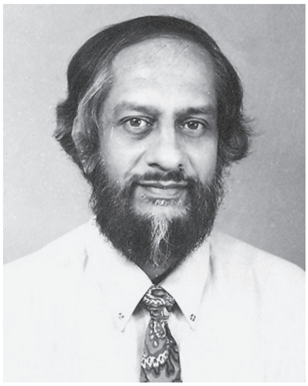
Chapter 12

Insights into the climate challenge

Rajendra Pachauri



Rajendra Pachauri was born in Nainital, India, in 1940. He studied industrial engineering at North Carolina State University in Raleigh, USA, where he also obtained a PhD in industrial engineering and a PhD in economics. In 1982 he joined the Energy and Resources Institute (TERI), which conducts research in the fields of energy, environment, forestry, biotechnology, and the conservation of natural resources, providing professional support to governments, institutions, and corporate organizations worldwide. In 2002, Pachauri was elected Chairman of the Intergovernmental Panel on Climate Change (IPCC). Established by the World Meteorological Organization and the United Nations Environment Programme in 1988, the IPCC assesses scientific, technical and socioeconomic information relevant to the understanding of climate change, its potential impacts, and options for adaptation and mitigation.

Climate change has emerged as one of the most contentious and critical issues of our time, with far-reaching implications for the way the human race will live and develop, especially over this century. While skeptics continue to doubt the human contribution to the phenomenon, the majority of the scientific community has come to a clear conclusion regarding the reality of human-induced climate change. These studies, many of which are included in the reports of the Intergovernmental Panel on Climate Change (IPCC), clearly show that human activities are the main reason for altered climate patterns in the last century.

The findings of the IPCC's Fourth Assessment Report, released in 2007, indicate that the warming of the climate system is unequivocal (Solomon *et al.,* 2007). They also reveal several disturbing trends regarding levels of atmospheric greenhouse gases since the Industrial Revolution, and changes in climate over the same period. According to the report, continued emissions would lead to further warming of 1.1 ºC to 6.4 ºC over the twenty-first century, depending on different scenarios of economic growth, population projections, technological change, energy demand, structure of energy use, and other factors (see Rahmstorf *et al.,* this volume).

The impacts of climate change are widespread and complex, and are projected to vary according to the timing and magnitude of change, as well as according to adaptive capacity. It is clear, however, that climate change impacts have serious implications for the livelihoods of billions of people worldwide, and pose one of the greatest challenges to development in our time.

The ecological footprint, a sustainability indicator measuring the pressure exerted by human activity on the Earth's systems, indicates increasingly unsustainable global consumption trends (see Leape and Humphrey, this volume). The ecological footprint is an estimate of the amount of biologically productive land and sea area are needed to regenerate (if possible) the resources that a human consumes, and to absorb and neutralize the corresponding waste, given prevailing technology. According to the Global Footprint Network,[1] it currently takes one year and four months to regenerate the resources consumed globally in a year. The 'carbon footprint'[2] is by far the largest component of the overall ecological footprint, comprising half of the total. Climate change is clearly one of the most pressing sustainability challenges of the century, and one that urgently needs to be addressed as part of mainstream development policy.

[1] The *Global Footprint Network* is an international think tank working to advance sustainability.
[2] The amount of forests and other vegetated areas to sequester carbon dioxide emissions.

Impacts of climate change on developing countries

The IPCC's Fourth Assessment Report projected that climate change will have a disproportionately high impact on developing countries, thereby exacerbating inequalities in health status and in access to adequate food, clean water, and other resources. In all countries, certain sections of the population, such as the elderly and poor, tend to be at a higher risk, thus also exacerbating inequalities within nations.

While industrialized countries bear the greatest responsibility for the changing climate, developing countries are already bearing the major burden of its effects. Between 1990 and 2005, nearly 3.5 billion people were affected by natural disasters, of which approximately 90 % live in developing countries (LaFleur *et al.,* 2008). As if this inequality were not enough, developing countries also have far fewer resources to adapt to climate change than developed economies. Factors influencing vulnerability to climate change include dependence of communities on climate-sensitive resources, vitality of local communities, the integrity of key infrastructures, level of current preparedness and planning, the sophistication of public healthcare systems, and existing exposure to conflict.

The impacts of climate change on developing economies are projected to be severe in terms of several critical factors. These include not only access to key resources such as water, but also factors related to health and vulnerability to a rise in sea level. Climate change also has serious implications for the Millennium Development Goals, particularly those related to environmental sustainability and poverty reduction. Some of the projected impacts include:

Access to food: In the Sahel region of Africa, warmer and drier conditions have already led to a shorter growing season with detrimental effects on crops. In some countries of Africa, yields from rain-fed agriculture could be reduced by up to 50 % by 2020 (Parry *et al.,* 2007, chapter 9). Local food supplies are projected to be negatively affected by decreasing fish populations in large lakes due to rising water temperatures, and the shortage may be exacerbated by continued over-fishing. These consequences would further adversely affect food security and increase malnutrition in Africa. By 2020, between 75 and 250 million people in Africa are projected to be exposed to increased water stress due to climate change (Parry *et al.,* 2007, chapter 9).

Health problems: In addition to malnutrition and consequent disorders in child growth and development, projected climate change is likely to affect the health status of millions of people – particularly those with low adaptive capacity – through increased deaths, disease, and injury due to heat waves, floods, storms, fires and droughts; the increased burden of diarrhoeal disease; the increased frequency of cardio-respiratory diseases due to higher concentrations of ground-level ozone related to climate change; and the altered geographical distribution of some infectious disease vectors (Parry *et al.,* 2007, chapter 8).

Coastal risks: By the end of the century, many millions more people than today are projected to experience floods every year due to the rise of sea levels (Parry *et al.,* 2007, chapter 6). The number of people affected by sea-level rise and by storm floods will be highest in the mega-deltas of Asia and Africa, while small islands are also especially vulnerable.

Migration: In addition to the existing migration due to resource scarcity, the numbers of environmental refugees could increase as coastal flooding, extreme weather events, famines, and conflicts that will arise due to these events become more frequent.

Biodiversity: By 2020, significant loss of biodiversity is projected to occur in some ecologically rich sites, including the Great Barrier Reef and Queensland Wet Tropics. There is also risk of significant biodiversity loss through species extinction in many areas of tropical Latin America. Increases in sea surface temperature of about 1–3 °C are projected to result in more frequent coral bleaching events and widespread mortality, unless there is thermal adaptation or acclimatization by corals (Parry *et al.,* 2007, chapter 4).

These and the other projected vulnerabilities underscore the importance of promoting alternative, sustainable development paths for the 80% of the world's population that lives in developing countries. This poses a significant, though achievable, challenge for the world economy, which has so far relied heavily on fossil fuels.

Increasing emissions from developing and emerging nations

Whereas industrialized nations bear the greatest responsibility for the current situation, the contributions of emerging nations are becoming more and more problematic. Their rapidly growing economies will in the long run exacerbate the climate change problem. Clearly, incorporating sustainable patterns of consumption in countries at all levels of development is a critical component of a sustainable development path, and will be vital for ensuring the success of climate change policies.

At the same time, and in spite of rapid economic growth, per-capita emissions in the emerging countries are still a fraction of the per-capita emissions in most industrialized economies (see Narain, this volume). For instance, while China overtook the US in 2007 in terms of absolute emissions (see Fig. 1), the USA's per-capita emissions are still four to five times higher than China's. India's per-capita emissions are even lower, about one-twentieth of the US level.

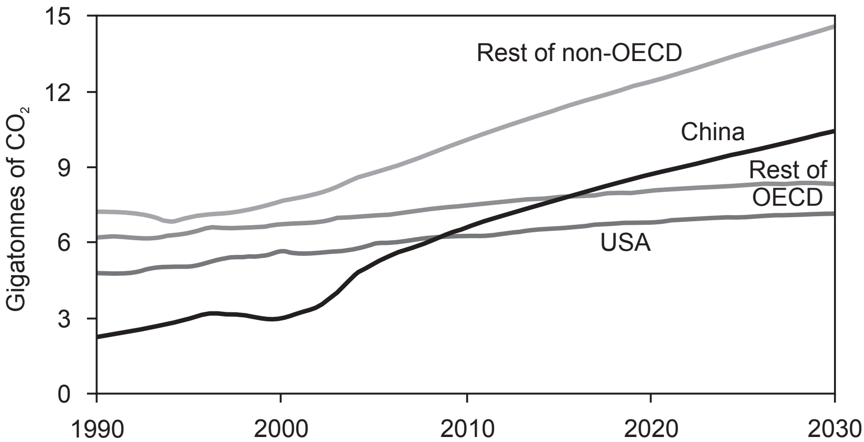


Fig. 1. Increase in carbon dioxide emissions in gigatonnes for different countries or groups of countries. (*Source:* IEA, 2006)

Coping with climate change through adaptation and mitigation

Adaptation and mitigation measures both have the potential to minimize climate change impacts. Adaptation includes initiatives and measures to reduce the vulnerability of natural and human systems to actual or expected climate change effects. Examples include raising river or coastal dikes, and substituting more temperature- and shock-resistant plants for sensitive ones (Metz *et al.,* 2007). Several countries are already undertaking adaptation measures, including crop diversification, irrigation, water management, disaster risk management, and adjusted insurance rates for people in areas that are likely to be most severely affected. Mitigation involves technological change and substitution that reduce resource inputs and emissions per unit of output. While several social, economic and technological policies can indirectly enhance emissions reductions, in this context climate change mitigation refers to policies undertaken to directly reduce greenhouse gas emissions and to enhance carbon sinks such as forests (ecosystems that absorb carbon).

Adaptation requires a conscious reorientation of global priorities to ensure the availability of adequate resources. Even though several international funds have been established, there is still a lack of available adaptation funding, particularly in developing countries. Only USD 163.3 million and USD 57.1 million have been pledged to the UN’s LDCF (Least Developed Country Fund) and SCCF (Special Climate Change Fund) funds, of which only USD 67.3 million and USD 49.3 million respectively have been received (GEF, 2007). By contrast, developed nations spent about USD 250 billion in 2005 supporting their own agriculture (WTO, 2006), and global military expenditure was about USD 1.2 trillion in 2006 (UNDP, 2007).

Given their high vulnerability to climate change, developing countries urgently need to increase their adaptive capacity. Adaptation mechanisms for developing and emerging nations that can decrease their vulnerability include (Parry *et al.,* 2007, chapter 10):

- Improving access to high quality information about the impacts of climate change and about best-response mechanisms to the anticipated effects;
- implementing early warning systems and information distribution systems to enhance disaster preparedness;
- reducing the vulnerability of livelihoods and infrastructure to climate change;
- promoting good governance, including responsible policy and decision making;
- empowering communities and other local stakeholders so that they actively participate in vulnerability assessment and adaptation;
- mainstreaming climate change into development planning at all scales, levels and sectors.

While adaptation measures are vital, particularly in the short term, sustainable solutions to climate change need to include a mix of adaptation and mitigation policies, suited to each country's vulnerabilities and level of development.

It has been well established that delaying emissions reduction leads to investments that lock in more emission-intensive infrastructure and development pathways. This significantly constrains the opportunities to achieve lower stabilization levels and increases the risk of more severe climate change impacts (Metz *et al.,* 2007, SPM). The fact that mitigation efforts have visible long-term impacts underscores the need to scale up current mitigation efforts. Even if the concentrations of all greenhouse gases and aerosols were kept constant at 2000 levels, further warming of about 0.1 °C per decade could be expected for the next two decades (Solomon *et al.,* 2007, SPM, p. 12). Energy system inertia adds a further dimension to the time scales involved in climate change. It has taken at least 50 years for each major energy source to move from a 1% penetration to a major position in global supplies. This inertia, as well as the even longer periods associated with interactions between systems, implies that abatement must begin as early as possible to ensure stabilization of greenhouse gases and temperature at targeted levels.

Figure 2 illustrates that the maximum projected cost of mitigation would not exceed 3 % of global GDP in 2030.

Several common drivers exist among policies addressing economic development, energy security, and health and climate change mitigation. Therefore, there are numerous co-benefits associated with mitigation, including health benefits and enhanced energy security. Mitigation measures present various opportunities for no-regrets policies, which should be integrated into the overall socio-economic policy framework.

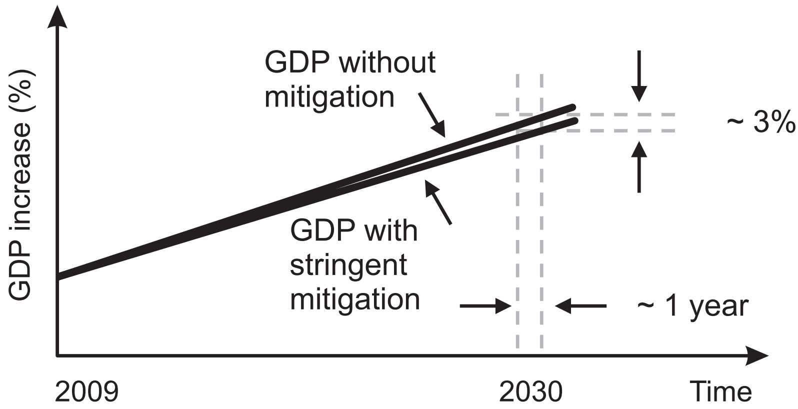


Fig. 2. Projected percentage increase of global GDP from today until 2030, with and without climate mitigation measures. The difference between climate mitigating efforts or the absence thereof would be relatively small: approximately 3 % of GDP. (*Source:* Pachauri, 2007)

Many technologies that have the potential to provide solutions for low-carbon development are already available, though several are not economically competitive at present. Investments in renewable technologies would contribute towards making them competitive with fossil fuels at an earlier stage, and this would enable greater energy security. Policies that divert unsustainable, distortive subsidies from fossil fuels to cleaner technologies would make resources available for increased investments in renewable energies, and thus facilitate the transition to low-carbon economies.

The four main sectors that require massive reductions in greenhouse gas emissions are energy supply, transportation, housing, and land use change:

Energy supply. The energy supply sector accounted for about 25.9 % of global greenhouse gas emissions in 2004 (IPCC SYR, 2007, Fig. 2.1). All assessed stabilization scenarios indicate that 60 – 80 % of reductions would come from energy supply and use and industrial processes, with energy efficiency playing a key role in many scenarios (IPCC SYR, 2007, p. 20). Mitigation technologies for this sector include improved supply and distribution efficiency, fuel switching from coal to gas, nuclear power, renewable heat and power (hydropower, solar, wind, geothermal and bioenergy), combined heat and power, and early application of carbon capture and storage (CCS) technology (see Bruckner *et al.,* this volume).

Transport. The transport sector accounted for about 13.2 % of global greenhouse gas emissions in 2004 (IPCC SYR, 2007, Fig. 2.1). Rapidly growing mobility demands from developing countries pose a significant challenge in terms of ensuring that mitigation efforts are not offset by increased transport activity. If current trends continue, by 2035 there will be around 250 million more cars and SUVs operating in China and India (USAID, 2007, p. 3). The increased demand for transportation will lead to a 2.6-fold increase in oil demand in developing Asia during this period, and a corresponding three-fold increase in carbon dioxide emissions. Currently available mitigation technologies include more fuel-efficient vehicles, hybrid vehicles, cleaner diesel vehicles, second-generation biofuels, electric vehicles, modal shifts from road transport to rail and public transport systems, non-motorized transport such as cycling or walking, and improved land-use and transport planning. Transport policies that enhance co-modality and efficient public transport systems would be crucial in supporting technological change to reduce emissions in this sector.

Buildings. Mitigation technologies in the building sector include efficient lighting and use of natural light, more efficient electrical appliances and heating and cooling devices, improved cooking stoves, improved insulation, passive and active solar building designs for heating and cooling, alternative refrigeration fluids, and the recovery and recycling of fluorinated gases. The building sector accounts for a sizeable share of overall emissions. The expansion of this sector in the rapidly growing transition economies provides the potential to integrate energy-efficient buildings into the infrastructural development process at an early stage, thereby providing co-benefits. It is vital, however, that energy-efficiency regulations are adaptable, suit local conditions, and draw on sustainable local building practices.

Deforestation and land use change. The IPCC estimates that the cutting down and degradation of forests currently account for close to 20% of all greenhouse gases entering the atmosphere (Metz *et al.,* 2007, TS, Fig.1b). Deforestation and forest degradation are significant causes of concern, particularly in the developing nations. Key mitigation initiatives and technologies in this sector include afforestation, reforestation, forest management, reduced deforestation, harvested wood product management, use of forestry products for bioenergy to replace fossil fuels, tree species improvement to increase biomass productivity and carbon sequestration, improved remote sensing technologies for analysis of vegetation/soil carbon sequestration potential, and mapping land use change. Policies incorporating financial incentives that value carbon sequestration and other ecosystem services provided by forests would represent potentially significant mitigation measures. To this end, the UN's REDD (Reduced Emissions from Deforestation and Degradation) programme has been initiated, one of the goals of which is to assess whether careful payment structures and capacity support can create the incentives to ensure actual, lasting, achievable, reliable, and measurable emission reductions, while maintaining and improving the other ecosystem services forests provide.

A vital component of market-based climate change policies is to put an accurate price on carbon that reflects the social costs of emissions. Policies that implement a real or implicit price on carbon could create incentives for producers and consumers to significantly invest in products, technologies and processes that produce low amounts of greenhouse gases. Such policies could include economic instruments, government funding and regulation. For stabilization at around 550 ppm carbon dioxide equivalent, carbon prices should reach USD 20–80 per tonne of carbon dioxide equivalent by 2030 (Metz *et al.,* 2007, SPM, p. 19). To limit global warming to the two-degree guardrail mandated by the Potsdam Memorandum (see pp. 369 ff.), deeper cuts in the short and medium term, leading to lower concentrations of greenhouse gases, will be necessary. This implies higher price ranges. However, it should be kept in mind that appropriate policies, such as those inducing technological development, have the potential for achieving the emissions reductions targets at generally lower price ranges.

Common but differentiated responsibility

The United Nations Framework Convention on Climate Change (UNFCCC), which has been ratified by 192 countries, outlines the principle of common but differentiated responsibility (CISDL Legal Brief, 2002, see also Narain, this volume). This principle recognizes the need for concerted global action, while emphasizing the need for proportionate and appropriate action by nations, taking into account those nations' historical contributions to climate change. Developed nations need to reduce their per-capita emissions, and at the same time consider the requirements of developing nations to industrialize, with overall global per-capita emissions not exceeding acceptable agreed levels. In addition to taking the lead on mitigation, developed nations also need to transfer financial, technical and other resources to emerging and developing nations to facilitate adaptation and mitigation. In principle, one could anticipate that the share of global emissions from developing countries will initially grow in line with their social and development needs.

The contraction and convergence policy option proposes that equalizing global per-capita emissions across countries would ensure equity in the global climate change mitigation process. It supports climate change negotiations that aim to equalize per-capita emissions at a future date, with the levels of permissible global per-capita emissions and the different years by which the emissions have to be equalized varying according to several formulae. This would allow citizens of all countries, regardless of size or level of development, equal space in the atmosphere, and thus equal responsibility to mitigate. While there are concerns that contraction and convergence may provide incentives to high population growth rates, it is entirely feasible, and indeed widely proposed, to place a limit on population beyond which no further entitlements would be granted. Furthermore, countries with high population growth rates would still have to provide resources for their growing populations. Therefore, the economic incentive to encourage high population growth rates may not even exist.

Adopting a sustainable development path

While there is immense potential for developing economies to integrate sustainable development initiatives into their economic and development policies, technology and capacity transfer is crucial to ensure widespread and effective mainstreaming of low-carbon technologies. An environment that is conducive to the transfer of low-carbon technologies would aid in implementing appropriate future policies for emerging economies, and would combine development policy with climate change mitigation. As mentioned earlier, there are numerous co-benefits associated with several mitigation measures, such as health benefits and enhanced energy security. Investing in sustainable infrastructure, planning cities with minimized environmental and ecological impacts, and conducting appropriate research and development (R&D) are some of the policy options that can re-orient an economy onto a sustainable path.

The assumption that economic growth is the panacea for all development problems, including climate change, may be worth discussing at this point. A narrow policy approach that solely promotes economic growth provides, at best, a partial solution to climate change by providing increased resources for adaptation while possibly worsening the overall problem. At worst, it will instigate a highly unsustainable development path that undercuts the foundations of future economic growth. The original inverted U-shaped Kuznets Curve suggests that with increasing economic growth income inequality will first increase, and then, after a point, decrease. Drawing on this concept, the Environmental Kuznets Curve suggests that economic growth would, after a point, lead to better environmental quality (Fig. 3). This carries the implication, at least to some degree, that there is potential for developing economies to 'grow out' of environmental degradation, since at a certain income level the population's preferences, or the increased resources due to development, would lead to better environmental quality, including decreased pollution and sustainable management of resources. The Environmental Kuznets Curve hypothesis is one of the most contentious empirical phenomena in environmental economics, at least in part due to its implications for economic and environmental policy in developing countries.

The Environmental Kuznets Curve for carbon dioxide emissions in particular, which predicts that as countries develop a certain level of wealth carbon dioxide emissions will fall, seems fraught with uncertainties on several grounds (Galeotti *et al.,* 2006; Stern, 2003). The most significant of these is that by the time most of the current high emitters have developed 'sufficiently' to reach the other side of the curve, it will be much too late to begin mitigation. Also, the very existence of the Environmental Kuznets Curve for global pollutants such as carbon dioxide is contentious in the first place. Clearly, climate change mitigation is not something a

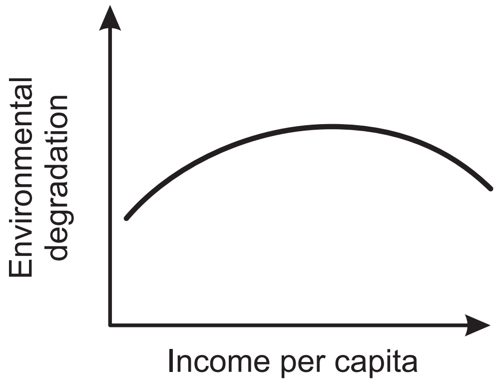


Fig. 3. Illustration of the Environmental Kuznets Curve.

developing country can simply 'grow into', but rather is a development path that needs to be agreed and acted upon quickly and effectively.

Conclusion

Climate change is a critical global challenge, one that requires international and inter-sectoral collaboration on an unprecedented scale. In addition, the present direction of the global economy requires a re-orientation, both in terms of outlook and development priorities. No country will be unaffected by climate change, and the socio-economic links between countries may in some cases exacerbate these impacts. This poses a daunting challenge, but one – if acted upon quickly and effectively – that promises a more inclusive and less vulnerable planet for the global population as a whole.

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