Adapting to climate change

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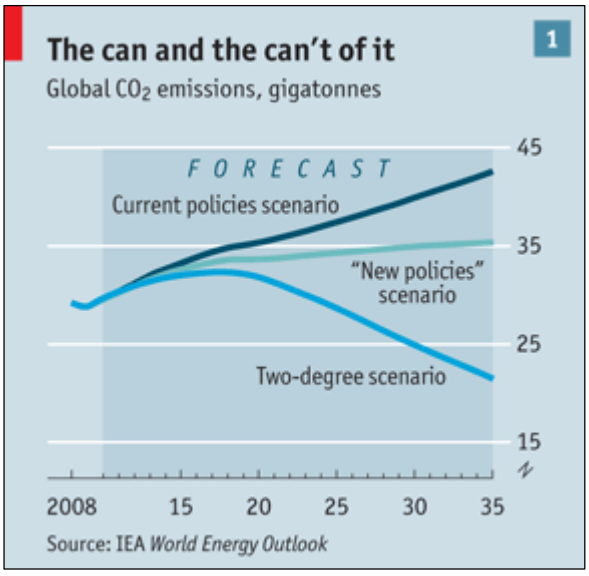
Global action is not going to stop climate change. The world needs to look harder at how to live with it

ON NOVEMBER 29th representatives of countries from around the world will gather in Cancún, Mexico, for the first high-level climate talks since those in Copenhagen last December. The organisers hope the meeting in Mexico, unlike the one in Denmark, will be unshowy but solid, leading to decisions about finance, forestry and technology transfer that will leave the world better placed to do something about global warming. Incremental progress is possible, but continued deadlock is likelier. What is out of reach, as at Copenhagen, is agreement on a plausible programme for keeping climate change in check.

The world warmed by about 0.7°C in the 20th century. Every year in this century has been warmer than all but one in the last (1998, since you ask). If carbon-dioxide levels were magically to stabilise where they are now (almost 390 parts per million, 40% more than before the industrial revolution) the world would probably warm by a further half a degree or so as the ocean, which is slow to change its temperature, caught up. But CO_2 levels continue to rise. Despite 20 years of climate negotiation, the world is still on an emissions trajectory that fits pretty easily into the "business as usual" scenarios drawn up by the Intergovernmental Panel on Climate Change (IPCC).



The Copenhagen accord, a non-binding document which was the best that could be salvaged from the summit, talks of trying to keep the world less than 2°C warmer than in pre-industrial times—a level that is rather arbitrarily seen as the threshold for danger. Many countries have, in signing the accord, promised actions that will or should reduce carbon emissions. In the World Energy Outlook, recently published by the International Energy Agency, an assessment of these promises forms the basis of a "new policies scenario" for the next 25 years (see chart 1). According to the IEA, the scenario puts the world on course to warm by 3.5°C by 2100. For comparison, the difference in global mean temperature between the pre-industrial age and the ice ages was about 6°C. The IEA also looked at what it might take to hit a two-degree target; the answer, says the agency's chief economist, Fatih Birol, is "too good to be believed". Every signatory of the Copenhagen accord would have to hit the top of its range of commitments. That would provide a worldwide rate of decarbonisation (reduction in carbon emitted per unit of GDP) twice as large in the decade to come as in the one just past: 2.8% a year, not 1.4%. Mr Birol notes that the highest annual rate on record is 2.5%, in the wake of the first oil shock.

But for the two-degree scenario 2.8% is just the beginning; from 2020 to 2035 the rate of decarbonisation needs to double again, to 5.5%. Though they are unwilling to say it in public, the sheer improbability of such success has led many climate scientists, campaigners and policymakers to conclude that, in the words of Bob Watson, once the head of the IPCC and now the chief scientist at Britain's Department for Environment, Food and Rural Affairs, "Two degrees is a wishful dream."

The fight to limit global warming to easily tolerated levels is thus over. Analysts who have long worked on adaptation to climate change—finding ways to live with scarcer water, higher peak temperatures, higher sea levels and weather patterns at odds with those under which today's settled patterns of farming developed—are starting to see their day in the uncomfortably hot sun. That such measures cannot protect everyone from all harm that climate change may bring does not mean that they should be ignored. On the contrary, they are sorely needed.

Public harms

Many of these adaptations are the sorts of thing—moving house, improving water supply, sowing different seeds—that people will do for themselves, given a chance. This is one reason why adaptation has not been the subject of public debate in the same way as reductions in greenhouse-gas emissions from industry and deforestation have. But even if a lot of adaptation will end up being done privately, it is also a suitable issue for public policy.

For a start, some forms of adaptation—flood barriers, for instance—are clearly public goods, best supplied through collective action. Adaptation will require redistribution, too. Some people and communities are too poor to adapt on their own; and if emissions caused by the consumption of the rich imposes adaptation costs on the poor, justice demands recompense.

Furthermore, policymakers' neat division of the topic of climate change into mitigation, impact and adaptation is too simplistic. Some means of adaptation can also act as mitigation; a farming technique which helps soil store moisture better may well help it store carbon too. Some forms of adaptation will be hard to distinguish from the sort of impact you would rather avoid. Mass migration is a good way of adapting if the alternative is sitting still and starving; to people who live where the migrants turn up it may look awfully like an unwelcome impact.

Its frequently private and slightly blurry nature is not the only reason why adaptation has been marginalised. The green pressure groups and politicians who have driven the debate on climate change have often been loth to see attention paid to adaptation, on the ground that the more people thought about it, the less motivated they would be to push ahead with emissions reduction. Talking about adaptation was for many years like farting at the dinner table, says an academic who has worked on adaptation over the past decade. Now that the world's appetite for emissions reduction has been revealed to be chronically weak, putting people off dinner is less of a problem.

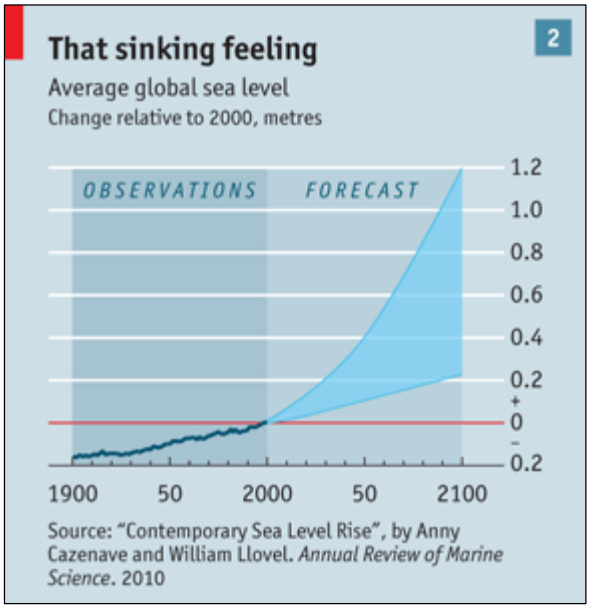
Another reason for taking adaptation seriously is that it is necessary now. Events such as this year's devastating floods in Pakistan make it obvious that the world has not adapted to the climate it already has, be it man-made or natural. Even if the climate were not changing, there would be two reasons to worry about its capacity to do more harm than before. One is that it varies a lot naturally and the period over which there are good global climate records is short compared with the timescale on which some of that variability plays out. People thus may be ignoring the worst that today's climate can do, let alone tomorrow's. The other is that more lives, livelihoods and property are at risk, even if hazards do not change, as a result of economic development, population growth and migration to coasts and floodplains.

The three-degree difference

In a late 21st-century world 3°C warmer than the pre-industrial norm, what changes are most marked? Start with the coldest bits. Arctic summer sea ice goes, allowing more shipping and mining, removing a landscape of which indigenous peoples were once an integral part. Permafrost warms up, and infrastructure built on it founders. Most mountain glaciers shrink; some disappear. Winter snows melt more quickly, and the risks of spring floods and summer water shortages on the rivers they feed increase.

Sea level rises, though by how much is hard to say (see chart 2). Some of the rise will be predictable, in that oceans expand as they get warmer. Some, though, will depend on the behaviour of the Greenland and West Antarctic ice caps, which cannot be predicted with any certainty. Less than half a metre by 2100 would be a lucky break; a metre-plus is possible; more than two is very unlikely, but possible later.

Even as the waters rise, many coasts will be sinking because of the subsidence that follows as cities suck up groundwater. Deltas are doubly damned, since any subsidence is often coupled with a lessened supply of replenishing sediment, which is often trapped upstream by irrigation, hydropower production and flood-control projects. One estimate puts 8.7m more people at risk of flooding in deltas by 2050 if sea level follows current trends.



Tropical cyclones, which account for much of the damage the sea does to the land, may become less frequent. But the share of the most destructive—category 4 and category 5 hurricanes—seems likely to increase. And bigger storms do disproportionately greater damage.

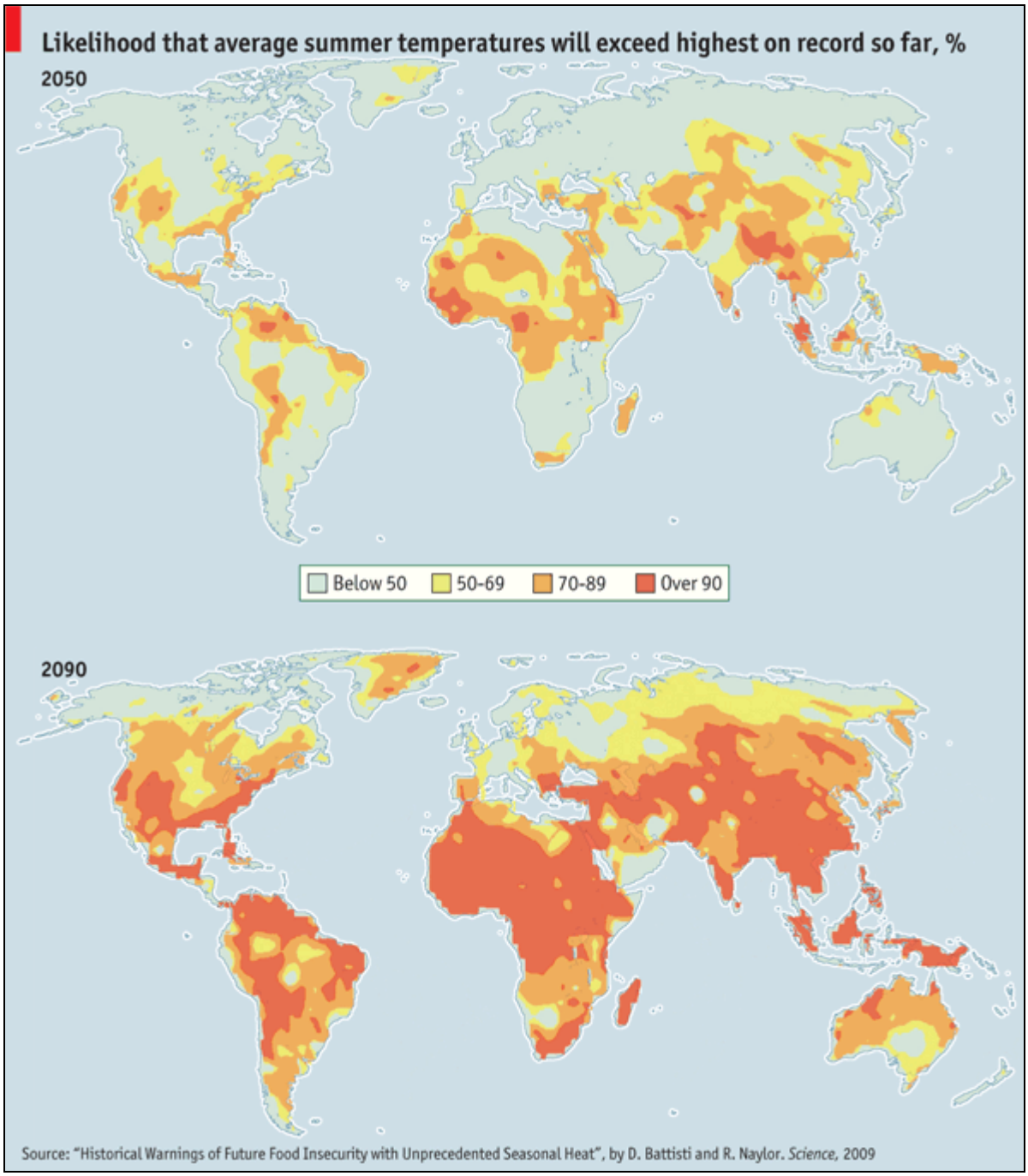
In warmer oceans, coral bleaching triggered by temperature stress will be more common. This is bad for fishing and tourism but not necessarily fatal to all the reefs: bleached reefs may be recolonised by new corals. Reefs may also face damage from ocean acidification, an effect of higher CO_2 levels rather than of warming, as may other ecosystems, though the size of the impacts is uncertain. In warmer oceans nutrients in deeper water will be less easily recycled to the surface, which may lead to lower biological productivity overall. On land, wet places, such as much of South-East Asia, are likely to get wetter, and dry places, such as much of southern Africa and the south-western United States, drier. In northern climes some land will become more suitable for farming as springs come sooner, whereas in the tropics and subtropics some marginal land will become barely inhabitable. These places may be large sources of migration. Such effects are already visible in, for example, the large part of the population of Côte d'Ivoire who come from Burkina Faso.

Increases in average temperature will be less noticeable than those in extremes. According to a comparison of over 20 climate models, by 2050 the probability of a summer warmer than the warmest yet recorded will be between 10% and 50% in much of the world. By 2090 it will be 90% in many places (see map).

Watching the weather

People will also have to contend with unpredictable shifts in weather patterns. Many models say the factors that give rise to the Indian monsoon are likely to weaken. The strength of the rainfall within it, though, is likely to rise, because the air will be warmer, and warmer air can hold more water. No one can say how these two trends will play out. Similar uncertainties dog predictions about the great slopping of warmth back and forth across the Pacific known as El Niño and other climatic oscillations. In general, the closer you want to get to firm statements about what is likely to happen, the less adequate current climate science is revealed to be.

It is tempting to imagine that adaptation decisions might wait for models that can provide greater certainty about what might happen where. This is a forlorn hope. Faster computers and new modelling techniques might well provide more details and finer distinctions. But they will not necessarily be more accurate, or capable of being shown to be so: if different models become more precise and as a result their disagreements grow rather than shrink, which are you going to trust? Decisions about adaptation will be made in conditions of pervasive uncertainty. So the trick will be to find ways of adapting to many possible future climates, not to tailor expectations to one future in particular.



Even then, adaptation can help only up to a point. A 2009 review of the cost of warming to the global economy suggests that as much as two-thirds of the total cannot be offset through investment in adaptation, and will be felt through higher prices, lower growth and misery regardless. But adaptation can still achieve a lot.

The best starting point for adaptation is to be rich. It is not foolproof: not even the rich can buy off all hazards, and rich countries and individuals will make poor decisions. The need to restrict farming with subsidised water in a drier south-western United States does not mean that the political means of doing so will be found before damage is done. But wealth buys information (a lot of people are studying what to do in the south-west) and it opens up options. Resources help people adapt both before the fact, by reducing risks, and after it, by aiding recovery from harm.

Wealth can create hedges against the effects of climate change, even if they are not conceived of as such. Insurance markets are a case in point, though they have flaws: a lack of relevant history makes evolving risks

hard to price, and government policies often dampen the signals that would otherwise make people more realistically wary of coasts and floodplains. Public-health systems are another: in better-off countries these did far more to reduce the effects of malaria in the 20th century than warming did to worsen them. Economic development should see improvements in health care that will, in aggregate, swamp the specific infectious-disease threats associated with climate change.

The indiscreet charm of being loaded

Rich countries can also afford big, expensive projects. Studies suggest that although much of the Netherlands lies below sea level or is at risk of river flooding, the Dutch can view the prospect of a rising sea level with a certain equanimity, at least for their own land. Plans outlined in 2008 to deal with a rise of more than two metres by 2200, as well as increased winter flow along the Rhine and Meuse rivers, put the cost of holding at bay the worst flood expected for 10,000 years at €1 billion-2 billion ($1.5 billion-3 billion) a year for a century. That is easily affordable.

Other rich coastal areas have considered similar commitments. The Marina Barrage offers Singapore some protection against floods, as well as improving its ability to store fresh water. London has its Thames Barrier, first imagined after floods in 1953. The barrier was intended to deal with the worst flood expected over a millennium or more. That period looks more testing now than when the barrier was built, but Britain's Met Office thinks the barrier, combined with other measures, is pretty much fit for purpose for this century.

London versus the ocean

New York might, in principle, protect itself against a hurricane-driven storm surge on top of a higher sea level with a much more massive set of barriers that could seal the Verrazano Narrows and the smaller spans of Throgs Neck, at the base of Long Island Sound, and the Arthur Kill, west of Staten Island. However, as Matthew Kahn, an economist at the University of California, Los Angeles, points out in his book, "Climatopolis", the politics of such huge and hugely costly engineering might prove difficult. New Amsterdam does not have the attitudes of old Amsterdam.

Poor countries will often lack the financial means, technical expertise or political institutions necessary for such endeavours. Yet they are often at increased risk, principally because they are usually more dependent on farming than rich countries, and no other human activity is so intimately bound up with the weather. Crops are sensitive to changes in patterns of rainfall and peak temperature, as well as to average temperature and precipitation; so are the pests and diseases that attack them.

In its 2007 assessment, the IPCC's picture of agriculture in a warmer world was one of two halves. In low latitudes higher temperatures are likely to shorten growing seasons and stress plants in other ways. In high latitudes, if warming is moderate, growing seasons are expected to lengthen and yields to rise, in part because raised CO_2 levels aid photosynthesis.

The IPCC thus sees agriculture as being not too badly affected by 2°C of warming, as long as you stick to global averages. Above that (probably towards the end of the century) things look bad. Some think they look bad well before that. One worry is that a lot of harm may be done if temperatures breach certain thresholds

even briefly. A fine-grained analysis of historical data from the United States by Wolfram Schlenker of Columbia University and Michael Roberts of North Carolina State University found such thresholds for maize (corn), soya and cotton, America's largest crops by value. One extremely hot day, their model suggests, can cut annual productivity by 7%. Applying their findings to models of a world with unabated emissions, they found yield declines of 63-82% by the end of the century, with hefty drops even in the relatively clement first half.

This study, like many, made no provision for CO_2 fertilisation. The question of how to do so is vexed. If plants grow in chambers with high concentrations of CO_2, yields rise a lot (which is why tomato farmers and others use CO_2 in their greenhouses). More realistic experiments using carefully contrived sprays of CO_2 upwind of crops show a much lower bonus. Remarkably, experiments like this, which provide the nearest analogues to what the world may be like in a few decades' time, are carried out in only a handful of places. None regularly looks at tropical crops.

Against the uncertainty over thresholds and CO_2 fertilisation must be weighed farmers' ability to adapt to change and improve yields. Despite many warnings of doom, yields of arable crops have grown remarkably in the past half-century. Among other things, this intensification of farming has saved a great deal of wilderness from the plough: to feed today's population with 1960's yields would require an area of extra farmland roughly as big as Russia. In that it avoids deforestation, intensification is one of a number of adaptation strategies which also help mitigation.

Successful adaptation will require not just expanded research into improved crop yields and tolerance of temperature and water scarcity, but also research into new ways of managing pests, improving and conserving soil, cropping patterns and crop-management techniques that add resilience. Such research—and its application—will make it more likely that enough food for 9 billion people can be grown in a three-degrees-hotter world without much of the planet's remaining uncultivated land or pastures coming under the plough.

If yields cannot be improved sufficiently, though, desperation may lead to more wilderness being uprooted or burned. A headlong rush for biofuels might have similar effects. This would be one of those adaptations to climate change that looked a lot like an adverse impact. Faster loss of species is highly likely in many ecosystems as a result of warming; greatly expanding farmlands will make this worse. It will also add to the fundamental problem, as clearing forests releases greenhouse gases.

Keeping the poor always with us

Even if the world contrives to keep feeding itself without too much ecosystem damage, many of those dependent on agriculture or in poverty could still suffer a great deal. Regional droughts could wreak havoc, with bad ones causing global surges in food prices.

Many of the millions of poor farming households in poor countries, who make up the bulk of the world's agricultural labour force if not its agricultural output, already face more variable weather than farmers in temperate countries do. That and a lack of social safety-nets makes most of them highly risk-averse, which further limits their ability to undertake some adaptation strategies, such as changing crop varieties and planting patterns. They will often prefer surer chances but lower yields. Worse, in bad weather a whole region's crops suffer together.

Here as elsewhere, there is a role for insurance to transfer and spread the risks. Marshall Burke of the University of California, Berkeley, a specialist in climate impacts, argues that the best agricultural-insurance options for developing countries will pay out not when crops fail (which reduces incentives for the farmer) but when specific climatic events occur, such as rainfall of less than a set level. But getting farmers to invest in such schemes, even with small premiums, is hard. It also requires finding reinsurance for the local insurer, because there is a high chance of a lot of claims coming in at once. What's more, actuarial accounts of future climate risk are necessarily speculative and error-prone.

Farmers may be cheered by the thought that food prices are likely to rise. For poor farmers, who spend much of their income on food, this is a mixed blessing, especially if higher frequencies of drought make prices more volatile too. For poor people more generally, it is even worse news.

Even if prices are higher, crops more resilient and insurance more readily available, abandoning the farm may be the way many farmers choose to adapt. It may be prudent even before the fact. Paul Collier, Gordon Conway and Tony Venables, three British development specialists, have suggested that attempts to provide anticipatory help to poor African farmers could be badly overdone. Better to encourage them into cities and to reform labour markets, restrictions on the opening and closing of firms and so forth in ways that will help them earn money.

More than half the world's people live in cities already. Three-quarters or more may do so by mid-century. Encouraging this trend further, at least in some places, may be a useful way of reducing the economy's exposure to climate change. Statistical analyses by Salvador Barrios of the European Union's Joint Research Centre and his colleagues suggest that climate change is already a factor in African urbanisation. A related study shows strong climate effects on sub-Saharan agriculture in Africa not seen elsewhere, which is not perhaps surprising given the huge effect of the 1980s droughts across the Sahel.

A downside to urbanisation is that cities are hotter than the surrounding countryside, creating what meteorologists call "urban heat islands". But there are ways of dealing with this. More greenery in a city, spread through streets and over roofs, means more cooling as water evaporates from leaves; the bits which are not green can be painted white, to reflect sunlight.

And cities have intrinsic advantages. City dwellers' emissions per person tend to be lower, and the more planners can do to increase population density the better. Protecting a single port city from floods is easier than protecting a similar population spread out along a coastline of fishing villages (though when things go wrong disasters can be correspondingly larger and harder to address). Cities have higher rates of innovation and of developing new businesses, business models and social strategies, formal or informal.

Ideally, there would be opportunities to move to cities in other countries, too; the larger the region in which people can travel, the easier it is to absorb migrants from struggling areas. This is one reason why adaptation is easier for large countries or integrated regions. Within the EU, Greeks and Italians will be better placed to move to cooler climes than inhabitants of similarly sized countries elsewhere.

Powers of example

The cost of all this adaptation is hard to judge—and is another area where adaptation and impact become confused. Melissa Dell of the Massachusetts Institute of Technology and her colleagues argue that in developing countries GDP growth has been lower in hotter years than in cooler ones. This may carry over into longer-term increases in temperature. The mechanism is obscure: it may simply be that overheated people work less hard. That can be seen either as adaptation or as a worrying impact, slowing down the economic growth which is the surest foundation for other, more positive adaptations.

If climate change does slow poor countries' growth rates, the onus on rich ones to help will be even larger. This was recognised to some extent in the Copenhagen accord, which proposed that $100 billion a year should flow from north to south by 2020, to be split between investments in mitigation and adaptation. But whereas investments in mitigation are fairly easy to understand—build windmills not coal-fired power stations, and so on—those in adaptation are harder to grasp. Action on climate bleeds into more general development measures.

The poorest countries all have wish-lists for adaptation funding, drawn up in the UN climate-convention process of which the Copenhagen and Cancún meetings are part. Money and know-how are essential, but so is example. Rich countries can show, through their own programmes for flood defence, zoning laws, sewerage and so on that adaptation must be part of the mainstream of political and economic life, not an eccentric and marginal idea. Adaptation by and for the poor alone is likely to be poor adaptation.