced once adaptation takes place. Comparing the two present values, there are three cost components that will determine adaptation timing:

- The difference in adaptation costs over time. The effect of discounting would normally favour delayed action, but there is also a class of adaptations where proactive action (e.g., during the design phase of a project) is cheaper than costly retrofits at a later point. Long-term development plans – for example the development of a coastal zone – and long-lived infrastructure investments such as water and sanitation systems, bridges and ports fall into this category. For such investments it makes sense to incorporate climate change considerations already today. This was the view taken for example by the Canadian authorities when they built sea level rise into the design of the Confederation Bridge that links Prince Edward Island with New Brunswick.<sup>13</sup>
- The short-term benefits of adaptation. Early adaptation will be justified if it has immediate benefits that later action would forego. The prime example is measures that address current climate variability as well as future change. Similarly, many of the more developmental measures in the adaptation pyramid (see above) have immediate development benefits and are a precondition for effective adaptation later on.

<sup>13</sup> J. B. Smith, R. Tol, S. Ragland, and S. Fankhauser (1998). *Proactive Adaptation to Climate Change. Three Case Studies on Infrastructure Investments*, Working Paper D-98/03, Institute for Environmental Studies, Free University, Amsterdam, The Netherlands.

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- Long-term irreversibilities or cumulative effects. Early adaptation is justified if it can lock in lasting long-term benefits. For example, failure to protect ecosystems from current-day stress may leave them in too weakened a state to cope with future climate change.

These points suggest a preference, in the short-term, for adaptations that have immediate benefits, are long-lived and prevent costly retrofits or even irreversible loss. Notably, these conditions are met by most measures to close existing adaptation gaps.

## UNCERTAINTY MATTERS

Timing decisions, in fact all adaptation decisions are complicated by uncertainty about the exact nature of climate change impacts, especially at the local level (for example in terms of precipitation and storminess). This makes it difficult to fine-tune adaptation measures proactively.

Uncertainty will favour measures with strong near-term benefits, which are easier to ascertain, and win-win measures that are justifiable independently of the climate outcome. Measures to close existing adaptation gaps clearly fall into this category.

Others have argued that given the prevailing uncertainties, the best way to account for potential climate change in current investment decisions is to increase the *flexibility* systems – that is, allowing them to adjust to a range of climate outcomes – and/or their *robustness*, that is, designing them to function under a wide range of climatic conditions and withstanding more severe climatic shocks.<sup>14</sup>

The call for increased flexibility and robustness applies to both for physical, natural and social systems. In the case of physical capital, the capacity of water storage systems may be increased in anticipation of possible future droughts and sewage systems may be enlarged to deal with heavy down pours. In the case of natural capital, measures to protect the environment may increase the ability of species to adapt to a changing climate. Institutionally, creating regulatory frameworks that encourage individual adaptability would help to increase the flexibility and robustness of economic systems. It has been argued, for example, that opening agricultural markets to competition and trade would help to dampen the negative shock of a bad harvest in individual regions.

## CONCLUSION

This paper sets out the case for adaptation as a core aspect of the global policy response to climate change. The case for adaptation is made through a set of six propositions.

The paper argues that some adaptation is unavoidable. There are no realistic mitigation policies that restrict warming to a level that does not require substantial adaptation. Moreover, the adaptation needs over the coming decades are already set. They are predetermined by the amount of warming that is already in the pipeline.

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14 Fankhauser et al., *op. cit.* S. Hallegatte (2009). "Strategies to adapt to an uncertain climate change", in: *Global Environmental Change*, forthcoming.

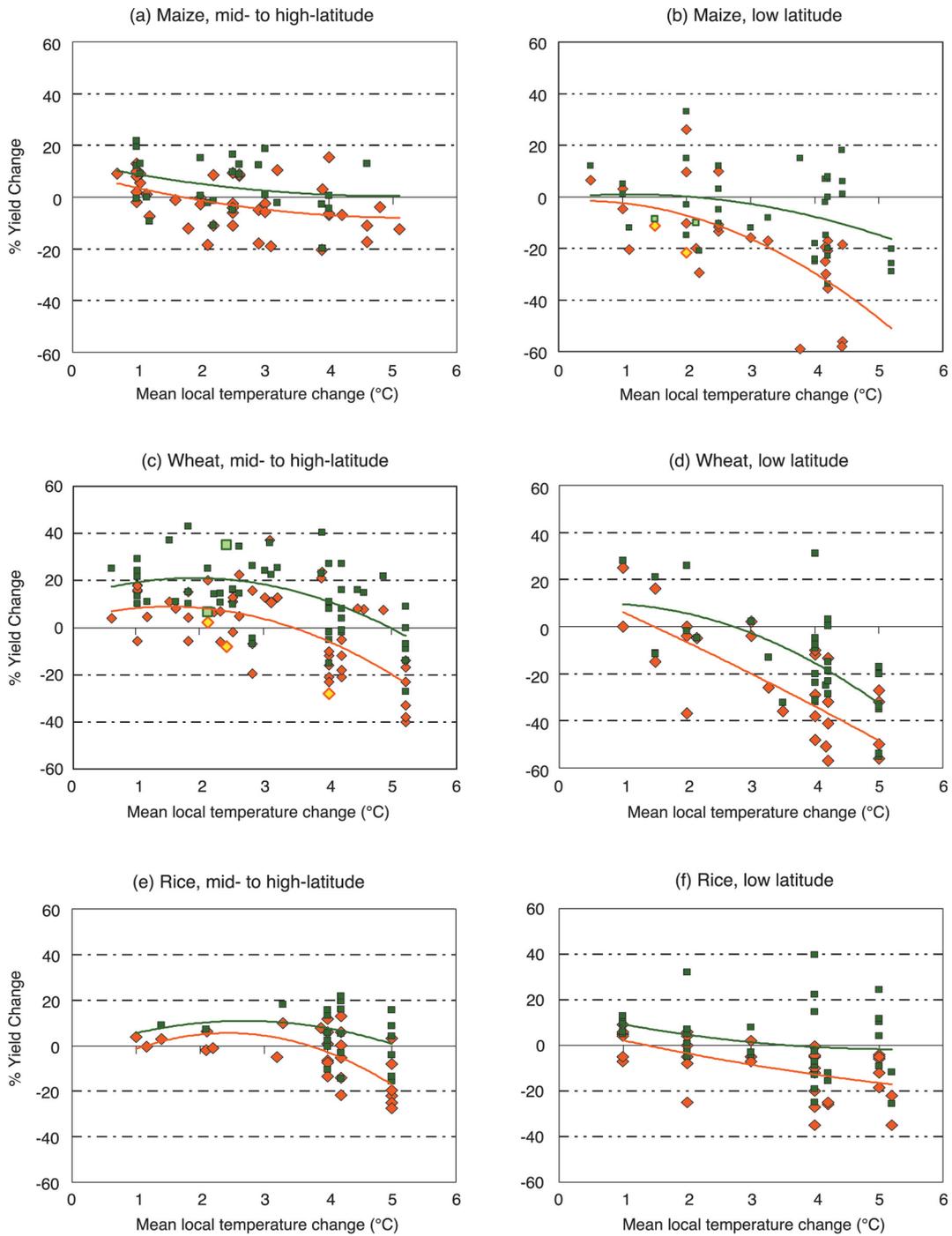
In the longer term there is a choice between adaptation and mitigation. The two policy options are complements. The paper shows that adaptation is an important part of the policy mix. The net benefits of basic adaptations, such as coastal defence and adjustments in agricultural practices, are often substantial, although cost-effectiveness should not be the only criteria in making adaptation decisions. In the international negotiations adaptation is often linked to questions of fairness and compensation.

In practice proactive adaptation is also made difficult by uncertainty about the exact nature of the expected change. A key area where proactive adaptation has strong and unequivocal benefits independent of climate change outcomes is action to close prevailing “adaptation gaps”, that is measures that simultaneously address development and adaptation needs. In developing countries adaptation and development have to go hand in hand. Or in the words of Nicholas Stern, “adaptation is development in a hostile climate”.<sup>15</sup>

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<sup>15</sup> McKinsey, *op. cit.*

Chart I: The benefit of low-cost adaptation in agriculture



Note: The red line shows yield change without adaptation; green line shows yield change including basic adaptation measures. Lines are derived from 69 published studies.

Source: Easterling W.E. et al (2007). "Food, Fibre and Forest Products", in IPCC, Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge: CUP.

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T. Schelling (1992). "Some Economics of Global Warming". *American Economic Review* 82(1): 1-14.

UNFCCC (2007). *Investment and Financial Flows to Address Climate Change*. UN Framework Convention on Climate Change, Bonn.

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The science is clear. Human-caused global warming is a problem that we must confront.

But which response to global warming will be best for the planet? The Copenhagen Consensus Center believes that it is vital to hold a global discussion on this topic.

The world turned to scientists to tell us about the problem of global warming. Now, we need to ensure that we have a solid scientific foundation when we choose global warming's solution. That is why the Copenhagen Consensus Center has commissioned research papers from specialist climate economists, outlining the costs and benefits of each way to respond to global warming.

It is the Copenhagen Consensus Center's view that the best solution to global warming will be the one that achieves the most 'good' for the lowest cost. To identify this solution and to further advance debate, the Copenhagen Consensus Center has assembled an Expert Panel of five world-class economists – including three recipients of the Nobel Prize – to deliberate on which solution to climate change would be most effective.

It is the Copenhagen Consensus Center's hope that this research will help provide a foundation for an informed debate about the best way to respond to this threat.

## COPENHAGEN CONSENSUS CENTER

The Copenhagen Consensus Center is a global think-tank based in Denmark that publicizes the best ways for governments and philanthropists to spend aid and development money.

The Center commissions and conducts new research and analysis into competing spending priorities. In particular it focuses on the international community's efforts to solve the world's biggest challenges.

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