A Global Contract on Climate Change

Summary

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Climate Change represents an unprecedented challenge to global society. Unmitigated climate change will introduce large-scale risks to ecosystems and human societies, while its mitigation represents a major task for the world economic system. Ultimately, managing the problem of climate change will require the weighing of different kinds of risks arising from climate change, adaptation, and mitigation.

The risk of dangerous climate change

Climate change is already under way and can lead to an increase of global mean temperature of up to 5°C relative to pre-industrial levels by the end of the 21st century, implying large-scale shifts in global and regional climates, ecosystem patterns, and human activities. Global warming could push components of the climate system ('tipping elements') past critical thresholds so that they switch into qualitatively different modes of operation, resulting in considerable consequences for human and ecological systems. The Arctic sea-ice, where summer minima have been decreasing at alarming rates in recent years, and the Greenland ice sheet, which stores ice masses equivalent to a sea level rise of seven meters, are highly sensitive tipping elements. Other, more uncertain tipping elements include the West-Antarctic Ice Sheet, boreal forests, the Amazon rainforest and the Indian summer monsoon. The current state of research suggests, however, that the EU target of limiting the rise in global mean temperature to 2°C above pre-industrial levels will likely be sufficient to

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avoid most of these effects. It will probably be insufficient to avoid the loss of Arctic summer sea-ice.

Key impacts of climate change include flooding of coastal areas and river deltas, more intense droughts and desertification, increased occurrence of weather extreme events, and water scarcity due to melting glaciers and changing precipitation patterns. Particularly vulnerable regions include Africa, small islands, Asian megadeltas, and the Arctic. In general, developing countries are more vulnerable to climate change. While no level of climate change is inherently "safe", stabilization of global climate change at 2°C above pre-industrial level is expected to prevent the most severe impacts.

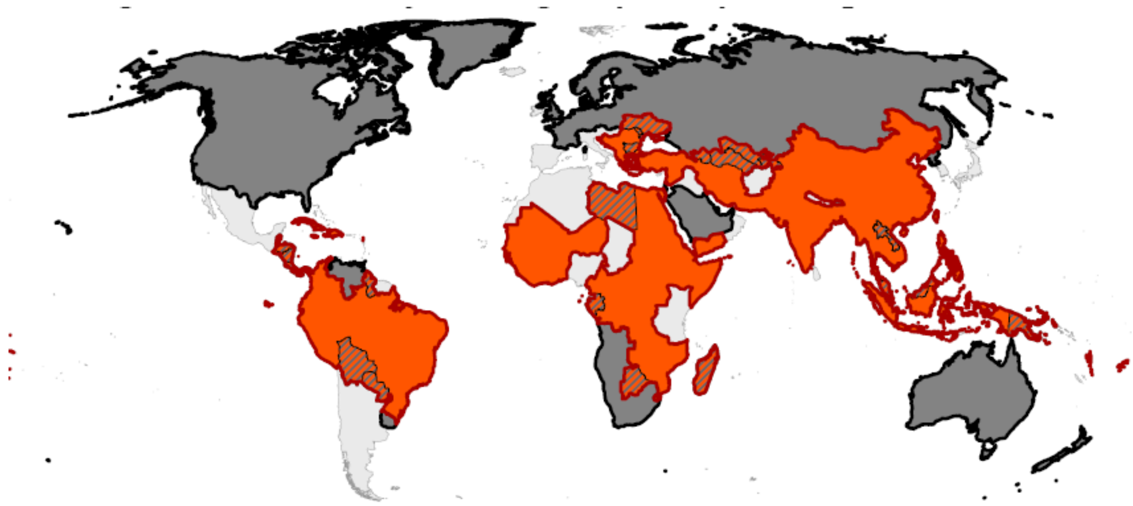

Figure 1: ***The moral dilemma of climate change – there is only little overlap between the countries with highest historical per-capita greenhouse gas emissions (grey) and countries that are most vulnerable to climate change (red).***

Climate change seriously affects the global distribution of welfare and thus raises questions about equity and justice. The historical responsibility for climate change is distributed unequally across the world, and so are its impacts. As depicted in Figure 1, present climate change is caused mainly by greenhouse gas emissions from industrialized countries in the Northern hemisphere, whereas most developing countries have contributed very little to the greenhouse effect. For instance, average CO_2 emissions from fossil-fuel burning in the period 1950 to 2003 were 5.2 tons per person and year in the US, 2.7 tons in Russia, 0.4 tons in China and less than 0.2

tons in India. Developing countries are, however, disproportionally affected by the consequences of climate change. Due to high exposure to climate risks and limited adaptive capacity, they are projected to feel the bulk of impacts. Unmitigated climate change will further increase global inequalities.

Costs and risks of mitigation

In economic history, the accumulation of physical capital stocks and the accumulation of carbon emissions in the atmosphere have gone hand in hand. The combustion of fossil fuels has been at the heart of the model of economic growth that was developed in Europe some 200 years ago.

The economic challenge of climate change lies in developing an economic growth paradigm that decouples the growth in carbon emissions from the growth in capital stocks. It is necessary to overcome the tragic choice between economic growth at the expense of dangerous climate change on the one hand, and climate protection sacrificing economic growth on the other. It would be inequitable to require developing countries to forego economic growth for climate protection, in particular in view of their low historic use of the atmosphere as a deposit for greenhouse gas emissions.

While CO_2 emissions from fossil fuels increased 1.0% per year during the 1990s, their growth rate accelerated to almost 3% per year from 2000 to 2005. If current trends continue, future emissions will exceed even the highest of the emissions scenarios used by the IPCC for simulations of future climate change. The situation is aggravated by the fact that an increasing fraction of emissions remains airborne due to a decreasing efficiency of natural sinks. In combination, the increasing emissions and declining sinks result in rapidly growing atmospheric CO_2 concentrations.

Is it possible to stabilize the climate system at reasonable economic cost and overcome the tragic choice between climate and economy? In recent years, modelling exercises with integrated economy-energy-climate models featuring an improved formulation of endogenous technological change show that the cost of climate stabilization are rather modest at 1-2% of global GDP. These results are prominently discussed in both the Stern Review and the IPCC's Fourth Assessment Report.

Figure 2 displays the portfolio of mitigation options ("mitigation wedges") as calculated by the energy-economy-climate model REMIND developed at PIK. The upper curve in the diagram represents business-as-usual emissions that would occur in absence of any climate policy. The challenge lies in reducing emissions to the lower curve, which shows a global emissions trajectory that is consistent with limiting global warming to 2°C above pre-industrial levels. The coloured wedges indicate the contribution of each mitigation option to the overall reduction effort.

There are four key mitigation options:

Energy efficiency and fuel switching: Efficiency improvements and switching to fuels with lower carbon content, e.g. replacing coal by gas, are projected to contribute substantially in the near future. Many energy efficiency improvements are possible even at negative costs, e.g. in the building sector. However, while coal is more evenly distributed over the globe, many major emitters have no or only limited access to domestic natural gas resources, and are reluctant to increase the share of gas in primary energy due to concerns over energy security.

Carbon capture and storage (CCS) refers to the technology of capturing CO_2 and storing it in geological formations instead of releasing it into the atmosphere. It may become particularly significant for emerging economies with substantial resources of coal, such as China and India. Combining biomass energy with CCS even bears the possibility to generate negative atmospheric CO_2 emissions, since the carbon is absorbed by plants in their growth phase, and eventually becomes stored underground after the combustion. CCS technologies are, however, not expected to be available for large-scale implementation before 2020. Also, a number of risks and uncertainties need to be resolved, particularly with respect to leakage from reservoirs.

Renewable energies: Currently, many renewable energy technologies are not competitive compared to fossil fuels, particularly in absence of carbon pricing. However, there is a significant cost reduction potential due to learning effects. Thus, they are projected to contribute substantially to curbing emissions in the second half of the 21st century. Issues concerning the grid integration of renewable energies and fluctuations in energy supply require further research. Given the competition for land and water with food production, the use of bioenergy is particularly controversial.

Nuclear energy: Nuclear energy has low specific CO_2 emissions, even if the energy requirement for extraction and processing of uranium is taken into account. The role of nuclear power is, however, constrained by uranium availability unless large-scale investments into closed fuel-cycle reactor designs such as the fast breeder reactor are undertaken. Significant concerns persist with respect to nuclear safety, the long-term safety of geological storage of waste, and, particularly for fast breeder designs, control of nuclear proliferation for military use.

Model simulations tell us that some mitigation options are more important for achieving ambitious mitigation targets at moderate costs than others.

For example, our results show that limiting nuclear energy to the business-as-usual level would only result in marginally higher mitigation costs. The option value of expanding nuclear power for mitigation is thus small. Solar power and CCS, by contrast, have greater option values. Depending on the assumptions on fossil fuel prices, climate stabilization without using CCS can even result in almost a doubling of mitigation costs.

Since each mitigation technology comes with its own set of opportunities, drawbacks and uncertainties, an integrated assessment of the greenhouse gas mitigation potential on the one hand and non-climate related benefits and risks on the other is a crucial exercise for forming a sound basis for decisions relating to the future energy mix. Developing a broad mitigation technology portfolio is of key importance to hedge against uncertainties and yet unidentified risks.

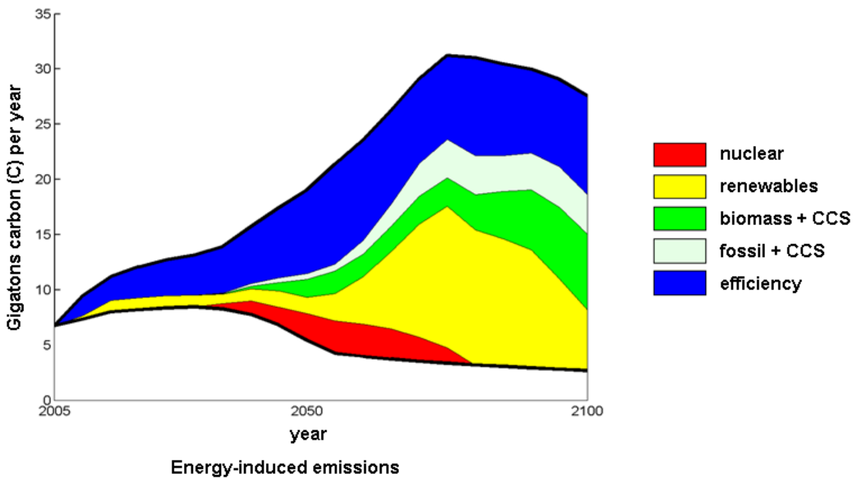

Figure 2: Contribution of mitigation options to global emission reductions in the energy sector for a scenario with cheap fossil fuels. Source: REMIND-G (PIK)

Principles and core elements of a Global Contract

The climate problem as outlined above poses a threefold challenge: To avoid dangerous climate change, to avoid economic losses due to overly stringent or ill-designed climate policy, and to shield the world's poor from the worst effects of climate change. A Global Contract should thus have the goal to address the problem along the following principles:

Environmental effectiveness: The first priority of international cooperative action on climate change is to limit climate change to an acceptable and manageable level. By identifying a temperature or concentration target, the division of labour between adaptation and mitigation is defined. Thus, it is important hat this target takes into account the limits to adaption. At the same time, overly ambitious mitigation targets can have adverse environmental and economic consequences, such as excessive biomass use. Limiting global warming to 2°C is a reasonable policy target, as it will likely avoid the most dangerous impacts of climate change, making it possible to adapt to the residual climate change. At the same time, with 1-2% of global GDP the costs of mitigation remain relatively low.

Cost-efficiency: Climate policy needs to ensure that the stabilization target is reached at minimal cost, in order to mitigate the conflict of objectives between climate protection and economic growth. This requires a wise choice of policy instruments on the national and international level. In order to be cost-efficient, action must be comprehensive, i.e. broad coverage of emitting sectors and regions is required to reduce emissions where this is cheapest.

Equity and justice: Industrialized countries are responsible for the bulk of historic CO_2 emissions. By contrast, many low-income developing countries that contributed least to the problem are among the most vulnerable to climate change, and people there will be hit hardest. It will be a key challenge for international climate policy to confront this dilemma and to ensure a fair distribution of the costs of curbing greenhouse gas emissions and adapting to climate change.

Along these lines, we propose that a Global Contract should focus on four major issues: establishing a global carbon market, inducing the development and sharing of low carbon technologies, reducing emissions form deforestation and land degradation (REDD), and setting up a framework for addressing adaptation (Figure 3). Such a Global Contract represents a guiding vision that can be implemented via a set of policy roadmaps that eventually merge into an integrated climate policy architecture.

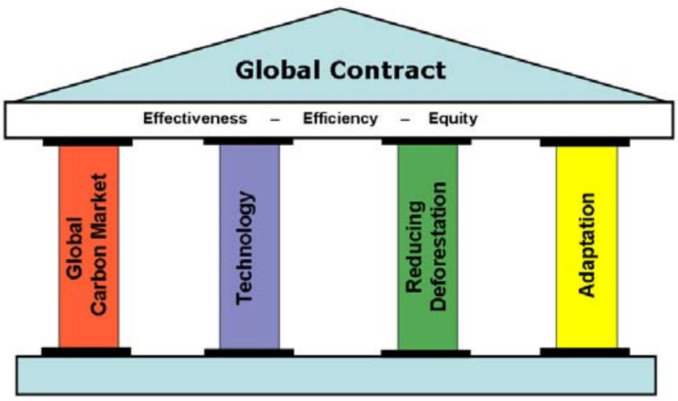

Figure 3: The Global Contract on Climate Change should embrace four major components: a global carbon market, technology, action for reducing deforestation, and adaptation.

A Global Carbon Market

For achieving a given stabilization target cost-effectively, putting a price on greenhouse gas emissions is fundamental. Ideally, the carbon price signal should be global, covering all sectors and regions, to ensure emissions are reduced where this is cheapest.

The Kyoto Protocol defines emission caps for industrialized countries and allows the trade of emission allowances at the government level. Under the Clean Development Mechanism (CDM), emission reductions from projects implemented in developing countries can be counted towards the reduction obligations of industrialized countries. In Europe, the EU Emissions Trading Scheme (EU ETS,) has demonstrated that setting up a company-level trading system in the context of the Kyoto trading system is a feasible climate policy option. Other domestic trading schemes are emerging or in discussion in a number of countries.

How can the international carbon market evolve from the current patchwork of trading systems to an environmentally effective, economically efficient and equitable integrated global trading regime? A global trading system may be implemented top-down via UNFCCC negotiations, or bottom-up by linking regional schemes in the context of the International Carbon Action Partnership (ICAP).

It is questionable whether linking systems bottom-up will lead to reductions that can be as large as those of a more comprehensive global system. The fear of emissions leakage and doing too much relative to others – thus hurting the economy without significantly benefitting the global environment – will likely lead to reduction efforts that are less ambitious than in a top-down approach. Therefore, in a bottom-up linking scenario – a possible fallback option to a more comprehensive approach - UNFCCC negotiations should focus on setting reduction targets for countries to overcome these concerns. Linking activities may be organized in another forum. Also, the UNFCCC could address the issue of reforming and supervising the CDM.

Ideally, top-down and bottom-up approaches will complement each other: a global trading system may be constructed by simultaneously implementing an intergovernmental emissions trading scheme with national caps building on the existing Kyoto trading structure, while linking domestic trading systems in this context. The top-down element resolves the questions of burden-sharing and overall ambition, while linking delivers efficiency by establishing a liquid international carbon market.

Developing countries should at least participate by means of one-sided trading mechanisms such as a reformed and up-scaled clean development mechanism for three reasons. First, while industrialized countries are responsible for the bulk of the historic emissions and have much higher per capita-emissions, developing countries already account for more than half of global emissions and their share is rising due to higher population growth and rapid economic development. Second, economies of developing countries feature considerable low-cost abatement potentials that can enhance cost effectiveness of the global mitigation effort. Third, to prevent emissions leakage that undermines environmental effectiveness, all world regions should implement comparable carbon prices in the long-term.

With a global trading system in place, the allocation of emission rights will influence the regional distribution of mitigation costs. At the same time, other factors such as domestic abatement opportunities and costs as well as shifts in global trade of energy resources strongly influence the distribution of costs. Model-based results suggest that, even for very divergent and extreme allocation rules such as equal-per-capita (every person in the world receives the same amount of emissions rights) or grandfathering allocation (each region receives allowances proportional to its GDP, thus favouring rich countries), the allocation effect is small compared to impacts of changes in energy resource trade flows and domestic abatement costs.

Technology development

A large-scale transformation of the global energy system will be needed to achieve the deep emission reductions required to avoid dangerous climate change. Is a global carbon market sufficient for inducing this transformation? The answer is negative because there are a number of market failures and barriers that are not resolved by pricing emissions. This is largely due to learning effects: for many innovative low-carbon technologies there is substantial potential for cost reductions with increasing production and experience learning. Since many low-carbon technologies are still at the beginning of their learning curves, it is currently cheaper to invest into conventional technologies, even though new technologies will become competitive in the longer term. In many cases, the advantage of leaving technology development to others and benefit from their experience by adopting their innovations is larger than the advantage of being the first mover. Thus, firms tend to underinvest in low-carbon technologies. Similarly, there is an incentive for countries to free-ride on knowledge and technology spillovers from abroad rather than fostering domestic research and development (R&D) to the socially optimal extent. Risks and uncertainties about future developments, both with respect to the political framework (e.g. national and global mitigation targets) and techno-economic parameters (e.g. fossil fuel prices) are another important barrier. In view of such uncertainties, risk-averse investors tend to delay investments. This is particularly adverse for many low-carbon technologies that are capital intensive and require substantial up-front investments.

Policy instruments in addition to carbon pricing on the national level include enhanced R&D funding for low-carbon technologies, publicly supported demonstration projects for complex technologies such as Carbon Capture and Storage (CCS), and market introduction programs for renewable energies. In order to exploit synergies and avoid free-riding, the industrialized countries should agree on a burden sharing for R&D as well as market introduction incentives for renewable energies.

In addition, sustainable energy provision for developing countries is of key importance for a long-term and global solution of the climate problem and comes with numerous ancillary local and regional benefits. Mainstreaming low-carbon development into development policy, promoting the sharing of technologies, and setting up a low-carbon fund for least developed countries and regions are important policy options to foster leapfrogging of developing countries into a low-carbon future.

Reducing Emissions from Deforestation and Forest Degradation (REDD)

Deforestation and forest degradation accounts for roughly 20% of global anthropogenic greenhouse gas emissions. According to most estimates, these emissions can be reduced at very low costs. Also, reducing deforestation comes with significant ancillary benefits due to the preservation of ecosystems and their services. Important challenges in establishing an environmentally effective REDD regime lie in ensuring additionality and permanence of emissions reductions and carbon storage, limiting leakage of deforestation activity to other regions, and coping with uncertainty in determining baseline deforestation rates and carbon emissions. A fair procedure for defining baselines against which emission reductions will be credited as well as equitable distribution of REDD proceeds will be vital for making such a mechanism acceptable for communities in developing countries.

Several proposals have been tabled on how to implement policy instruments that provide incentives to reduce deforestation and degradation in a future international climate policy framework. They can be grouped into three basic types. Integrated market approaches envisage tradability of REDD-generated credits on the international carbon market. Fund-based schemes propose compensation payments from an international fund as an incentive to reduce deforestation. Finally, hybrid mechanisms combine elements of the two other approaches by creating a separate market for deforestation credits. In hybrid systems the carbon market is utilized for providing finance for REDD in an efficient manner while preserving the environmental integrity and avoiding crowding out of emissions reductions in the energy sector.

Adaptation

Finally, it is clear that to solve the climate problem mitigation and adaptation must go hand in hand to meet the principle of "avoiding the unmanageable and managing the unavoidable". Most adaptation actions yield short to mid-term benefits for those implementing them. Therefore, adaptation often occurs autonomously, i.e. without the need for policy interventions. There are, however, three main reasons why governments and international organizations have an important role to play in adaptation: First, their intervention is required to ensure inter- and intranational equity, as adaptation by self-interested actors pays no attention to equity issues, such as differential responsibility for climate change and capacity to adapt. Second, new public goods such as the provision of accessible information about current and future climate change and its likely impacts as well as knowledge on best practices for adaptation are required. Third, governments are engaged in many climate-sensitive activities such as transport and water-related infrastructure, health services, setting of building codes, or disaster prevention. They need to adapt and take climate change into account in infrastructure planning to ensure continued effectiveness of their services and to avoid stranded investments.

The funding required to finance adaptation to climate change in the developing world is significant. As the adaptation fund set up under the Kyoto Protocol is inadequate in meeting these needs, a broadened funding mechanism should provide a sufficient and reliable financial basis for adaptation activities in developing countries.

Outstanding Challenges for Research

There are several areas where we need to improve our knowledge to ensure that the challenge of climate change can be managed in an effective, efficient and equitable manner. First, a better understanding and management of the risks and uncertainties surrounding the climate problem is required. For example, given our current knowledge the 2°C-limit is a reasonable target for climate policy, but further research is required to understand the implications of this target for mitigation, impacts, and adaptation. Second, the climate problem touches upon multiple and overlapping public goods: mitigating climate change may require an extensive use of biomass for energy production, for example, but this may interfere with other public goods such as food security or biodiversity. We need to understand how to tailor policies that avoid solving one public good problem at the expense of another. Third, climate change mitigation and adaptation require a global burden-sharing effort in various issue areas. Designing climate policies involves explicit and implicit judgments between the interests of (a) different generations, (b) different countries and regions of the world, and (c) different economic sectors and stakeholders. We need to better understand the distributive effects on these groups when implementing climate policy instruments. Fourth, the long-term nature of climate change gives rise to credibility problems in policy making. We require a better understanding of how to design institutions and instruments that can translate long-term targets into effective short- to mid-term policies.

Conclusions

While fundamental challenges for science and policymaking remain, we know enough to justify action that should aim at limiting global warming to 2°C. In view of the scale of the challenge, the historic responsibility of industrialized countries, the vulnerability of the developing world and the rapidly increasing energy demand in emerging economies, it is evident that international cooperation is central to a sustainable solution of the climate problem. Implementing a global price on emissions, fostering low-carbon technology research and development, reducing emissions from deforestation and land degradation, and supporting adaptation in poor vulnerable countries should form the central pillars of an environmentally effective, economically efficient, and equitable Global Contract on Climate Change.