PART VI

Burden Sharing and Development

26 Poverty and climate change: Natural disasters, agricultural impacts and health shocks

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The international community aims to eradicate extreme poverty, and to do so in a sustainable manner. This chapter suggests that climate change poses a major obstacle to this challenge. Climate-related shocks and stresses – from natural disasters, to agricultural impacts and health shocks – already prevent households from escaping poverty. Poor people are disproportionally vulnerable to these shocks, because they are more exposed and lose more when affected. Climate change will worsen the situation, making it more difficult to eradicate poverty in a sustainable manner. Many policy options are available to help reduce poor people's risk and vulnerability, including building climate-smart infrastructure, providing universal health coverage, implementing social safety nets that can be scaled-up and rapidly targeted towards people affected by a shock, and facilitating migration. With regards to natural hazards, agricultural impacts and health shocks, climate change makes existing priorities more urgent. If addressed correctly, this urgency can turn into an opportunity to reduce both current poverty and future climate vulnerability, before most of the impacts of climate change materialise.

1 The impacts of climate change: Should we focus on poverty instead of GDP?

Estimates of the economic cost of climate change have always attracted interest and debate among policymakers and the public. These estimates, however, have mostly been framed in terms of the impact on country-level or global GDP, which does not capture the full impact of climate change on people's well-being.

One reason is that such estimates do not reflect distribution. The distribution of climate impacts – that is, which countries, regions and people are hit – will determine their effects on well-being. Three-quarters of global income belongs to North America, Europe, and East Asia; the other regions are economically much smaller, and in particular sub-Saharan Africa, which only generates 2% of global income (World Bank 2015). The location of impacts to GDP therefore matters.

Equally important is the fact that the impacts of climate change will be highly heterogeneous within countries. If the impacts mostly affect low-income people, the welfare consequences will be much larger than if the burden is borne by those with a higher income. Poor people have fewer resources to fall back on and lower adaptive capacity. And – because their assets and income represent such a small share of national wealth – poor people's losses, even if dramatic, are largely invisible in aggregate economic statistics.

Investigating the impact of climate change on poor people and on poverty requires a different approach, focused on people that play a minor role in aggregate economic figures and are often living within the margins of basic subsistence. Such an approach was behind a research programme on 'Poverty and climate change' at the World Bank, and this chapter is based on some of the programme's results (for a comprehensive presentation of the results, see Hallegatte et al. 2016). The research starts from the idea that poverty is not static, and poverty reduction is not a monotonic, one-way process. Over time, some people build assets and move out of poverty while others experience shocks and are pulled into poverty. What we call poverty reduction is the net result of these mechanisms. For instance, Krishna (2006) documents poverty dynamics in 36 communities in Andhra Pradesh, India, over 25 years. Each year, on average 14% of households escaped poverty while 12% of non-poor households became poor, so that,

overall, poverty was reduced by 2% per year. These numbers show that a relatively small change in the flows in and out of poverty has a significant effect on overall poverty dynamics. For instance, increasing the flow into poverty by 10% is enough to halve the rate of poverty reduction.

Climate change can affect the flow of people into poverty. In the Andhra Pradesh sample, drought is a major factor – a household affected by drought in the past was 15 times more likely to fall into poverty (Krishna 2006). Droughts may also result in people falling into poverty traps as a result of asset losses. They often affect human capital, especially for children who may be pulled out of school or suffer permanent health consequences (Carter et al. 2007). Even just the risk of a drought can lead poor people to invest in low-risk but low-return activities, perpetuating poverty (Elbers et al. 2007). An impact of climate change on drought frequency and intensity could therefore hamper poverty reduction, with more people falling into and fewer people escaping poverty.

But droughts and natural hazards are not the only climate-sensitive factors to affect the flows in and out of poverty. Agricultural income and food prices matter, as do health shocks. The next sections investigate the following major channels through which climate change affects poverty dynamics: natural hazards, agriculture and health. Of course, many other factors play a role, but these three channels already have well-documented impacts on poor people and poverty reduction, and will be affected by future climate change.

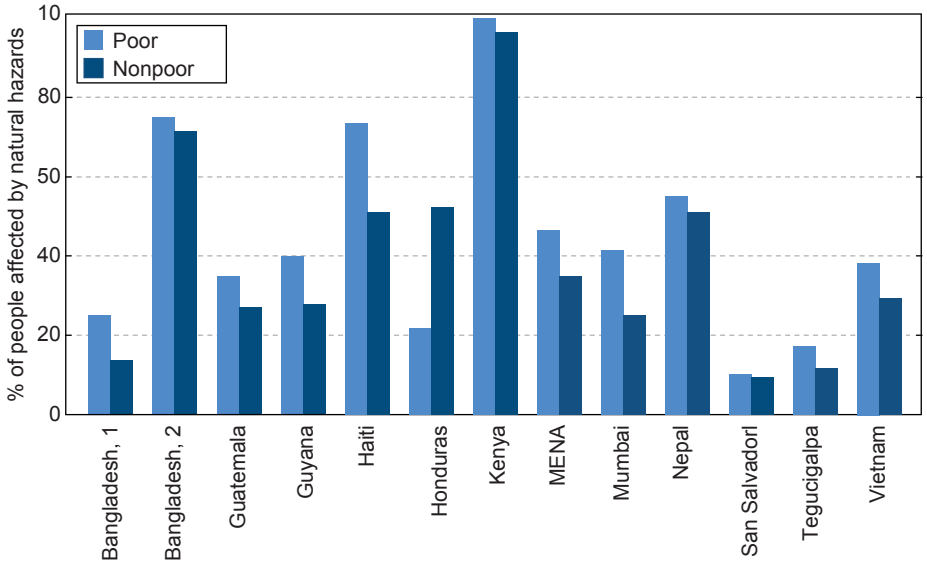
2 Natural hazard impacts

In some regions, natural hazards such as floods, droughts, and extreme temperatures will increase in frequency or intensity as a result of climate change. The exposure, vulnerability, and lack of adaptive capacity of poor people puts them at particular risk.

Regarding exposure, it is often the case that poor people live in risky areas. A number of case studies have examined the exposure of poor and non-poor people to disaster risk, with most finding poor people to be more exposed (Figure 1). For instance, when

large-scale floods hit the Shire River Basin in Malawi in January 2015, the areas with the highest exposure were also the poorest (Winsemius et al. 2015).

Figure 1 Several studies have examined the exposure of poor and non-poor people to natural hazards. All but one case reviewed find poor people are more exposed than non-poor people.



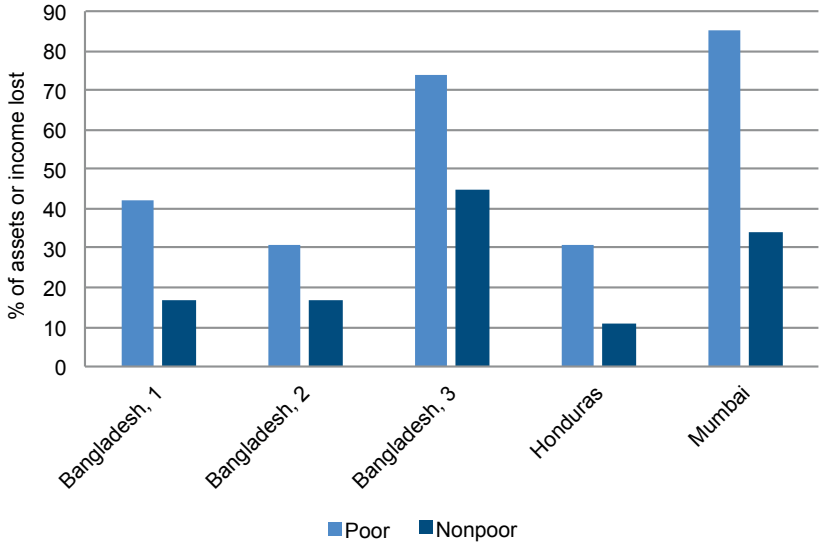
Note: MENA = Middle East and North Africa.
Source: Winsemius et al. (2015).

But the relationship between poverty and exposure to risk is not straightforward. Causality runs in both directions: poor people sometimes choose to settle in risky areas where land is available or affordable; and living in risky areas may make people poor when hazards destroy assets and livelihoods. But poor people are not always more exposed; for instance, flood-prone coastal or river areas benefit from low transport costs that attract firms and opportunities, and the wealthier populations in a country. In these cases, rich people may be the ones most exposed. In-depth analyses find no systematic overexposure of poor people to floods at the national level, although poor people are often the most exposed within a city or a region (Winsemius et al. 2015).

While not systematically more exposed, poor people are certainly more vulnerable when a disaster strikes and lose larger shares of their assets or income. This is because

poor people hold a large fraction of assets in material and vulnerable form (rather than as financial savings in a bank), live in lower-quality housing (such as slums), and depend on lower-quality infrastructure (such as non-paved roads). In the small number of surveys that compare asset and income losses of poor and non-poor people after floods and storms, poor people are found to lose a larger share (Figure 2). With regards to droughts, the fact that poor people are more dependent on agricultural income makes them more vulnerable (see Section 3). In the future, these vulnerabilities will evolve as the share of people in agriculture changes and as differences between poor and non-poor people are reduced (for example, in terms of building quality and access to infrastructure).

Figure 2 Generally, poor people lose a larger percentage of assets or income after floods and storms.



Note: Each study has a different definition of 'poor' and 'non-poor' in their sample. Vulnerability depends on the type of hazard and context in which it occurs; even within the same country (Bangladesh), vulnerability measures vary greatly based on location and severity of flooding. The first three studies use percent of income loss as a metric, while the Honduras and Mumbai cases use asset loss.

Source: Based on Brouwer et al. (2007) for Bangladesh (1); del Ninno et al. (2001) for Bangladesh (2); Rabbani et al. (2013) for Bangladesh (3); Carter et al. (2007) for Honduras; and Patankar and Patwardhan (2014) for Mumbai.

In addition, poor people often have more limited access to social protection, a factor that makes them more vulnerable after disasters. A consistent finding across countries is that transfers (from social protection and labour markets) received are much lower for poor

people (ASPIRE 2015). For example, in Colombia, the poorest 20% receive on average US$0.23 per person per day, while the richest 20% receive $4.60. Even after a disaster, ad hoc schemes to provide compensation have not targeted poor people, as evidenced by the 2005 Mumbai floods (Patankar 2015) and the 2011 Bangkok floods (Noy and Patel 2014). With less income coming from transfers and less savings, poor households are more dependent on their labour income for their consumption, making them more vulnerable to shocks and lost days of work (their inability to smooth consumption can even translate into avoidable health impacts, as discussed in Section 4).

It is therefore no surprise that natural disasters have a well-documented impact on poverty (Karim and Noy 2014). For example, at the municipal level in Mexico, Rodriguez-Oreggia et al. (2013) find that floods and droughts increased poverty by between 1.5% and 3.7% from 2000 to 2005. To compound these effects, disasters often result in reduced food consumption for children as well as interrupted schooling, with likely lifelong impacts such as stunting and reduced earning capacity (Alderman et al. 2006).

But looking only at the impact of actual disasters may underestimate the effect of risk on development and poverty. Ex ante, in the presence of uninsured weather risk, poor households engage in low-risk, low-return activities, perpetuating poverty. This ex ante effect, while much less visible, can dominate ex post impacts of disasters (Elbers et al. 2007). While progress has been made in recent years, many poor people remain uninsured and they exhibit lower financial inclusion than non-poor people (FINDEX 2015).

Climate change will worsen the frequency and intensity of natural disasters in some regions (IPCC 2014), but future impacts will depend not only on climate change, but also on the policies and actions implemented to manage risk. Land-use planning – especially in growing cities – is critical to ensure that new development is resilient and adapted to a changing climate (Hallegatte et al. 2013). Early warning systems, hard and ecosystem-based protection against floods, preservation of ground water, and improved building quality for poor people are all policies that can save lives and reduce asset losses. Providing options to poor households to save in financial institutions is critical to protect their savings. Social protection that can be scaled up after a disaster, and targeting instruments that are able to identify affected households and deliver aid in a

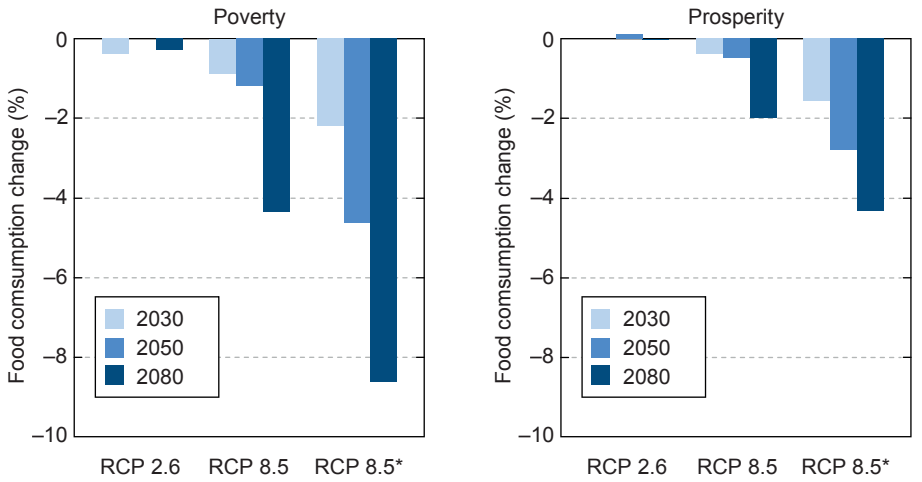
timely fashion to those who need it can help avoid long-term, irreversible consequences and poverty traps (Pelham et al. 2011).

3 Agricultural impacts

Climate change will impact agricultural and land productivity, especially for major crops (wheat, rice and maize) in tropical and temperate regions, with higher emissions pathways worsening the impacts (Porter et al. 2014). Under the most optimistic climate scenario – and with CO_2 fertilization (an effect that suggests plants can improve photosynthesis and productivity with higher CO_2 concentrations) – crop yields may decrease globally by 2% by 2030; but if emissions continue unabated, the reduction could amount to 6% by 2050 and 14% by 2080. And without CO_2 fertilization, the impacts may be even more severe, with yields falling by 10% and 33% by 2030 and 2080, respectively (Havlík et al. 2015). But the global impacts will not be uniform across crops and regions. These impacts are also extremely uncertain – they depend on the extent to which CO_2 fertilization materialises, the availability of water, and the development of new varieties and techniques better suited to future climates.

Productivity impacts will be transmitted through markets, with very uncertain impacts on food prices; the IPCC suggests that global food prices may vary between -30% and +45% (Porter et al. 2014). Higher food prices would reduce consumption, but modelling exercises show the final effect will depend not only on the change in climate, but also on the socioeconomic context, including GDP growth and access to global food markets. Food security concerns are less in a world with fast economic growth and low poverty (a 'Prosperity' scenario) compared to a world with slow growth and high poverty (a 'Poverty' scenario). For instance, under RCP 8.5 (a high emissions scenario) without CO_2 fertilization, global losses in food consumption are estimated at 2.5% and 4% for 2050 and 2080 in the Prosperity scenario, while the figures are over 4% and 8% in the Poverty scenario (Figure 3).

Figure 3 Impact of climate change on food consumption for three climate scenarios, three time periods and two socioeconomic scenarios (Prosperity and Poverty)



Note: The climate scenarios are: RCP2.6, a low emission scenario; RCP8.5, a high emission scenario; and RCP8.5*, a high emission scenario without the (uncertain) effect of CO_2 fertilization. Impacts are much less severe under the Prosperity scenario.

Source: Havlík et al. (2015).

Any change in food consumption will be particularly severe for poor people, who spend a larger share of their budget on food (62% on average, compared to 44% for non-poor people; see Ivanic and Martin 2014). Poor people in urban areas often have higher shares than rural people, as the latter may produce some of their own food to cover their needs.

Increased food scarcity is likely to translate into more 'food crises' during which food prices rise rapidly, for instance due to weather- or pest-related reductions in production in a major producer country. As illustrated by the spike in 2008, such episodes have a major impact on poverty, and studies suggest that future increases will have significant impacts. In the absence of safety nets and economic adjustments, a number of countries – including Guatemala, India, Indonesia, Pakistan, Sri Lanka, Tajikistan and Yemen – could suffer from an increase in extreme poverty of 25 percentage points if faced with a 100% food price increase, with severe impacts in urban areas (Ivanic and Martin 2014).

But for food producers, an increase in food prices is not necessarily a bad outcome. The final impacts will depend on how changes in prices and in productivity balance (an increase in food prices due to reduced productivity does not automatically lead to increased revenues) and on how increased revenues are distributed among farm workers and landowners (Jacoby et al. 2014). Taking a comprehensive view of farm households (i.e. both their consumption and production), Hertel et al. (2010) argue that such households may benefit from climate impacts if the shock is widespread, farm-level demand for their production is inelastic (while the supply response is low), there are few sources of off-farm incomes, and food represents a relatively small share of expenditures.

In some areas, however, transformational change in the production sector will be required. For instance, in Uganda, coffee production is a central activity, employing more than 2 million people and contributing close to US$400 million to the national economy in 2012. But climate change will make growing coffee increasingly difficult in the next decades, making it necessary for the local economy to restructure around a different crop or sector (Jassogne et al. 2013). Going through such large-scale transformations is highly challenging; in the 1930s, the Dust Bowl eroded large sections of the Great Plains in the US (an area previously renowned for agriculture), and the impacts endured for decades (Hornbeck 2012).

Vulnerability to agricultural impacts will be shaped by the future of poverty and by future market structure and access. Evidence suggests that remote markets have higher price volatility (Ndiaye et al. 2015). Enhancing road infrastructure can strengthen links between rural markets and urban consumption centres, stabilising prices. And the share of their income that people spend on food will decrease as people escape poverty, making the consequences of higher food prices more manageable in the future (if poverty decreases as rapidly as expected, and if poverty reduction reaches the remote rural areas where it is largely absent at the moment) (Ravallion 2014).

4 Health impacts

Health shocks are the leading reason why households fall into poverty (Moser 2008). They affect households through many channels: the direct impact on well-being; the

consequences of the death of a family member; loss of income when a family member cannot work; expenses from care and drugs, especially in the absence of health insurance; and time and resources spent on caregiving.

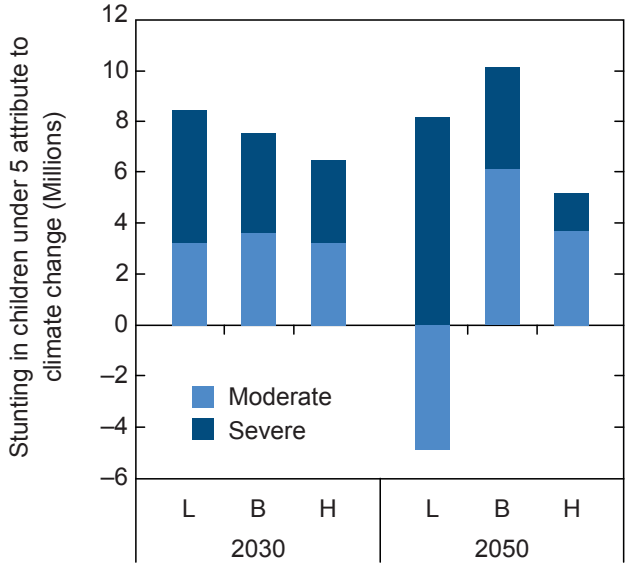
This is why the effect of climate change on health is particularly worrisome.

Impacts can occur through increased natural disasters, which have well-documented health effects. Disasters directly impact health through fatalities and casualties, particularly in low-income and lower-middle-income countries, which account for only a third of all disasters but more than 80% of all deaths (UNDP, UNICEF, OXFAM and GFDRR 2014). After a disaster, health conditions worsen when there is inadequate food, water and sanitation. The health effects also surge when affected poor households cannot smooth consumption – a drop in income often translates into reduced food intake, with potentially long-term effects on child development, affecting for example future strength, cognitive capacity and earning potential (Alderman et al. 2006).

As well as from disasters, health impacts also occur from environmental disruptions to crop productivity and food availability (Smith et al. 2014). One example is under-nutrition, which is not only influenced by crop productivity and food availability, but also by water quality and access to sanitation. Climate change is expected to increase stunting, with up to 10 million additional children stunted under a base case economic growth scenario in 2050 (Lloyd et al. 2011, Hales et al. 2014) (Figure 4). Some regions will be particularly affected, with cases of severe stunting possibly increasing by up to 23% in sub-Saharan Africa and 62% in South Asia (Lloyd et al. 2011). These trends are all the more alarming considering that moderate stunting increases the risk of death by 1.6 times and severe stunting by 4.1 times (Black et al. 2008).

Climate change will also change patterns of vector-, soil- and waterborne diseases, introducing them into new areas (Smith et al. 2014). The combined effects of temperature fluctuation, coastal salinity, humidity, heavy rainfall, flooding and drought can contribute to outbreaks of diseases such as schistosomiasis, cholera, malaria and diarrhoea (Cann et al. 2013, Hales et al. 2014).

Figure 4 Additional number of children aged under five years stunted due to climate change in 2030 and 2050 under low growth (L), base case (B) and high growth (H) socioeconomic scenarios.



Source: Hales et al. (2014).

All of these diseases affect poor people more than the rest of the population, and children more than adults. They also have an impact on income and economic growth. These micro-level impacts translate into lower macroeconomic growth; Gallup and Sachs (2001) find that countries with intensive malaria grew 1.3% slower than other countries in the period 1965-1990.

Estimates suggest that 3% of global diarrhoea cases can be attributed to climate change, and the frequency of malaria cases may increase by up to 10% by 2030 in some regions (WHO 2009). Higher temperatures are one reason for this: a study in Lima, Peru, found a 4% increase in hospital admissions for diarrhoea for each 1°C temperature increase during warmer months, and a 12% increase for every 1°C increase in cooler months (Checkley et al. 2000).

We can only begin to measure the global burden of disease from climate change, but observed patterns are worrisome. A recent synthesis of five key aspects – under-nutrition, malaria, diarrhoea, dengue and heat waves – estimates that under a base case

socioeconomic scenario and a medium/high emissions scenario, approximately 250,000 additional deaths per year between 2030 and 2050 will be attributable to climate change (Hales et al. 2014).

But the future burden of disease will depend on development. Despite rising temperatures in the twentieth century, malaria rates dropped significantly. This is because socioeconomic trends – urbanisation, development, and improvements in health facilities – matter much more for controlling malaria than climate impacts (Gething et al. 2010). Development objectives such as achieving universal health coverage by 2030 could contribute greatly to adapting to climate change impacts on health. In fact, the recently released Lancet report on health and climate change declared that responding to climate change could be "the biggest global health opportunity of the 21st century" (Watts et al. 2015).

5 How can we achieve low-carbon resilient development?

While climate change impacts poverty, poverty reduction reduces vulnerability to climate impacts. The previous discussion highlights some of the benefits that development and poverty reduction can bring in terms of climate vulnerability. For instance, better social safety nets, improved access to financial institutions and insurance, and reduced inequality would mitigate the impact of disasters, and especially the irreversible impacts on children's health and education. Improved connection to markets – with better infrastructure and appropriate institutions – would protect consumers against large food supply shocks, and help farmers access the technologies and inputs they need to cope with a different climate. Basic services – for example, improved drinking water and sanitation and modern energy – can also help protect against some of the impacts of climate change, such as waterborne diseases and environmental degradation. And access to health care has been improving with development and growth in most countries, with the benefits being exemplified by reductions in child mortality and malaria.

Most importantly, development and climate mitigation need not be at odds with each other. Evidence suggests that raising basic living standards for the world's poorest will have a negligible impact on global emissions (Rao et al. 2014, Fay et al. 2015). Initiatives

such as the UN's 'Sustainable Energy for All' can improve access to electricity and at the same time be compatible with a warming limit of 2°C (Rogelj et al. 2013). Making mitigation and poverty eradication compatible will require a sequenced approach where richer countries do more, special attention is given to the impacts of land-use-based mitigation on food production, and complementary policies (e.g. cash transfers) are introduced to protect poor people against negative side-effects of mitigation (Fay et al. 2015). In many cases, it will also require richer countries to support poorer countries to provide technologies and financing instruments.

The impacts of climate change will increase over time. There is therefore a window of opportunity to reduce poverty now and thereby reduce vulnerability tomorrow. Any climate agreement that aims to be workable and effective should have this goal of reducing vulnerability in mind, and be designed in a way that contributes to development and poverty eradication.

But not all development pathways reduce climate risks in the same way. Of course, low-carbon development mitigates climate change and reduces risks over the long term, benefiting everybody, particularly the poorest. In addition, resilient development would go further in reducing the impacts of climate change. But what does it entail? From our analysis, a few recommendations emerge:

- **Planning for a different (and uncertain) climate**. Many investment and policy decisions have long-term consequences. The effect of transport infrastructure on urban form and economic activity can be observed over long timeframes, sometimes even after the infrastructure has become obsolete (Bleakley and Lin 2010). Policies such as urbanisation plans, risk management strategies, and building codes can influence development for just as long. Therefore, to ensure development is adapted not only to present but also to future conditions, plans must consider the performance of investments and decisions in the short and long term.

  But doing so is challenged by deep uncertainty – we cannot predict future climate conditions precisely, we do not know which technologies will appear, and we are unsure about socioeconomic conditions and future preferences. There is a risk of locking development into dangerous pathways, for instance by urbanising impossible-to-protect flood plains or by specialising in agricultural production at

risk of climate change. To avoid this, the planning process needs to investigate a large range of possible futures, and to make sure it does not create unacceptable risks when climate change and other trends are accounted for, especially if these changes differ from what is considered most likely today (Kalra et al. 2014). Such a robust approach leads to strategies that include safety buffers (e.g. adding safety margins around what areas are considered prone to flooding today), promoting flexibility (e.g. select solutions that can be adjusted over time as more information becomes available), and increasing diversification (e.g. developing the economic sectors that are less exposed to risk).

- **Improving access to healthcare**. Helping households manage health risks is already a priority, considering the role of these shocks in maintaining people in poverty. Climate change only makes this task more urgent and more important. Skilled health staff, with the right equipment and drugs, need to be available in all areas. But even if health care is available, the ability to afford health care is essential – about 100 million people fall into poverty each year due to having to pay for healthcare (WHO 2008). Increasing healthcare coverage and decreasing out-of-pocket expenses is a smart investment for development and poverty reduction, and would be an efficient tool to reduce climate change vulnerability. Doing so is possible at all income levels. For instance, Rwanda invested in a universal health coverage system after the 1994 genocide, with premature mortality rates falling precipitously, and life expectancy doubling (Binagwaho et al. 2014). Climate change does not dramatically change the challenges for the health sector, but emerging issues and diseases increase the importance of monitoring systems that can identify and respond quickly to new – and sometimes unexpected – emergencies.
- **Provision of well-targeted, scalable safety nets**. Safety nets can help manage weather shocks. During the 1999 drought in Ethiopia, the poorest 40% of the population lost almost three-quarters of their assets (Little et al. 2004). Today, Ethiopia's Productive Safety Net Program supports 7.6 million food-insecure people and builds community assets to counteract the effects of droughts. The programme has improved food security, access to social services, water supply, productivity, market access, and ecosystems (Hoddinott et al. 2013). Safety nets can also play a critical role in avoiding irreversible losses from under-nutrition,

but only if scaled-up and deployed quickly after shocks and targeted to the poorest and most vulnerable (Clarke and Hill 2013). In addition, the increasing impacts of natural disasters makes it essential for safety nets to be able to identify quickly those in need, and to scale-up and retarget support after a shock or disaster (Pelham et al. 2011).

Further, trends in climate conditions and risks mean that some places will become increasingly less suitable for development. As a result, temporary and permanent migration is an important risk-management tool, and can be an adaptation option. Independently of climate change, migration plays a key role in the ability of poor households to escape poverty by capturing opportunities for better jobs, higher pay, and improved access to services and education. Climate change may trigger more migration – for instance, if opportunities disappear because of climate impacts (for the example of coffee in Uganda, see Jassogne et al. 2013) – but may also impair migration, for example through increased conflict and exclusion (for an extended review, see Adger et al. 2014). Given the importance of mobility as an instrument for poverty reduction, it is critical that social protection does not lock people into places or occupations from which it will become harder for them to escape poverty. Portability of social protection (geographically and in terms of occupation) is therefore made even more important by a changing climate.

With regards to natural hazards, agricultural impacts and health shocks, climate change only makes existing priorities more urgent for many countries. If addressed correctly, this urgency can turn into an opportunity to reduce current poverty and future climate vulnerability simultaneously. Of particular importance are the high economic and health impacts that climate change could have on children. Without action to move towards low-carbon, resilient development now, we may lock ourselves into a future of increased intergenerational transmission of poverty.

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27 Policy options in low-income countries: Achieving socially appropriate climate change response objectives

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Low-income countries have been propelled through international discourse to accord higher priority to adaptation to climate change compared to mitigation. The INDC 'bottom-up' approach to reaching the 2°C target gives the flexibility for low-income countries to articulate policies responsive to the needs of their communities and national development priorities. These include the entitlement of developing countries to growth and reduced climate change-induced scarcity of natural resources like water, food, energy, wood and fiber. Therefore, the negotiations should strike a balance between mitigation and adaption and include financial support to carry out these policies in line with Article 4.7 of the convention on implementation of commitments by developing countries. In this spirit, this chapter recommends that the target output of COP21 should be a legally binding agreement applicable to all that would be based on the principles of the UNFCCC and, in particular, the principle of Common but Differentiated Responsibilities based on respective capabilities. Challenges with enforcement and the feasibility of all aspects of actions being legally binding should be anticipated.

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1 Introduction: Incorporating social inclusion in low-income development strategies

All developing countries aspire to rapid growth. Extrapolating from Somanathan's review of India's situation in this book, slowing down growth would be very economically, socially and politically costly for many developing countries. This focus on growth is notable in the position taken by the 'BRICS' (Brazil, Russia, India, China and South Africa) at UNFCCC negotiations and as shown by India's experience where, because of the need to safeguard committing only to what can be accommodated by national policy, the country submitted an INDC with a focus on reduction of CO_2 and not on the entire portfolio of GHGs (Moarif and Rastogi 2012). How such a decision will play with the rest of the low-income countries, and especially those that can benefit from methane auction due to their predominantly livestock economy, remains to be seen at COP21. In any case, efforts required to meet the demands of the Alliance of Small Island States (AOSIS) and those of Least Developed countries (LDCs) require strong mitigation efforts from the BRICs. This could threaten their rapidly growing economies.

Besides growth, social concerns are evident in the aspirations captured in continental development blueprints. For example, the Africa Union Agenda 2063 aspires that Africa should be "an integrated, prosperous and peaceful Africa, driven by its own citizens and representing a dynamic force in the global arena" (African Union 2014). Overall, Africa's Vision 2063 aspiration provides a foundation for policy orientation with respect to climate change negotiations in the sense that prosperity and peace cannot be achieved if climate-related natural disasters – which constitute up to 70% of disasters in countries like Kenya (Government of Kenya 2009) – lead to loss of achieved development and aggravate poverty. Indeed, summarising the evidence from 60 studies examining the links between climate and human conflict after controlling for location-specific and time-specific effects, Hsiang et al. (2013) conclude that a one standard deviation change in climate towards warmer temperatures or more extreme rainfall increases the frequency of interpersonal violence by 4% and intergroup conflict by 14%. These results suggest the possibility of amplified human conflict in the future as the inhabited world is expected to warm by between two and four standard deviations by 2050.

In pursuing this aspiration, African governments are initiating programmes on a continental scale that, if implemented effectively, should transform growth and human development towards a strategy that is compatible with the continent's environmental resources. For example, the free movement of people, goods and services among the East Africa Partner States and the pursuit of common climate change policies by the Regional Economic Communities are indications of the growing political will to pool and consolidate economic development to attain economies of scale benefits and associated efficiencies towards the Vision 2063. Such regional programmes present optimistic indications.

Addressing the social concerns of low-income countries should then drive the negotiation pathways that low-income parties adopt through the Group of 77 and China, the African Group of Negotiators (AGN), the Small Island Developing States (SIDS), and other low-income regional negotiation groups. The risks posed to the SIDS are particularly critical given that continued sea-level rise, which has already reached 0.19 meters according to the IPCC Fifth Assessment Report (AR5), is real and the sea level could rise by between 0.5 and 1.0 metres relative to 1986-2005 by the end of the century under a business-as-usual scenario (see the chapter by Stocker in this book).

Acknowledging the growth-related constraints on mitigation efforts by many high-emitter fast-growing middle-income countries, what are appropriate and implementable socially inclusive policy objectives for low-income countries and how should they pursue these objectives? Section 2 discusses these policies. Taking Kenya as an example, Section 3 discusses what could be an ambitious but implementable INDC for a low-income country. Section 4 gives examples of policies that have been carried out in this regard. Section 5 concludes with the commitments low-income countries should pursue at the negotiations.

2 Socially inclusive targets for low-income countries

The poor are generally more exposed to climate risks and more vulnerable because of their lesser resilience to negative shocks, especially so in low-income countries (see the chapter by Hallegate et al. in this book). On the environmental side, socially inclusive policies require securing the availability of environmental goods and services

like water, energy, food, biodiversity and quality air, as well as ensuring a healthy and hence productive population despite climate change.

Meeting these objectives will help low-income countries transition to de-carbonised lifestyles in their quest to reach 'secure middle-class status', i.e. when about 20% of the population has achieved that status.[2] Then, through their willingness to pay taxes, enough public goods are likely to be available and sufficiently 'good' policies are likely to be chosen to protect most of the population from adverse shocks.

Yet, 'good' policies are not a sufficient condition for the effective uptake of climate change mitigation, particularly in low-income countries where social expression of affluence is exhibited by 'living large' – multiple, large cars per household, a big house, food waste due to over-purchasing and so on, all of which are important contributors to GHG emissions. This is a major challenge for the low-income countries that are still far from having reached 'middle-class status' where the enforcement of climate-friendly policies is limited because of the confounding interplay between weak institutional settings, and the negative influence exercised by politically influential groups.

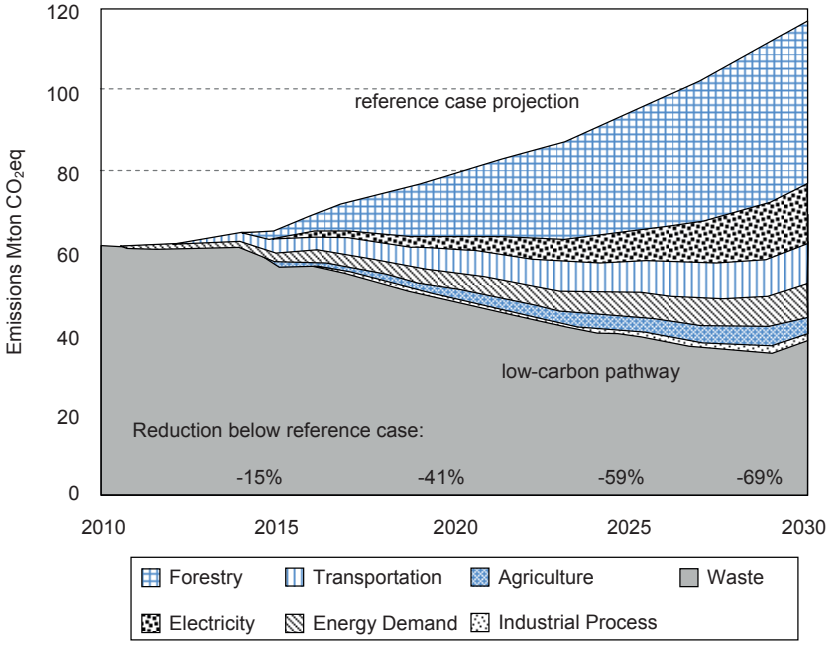
3 Are the INDCs of low-income countries appropriate?

A socially relevant agreement applicable to all should embrace policies that provide low-income groups with security and rights to life-supporting goods and services. Consideration of eradication of absolute poverty, equity, justice, rights, and halting or at least slowing the loss of biological diversity (an important source of income for the rural poor; see the chapter by Hallegate et al. in this book) should be the anchor points for the negotiation position of low-income countries. The challenge in reaching this objective arises from the diversity of needs and actions that are captured in the INDCs by low-income countries.

2 In 2010, only 10% of Kenyans had reached the struggler status (daily per capita income, yp, above the $1.25/day poverty line and below $10) and 2% had reached middle-class status ($10/d<$y_p$<$50). Projections for 2030 are 23% and 5% of the population, respectively. Birdsall (2015) argues that around 20% of a country's population reaching middle-class status is a threshold to safeguard against impacts of negative shocks.

While all INDCs submitted by low-income countries could not be reviewed at the time of writing, early submissions by Gabon, Mexico, Kenya and Ethiopia illustrate some of the challenges. Let me illustrate this with Kenya's experience, which is typical of a low-income country moving up the growth ladder while aspiring to pursue climate-friendly policies. According to Kenya's INDC submission, its GHG emissions, estimated at 73 $MtCO_2eq$ in 2010, are very low with an estimated 75% attributable to land-use activities including agriculture, forestry and free-range rearing of livestock. Figure 1 shows that under a business as usual (BAU) scenario where Kenya aspires to attain a 10% GDP growth by 2030, the country's GHG emissions are projected to be 143 $MtCO_2eq$ by 2030; slightly double the 2010 estimates. According to Kenya's National Climate Action Plan, the country's INDC is to reduce its GHG emissions by 30% by 2030. This ambition is against a historical contribution of only 0.1% to total global emissions, with per-capita emissions at less than 1.26 $MtCO_2eq$ compared to the global average of 7.58 $MtCO_2eq$. The wedge decomposition in Figure 1 shows that that forestry has the highest GHG abatement potential, underscoring the importance of REDD+ to Kenya's INDC.

Figure 1 Kenya's sectoral decomposition of GHG abatement potential



Source: Government of Kenya (2012b).

Kenya's submission, typical of low-income countries, suggests that these countries are subtly being pushed by COP19 and COP20 decisions to take up climate change mitigation targets that may not be feasible to attain if the principles of equity and fairness enshrined in the spirit of the UNFCCC convention are not honoured by developed countries. While it is understood that the commitments by low-income countries are interpreted as 'voluntary', a legally binding agreement applicable to all might not provide the necessary degree of freedom to low-income countries unless this is categorically specified in the agreement. The implications of high aspirations of INDCs against a background of limited emissions and limited means of implementation could overshadow balanced negotiations and the subsequent implementation of Nationally Determined Contributions (NDCs) post COP21. Besides, the INDCs of low-income countries are based on mitigation activities that require capital-intensive investments. This explains why, as in the case of Kenya, the INDC submissions of low-income countries are contingent on external financial resources and on technological capability.

4 Policies to support the implementation of a negotiated agreement

Taking Kenya as an example, I will review fiscal policies and environment and climate change policies aimed at mitigation and adaptation.

4.1 Fiscal policies

Fiscal policies, conceptualised broadly to embrace sustainable development in the context of a response to climate change, can be effective in encouraging a transition towards a sustainable production and consumption of critical life-supporting resources like water, energy, food and other natural resources (GGKP 2015). Well-designed and properly targeted fiscal policies would produce many benefits that include:

- *Reducing emissions through the introduction of taxes to curb polluting GHG emissions by applying the 'polluter pays' principle*. In Kenya, the government

has introduced a tax for older vehicles and limited the age of vehicles that can be imported to a maximum of eight years.

- *Pricing electricity*. Lee et al. (2014) report that the large majority of households in Kenya within a few hundred meters of the grid are not connected due to high connection fees. A recent presidential directive of May 2015 that reduces connection fees from about US$35 to $15, payable in instalments through monthly bills, should help increase connectivity to the grid. But connection to a grid is does not guarantee supply and use of electricity; weak grid infrastructure and frequent power outage deny users services.
- *Pricing resources and managing consumption for efficiency and equity consideration*. Price is the most important decision-influencing factor for resource-poor communities. This is why a climate-friendly innovation like a clean, energy efficient cook-stove with evident climate and health benefits to the poor and costing $50 will not reach many households over decades. Differentiated pricing should be applied either to curtail consumption or enable consumption by different segments of society.
- Along with energy, water is a key natural resource that can be managed by a pro-poor policy regime to ensure pro-poor distributional and efficiency impacts along with potential climate benefits. Some countries, like South Africa, have differentiated water tariffs so that the poor pay less than high-income consumers.

4.2 Environment and climate change policies

Most low-income countries rely on their natural capital to develop a green growth development strategy. In Kenya, tree-planting would be the least-cost approach to tackling climate change (UNEP 2008). This implies that these low-income countries should focus on environment and natural resource management.

Environmental policies

Environmental policies are critical for climate change and are very interconnected. Policies that have demonstrated impact are those relating to waste management, energy,

air pollution and human health and forestry. To accommodate space limitations, only Kenya's experience is reported here.

Policies that have incentivised minimising waste through increased resource-use efficiency and cleaner production have encouraged industries to invest in clean technology and processes, often resulting in multiple wins: increased profits, compliance with environment polices and regulations, secured dependable large market-share and improved public image. A case in point is Chandaria Industries Limited. Its line of personal hygiene products has achieved these outcomes through no, or low-cost, investment in regular energy audits, resulting in 25%, 2% and 63% reductions in energy, material and water use, respectively, in the manufacturing process (UNEP 2015).

Energy, and especially domestic energy, policies are closely linked to climate change mitigation, indoor air pollution and human health. In low-income countries like Kenya – where over 70% of households depend on wood-fuel as the primary source of energy for cooking and where cooking devices are still typically three–stone stoves – policies that promote the adoption of cleaner cooking devices have the co-benefit of contributing to improving human health. The adoption of improved stoves with higher thermal efficiency is noted to have the potential to reduce the chronic respiratory illnesses associated with indoor air pollution from short-lived organic pollutants, such as the soot emitted by traditional stoves. According to the World Health Organization, these emissions account for 14,300 deaths in Kenya annually (Global Alliance for Clean Cookstoves 2013).

Closely related to clean wood-fuel efficient technologies is the great potential of minimising GHG emissions through a slowdown in the rate of deforestation. As discussed by Angelsen his chapter in this book, REDD+ is potentially very promising, yet it has not materialised due to the combination of insufficient financial support and the slow pace of policy and political-level commitments to forest conservation. These limitations are compounded, in my view, by the volatile carbon markets that are controlled internationally. If developed countries transform their consumption and production systems towards highly efficient technologies that reduce GHG emissions, then existing cap and trade systems are likely to collapse.

Policies directly related to climate change

Following COP15, low-income countries started to develop policies to mitigate climate change. Some are anchored in the need to pursue national development against the background of a commitment to implementing decisions of the UNFCCC. For example, in Kenya, climate change has been integrated into the national planning process at the national and county level and for state and non-state actors. Climate Innovations Centers established through the InfoDev project of the World Bank have had a positive impact through climate change-driven investments at different levels and scales. Initially established in Kenya, Climate Innovation Centers have spread to other developing countries in the Caribbean, and to Vietnam, Ghana and South Africa. The technology solutions produced through these centres – like the production of livestock fodder using hydroponic solution in Kenya – reduce the release of soil carbon and hence contribute to the mitigation of climate change (although the impact is yet to be quantified). Such technology solutions in low-income countries will require finance that has so far proved elusive (see the chapter by Buchner and Wilkinson in this book).

5 What developing countries should target at the negotiations

Social inclusion, the eradication of absolute poverty, ensuring employment (especially for the young), equity, climate-driven risk management, rights-based development, entitlement to a life within a clean environment, along with education, gender and youth considerations, are the social issues that should influence the position of low-income countries at the upcoming climate change negotiations.

As discussed above, failure to focus on adaptation is a risk to be managed during the negotiations. Such a risk is evident from a report on climate change actions by cities, industries and other non-state actors by UNEP (2015). The report shows that out of over 180 analysed initiatives by industries, cities and other non-state actors, fewer than 10 included a focus on adaptation, indicating an over-focus on mitigation activities while an emphasis on adaptation measures is urgent for low-income countries. A lack of emphasis on initiatives focusing on adaptation in the determination of INDCs suggests the possibility of a commitment to targets that might not be met because of limited

implementation capacity in low-income countries. This implies that there should then be an emphasis on the inclusion of transparency for high-income countries in the form of effective monitoring, reporting and verification (MRV) (see the chapters by Aldy and Pizer and Wiener in this book). In light of these observations, the following negotiation positions should be considered by low-income countries to ensure that the proposed agreement continues to address their policy objectives while ensuring that resource-poor communities are able to adapt to changing climatic conditions.

More concretely, evaluation of the common position of the G77 and China and the common African position to COP20, as well as the outcomes of the Geneva and Bonn inter-session negotiations in February 2015 and June 2015, respectively, suggest that socially relevant negotiation points should articulate the following:

- Equal treatment of mitigation, adaptation and means of implementation in the climate policy compact.
- Ambitious mitigation actions by low-income countries and specific measurable, verifiable and reportable GHG reduction targets by developed countries that can lead to a steep decline in global emissions in line with a 2°C warming scenario, based on a uniform baseline for all Parties;
- A financial flow architecture that will ensure ease of access by low-income countries to predictable, adequate finance that will support adoption of and scaling up of low-emission, climate-friendly technologies at different scales of use;
- Appropriate financing for capacity building aimed at diffusing knowledge and understanding of the impact of unsustainable lifestyles and the importance of climate-friendly technologies by national and community-level actors;
- Ambitious international financing towards adaptation actions in line with the Cancun climate finance commitments of $100 billion disbursement annually by 2020 – for the subsequent periods, adequate (large-scale and increasing) and predictable funding must be planned for and mobilised; and
- Last but not least, while the agreement will be applicable to all parties, continued compliance with the UNFCCC Charter recognising that the CBDR principle should be the over-arching reference document for the global climate change architecture as we elaborate a KP successor. In particular, the CBDR principle should be the

under-pinning principle if the world is to attain the aggregate commitments as for low-income countries are the most vulnerable to climate change (see the chapter by Mekonnen in this book).

Depending on the socio-political dynamics at the COP, the negotiation points listed above could influence the outcome of COP21. The slow pace at the Bonn negotiations in June 2015 and the decision by Parties to allow Co-Chairs to work on the text points towards continued challenges ahead. Regardless of the nature and content of the agreement that will be generated, drastic action to prevent further changes in climatic conditions is of the utmost priority for low-income countries. And building the capacity of vulnerable communities to adapt to climate change is a matter that does not need negotiation but calls for immediate action by all Parties.

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28 REDD+: What should come next?

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While REDD+ has been a remarkable success as an idea and as a flagship of international climate negotiations, its implementation has been slower and the results smaller than most expected when the initiative was launched in 2005. The Warsaw Framework (2013) established the structure for an international REDD+ mechanism, but the corresponding funding to make it operational has not been forthcoming. National REDD+ policies are shaping up in major forest countries, but face continuous political struggles with vested interests for continued forest exploitation and/or legitimate development objectives. So far, REDD+ efforts have not been able to change – at any scale – the basic deforestation logic and to make living trees worth more than dead trees. The way forward, this chapter argues, is for REDD+ countries to assume a stronger role and ownership in the implementation of REDD+, and to incorporate it in their INDCs and in their domestic emission targets. Corporate efforts – through the greening of supply chains – can play a major role, pushed by consumer pressure and environmental watchdogs, and complemented by domestic policy reforms. International agreements should nudge countries towards making stronger commitments, and provide funding for capacity building and partial incentives for forest conservation through result-based mechanisms.

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1 Introduction

> *"Through effective measures against deforestation we can achieve large cuts in greenhouse gas emissions - quickly and at low cost. The technology is well known and has been available for thousands of years. Everybody knows how not to cut down a tree"*
> (Jens Stoltenberg, (then) Prime Minister of Norway, COP 13, 2007)

The AFOLU sector (agriculture, forestry and other land uses) is responsible for 24% of global GHG emissions (Smith et al. 2014). Tropical deforestation alone is estimated to account for approximately 10% of the global emissions (Harris et al. 2012), but will – due to the comparatively low mitigation costs – constitute a much larger share of a cost-efficient global mitigation plan. Efforts to reduce forest emissions are spearheaded through the REDD+ initiative. REDD+, the acronym for 'Reducing emissions from deforestation and forest degradation and the role of conservation, sustainable management of forests and enhancement of forest carbon stocks in developing countries', has been among the most prominent ideas in international climate negotiations during the past decade. It has also achieved unprecedented visibility for forest issues in the political and corporate spheres. The Warsaw framework (UNFCCC COP19 in 2013) and a new set of decisions to be agreed at COP21 (in Paris in December 2015) provide the structure for an international REDD+ mechanism. Mission completed.

Well, not yet. The funding that is supposed to back up an international REDD+ mechanism has not been forthcoming, neither from carbon markets nor from other sources. At the national level, REDD+ implementation has focused on capacity building, while the policy reforms needed to scale up REDD+ projects face strong opposition from entrenched business interests. Ten years after REDD+ first appeared on the UNFCCC agenda (in 2005), we are still waiting for the concept to be applied at a scale that will reduce emissions substantially.

The early optimism was reflected in the opening quote in this chapter and in the influential *Stern Review*, which claimed that, as the opportunity costs of forest conservation are often low, emission cuts could be achieved cheaply and quickly (Stern 2006, p. ix). Given the failure to reach a substantial scale, REDD+ is increasingly viewed with a healthy dose of cynicism. But, I would argue, this is in part due to how REDD+

has been interpreted (see Section 2.1 below). Viewed as a mechanism for large-scale, results-based funding from developed to developing countries, REDD+ has failed and is unlikely ever to be realised at the envisioned scale (Section 2.2). Viewing REDD+ as a broad set of policy instruments at different scales, significant progress has been made toward achieving the ultimate goal: reduced emissions (Section 2.3).

The future success of REDD+ hinges on successfully pursuing actions within three areas. Developing countries must assume a stronger ownership of REDD+ and the efforts for reduced forest emissions, and make it part of their contribution to curbing climate change (Section 3.1). This is then complemented by corporate-consumer initiatives for greener supply chains and deforestation-free commodities (Section 3.2). International support for capacity building should continue, but the magnitude of the support will only be sufficient to provide partial financial incentives and compensation for the opportunity costs of conservation (Section 3.3).

2 Taking stock

2.1 Evolving REDD+

REDD+ was conceived within the global climate negotiations (UNFCCC) and envisioned as a mechanism whereby developed (Annex I) countries would incentivise and compensate developing (non-Annex I) countries for verifiably achieved emission reductions. This results-based payment mechanism could be mirrored within countries, to ensure that forest owners and users are incentivised and compensated for the carbon sequestered and stored in forests. Other policies, such as effective enforcement of protected forest areas, were also assumed to play a role in national and local implementation. While UNFCCC has provided a global arena for discussions and decisions, most of the actions have been among multilateral and bilateral donors, national and state governments, and private actors (corporations and NGOs).

In this process, REDD+ has changed in three significant ways (Angelsen and McNeill 2012). First, REDD+ has moved from having a single to multiple *objectives*. Initially (from 2005 to 2008), contributing to the "stabilisation of greenhouse gas concentrations in the atmosphere" was the principal objective of REDD+, but other objectives (referred

to as "co-benefits" or "non-carbon benefits") have been added to the debate: protecting biodiversity, reducing poverty/enhancing local livelihoods, strengthening indigenous rights, improving governance, and expanding capacity for climate adaptation.

Second, the *implementation* focus has moved from results-based payments to a portfolio of policies. Creating a market for forest climate services presupposes a demand (created by emission caps), a well-defined commodity in the form of verified emission reductions (measured emissions, and a credible reference level), well-defined sellers (carbon rights clarified), and a marketplace with associated rules and regulations (Angelsen 2014). These elements are not yet in place in most countries. REDD+ must therefore be pursued as a broader set of national forest conservation policies (Angelsen 2009). The results-based payment idea has survived and is still seen (in different versions) as a key component of REDD+ policies and projects, but alongside other instruments (Sills et al. 2014).

Third, the *funding* for REDD+ was initially supposed to come mainly from an international carbon market. That demand for REDD+ credits has not materialised due to the lack of a global climate agreement with cap and trade (CAT) that includes REDD+ credits, either as an offset mechanism in a compliance carbon market or indirectly through, for example, auctioning emission allowances to generate revenues for a global REDD+ fund. As a result, 90% of international funding is currently coming from public sources, mainly official development aid (ODA) budgets (Norman and Nakhooda 2014).

2.2 Global negotiations and commitments

The Warsaw framework for REDD+ is a set of decisions in seven areas made at COP13 in 2013: finance; coordination; national monitoring; safeguards; reference levels; measuring, reporting and verification (MRV); and drivers; with a few outstanding issues (safeguards and non-carbon benefits) to be concluded at COP21 in Paris (December 2015). The agreement is a major diplomatic achievement. Parties with divergent views and interests were able to reach consensus, but arguably at the cost of clarity, specificity and concrete actions. Most importantly, a large-scale funding mechanism for REDD+ has yet to be established, although the decisions recognises "the key role that the

Green Climate Fund [GCF] will play in channelling financial resources to developing countries and catalysing climate finance" (UNFCCC 2011, par. 70). GCF funding is to be provided principally by developed (Annex I) countries, which at COP16 (Cancun, 2010) committed to contributing US$100 billion per year by 2020. It is, however, highly uncertain whether this promise will be fulfilled, and what share will go to REDD+.

Approximately $8.7 billion of international funding has been pledged from 2006 to 2014 for REDD+, with annual pledges declining after 2010 (averaging $605 million since 2010) (Norman and Nakhooda 2014). While some donors are experimenting with light versions of performance-based funding, at least 61% of the public funding pledged so far is for readiness activities, such as capacity building and information systems. Three-quarters of the funding comes from five donor countries (Norway, the US, Germany, Japan and the UK), with Norway being the REDD+ superpower (contributing 41% of the total, or $3.5 billion). A significant share of the funding is channelled through multilateral programmes,[2] while Norway has bilateral agreements with Brazil and Indonesia, each totalling $1 billion. These two countries are expected to receive about 40% of the international funding. The share is justifiable based on their share of tropical forest cover and emissions, but questionable as development aid which has poverty reduction as its primary aim.

The current international pledges – approaching $10 billion – represent an unprecedented level of funding to a single environmental effort in developing countries. Yet, this amount constitutes only a small fraction of the estimated funding needed if REDD+ countries are to be compensated for their emissions reductions. For example, paying for a 50% reduction in the current rate of deforestation, if valued at $5 per tCO_2, would cost around $9-10 billion *per year*.[3] This funding gap (between this amount and the current pledges) is unlikely to be filled in the near future, and REDD+ as an international, results-based mechanism risks never achieving its envisioned scale and role. This is in spite of the many attractive features, including the fact that reduced forest emissions remains one of the most cost-efficient mitigation options.

2 These include the World Bank's BioCarbon Fund, Forest Investment Program (FIP) and FCPF, the UN-REDD Programme, and the Congo Basin Forest Fund.

3 Assuming current (2000-2010) emissions from tropical deforestation to be in the order of 1GtC/year (Baccini et al. 2012), that REDD+ achieves a 50% reduction (with reference level = historical emissions) and that the price is $5/$tCO_2$, the annual international transfer to REDD+ countries is $9.2 billion (1*3.67*0.5*5 = 9.2).

2.3 National politics and local realities

Brazil has been the poster child for successful reductions of forest emissions, with annual Amazonian deforestation after 2009 being only one-quarter of the rates over the period 2001-2008.[4] The decline is due to a combination of factors: removal of agricultural subsidies, granting of conditional agricultural credit, establishment of protected areas, improved enforcement of laws and regulations, and supply chain interventions combined with an appreciation of the real until 2011 that made export less profitable (e.g. Nepstad et al. 2014).[5] Recent developments are, however, disquieting. There are signs that regional deforestation rates have increased, and that conservation policies have been relaxed.[6] The revised Forest Code (2012) increased the amount of land that can be deforested legally, new protected areas have become more difficult to establish, and the development/farm lobby has gained momentum at the expense of environmental interests.

The Brazilian success demonstrates that strong policy reforms that directly affect the cost-benefit calculus of landowners have a strong impact. The fact that policy reforms were mainly undertaken pre-REDD+, and that the country does not even have a national REDD+ strategy as such, does not diminish the lessons to be learned from Brazil (and other countries such as Costa Rica and Mexico).

Indonesia, the other important REDD+ country, has undertaken a number of policy reforms, but it remains to be seen whether they will slow down deforestation rates.[7] The Letter of Intent with Norway (2010) resulted in a two-year moratorium on forest conversion, effective from May 2011 (and extended twice, until May 2017). The real impact of the moratorium is debated, as it is limited to primary forests and peatlands, thus leaving more than 40 million hectares of logged-over forests and peatlands open to conversion. In addition, several loopholes exist; for example, it only applies to new concessions and an exception is made for the production of vital commodities. Other bureaucratic and legal reforms in support of traditional forest management, as well

4 See www.inpe.br.
5 Evidence of the importance of the real exchange rate for deforestation is given in Arcand et al. (2008).
6 See http://e360.yale.edu/feature/what_lies_behind_the_recent_surge_of_amazon_deforestation/2854/.
7 Deforestation was significantly down in 2013, after having risen for a decade, but it is too early to say if this represents a trend shift, and whether the shift reflects lower commodity prices (palm oil) or policy changes (see http://blog.globalforestwatch.org/2015/04/tree-cover-loss-spikes-in-russia-and-canada-remains-high-globally/).

as recent signals and changes of practice from the corporate sector, are nevertheless encouraging.

The third major rainforest country, the Democratic Republic of Congo, has had comparably low deforestation rates, due to civil war and unrest, political instability and forest inaccessibility for commercial exploitation. The main challenge is to keep the rates low, while securing peace and economic development. REDD+ implementation in such fragile states raises particular challenges (Karsenty and Ongolo 2012). Yet, the development transition presents a unique opportunity and the country has made significant progress on REDD+ (Lee and Pistorius, 2015)

In these and other REDD+ countries, the political economy issues remain a strong – and perhaps the most critical – barrier to implementation: deforestation happens because some people or companies benefit from it (from the poor African smallholder, to the rich Brazilian cattle-owner and the Indonesian palm oil company). The large beneficiaries often hold the power to block or slow down policy reforms. The concept of REDD+ was to make it beneficial to conserve forests, but the cost-benefit equation of most land owners has not shifted in favour of forest conservation. And, perhaps not all actors should be compensated for the opportunity costs of forest conservation. Can we justify spending development aid (most of the international funding) on rich and powerful agents of deforestation? The question is particularly pertinent as the process of allocating concessions and land rights in the first place often is flawed.

A broad consensus has emerged in response to this dilemma. The big holders (large commercial farmers and companies) should be discouraged from undertaking deforestation by direct regulation (concessions, licences, minimum forest requirements, etc.) *without* compensation. The smallholders (semi-subsistence farmers) should be encouraged to undertake forest conservation by Integrated Conservation and Development Programmes (ICDPs), the workhorse for international conservation initiatives for decades. ICDPs typically consist of a mix of interventions: information and education, local management and control, direct regulation, alternative income creation, and – more recently in REDD+ projects – some form of performance-based payment to communities or individuals (Sunderlin and Sills 2012).

Local and sub-national REDD+ projects exist in 47 countries. Most of these are self-defined and not part of a national REDD+ strategy as such (Simonet et al. 2014). In an in-depth review of 23 initiatives, de Sassi et al. (2014, p. 421) conclude that most projects have served their explorative roles, but "are struggling to make the transition from pilots to sustained REDD+ interventions". Most initiatives initially planned to sell REDD+ credits from the project area, but only four of them have done so. More generally, lack of funding has not enabled the basic political economy forces that drive deforestation and forest degradation, and that seek to maintain business-as-usual, to be changed. Challenges also abound in other areas, notably in the form of unclear and insecure land tenure and carbon rights, and safeguards and co-benefits that protect the livelihoods of local stakeholders. The national-level policy learning from local demonstration sites is also limited.

Many underestimated the technical and practical challenges of designing and implementing REDD+, assuming that advanced remote-sensing technologies would just make it 'plug and play'. This is far from the reality. Few issues are purely technical; they are embedded within political systems and in arenas of conflicting interests. Estimating changes in forest carbon stocks requires ground trothing to establish emission factors credibly. Information must be harmonised and coordinated across scales and actors. For example, in Indonesia, multiple and inconsistent maps of the forest area and the size and location of concessions, used by different government agencies, have held up the REDD+ process. Finally, realistic benchmarks (reference levels) are needed to estimate actual reductions (as compared to a BAU scenario), and to ensure additionality (see the chapter by Aldy and Pizer in this book).

REDD+ has, nevertheless, initiated advances in forest governance, in part due to major improvements in forest monitoring. For example, the monitored tropical forest area with good or very good forest inventory capacities increased from 38% in 2005 to 66% in 2015 (Romijn et al. 2015). Countries that participated in capacity-building programmes showed more progress. Interestingly, countries with poor monitoring capacities in the past tended to overestimate net forest loss. This might appear to be welcome news, but it also raises a warning if exaggerated historical deforestation rates become the benchmark for measuring success and the basis for making payments.

3 The REDD+ road ahead

Any proposal for how to solve the climate gridlock should place itself along a continuum between: (i) the necessity of what is needed to stay within the 2°C target; and (ii) the political reality of what is feasible. Many proposals are rightly criticised for being either insufficient or unrealistic, or sometimes both. In this section, I focus on three key topics that are critical for future progress: national commitments and policies; corporations and consumers; and international agreements and funding. The selection of these topics is based on the following three observations. First, national policies are key determinants of deforestation rates, more so than international funding and local REDD+ projects. Second, deforestation is increasingly driven by global trade involving multilateral corporations that have strong influence over the supply chains. Third, the global climate regime over the short-to-medium term will likely be a bottom-up, 'pledge and review' system, based on the countries' Intended Nationally Determined Contributions (INDCs).[8]

3.1 National commitments and policies

To achieve substantial emission reductions, forest conservation will increasingly have to be considered as REDD+ countries' contribution to the global effort of limiting climate change, as integrated into national green/low-emission/low-carbon/sustainable development strategies. In a post-2020 climate regime that "reflects the principle of common but differentiated responsibilities and respective capabilities, in light of different national circumstances" (UNFCCC 2014, par. 3), this could imply that middle-income countries factor REDD+ partly into their domestic target and partly as a conditional pledge subject to international support.

Analysing the policy process in key REDD+ countries, Di Gregorio et al. (2012, p. 69) argue that "achieving emission reductions through REDD+ requires four preconditions for overcoming politico-economic hurdles: (i) the relative autonomy of the State from key interests that drive deforestation and forest degradation, (ii) national ownership over REDD+ policy processes, (iii) inclusive REDD+ policy processes, and (iv) the

8 http://unfccc.int/focus/indc_portal/items/8766.php

presence of coalitions that call for transformational change." When the REDD+ process is driven by international actors, it is unlikely to make a difference on the ground.

National governments are therefore in the driver's seat for achieving reduced forest emissions. They have the primary ability for achieving this goal, and – some would argue – also the primary responsibility. Governments can implement a range of specific policies that have proved efficient in limiting deforestation. I have reviewed these elsewhere (Angelsen 2010, Angelsen and Rudel 2013), and they include: (i) reducing/removing agricultural subsidies to deforestation agents/crops/areas, (ii) avoiding road building that makes forested areas more accessible, and (iii) establishing and enforcing protected areas.

Subsidised emissions are not just a problem for fossil fuel emissions. A recent report by the Overseas Development Institute points to the pervasive effect of subsidies on key commodities, such as beef and soy in Brazil, and palm oil and timber in Indonesia. The subsidies amount to $40 billion per year for these two countries combined. "These subsidies are likely to have a far more significant impact on private investment in activities that drive deforestation, than current REDD+ finance" (McFarland et al. 2015, p. 43). Reducing these subsidies, or making them conditional on compliance with zero-deforestation practices, represents a win-win change for conservation and development, although some groups will stand to lose from such a reform.

3.2 Corporations and consumers

In parallel with the UNFCCC process, a number of initiatives at the global and national levels have involved the private sector as a key partner in REDD+. The most noted national example is the Soy Moratorium of Brazil, adopted in 2006. This made traders agree not to sell soy from farmers who had cleared Amazon forests (Nepstad et al. 2014). Internationally, 'zero deforestation' initiatives have resulted in several global companies making significant efforts in greening their value chains.[9] Studies among business executives also confirm that corporate reputation, media attention and customer pressure are the most important reasons for taking climate issues into

9 An example is the Palm Oil Scorecard: http://www.ucsusa.org/global-warming/stop-deforestation/palm-oil-scorecard-2015#.VYPp0fnq3St

consideration, well ahead of policy regulation and investment opportunities (Enkvist and Vanthournout 2008). Security of supply (in areas where production is not sustainable) is likely to become more important as land competition and climate extremes increase in frequency and severity.

In the New York Declaration on Forests (2014),[10] signatories committed to doing their part to halve current deforestation rates by 2020 and to end deforestation by 2030. They also agreed to ensure that the production of four key commodities (palm oil, soy, paper, and beef) did not add to deforestation. So far, the declaration has been signed by 36 countries, 20 states/provinces, 53 companies, and 4 indigenous peoples groups.

A combination of higher awareness of the costs and risks involved in continued climate change, consumer pressure and demand for green products, and 'naming and shaming' by NGOs and other watchdogs can strengthen this trend even further. With international climate negotiations proving ineffective in delivering credible emission cuts, private actors can define new standards and rules in (international) environmental governance, and gain what Green (2013) labels "entrepreneurial authority". Supply chain reforms need to be backed by domestic legislation and supportive policies to make them function better and to hold companies accountable, while encouraging frontrunners.

A very different ballgame would emerge if companies were allocated emission caps, and these could be offset through buying REDD+ credits. The private sector would then become a major funder for REDD+. The very modest demand for carbon credits in the voluntary market suggests that only policy regulations in the form of emission caps can create sufficient demand.

3.3 International agreements and funding

The initially envisioned role of REDD+, or perhaps the core of REDD+, was a massive transfer of resources to incentivise forest conservation in developing countries. With that scenario unlikely to unfold, how could an international agreement advance the implementation of REDD+?

10 See http://www.un-redd.org/portals/15/documents/ForestsDeclarationText.pdf.

'Pledge and review' seems to be the new, or indeed the only, game in town: countries make their pledges through their submission of the INDCs, which are then subject to an assessment and review process (A&R). In the best scenario, this process would help align national contributions with the 2°C target, enhance transparency and build trust. The Paris Agreement is likely to recognise the need to "achieve net zero greenhouse gas emissions within the second half of this century", which implies building and maintaining terrestrial carbon sinks counterbalancing residual emissions in other sectors. Halting and reversing the loss of carbon in forests and soils could become the main contribution of many developing countries in their INDCs. In other words, rather than REDD+ being seen solely as a vehicle to generate international funding, part of it could be claimed as a national contribution to the global efforts of curbing climate change, particularly for middle-income countries. The A&R process could play a similar role for REDD+ as for other mitigation areas. A major step forward would be if the INDCs and A&R process could also focus on policies and possibly establish some consensus on key policy reforms.

The GCF and possible other mechanisms to be established can provide funding for capacity building, upfront investments, concessional finance and possibly also direct payments for results (i.e. for reduced emissions). International funding for REDD+ (and climate funding in general) should arguably focus on the poorest countries, rather than middle-income countries like Brazil that have sufficient resources to cover the domestic costs of forest conservation.

The limitations for international transfers to be a game changer should be recognised. First, in spite of the low costs of REDD+ compared to most other mitigation options, the realistic level of funding is small compared to the overall costs and associated co-benefits. Second, the real cost of REDD+, the opportunity costs of forest conservation (mainly the foregone profit from agricultural production on forest land conserved) does not lend itself easily to the dominant ODA modalities. Third, designing results-based funding schemes is hard (reference levels, criteria, spending pressure, and so on; see Angelsen 2013). Policy reforms can only be bought by foreign money to a very limited extent (Collier 1997).

4 Concluding thoughts

REDD+ is frequently presented as one of the climate success stories, partly because the idea looks so simple and appealing, partly because of the unusual inclusiveness of the process (the wide variety of active CSO and IP observers), partly because of the funding mobilised and activities generated, and partly because UNFCCC has for once reached a balanced agreement despite huge technical challenges. Powerful actors – from presidents and finance ministers in REDD+ countries to top executives in international corporations – are engaged like never before in debates on the role of forests in the global carbon cycle. The issues of transparency, accountability, tenure and rights and indigenous peoples have been put on domestic political agendas by REDD+. The dramatic change in the global narrative and the political momentum generated are reasons for cautious optimism.

But a thorough reality check is needed. The envisioned results in terms of reduced emissions have – by and large – not been delivered. Brazil is a success story, although little of its success can be attributed to REDD+. For other countries, there are few stories of substantial early progress in terms of reductions in deforestation (and its harder-to-measure twin, forest degradation). Old and new business-minded coalitions have blocked progress, suggesting that REDD+, if implemented, would actually make a difference.

Arguably, many were overly optimistic about REDD+ as a cheap and quick fix. Change takes time. REDD+ has improved the capacity, created an enabling environment, and raised the awareness of the role of forests in climate change (Lee and Pistorius, 2015). The momentum might eventually lead to results on the ground. But to keep that momentum going, current REDD+ efforts must deliver significant, measurable reductions in forest emissions by the end of this decade.

To achieve significant reductions in forest emissions, the REDD+ countries themselves must take the driver's seat with a focus on domestic policy reforms and enabling environments; the corporate sector should continue the greening of its supply chains, pushed by consumers, watchdogs and demand-side policies; and the international regime must gently nudge the countries to stronger pledges and provide finance to nudge and supplement domestic efforts in the poorest countries.

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He has edited three REDD+ books: *Moving Ahead with REDD: Issues, Option and Implication* (2008), *Realising REDD+: National Strategy and Policy Options* (2009), and *Analysing REDD: Challenges and Choices* (2012), and served on several expert committees. He also works on environmental income and in experimental economics.

29 Curbing carbon without curbing development

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The poorest countries have a strong interest in curbing global carbon emissions, because they have relatively more to lose from global warming. But they also have a strong interest in economic growth – only if they grow rapidly can they address the mass poverty which is their current experience. These two objectives potentially conflict. Global restrictions on carbon energy could impede the development of poor countries by denying them cheap energy, and also directly threaten the income of those poor countries which export carbon fuels. Hence, they need global arrangements which are effective, but which do not damage their economic interests. To date, the approach has been for richer countries to set themselves emissions targets while the poorest countries do nothing. This has neither been sufficiently effective in curbing emissions, nor has it provided the poorest countries with viable mechanisms for compensation. In this chapter I propose a different approach which targets the gradual closure of the global coal industry. Any effective approach to climate change will require drastic shrinkage of the coal industry. Focusing on the practicalities of closing coal, instead of the abstract concept of curbing carbon emissions, makes it easier to tap the potential moral pressure of ordinary citizens. Without this pressure, no conference agreement is likely to be implemented. Further, focusing on closing coal opens up straightforward ways by which the interests of poor countries might be protected.

Introduction: The dilemma for poor countries

To address climate change, carbon emissions will need to be curtailed. This is in the interest of poor countries because they are among the countries which are most vulnerable to climate change. This is partly because poor countries are mostly already

hotter than rich ones, partly because they will mostly lose a higher proportion of their GDP, and partly because of the structure of their economies, with a far higher proportion of their population dependent upon climate-sensitive agriculture. However, while addressing climate change is in their interest, poor countries are also potentially threatened by global measures to curb carbon emissions. This is because curtailing carbon emissions conflicts with the need of poor countries for large increases in energy consumption as an integral part of their development process, and with the need to clear forest for the expansion of cultivation. Further, many of poor countries are heavily dependent upon the export of carbon-based energy to finance their imports.

These tensions cannot be resolved by the pretence of a bifurcation between 'rich' countries that are 'guilty' of causing climate change and 'developing countries' which are merely the 'victims'. This ethical bifurcation is untenable. First, there is no longer a bifurcation between 'developed' and 'developing' countries, but a continuum from the very poor, such as Malawi, to very rich such as Qatar, with China, now an above-middle-income giant, being the largest carbon emitter. Second, neither individuals nor entire societies are morally liable for the adverse consequences of carbon emissions prior to the recent time at which those adverse consequences became understood. Third, even for those recent emissions where some moral responsibility can reasonably be invoked, how should that liability be assigned between those countries which burn carbon-based energy, notably Europe, and those which extract it and sell it for others to burn, notably the Middle East, since both have evidently benefited? To date, negotiations have arbitrarily assigned all responsibility to the locations where energy is burnt rather than extracted, but this lacks moral rationale.

The interest of poor countries is therefore to encourage effective international action, from which they would benefit, while safeguarding their scope for rapid economic development. To be effective, proposed actions must be based on a global consensus on shared responsibility for curtailing future emissions. While the interests of the poorest countries such as Malawi will need to be protected, and high-income countries such as Saudi Arabia and Germany will need to make the earliest sacrifices, middle-income countries such as China and Poland will need to accept the duty to undertake costly actions.

Why current approaches have had limited success

To date, the international approach to climate change has largely been ineffective. It has been based on national emissions targets for OECD countries, implemented primarily through a mixture of regulatory measures, the promotion of energy efficiency, a pan-European cap-and-trade scheme and national carbon taxes. This has several weaknesses.

First, its implications for individual action by firms and households are highly unspecific. Carbon emissions could potentially be curbed by a myriad of behavioural changes which would generate largely unobserved, and mostly small, reductions in emissions. Unfortunately, this completely diffuses the responsibility for behavioural change and this feature in turn maximises the difficulty of achieving change. Indeed, the only practical mechanism for achieving such diffuse coordination is the price mechanism – carbon would need to be taxed, globally, to a common degree. However, this poses extreme political difficulties. Societies differ considerably in the degree to which citizens see their government as responsible for the price of carbon products. In many countries petrol is heavily subsidised; in Nigeria, for example, an attempt to remove this subsidy led to a violent national strike. As Sandel (2012) has argued, the market mechanism is contentious as a means of allocating morally charged resources. Concern over climate change has intentionally (and understandably) made carbon morally charged. The idea that the solution to a negative global externality is a global tax, while technically appealing to economists, is likely to be radically unacceptable to many people.

It is indeed notable that to date the civil society campaigns to arrest climate change, and the economic policy advice to a achieve it, have been radically divergent. Civil society has emphasised personal moral responsibility – people should buy smaller cars, reduce their air travel, and suchlike – whereas economists have proposed the issuance of emissions rights which would be tradable on global markets. The tradable rights central to cap-and-trade can be efficient and generate mutual gains, but to many people they will appear to be morally repugnant – the ethical equivalent of medieval 'indulgences' in which a price is placed on the 'right to sin', with its implications that the rich will be able to continue sinning while the necessary behavioural change is undertaken by

poorer societies. Thus, the ethical weakness of the technical solution inadvertently undermines the overarching moral basis for global action.

Similar criticisms can be made of the Clean Development Mechanism, by which firms in developed countries buy emissions rights from firms in poorer countries which are paid to refrain from actions that they would otherwise have taken that would have increased their emissions. This opens considerable scope for scams and so only environments with reasonably trusted governance have met the criteria for verification. In practice this has meant that the main beneficiary from cap-and-trade has been China. Even before the ethics of such transactions are considered, it is apparent that an arrangement which required the US to make very large payments to China would not be acceptable to US citizens, so it is difficult to imagine this approach becoming global. Ultimately, 'international mechanisms' whereby continued emissions by some countries are offset by actions in others may prove to be ethically corrosive even if in principle they yield mutual benefits.

An alternative approach: Focus on coal

Carbon taxes, cap-and-trade, and emissions targets are all highly technocratic – they are very distant from the sort of practical actions that ordinary people can readily envisage. Yet carbon emissions are substantially reducible to one practical, concrete action: *closing the world's coal industry*. Coal is the king of carbon emissions. All technocratic mechanisms for curbing emissions implicitly involve the closure of the coal industry, but they have singularly failed to make this apparent, let alone addressing how, practically, it might happen. I now outline an alternative approach to curbing emissions which focuses on this practical issue of how gradually to close down the world's coal industry. Central to this approach is the protection of the developmental interests of poor countries (Harstad 2012, Collier and Venables 2014).

While emissions have been the overwhelming focus of policy attention, the corresponding issue of curbing the extraction of carbon-based energy from beneath the ground has received little practical attention. It may be much easier to control carbon emissions at the point of fuel extraction than at the point of consumption. While consumption is the result of a myriad of decisions by billions of people, extraction is

the result of a very limited number of decisions by a small group of firms. As a result, it is highly specific as regards moral agency – specific both in terms of the particular people whose decisions need to change and the particular actions that they need to take. This is important because the moral force of an action is not well-determined by its ultimate consequences. Pinker (2007) demonstrates how moral attribution can be teased out of the way we use ordinary language: 'the concept of causation we apply when choosing our verbs is also the concept we apply when we hold people responsible. We single out the acts that a person *intentionally*, and *directly*, and *foreseeably* caused.' (p. 228). If the power of moral agency is to be harnessed to curb carbon emissions, the generalised, diffused responsibility of everyone for every act that might directly or indirectly emit carbon, which is the approach taken by carbon pricing, is precisely wrong. Instead, public policy needs to focus on a very few salient emissions that can be directly connected to major decisions of a few key actors. On this approach, there is no doubt as to what the focus should be – it should be on closing the world's coal industry. Ultimately, closing coal will not be enough, but as the single most important action, which is also likely to be the least costly, it is the right place to start. Practical success in closing coal would provide momentum for more complex actions which are correspondingly more demanding.

Coal accounts for around a quarter of all carbon emissions and around 40% of all known CO_2 in fossil fuel reserves. However, while it is the single most important source of carbon emissions, it is not an economically valuable source. Its energy output per unit of carbon emissions is lower than gas, and its cost of extraction and transformation into usable energy is higher than other fossil fuels. As a result, even before the fall in energy prices in late 2014, although coal constitutes 40% of the CO_2 in fossil fuel reserves, it constituted only 16% of the economic value of those reserves. As a result of the fall in global energy prices, the market value of coal mining companies has fallen by around 80%, which is a far larger drop than oil companies. This is an indication that the economic rents on coal extraction (the surplus of value over cost), which were already modest, are now very small. By closing coal ahead of other fossil fuels, there would be a larger impact on carbon emissions for a given loss of energy, and only a small loss of economic rents. Should CCS technology ever become viable, clean coal may redevelop, but to date it has proved to be far more difficult than envisaged (for example, Norway has recently abandoned its programme of research).

Further, by taking measures that directly curb the supply of coal instead of starting from curbing the demand for carbon energy, the problems posed by the 'green paradox' and international 'leakage' would be reduced. The green paradox arises as producers of carbon energy increase extraction in anticipation of the loss of future rents. Potentially this could happen with coal, since there are very large stocks in the ground. But the collapse in rents reduces such inter-temporal substitution of production – if there are no significant rents to protect, producers gain nothing by pre-empting anticipated controls. Additionally, the possibility of future CCS technology provides an incentive for leaving coal in the ground until it can be sold at a premium price as clean energy.

Leakage arises because those countries which act responsibly, curbing their carbon emissions, inadvertently create an incentive for other countries to do the opposite (see Fischer 2015). Action on both supply and demand faces this problem. If some countries (a 'coalition of the willing') act to reduce their demand for carbon energy, this reduces the world price of carbon energy and so increases consumption in other countries. Similarly, if some countries reduce their supply of coal, this increases the world price of coal and so increases coal production in other countries. However, the extent of leakage depends upon the price elasticity of response. The leakage from curbing carbon demand depends upon the elasticity of demand for carbon-based energy; this is high because there is a lot of scope for substitution from other fuels. In contrast, the leakage from curbing coal production depends upon the elasticity of coal supply, which is low. Hence, curbing coal production is likely to be the more efficient approach, less subject to being undermined by leakage, than curbing the demand for carbon energy.

Considerably more carbon-based energy has already been discovered than can safely be burnt, and so some of it must remain *permanently* unused. This creates the phenomenon of 'stranded assets'. McGrade and Ekins (2015) estimate that to achieve the target of keeping the increase in temperature to only 2°C, a third of known oil reserves will be stranded and over 80% of known coal reserves. A key issue for poor countries is whether their own carbon assets will become 'stranded'. For many poor countries, dependent upon carbon-energy for their exports, the threat of their currently valuable carbon energy assets becoming stranded is even more serious than the threat from climate change.

The new awareness that not all carbon-based energy can be used, and that coal is the least efficient source of carbon energy, is currently inducing the governments of high-income countries to inhibit the extraction of new coal deposits in low-income countries. For example, the Board of the World Bank is disinclined to approve loans for coal mining projects. There is a superficial rationality to saying that if we have already discovered more than we can burn there is little point in financing further discovery, a point made by McGlade and Ekins (2015). But the scope for new discoveries is far greater in poor countries. For example, according to World Bank data for the year 2000, the value of discovered sub-soil natural assets per square kilometre was five times greater in the OECD than in Africa. It is highly unlikely that this is because there was less to be discovered in Africa, it simply reflects Africa's much lower past investment in prospecting (itself a consequence of past poor governance). This was indeed confirmed during the carbon super-cycle of 2003-14, during which high prices induced a major increase in global search. Analysing the pattern of new discoveries and prospecting, Ross (2012) concludes that 'the vast majority of the world's new hydrocarbon supplies will come from developing countries in the next few decades' (p. 10). These new carbon discoveries in poor countries have the potential to provide transformative revenues, but many of them still require substantial investments in order to be extracted; examples being off-shore gas in Mozambique and Tanzania, and oil in Kenya and Uganda. Badly managed carbon regulation and NGO pressure for portfolio divestment programmes could have a chilling effect on many of these investments.

Freezing the discovery and new investment processes would therefore massively disadvantage poor countries. As a consequence, it would maximise the conflict of interest between poor countries and rich ones. Yet action on climate change requires a global consensus in order to generate moral pressure. What is needed is a morally reasonable basis for agreeing a path to reduce the production of coal. Two approaches have been proposed.

Harstad's (2012) approach is that a coalition of willing high-income countries should reduce global coal production by buying up commercial coal production and closing it. The approach of Collier and Venables (2014) is that coal production should be reduced through a sequence of closure according to the income level of the country. The Harstad proposal is technically the more efficient since the least valuable coal mines would be

closed first, wherever they might be located. However, it would be exposed to nationalist critiques brought by coal miners threatened with losing their jobs. For example, even an attempt by an Australian company to purchase a potash mine in Canada was vetoed politically because there was seen to be a risk that the mine would be closed by the foreign purchaser to increase market dominance. Further, by relying on an international market process it inadvertently undermines moral pressure. Allowing rich countries to reduce global carbon emissions by buying up and shutting down mines in poorer countries might be seen as weakening rather than implementing the moral case for collective action on climate change.

In contrast, the Collier-Venables proposal attempts to harness the moral energy generated by popular concern about climate change. It does so by using a fair basis for the sequence of coal closures to generate intense moral pressure on specific decision-takers at specific times. The sequence would require high-income coal producers to act first – specifically, Germany, the US and Australia. Until these three countries have begun closing their coal mines, no action would be required of others. However, once they have started to implement a closure plan, middle-income coal producers would be required not to expand their production. Once high-income producers have completed their closures, upper-middle-income countries such as Poland would be required to start their own closure programmes. Only once they start to close their mines would lower-middle-income countries such as Indonesia be required not to expand their production. At this point, a variant of the Harstad proposal could be added: oil producers in high-income countries could become subject to a ring-fenced cap-and-trade scheme. They would be permitted to buy rights to increase emissions from those coal mines in middle-income countries which were required to close. This would be morally attractive; for example, some of the oil rents of Norway and Saudi Arabia would be diverted to compensate Polish miners for their loss of jobs. The superiority of this over generalised transfer mechanisms is its specificity – clear and substantial losers are compensated, and clear and substantial beneficiaries of carbon rents are required to provide it. The process of closure would continue through lower-middle-income countries, eventually reaching low-income countries such as Mozambique.

Meeting rising energy demand in poor countries

The above approach could effectively defuse tensions between action on climate change and development in respect of the *production* of carbon-based energy. Low-income and lower-middle-income producers would be given considerable time before they were required to take action, with the precise duration depending upon how rapidly richer countries took action. However, it would not address the concerns of low-income *users* of carbon-based energy. Addressing climate change, especially through supply-side measures such as closing coal, will inevitably increase the global cost of energy. Poor countries will need large increases in their consumption of energy as they develop. To what extent is this higher cost of energy an impediment for them?

While it is in principle a legitimate concern, in practice it is minor. This is because in most poor countries the key energy-related impediment to growth is not the price of energy but its availability. Energy has been supplied through badly run public monopolies with the result that it has been highly unreliable. In consequence, firms have had to meet their electricity needs through individually owned diesel generators at very high unit cost. This is commonly listed in surveys of firms as their primary impediment. By increasing the availability of electricity governments of poor countries could substantially reduce its effective unit cost to their firms and households, even though the global unit cost of energy will be rising.

Poor countries have several means of meeting rising energy demand that are consistent with the above strategy for addressing climate change through closing coal. Several poor countries have their own coal supplies and so would be able to meet electricity demand through domestic coal for several decades. For the majority that do not have their own coal, both hydropower and solar power will become viable options for power generation. Africa and Central Asia have huge potential for hydro. For example, Ethiopia, with high rainfall on high ground and consequent kinetic energy from water run-off, is developing its vast potential in hydropower with prospects of very low unit costs of electricity. Solar energy has to date been more challenging because favourable endowments of sunlight have been offset by the high capital cost of solar panels. Rural Africa is littered with abandoned solar panels. However, as costs continue to fall this may be in the process of being overcome (Collier and Venables 2012). The combination

of coal, hydro and solar power becoming available to poor countries implies that they have scope to ramp up the supply of electricity. While it would technically be possible to develop a climate-related scheme by which international public money was devoted to financing this expansion, politically this has proved to be infeasible. The present proposal would achieve the equivalent of a financial transfer to poor countries through privileging them in respect of the sequence of closure of the global coal industry. This would not be politically easy, but it is arguably considerably less difficult than a direct transfer of finance.

Conclusion

Effectively addressing climate change is more in the interest of poor countries than of rich ones. Poor countries are more threatened by climate deterioration. However, past approaches to climate change – notably through emissions targets, cap-and-trade, the Clean Development Mechanism, and carbon taxes – have been relatively ineffective, while future, more effective approaches along the same lines have the potential to be detrimental to poor countries. I have suggested a switch from market-dependent solutions to greater emphasis upon moral pressure, by focusing on the sequential closure of coal. Because coal is the king of carbon emissions, any effective approach to curbing emissions will involve radical reductions in coal production. Yet over the past three years, despite technocratic attention on climate change, global coal consumption has actually increased. This reflects the severe disconnect between the technocratic solutions and what ordinary citizens recognise as morally actionable changes in behaviour. Without the moral energy of mass public opinion, technocratic solutions may be agreed in conferences, but they will not be implemented when subjected to the continuous pressures of political interests. It would be easier for people to grasp that coal has to be closed than that a mechanism such as cap-and-trade should be implemented. It would also be easier for people to recognise that the coal industries of rich countries should close before those of poor countries than for them to agree to large financial transfers from rich to poor.

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30 Towards resilient and low-carbon cities

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Variations among cities of the developing world in terms of per-capita income, exposure to climate vulnerabilities, and GHG emissions levels are very significant and have to be taken into account in order to support their active engagement in global climate action. Ninety per cent of all urban growth by mid-century will occur in the developing world, and this build-up will require great quantities of energy and natural resources, further depleting the carbon budget. These cities will play an ever-greater role in global GDP generation and GHG emissions, and their exposure to climate change impacts will also increase. Urban climate action in the developing world will require good governance, technical capabilities and financial support. In view of the multiple priorities facing city governments, climate adaptation has to be mainstreamed within the sustainable provision of urban services and the build-up of urban resilience to natural hazards. Similarly, GHG mitigation should be embedded within green growth and urban welfare strategies, driven as much by quality of life goals as by climate protection considerations. Compact urban growth, connected infrastructure and coordinated governance can provide the way forward, and the resulting urban morphology can greatly contribute to reducing urban emissions. Further co-benefits can be obtained by integrating mitigation and adaptation strategies at the urban scale. Some cities in OECD countries are achieving significant GHG reductions and showing that a post-carbon urban future is possible. International city networks have emerged as vehicles for innovation sharing, learning, and advocacy for the recognition of cities in global climate action. For further action to take off in the cities of the developing world, a global climate deal should (a) increase the amount of international funding for urban adaptation, especially in LDCs; (b) multiply opportunities for channelling carbon financing into urban green growth; (c) make international financial support dependent

on innovative national urban policies; and (d) support urban learning, networking and knowledge-sharing programmes.

1 Diversity and complexity of cities in the developing world

Globally, cities currently account for 80% of GDP production and over 70% of GHG emissions, while hosting 54% of the world's population. As in the rest of the world, cities in developing countries and emerging economies concentrate population and economic assets, and contribute disproportionately to their countries' generation of wealth. As urban agglomerations attract national production, consumption, and provide transit for incoming and outgoing goods, they are also the centres of highest energy usage and therefore of highest GHG emissions. With the share of global GDP being increasingly generated elsewhere than the G20 countries, an ever-greater share of emissions will originate from cities in emerging economies in the near future.

As international negotiations are approaching the 21st Conference of the Parties in Paris, a global framework agreement to counter climate change should be shaped so that cities become fully engaged in its implementation. For this to happen, it is imperative to recognise the diversity and complexity of the urban settlements in developing countries and emerging economies, and to unpack the generic concept of 'cities of the global South' in order to engage them more effectively in climate action.

While GDP per capita is a coarse measure of wealth and welfare, it is still helpful in decoding the specific climate change challenges that various types of developing and emerging cities are already facing and will increasingly face in the future. Cities in least developed countries (LDCs) are likely to present a profile of low energy usage, accompanied by low GHG emissions levels, but a high level of urban risk and exposure to climate change impacts. This, in turn, is the result of a low level of infrastructure provision, a high percentage of the resident population living in informal housing, unmitigated natural hazards, and a low institutional capacity to manage urban growth as well as enforcing urban planning legislation, providing basic urban services and emergency response systems (Revi et al. 2014).

At the other extreme of the spectrum of cities in the developing world we find the complex urban agglomerations of Upper Middle Income Countries, with sophisticated modern infrastructure, generalised formal housing, high energy usage and high GHG emissions levels. These are in many cases boosted by the intensive export-oriented manufacturing activities that have displaced industrial production from Europe, North America and Japan. However, depending on their location (but especially if located in coastal zones), many such cities may be also exposed to high levels of unmitigated urban risk and vulnerable to climate impacts.

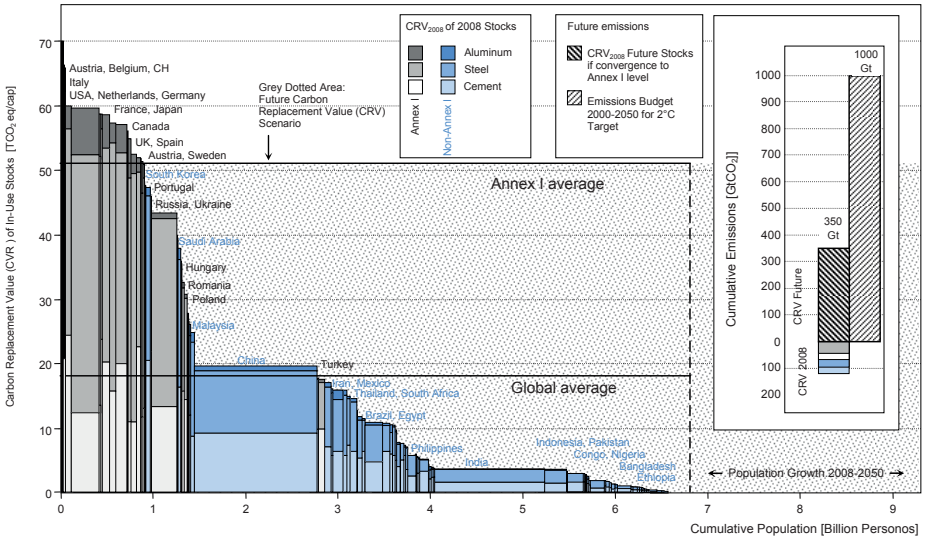
2 Combined challenges of future urbanisation and climate change

Cities have become the dominant form of human settlement on the planet, with urbanisation galloping ahead at a much faster rate than global population growth. This 'great acceleration' is in its overwhelming majority taking place in the cities of developing countries and emerging economies, where over 2.3 billion new residents are expected out of a global forecasted population increase of 2.5 billion by mid-century. The regional distribution of urbanisation will be uneven, with the vast majority expected to take place in Asia and Africa. By mid-century, the urban population of Africa is likely to triple and that of Asia to increase by over 60%. Future increases in the world's urban population are also expected to be highly concentrated in just a few countries. Taken together, China, India and Nigeria are projected to account for 37% of the increase of nearly 2.5 billion people in the urban population by 2050 (UN DESA 2014).

The relationship between urbanisation and economic growth is also very varied, and while the two are historically strongly correlated, in LDCs and in Africa in particular they appear to follow quite separate trajectories. The economies of many African cities may continue to stagnate or grow very slowly, putting additional strains on infrastructure, housing, welfare, and governance. An increasing proportion of urban informality will be the unavoidable consequence of further urbanisation with little or no economic growth, further exposing resident populations to urban risks and depriving them of the improved welfare generally associated with urban life.

Two trends, however, are common to all fast-paced global urbanisation in the 21st century: sprawl (i.e. the increase of the urban land footprint per inhabitant), and an increasing consumption of natural resources and energy for the production of buildings and urban infrastructure. If unmitigated, both have significant implications for the future trajectory of GHG emissions growth. Urban sprawl locks in greater distances between functional city locations, greater infrastructure and energy requirements, and ultimately creates a higher dependency on fossil fuels to keep urban systems operational, while causing labour productivity losses. The construction of the built environment represents huge commitments of natural materials, their extraction, processing and transport, with related energy consumption and emissions outcomes (Seto et al. 2014). These become the 'stocks' of emissions embedded in the built-up cities versus the 'flows' from recurrent or yearly urban energy usage, the only ones to be accounted for in standard urban emissions inventories.

Figure 1 Carbon replacement value per capita of existing stocks by country and as yet unbuilt stocks if developing countries converge on the current Annex I level



Source: Figure 12.12 in IPCC (2014), using data from Müller et al. (2013).

As illustrated in Figure 1, the carbon replacement value (CRV) for reference year 2008 (CRV2008) of key building materials (aluminium, steel and cement) currently embedded

in the national building stocks varies greatly, and is largely correlated to per capita GDP. The average CRV for Annex I countries has been calculated at 50 tCO_2eq/capita. Were that average of carbon intensity to be reached by all expected future construction and urban build-up by mid-century, one third of the available carbon budget (1,000 Gt CO_2) would be consumed (with 75% probability). Of this overall emissions budget for the planet to remain within the 2°C temperature increase, approximately 420 $GtCO_2$ have already been emitted during the period from 2000 to 2011.

Table 1 Emerging cities will play a significant role in growth of the global economy and carbon emissions to 2030

Urban group	Projected base GDP growth from 2012–2030 (US$ trillions)	Projected base case emissions growth from 2012–2030 (Mt CO_2)	Projected population in 2030 (BNS)	Per capita in 2030 (tonnes of CO_2 per person)
Emerging cities e.g. Bangalore, Kunming, Pune, Puebla	16	3,230	~1.3	~7.0
Small urban areas inc. villages, small towns, peripheral industrial areas pop. < 0.5 million	16	1,220	~2.2	~4.6
Established cities e.g. Stuttgart, Minneapolis, Stockholm, Hiroshima	11	390	~0.4	~12.1
Global megacities e.g. Beijing, New York, London, Rio de Janeiro	10	1,050	~0.6	~7.1
Total growth	~52	~5,890	Total population in 2030 ~4.5	
Share of world growth	~87%	~65%	Share of world population in 2030 ~4.5	

Source: Figure 2 in GCEC (2014).

In the analysis of the Global Commission on the Economy and Climate, "emerging cities will play an increasingly significant role in growth of the global economy and carbon emissions to 2030. Already in 2014 the GDP generated by China's ninety largest cities amounted to over US$6 trillion, the equivalent of Germany and France's economies combined". Under a business as usual (BAU) scenario, 468 cities will account for over

60% of global income growth over the period 2012-2030, and for nearly half of energy related emissions growth (GCEC 2014).

The subset of 291 'emerging cities' (rapidly expanding, middle-income, mid-sized cities in China, India and other emerging economies) is likely to account for over a quarter of global income growth (US$16 trillion) and over a third of global energy-related emissions growth (3,230 Mt CO_2) over the period 2010-2030. According to the Global Commission, action by this group of cities represents the most significant short- to medium-term global opportunity for avoiding lock-in to long-lived high-carbon urban infrastructure.

'Small urban areas' will account for a similar amount of income growth, but for a significantly lower growth in emissions of about 1,220 Mt CO_2 by 2030. This is consistent with the projected increase of urban centres with a population below 100,000, in which 40% of the world's population are supposed to reside by mid-century. Another 21% will reside in cities of between 100,000 and 1,000,000 inhabitants. This is where much of the urbanisation in LDCs will take place. The lower level of emissions growth in small urban areas is explained by their regional location and by agglomeration dynamics, which concentrate manufacturing and infrastructure in larger urban centres. Governance and institutional capacity are scale and income dependent, i.e. they tend to be weaker in smaller cities and in low-revenue settings. However, as the bulk of urban growth momentum is expected to unfold in small to medium-sized cities in the developing world, significant opportunities for GHG emissions reductions might be precisely in those urban areas where governance and institutional capacities to address them are weakest (Seto et al. 2014).

Cities in general, and particularly those in the developing world, are subject to a number of specific impacts of climate change: ambient temperature rise amplifies the urban heat island effect and generates heat waves, with severe consequences for the resident population, particularly the young, the elderly and the vulnerable; higher temperatures interact with air pollutants and worsen air pollution; more sudden and intense episodes of precipitation overwhelm drainage systems and multiply urban flooding risks; coastal erosion, storm surges and sea level rise threaten wetlands, riverine outflows, as well as seaboard infrastructure and housing in many locations already exposed to land subsidence; and finally, the provision of drinking water is impacted by climatic strains

on the resource base. Such impacts are expected to increase significantly by mid-century and onwards, depending on the future trajectories of emissions and of related global warming.

With urbanisation unfolding at such a rapid pace, increasing amounts of urban population, infrastructure, built environment and economic assets will be exposed to these impacts. As cities grow, and especially where urban expansion is not mastered or controlled but is purely driven by demographics and agglomeration economics, they eventually occupy areas at greater risk, be they exposed to intense flooding and landslides, typhoons or hurricanes, or below sea level. This is especially relevant for the low-income, informal settlements typical of LDCs, and for marginal neighbourhoods in middle-income countries.

3 Synergies of urban adaptation, development and resilience

The challenges of urban adaptation to climate change come on top of massive and as yet unmet development needs, especially in LDCs where often weak governance and limited financial and technical resources cannot match the fast pace of urbanisation and the increasing demands for basic urban infrastructure, shelter and welfare. Investments aimed at favouring growth and the productivity of urban agglomerations are required in order to provide the economic and fiscal basis for further urban expenditures. Against this backdrop, LDC governments often perceive urban adaptation as an additional exogenous burden caused by the cumulative historical GHG emissions of wealthier nations. Adaptation is rarely considered as a short-term priority, also in view of the high level of unmitigated exposure to natural hazards that many cities in the developing world are facing. Finally, the limited availability of financial resources for climate adaptation hampers much needed urban responses.

However, urban climate adaptation can be synergistic with investments related to natural hazard risk mitigation, the provision of basic infrastructure, the protection of the urban environment, and the improvement of welfare for the resident population, especially the poor. When such synergies are obtained, adaptation can be more easily mainstreamed in the strategic investment plans of the rapidly urbanising cities of the

developing world. Climate change impacts can be mitigated via pre-emptive actions, rather than in a more costly, disruptive and less efficient emergency response modality.

For instance, Durban in South Africa "has adopted and is implementing an eco-systems based adaptation strategy, including a large-scale community reforestation programme where community level '*tree-preneurs*' produce indigenous seedlings and help plant and manage the restored forest areas as part of a larger strategy to enhance biodiversity refuges and water quality, river flow regulation, flood mitigation, sediment control, and improved visual amenity. Advantages include employment creation, improved food security, and educational opportunities". Also, "[i]n Quito, where reduced freshwater supplies are projected with glacier retreat and other climate-related changes, local government has formulated a range of adaptation plans, including encouraging a culture of rational water use, reducing water losses, and developing mechanisms to reduce water conflicts" (Revi et al. 2014).

The benefits of adaptation can therefore be measured not only in terms of avoided damages and losses that would be inflicted on a given city by the impacts of climate change, but also in terms of additional improvements to the overall quality of the agglomeration to be obtained via such investments. For instance, the protection of certain areas from increased risk of flooding and mudslides may result in the upgrading of informal neighbourhoods, with significant social benefits; the management of larger volumes of runoff can lead to the protection of wetlands and waterways with amenity co-benefits for all residents; planting green canopies over central streets may reduce the impact of the heat island effect and of heat waves, while also providing the city with more greenery and more liveable public spaces; a coastal defence project may include the creation of a sea-front promenade and its costs may be offset by increased real estate values and the benefits of waterfront regeneration. Adaptation to climate change can thus become embedded in sustainable urban development and generate further rewards.

4 Synergies of urban mitigation, green growth, and welfare

Similar considerations apply to the task of reducing GHG emissions from cities in developing countries and emerging economies, starting with those that have taken

over the bulk of worldwide manufacturing and that are expected to grow the most in population, urban footprint, GDP, energy usage and GHG emissions in the next decades. The green growth paradigm seems to provide the best possible approach to achieve substantial reductions to projected GHG emissions from these cities, and more.

For cities that are expected to add significant amounts of built environment between now and mid-century, the challenge and the opportunity lie in embracing a low-carbon urban development framework, delinking economic growth from energy intensity and energy production from fossil fuels. Important synergies are also to be found between carbon reductions and improvements in urban air quality and related public health and urban welfare, which are much sought-after by residents of large developing and emerging cities. The synergies of air pollution reduction and GHG emissions abatement are significant and may provide the necessary public support for the climate change mitigation agenda.

In the words of the Global Commission on the Economy and Climate, "[n]ew analysis … suggests that the United States could save $200 billion per year if it pursued smarter, more compact growth policies, primarily due to savings in the cost of providing public services and capital investments such as roads. According to the World Bank, China could save up to US$1.4 trillion in infrastructure spending up to 2030 if it pursued a more compact, transit-oriented urban model – equivalent to around 15% of China's GDP in 2013. Analysis for the Commission suggests that more compact, connected urban development could reduce global urban infrastructure requirements by more than US$3 trillion over the next 15 years (2015-2030)" CGEC (2014: 11).

Compact urban growth, connected infrastructure and coordinated governance are the three 'Cs' recommended by the Commission to reduce urban investment requirements, capture productivity gains, abate GHG emissions, significantly improve the quality of urban environments for their resident populations, and lighten the load of cities on natural ecosystems. The IPCC's Working Group III recommends a sustainable low-carbon urban morphology based on density, land-use mix, connectivity and accessibility (Seto et al. 2014).

A similar approach has been tested by urbanist Peter Calthorpe in simulating alternative urban growth and GHG emission scenarios for the United States. Based on current

estimates, 60 million new units will have to be added to the housing stock by 2050. The BAU or 'trend sprawl' scenario would increase urbanised land by 38%, and require about US$50,000 per unit of on-site infrastructure alone. In a 'simple urbanism' scenario the demand for urbanised land would be slashed by two thirds, and the costs of on-site infrastructure by half. The increased density and lower infrastructure costs would be achieved by altering the mix of single-family, multi-family homes and town-houses, which would represent 55%, 31% and 14% of the additional stock, respectively, against 67%, 23% and 10% of the BAU scenario. The 'green urbanism' scenario, which would complement compact land-use with aggressive standards for mobility, fuel-efficiency, building efficiency and building retrofits, and high contributions of renewables to energy generation, would reduce additional GHG emissions by three quarters and air pollution by half (Calthorpe 2010).

Compact urban growth is thus articulated to achieve urban quality, encourage mass transit and non-motorised transportation, and create urban environments of high livability, in addition to the pursuit of GHG abatement. In the developing world, Curitiba in Brazil has been the regional pioneer for transit-oriented development since the 1970s, and its example has been followed by a number of more recent large-scale urban retrofits of mass transit systems, such as Bogotá's *Transmilenio*, which have contributed to limiting traffic congestion and air pollution, increasing labour productivity, reducing GHG emissions, and improving public health and quality of urban life in various Latin American cities.

Thus, the benefits and costs of carbon mitigation need not be measured only through dedicated GHG abatement cost curves, but rather as part of broader assessments of green growth yielding multiple parallel benefits as a result of sustainable urban strategies.

5 New urban policy directions, innovations, and city learning

In the previous sections of this chapter, adaptation and mitigation, as well as their respective linkages with sustainable urban development and green growth, have been addressed separately. However, recent urban practices worldwide are demonstrating that the most successful urban climate policies integrate the adaptation and mitigation

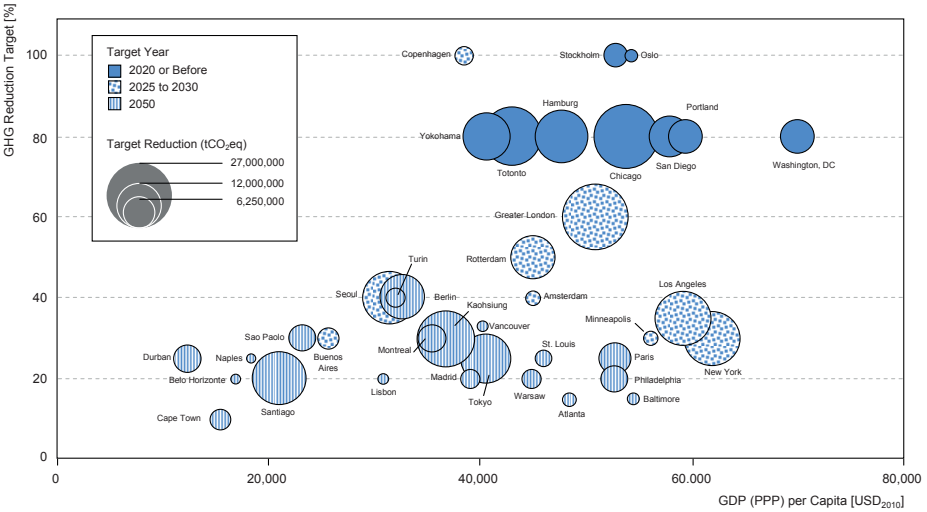
agendas. Many Climate Actions Plans – the 'road maps' that urban governments prepare in order to embark on, and then monitor, their strategies for climate action – include investments for adaptation as well as for mitigation, and many such actions naturally converge.

For instance, investments in providing a higher level of thermal insulation of the building stock, whether via the construction of green buildings or retrofitting existing ones, will certainly provide adaptation to a warmer climate, but will also mitigate GHG emissions on account of lower building energy usage. Green infrastructure meant to manage excessive, sudden runoff and to provide protection against flooding will also generate urban cooling comfort and absorb carbon emissions. Effective waste management and recycling will provide protection of urban waterways and public spaces from uncontrolled dumping, but also methane sequestration and a reduced consumption of natural resources.

Many cities in OECD countries have been generating substantive innovations by internalising the climate change agenda and making it an opportunity for countercyclical economic investments, urban renewal, job creation, jumpstarting the urban green economy, and developing specific and exportable know-how on managing cities in a warming world. Some cities have already achieved deep cuts in local GHG emissions and have increased their resilience and adaptation to climate change impacts. Urban commitments to mitigation often surpass the ones of national governments, showing that cities can lead the way forward.

As illustrated in Figure 2, some cities such as Copenhagen, Stockholm and Olso are 'ahead of the curve' and are showing that the urban economy can be entirely decarbonised, and indeed have committed to do so by 2030 or by 2050. Such cities clearly benefit from a high GDP per capita, a long-standing commitment to environmental sustainability and urban quality of life, a pro-active policy environment and supportive populations. Their mix of GHG abatement solutions includes compact urban form and density, non-motorised transportation and mass-transit systems, energy efficiency of the built environment, on-site and off-site renewables, heat and energy co-generation from waste management, as well as carbon offset programmes. Their examples pave the way for more urban innovation globally.

Figure 2 Mitigation targets for 42 cities



Source: Figure 12.21 in IPCC (2014); baseline emissions, reduction targets, and population from self-reported data submitted to Carbon Disclosure Project (2013).

In the EU's policy context, the Covenant of Mayors was set up in 2009 as a voluntary network of local governments committed to the EU goal of a 20% reduction in GHG emissions by 2020 over the 1990 baseline, with 20% of renewables in the energy mix. With vast control over local infrastructure, built environment construction regulations, waste management, and utility provision, city and regional governments are best suited to assess local energy usage, formulate GHG reduction strategies, and mobilise civil society and private-sector actors. Over 6,000 local governments representing 200 million citizens have signed on to the Covenant and are currently implementing emissions abatement programmes, many of which promise to surpass the EU-wide stated goal.

Not many cities in the developing world have gone as far, although some champions have emerged and many adaptation and mitigation projects are currently being implemented. Cities like Mexico City, Rio de Janeiro and Medellin in Latin America, Amman in the Middle East, Bangkok, Jakarta, Beijing and Shanghai in East Asia, Addis Ababa and Durban in Africa, Mumbai and Dhaka in South Asia, and many others are tackling climate change challenges. The plethora of developmental priorities that cities in the developing world have to contend with, as well as the limits to financial and technical

resources available, constrain the extent to which climate change has been addressed so far.

Over the past decade there has been a great increase in development assistance for urban climate change mitigation and adaptation by numerous multilateral and regional banks and agencies. They provide financial resources and technical assistance for specific investments, as well as for urban risk assessments, citywide emissions inventories and the development of low-carbon strategies, as well as for the expansion of carbon markets. Their support, as well as that of some key foundations, also facilitates the transfer of innovations from OECD cities to developing and emerging cities. Research programmes in major universities worldwide have generated a rich literature of case studies on the specifics of urban climate change, better informing urban decision making.

Some major international city networks have emerged, such as ICLEI and C40, which focus their work on policy and experience sharing and on providing assistance to their members for urban climate action planning and implementation, including in the cities of the developing world. Working through effective mayor-to-mayor collaboration, they play an invaluable role in prompting innovations, facilitating exchanges, and raising the priority of urban climate change action worldwide.

6 An international framework in support of resilient and low-carbon cities

Paradoxically, despite the finally prevailing view that cities are 'part of the solution' and not only 'part of the problem' in the global fight against climate change, they do not have any official role or 'seat at the table' in the context of international negotiations. These are conducted within the UNFCCC by national governments and their delegations. The Compact of Mayors, the World Mayors Council on Climate Change and other municipal networks have emerged in the past decade to ensure that the essential voice of cities is heard at the negotiations and beyond. Going forward, INDCs should clearly report their urban components so that the contributions of cities in mitigating GHG emissions may be internationally accounted for and recognised for the importance they have in meeting this global challenge.

The ongoing momentum of climate action in cities can be greatly boosted by a framework agreement at the international level, especially if it contains specific provisions to engage and support cities in the developing world, based on their specific characteristics, challenges, constraints, GHG emissions levels and climate vulnerabilities. Below are four recommendations on how an international framework agreement could provide support:

1. **Increase the amount of international funding for urban adaptation, especially in LDCs**. This could allow many cities critically at risk of climate impacts to carry out essential investments in coastal protection, flood control, water supply and other priority areas. The Green Climate Fund should provide the funding; multilateral and regional development banks should be the delivery vehicles and provide the related technical assistance, as they are engaged with assisting cities with infrastructure investments.
2. **Multiply opportunities for channelling carbon financing into urban green growth**. The growing relevance of emission trading schemes and carbon pricing already includes cities in the OECD as well as emerging economies. For cities to better participate in carbon markets, carbon emissions reductions originating from many urban sectors should be integrated and certified. The Global Protocol for Community-scale GHG emissions is becoming the internationally recognised standard and should be further endorsed.
3. **Make international financial support dependent on innovative urban policies**. Policy guidelines should ensure that financial resources for urban climate action integrate adaptation with sustainable urban development, and mitigation with green growth policies. Technical assistance for urban risk assessments and emissions inventories should be multiplied to develop optimal strategies, as the basis for political support and financing. Private sector actors could be further engaged in providing know-how.
4. **Support international learning, networking and knowledge-sharing programmes**. The voluntary efforts of membership-based associations need to be

supported financially as they can greatly accelerate the up-take of climate action in the developing world's cities. Specific knowledge-sharing programmes on metropolitan governance, climate-friendly fiscal policies and creditworthiness can facilitate the access of cities in emerging economies to capital markets and make their climate strategies more effective.

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31 Meaningful technology development and transfer: A necessary condition for a viable climate regime

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Technology development and transfer, or 'technology cooperation', facilitating climate change mitigation and adaptation, is widely understood to be an integral part of the solution to human-induced climate change. It is embedded in the UNFCCC's negotiating text, and has gained weight over the years as a necessary condition for a viable climate regime – especially with the establishment of the Technology Mechanism that emerged as part of the Cancun Agreements. The Technology Mechanism's implementation, however, has seen mixed success so far, and is limited by resources and politics. This chapter explores necessary conditions and concrete options for a treaty in Paris (and beyond) that provides for successful technology development and transfer for climate change mitigation and adaptation. Conditions include (1) global and active recognition, in all UNFCCC bodies, that capabilities and innovation systems in the field of adaptation and mitigation technologies need to be strengthened before markets can be effective; (2) financial commitments that allow for the Technology Mechanism to fulfil its mandate as agreed in the Convention; and (3) a variety of practical arrangements, including a research and development cooperation body to be instituted within the Technology Mechanism.

1 Introduction: The transformational challenge

This chapter investigates whether and how meaningful provisions for technology development and transfer in a climate regime can contribute to broad participation from developed and developing countries. This translates into what individual countries stand to gain from the overall agreement, and from the technology part specifically (Barrett and Toman 2010), as well as what is needed for the availability of low-carbon technology in all countries. The most commonly used argument for technology development and transfer (sometimes summarised as 'technology cooperation') under the UNFCCC revolves around R&D for cost reduction; although we have heard for years now that deep emission reductions can be achieved by technologies that are available today (e.g. IPCC 2014, Pacala and Socolow 2004), reducing costs through research is thought to be key for successful implementation of those technologies (see the chapter by Toman in this book).

If only it were that simple. The problem of technology implementation goes well beyond cost reduction. Technology functions in a social and cultural context (Cherlet 2015), market failures are prominent (Grubb et al 2013), and the incumbent socio-technical regime is incredibly robust (Geels 2002). As an example, achieving a global low-carbon energy system requires bringing about change in every single aspect of energy demand and supply, involves many actors, is up against huge vested interests and technological lock-in, and hence requires a major intervention in economic and cultural systems. Such a complex, multi-level change to the fundamental attributes of a system is often characterised as transformational change (O'Brien 2011, IPCC 2014). As transformational change is essential for staying within a 2°C global mean temperature rise, the climate negotiations ought to place more emphasis on taking the conversation on transformational technological cooperation forward.

Transformation (in energy, but also in other mitigation and adaptation-relevant sectors) is an issue for every country, but in developing countries the challenges are compounded by lower capabilities, weak institutions and widespread poverty. The specific situation of developing countries needs to be taken into account in the UNFCCC, both in the area of mitigation and adaptation.

The UNFCCC allows for a conversation on transformations, notably in the specific circumstances of developing countries, in its discussions around technology development and transfer, which is where long-term challenges, enabling environments, national systems of innovation, and capabilities are discussed. Provisions for technology development and transfer are engrained in the Convention but have had cursory follow-up (Haselip et al. 2015). Recently, the Technology Mechanism has been set up as the first international body explicitly aimed at enhancing climate technology development and transfer in both adaptation and mitigation (see below for further discussion). Although it is too early to tell whether its efforts will bear fruit, and an overall estimate of the (monetary) size of the effort to bring about transformational change is definitely several orders of magnitude bigger, it is clear that the current funding (of around US$30 million over five years) and the arrangements (based on one-off contributions from donor countries) provide too little to make a difference for a 2°C trajectory (Coninck and Puig 2015). Moreover, its mandate is not used to the full because of political barriers, including a hidden anxiety on the part of the current technology leaders to create their own competitors (Coninck and Sagar 2015). Therefore, this chapter indicates what key improvements can be made to the UNFCCC Technology Mechanism, and what the 2015 climate change deal, agreed at COP21, could include on technology.

2 What does 'technology development and transfer' mean?

As the word 'technology' is often misinterpreted, it is used with some hesitation in this chapter. Technology, to climate policy researchers and practitioners, evokes thoughts of renewable energy, electric vehicles and CO_2 capture installations. However, among scholars in innovation studies, and among a sizeable group of climate change negotiators, the word technology also incorporates the complex fabric of capabilities, institutions, connections, networks, policies and cultures that are an inalienable part of any strategy for renewable energy, electric vehicles or CO_2 capture installations. Many case studies support this view, for instance studies of the development of the solar and wind energy industry in India (Chaudhary et al. 2015) and the PV or battery industry in China (Gallagher 2014).

Technology development and transfer, as intended in the Convention, goes well beyond R&D agreements as discussed in Toman's chapter in this book – the Convention acknowledges that it is also about credible mechanisms that allow developing countries to 'catch up' technologically, to develop their own appropriate innovation capabilities, to make use of indigenous knowledge, and to become full participants in the global technological market place. Such mechanisms ought to enable developing countries to implement their own mitigation strategies and to benefit economically from other countries' mitigation strategies by becoming suppliers of the required knowledge and installations, much like China has managed for solar PV and other technologies. 'Catching up technologically', then, is very much a development question, relating to education systems, effective government interventions and entrepreneurial spirit. This is also indicated in Mekonnen's chapter in this book, specifically in relation to Africa.

The IPCC's definition for 'technology transfer' reflects this by comprising international transfer of installations and hardware, but also transferring and developing local capabilities, institutions and other non-hardware elements that are required for realisation of the hardware and the ability to improve on it (IPCC 2000). Therefore this chapter treats 'technology' in its manifestations as hardware (the installations), software (operational, manufacturing and innovation capabilities) and 'orgware' (institutional and policy capabilities). There are many documented examples of why this is relevant, from the implementation of energy-saving lightbulbs in Kenya and Ghana, which demonstrated the crucial role of local capabilities and manufacturing (Byrne 2013), to low-carbon and energy-efficient cement in sub-Saharan Africa, which relied on a range of factors, such as market liberalisation, government support for industrial development, activities of equipment suppliers, and OECD-based multinationals, local technical capacity and information and finance access (Ionita et al. 2013).

Consequentially, the question answered in this chapter is not limited to the hardware installation question of how do we get more solar PV and CCS installed globally, as discussed in the chapters in this book on CCS by Tavoni and on renewable energy by Bossetti. Rather, it answers the more political question of how participation and feasibility of an international climate regime can be improved by making technology part of the portfolio of agreements, and doing this in a meaningful way. The technology theme can thus also be seen as a building block or an enabler of mitigation and

adaptation strategies in development, as discussed in the chapter by Stewart, Rudyck and Oppenheimer.

3 Assessment of current provisions for technology within and outside the UNFCCC

3.1 Technology in the UNFCCC: 1992-2009

Technology has been an item in the UNFCCC since its inception in 1992; it is mentioned in Article 4.5, which states (UNFCCC 1992):

> *The developed country Parties and other developed Parties included in Annex II shall take all practicable steps to promote, facilitate and finance, as appropriate, the transfer of, or access to, environmentally sound technologies and knowhow to other Parties, particularly developing country Parties, to enable them to implement the provisions of the Convention. In this process, the developed country Parties shall support the development and enhancement of endogenous capacities and technologies of developing country Parties. (…).*

Clearly, the Convention obliges developed countries to assist in technology transfer, and it also explicitly mentions the relevance of building capabilities.

The technology development and transfer item under the UNFCCC went without much in terms of conclusions on actions in the field of technology development and transfer. This situation got worse over the years, as the developing countries continued to find evidence that developed countries were not compliant with the provisions of Article 4.5. In addition, discussions around intellectual property rights stalled progress in the negotiations, even up to the ministerial level (Abdel-Latif 2015).

The main activity that has been undertaken under the realm of the UNFCCC in the period until the Copenhagen Accord is the formulation of Technology Needs Assessments (TNAs), which aim to outline and prioritise activities around technology transfer under Article 4.5 in developing countries (and if appropriate, financed by Annex II countries). The first round of TNAs or similar activities in 60 countries was summarised in a synthesis report (UNFCCC 2006), which suggested that the technology and capacity needs, as well as barriers to technology transfer, are relatively clear but that actions to

address them are not pursued in most cases. Even after improvements in later rounds, it is unlikely that the TNAs significantly influenced decisions by developed countries for the allocation of assistance. Speculations about the reasons for this presumed lack of impact could include the appropriateness and user-friendliness of the documents, the often still far from ideal inclusiveness of the process of drafting the TNAs, and their insensitivity to matters of political timing.

3.2 Technology Mechanism: 2010 to present

One of the achievements of the Bali Action Plan (2007) and the Cancun Agreements (2010) (UNFCCC 2010) has been the development of a Technology Mechanism (TM) under the UNFCCC. After nearly two decades of painful and fruitless discussions on technology transfer, here was an outcome that developed and developing countries could accept and that helped cement the Cancun Agreements, an important package deal. Indeed, without the Technology Mechanism (in addition to discussions on loss and damage, the Green Climate Fund and the Adaptation Fund), developing countries would not have accepted the start of the breakdown of the firewall between Annex I and non-Annex I countries as agreed at COP 17 in Durban, and would not have committed to all countries submitting Intended Nationally Determined Contributions (INDCs). Technology is considered to be one of the mainstays of developing countries' negotiating points, and the Convention will have to deliver on it if it wants a balanced treaty that is agreeable to developing countries.

Moreover, as countries are submitting their INDCs, the emphasis on mechanisms to deliver technology development and transfer is even more evident. Several developing countries have put forward emissions reduction targets that are dependent on international support through technology transfer and cooperation, finance and capacity building. For example, as also noted by Kaudia in her chapter in this book, Kenya's INDC states plainly that its ambition to cut emissions by 30% by 2030 relative to the BAU scenario is "subject to international support in the form of finance, investment, technology development and transfer, and capacity building" (Republic of Kenya 2015). Mexico's INDC includes a commitment to lower its emissions by 40% by 2030 compared to BAU that is conditional on similar provisions (Republic of Mexico 2015).

The Technology Mechanism was designed to include a "policy arm" (the Technology Executive Committee, or TEC) and an "implementation arm" (the Climate Technology Centre and Network, or CTCN). The TEC was created with the intention of "providing an overview of needs for the development and transfer of technologies for mitigation and adaptation", and to suggest policies and initiatives to encourage 'technology cooperation'. The CTCN was expected to "facilitate national, regional, sectoral and international technology networks, organizations and initiatives to mobilize and enhance global clean technology capabilities, provide direct assistance to developing countries, and facilitate prompt action on the deployment of existing technologies" (UNFCCC 2010). It was envisaged that linkages between the Technology Mechanism and the Financial Mechanism would also be established, but so far no agreement could be reached on such a link.

The TEC has met over ten times since it started operations in 2011. It has produced a number of policy briefs on relevant topics, but it has not lived up to the hopes of being the go-to place for technological advice and a trusted source of information on technology development and transfer for developing countries. One of the issues seems to be lack of resources, and another the composition of the TEC – most members, both from developed and developing countries, are climate negotiators, which hampers practical discussions and replicates the same deadlocks and differences that can be observed in the climate negotiations (Coninck and Sagar 2015). If selection of TEC members could be based more on expertise, it might grow into the body that was envisaged when it was installed.

The CTCN is designed in such a way that it has more distance from the UNFCCC, as it operates mainly on its own account (although strategic guidance is given by a negotiator-populated Advisory Board). Its main activity so far is responding to requests by developing countries, through their newly instituted National Designated Entities, established especially for the CTCN. It is also supposed to develop a global network of organisations that are actors in the climate technology space – private, public, civil society and research actors. This Climate Technology Network is the hope of the developing countries – the diverse institutions (including companies, research organisations and NGOs) in the network are the places where capabilities for operation, maintenance, manufacturing and innovation on climate technology ought to be built.

Notably, although the mandate of the CTCN includes R&D cooperation (UNFCCC 2011), no activities have been facilitated in this space so far.

The CTCN started in February 2014, so is relatively young. Responding to requests, based on currently available information, seems to work properly. Requests vary from policy and technical assistance to research cooperation, and are so far evenly spread between adaptation and mitigation. The main weakness of the CTCN so far resides in the 'N', which non-Annex I Parties actually find the most important. There is no vision for what the Climate Technology Network will do, how it will be built up, and in particular how it will amount to relevant capabilities in developing countries, in particular least-developed countries. The CTCN director has also be calling for increased funding for the CTCN, which despite an earlier mandate in COP documents, does not enjoy structural funding and needs to fundraise from donors to be able to pursue its activities.

3.3 Non-UNFCCC technology interventions and financing

The vast majority of the activities around technology development and transfer, of course, take place outside of the UNFCCC. For instance, the private sector acts as an exporter and developer of technology, as a financier, and as a project developer. In order to address the barrier of accessing finance for riskier climate technologies, multilateral development banks have installed Climate Investment Funds that are funded by developed country development ministries. Numerous national, bilateral and international programmes that operate outside of the climate field contribute to global technology development and transfer, technology cooperation, green growth and the like (Hultman et al. 2012, Ockwell et al. 2015). It is hard to ascertain the level of technology cooperation (and the finance supporting it) outside of specific programmes. In addition, several authors have indicated that it is – probably unintentionally – even difficult to obtain an overview of just the public sector-initiated interventions on climate technology (Hultman et al. 2012, Coninck and Puig 2015, Ockwell et al. 2015).

4 Practical way forward for technology in the 2015 climate change agreement

No one believes that the UNFCCC will be the one and only institution for the global development and transfer of mitigation and adaptation technologies, or to facilitate grand transformative changes of the global energy system. However, many, in particular those based in developing countries, view the technology arrangements in the 2015 Paris climate change agreement as a condition for agreement as well as for implementing INDCs.

Moreover, developing countries value 'technology' as conditional to their right to development – specifically, fair access to technology, an opportunity to develop capabilities and the chance to play a role in the global technology market. Contrary to this, the behaviour of developed countries in the technology sphere is seen as protecting own technology interests. This can be understood in terms of an attempt to lower domestic political and social tensions in times of economic crisis and mounting international competition.

A balanced climate agreement would require provisions for technology cooperation to go forward. These could include the following elements:

- For technology cooperation on R&D, the Paris agreement should include provisions for an R&D cooperation body, possibly under the Technology Mechanism. Several authors have alluded to this in slightly different forms. We have argued earlier (UNEP 2010, Bhasin 2013) that the Technology Mechanism could facilitate setting up a multilateral single or distributed research body, similar to the CGIAR Research Programmes and Funds (established as the Consultative Group on International Agricultural Research). This could focus on R&D of low-carbon technologies cutting across national borders based on global public goods concerns relating to climate change. This would encourage scientific innovations and boost innovation capacities of developing countries. Similarly, in his chapter in this book, Toman argues for an int````ernational agreement to coordinate national RD&D programmes for low-carbon energy and to share the fruits of discoveries.
- As for improved innovation capabilities in developing countries, developed countries need to acknowledge that it is in their own interest to assist developing

countries in building these capabilities, as only when that happens will developing countries be able to achieve their INDCs and commit to further contributions to reducing emissions. The Technology Mechanism, in particular the CTCN through its network, could play a key role in this, but is not yet living up to expectations; more resources and an ambitious interpretation of its mandate are badly needed. In addition, the CTCN could encourage NDEs to submit requests that aim to increase capacity of a sector or the national innovation system.

- Climate technology development and transfer needs finance too. The Parties should elaborate on the provisions for financing technology development and deployment. They could decide in Paris to encourage partnerships between the Technology Mechanism bodies and multilateral development agencies, private sector associations, as well as specific climate-change financing bodies such as the Green Climate Fund. Until now, Parties in the UNFCCC have not agreed on a 'technology window' in the Green Climate Fund, or any other form of structural funding for technology activities. Without such provisions assuring financing, technology in the climate regime will not be able to play its envisioned role.

Since IPR remains a sticking point in the technology development and transfer negotiations, the TEC could attempt to bridge the gap between developing and developed countries by allowing discussion of a number of open licensing mechanisms (such as 'patent pools', open access, patent information databases, etc.) and supporting capacity building within developing country NDEs or other agencies. This should aim at contributing to developing countries' understanding of the legal nuances of using these pools, technology management, and familiarising scientists and lawyers in developing countries with patent drafting. It should also support the identification of projects that can benefit open-access technologies (Bhasin 2013). At the very least, discussion based on case-by-case evidence of the role of IPR in technology cooperation would be helpful, as the current oversensivity to the topic is blocking progress.

Technology is broadly viewed as a key building block in the climate regime and part of the package deal that will eventually be struck at COP21 in Paris. Despite sparse attention to the theme, the strength, financing, and design of the technology provisions in the Paris agreement will determine whether developing countries will accept the outcome of COP21. Ambitious yet realistic provisions around R&D cooperation,

innovation capabilities and finance is urgently needed, so that 'technology' can be the dealmaker it ought to be.

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