Climate change adaptation in dynamic economies

The cases of Colombia and West Bengal

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Executive summary

Adaptation presents developing countries with the ultimate dual challenge – building a rapidly evolving, sustainable economy within an environment increasingly altered by the impacts of climate change. To meet this challenge, adaptation policy must find balance and create synergy between the two, as climate resilience and economic resilience go hand in hand. Economic development is associated with structural change, including an evolving sector composition, the emergence of new comparative advantages and skills, and shifts in consumer demand as a result of rising incomes – all of which has implications for adaptation.

Existing attempts to adapt developing economies to climate change have nonetheless ignored these economic dynamics. Current approaches to adaptation often seek to preserve current structures, for example by protecting agricultural output, which neither acknowledges nor takes advantage of the fact that the status quo is evolving. In climate change risk assessments, the anticipated future climate change is often imposed on today's economies, rather than those of the future. But 'static adaptation' is a contradiction in terms. Effective adaptation policy must do more than simply shore up the status quo or protect economic activity that may soon be a relic of the past.

This policy brief explores the implications of dynamic economic development for adaptation to climate change. Policy lessons are derived from two case studies, the country of Colombia and the Indian state of West Bengal. The two economies are at different stages of development, with Colombia perhaps two decades ahead of West Bengal, but both economies experience rapid economic change and both have fairly sophisticated, if conventional approaches to climate change adaptation.

The case studies are illustrative and used to identify broader policy lessons. The purpose of the paper is not to comprehend the particular challenges of the two case study countries, but to identify general insights, which are relevant to all policy makers wishing to factor economic dynamics into their climate change adaptation plans. The main lessons are:

- **Economic development plans must not underestimate climate risks.** Current development plans often promote development models or set development objectives that are impractical or risky in the light of climate change, particularly for agriculture. Development plans have to become more climate-aware.

- **Conversely, adaptation plans must not underestimate the dynamism of modern economies.** Badly designed adaptation plans may hinder development by focusing too much on the status quo (e.g. in situ measures to maintain agricultural output) instead of embracing more transformative forms of adaptation (e.g. rural diversification).

- **Development planners and adaptation planners need to work more closely together.** This will force economic planners to consider sectoral growth dynamics in light of climate risks and adaptation planners to factor into their planning the evolving economic system. It will make it easier to identify potential synergies and manage development trade-offs. One such trade-offs is productivity, where some improvements may come at the expense of higher climate risk.

- **Economic growth offers an opportunity to alter for the long term the risk profile of countries with respect to climate change.** There is the possibility to build climate resilience into decisions from the outset. To do this, adaptation plans need to systematically identify the opportunities, or 'entry points', where proactive adaptation can be factored into development strategies and long-term investment plans.

The practical challenge is to make these lessons actionable in actual planning processes. The solutions will be situation-specific and depend on the institutional and political economy context. There are likely to be barriers to achieving a closer integration between climate adaptation and development planning, which need to be understood case by case. However, without closer integration, both adaptation planning and development planning could become increasingly ineffective.

1. Introduction

Adaptation to climate change in developing countries is now commonly framed as climate-resilient development, that is, development where economic growth, poverty reduction and other development objectives are viable under current and projected future climate conditions (OECD, 2014). Rather than a series of bespoke response measures aimed at particular climate risks (flood defences, drought plans, etc.), adaptation must become an integral part of development planning and embedded into wider development strategies (OECD, 2009).

Combining adaptation and development planning into a coherent climate-resilient development strategy has intuitive appeal (McGray et al., 2007; Millner and Dietz, 2015). It puts development at the centre of the analysis and shifts the responsibility for adaptation from environment departments and hydro-meteorological offices to planning and economic ministries, which are often better able to instigate the necessary reforms (Fankhauser and Schmidt-Traub, 2011; Sietz et al., 2011). This has been recognised for example in Colombia, where leadership on adaptation to climate change lies with the Department of National Planning, with support from the environment ministry and other institutions.

The notion of climate-resilient development is part of a trend to enhance development objectives. Some authors have sought to integrate mitigation and adaptation into climate and development policy to create win-win situations (Klein et al., 2005) and manage trade-offs between policy objectives (OECD, 2014). Others have called for mainstreaming climate information, policies and measures into ongoing development planning and decision-making (Ayers et al., 2013). More recently there have been calls for 'adaptive development' that aims to refocus both adaptation (by highlighting the importance of growth, equity and sustainability) and development (by emphasizing risk mitigation) (Agrawal and Lemos, 2015).

Climate-resilient development is an inherently dynamic concept. Development objectives are set to address current climate variability and future climate change whilst reflecting the vibrant nature of modern economies (OECD, 2014; World Bank, 2013a; Sperling et al., 2008). Yet, in practice adaptation strategies have remained fairly static.

Climate change risk assessments often impose future climate change on today's economies, rather than those of the future. The dual effect of climate change and economic change is analytically complex. Adaptation strategies are often geared at preserving current economic structures, for example by putting a heavy emphasis on preserving agricultural output, even though rural economies are fast evolving. After an extreme event, there is a temptation to rebuild the economy just as it was before, rather than factoring in manifest climate risks.

This policy brief asks how adaptation policy must change to acknowledge the dynamic nature of modern economies. It explores how adaptation can reflect the changes in sector composition (e.g. from agriculture into manufacturing) associated with economic development, the emergence of new comparative advantages and changes in the demand for goods and services over time.

We explore the question by looking at two concrete case studies, Colombia and West Bengal. Both jurisdictions have adopted fairly advanced adaptation and development plans and both have undergone substantial economic change over the past decades. The two economies are at different stages of development, with Colombia perhaps two decades ahead of West Bengal, but both have historically relied on the primary sector for output, employment and financial resources. Their adaptation efforts have targeted particularly vulnerable sectors such as

agriculture and energy and vulnerable regions such as the Cuenca del Río Cauca in Colombia or the Sundarbans in coastal West Bengal. Their lessons can therefore resonate with others.

The policy brief is structured as follows: Section 2 starts by describing the traditional, economically-static way in which adaptation and development are viewed. It summarises how climate change may impact development outcomes and how the adaptation strategies of the case study economies respond. Section 3 introduces economic dynamics by documenting how the two case study economies have evolved in the past and may continue to evolve. Section 4 then asks what these structural trends imply for climate-resilient development, in terms of a dynamic understanding of climate risks, but also in terms of less static adaptation strategies. Section 5 draws conclusions for adaptation policy in dynamic economies.

2. Climate change impacts: the static picture

2.1 Conceptual remarks

Future climate change is likely to put development outcomes at risk (World Bank, 2013b; IPCC, 2014). Development objectives have to be revised in light of these risks. For the purpose of this policy brief we focus on five key objectives of economic policy, which also summarise succinctly the most important contributions a modern economy makes to welfare and prosperity. A well-functioning economy is expected to contribute to:

- The creation of employment opportunities
- Strong economic output and household incomes
- The provision of public goods and services, both physical (e.g. infrastructure) and institutional (e.g. economic stability)
- A healthy external balance and good access to finance
- The promotion of technological progress and the adoption of new skills.

Climate change is likely to affect most if not all of these five objectives. Employment opportunities and household incomes are affected directly through factors such as reduced agricultural yields (e.g. Burgess et al., 2014), the destruction of productive assets during extreme events and lower labour productivity, particularly for outdoor workers (Heal and Park, 2013; Deryugina and Hsiang, 2014). On the positive side there may be new opportunities working for example on flood protection and water efficiency solutions (ASC, 2014).

Under climate change there might be higher demand for public services. In terms of physical infrastructure, additional efforts will be needed to “climate-proof” services like power supply, IT systems, transport links and critical buildings like hospitals and schools. There may be higher demands on health care systems and emergency services (ASC, 2014). More generally, a strong institutional framework (e.g. in terms of property rights or financial regulation) will be required to anticipate and manage climate change risks.

A squeeze is also possible when it comes to finance. There is evidence of capital outflows in the aftermath of natural disasters (Noy, 2009), at a time when fiscal positions are stretched by lower tax revenues and the need for reconstruction (Lis and Nickel, 2009). In Colombia, damages to transport infrastructure from heavy rains associated with the La Niña event of 2010/11 reached

US$3.2 billion (ICF, 2013). Expenses of this magnitude might have repercussions in terms of macroeconomic stability (Bowen et al., 2012), although there is little empirical evidence to corroborate this concern.

In terms of knowledge and skills, Fankhauser and Tol (2005) show that the prospects of future climate damages could reduce capital investment, which in turn (through endogenous growth effects) may reduce labour productivity and the rate of technical progress. Other studies find that school enrolment rates decrease in the aftermath of natural disasters and expenditure on human capital falls (Crespo Cuaresma, 2009; Anttila-Hughes and Hsiang, 2013).

The rest of this section discusses some of the main expected impacts of climate change in our case study economies.

2.2 Colombia

Colombia has recognised its high vulnerability to climate change (República de Colombia, 2010a; Gonzales Iwanciw, 2009). Studies suggest that changing rainfall patterns will affect hydrological conditions and increase the frequency and magnitude of extreme events, such as tropical storms and floods. Changes in the acidity of soil and increased erosion are expected to affect the productivity and may accelerate the shift from small scale to mechanised agriculture. Sea level rise is of particular concern for coastal cities, industry and tourism.

Approximately 39 per cent of households that live in precarious conditions also have high climate exposure – more than 780,000 households (República de Colombia, 2011). A high and growing concentration of people living in at-risk areas along the coast, large regional inequalities, also in the distribution of institutional capacities, compound the country's susceptibility to negative climate change impacts.

Climate extremes include episodes of both too much water (flooding) and too little (droughts). Since 1980 Colombia has experienced an increase in the frequency and average number of deaths per annum from floods. More than 90 per cent of natural disasters between 1998 and 2011 have been attributed to changes in hydrological conditions (República de Colombia, 2012). During the 2010 – 2011 La Niña event some 1,029,000 hectares of land were flooded (República de Colombia, 2014), affecting more than 2.7 million people and causing major losses and damages (Palmer, 2014).

The Plan Nacional de Desarrollo (PND) has stated that approximately 85 per cent of the productive systems in Colombia are located in areas that are at risk of desertification, and 48 per cent of the territory is vulnerable to erosion. The result is that approximately 2000 hectares of land per annum in the Andean region experience degradation (República de Colombia, 2011). The PND recognises the importance of arresting these tendencies through better environmental management, conservation and sustainability strategies. A World Bank estimate notes that losses from environmental degradation are equivalent to 3.7 per cent of the country's GDP (cited in República de Colombia, 2011).

Colombia's response to growing climate risks is the Plan Nacional de Adaptación al Cambio Climático (PNACC). The plan is designed to establish the country as a pioneer in Latin America on climate change and a leader in terms of its national disaster risk management system (Box 1). The PNACC is complemented by *Adaptación Bases Conceptuales (ABC)* (República de Colombia, 2012), which establishes a conceptual framework and guidelines for the formulation of sectoral and territorial adaptation plans. It defines five strategies to advance planned adaptation instead of reactive adaptation, which tends to be more costly: create awareness of climate change; provide information and know-how to measure climatic risk; plan land use; implement adaptation actions; and, strengthen the response capacity.

The Colombian authorities have also started to integrate climate change considerations into development planning with a view to prevent maladaptation (see Schipper, 2007 for a discussion on maladaptation) and reduce climate risk.

Box 1. Colombia's adaptation strategy

The Plan Nacional de Adaptación al Cambio Climático (PNACC) of 2012 puts forward a conceptual framework to guide Colombia's adaptation efforts at the sectoral and territorial levels. The overall goal is to reduce the risk and socioeconomic impacts of climate variability and climate change. Specific goals are to generate a better understanding of potential risks and opportunities, integrate risk management into sectoral and territorial planning, and decrease the vulnerability of socio-economic systems.

The PNACC is one of four strategies in the Plan Nacional de Desarrollo (PND) 2010 – 2014 to deal with the causes and consequences of climate change. The remaining three strategies focus on attaining low carbon development, reducing emission from deforestation and forest degradation, and financial protection from disasters. The latter includes a 2005 government programme to reduce fiscal vulnerability when confronted by a disaster (República de Colombia, 2014).

The PNACC is a rolling document that reflects the ongoing, dynamic nature of adaptation. New information on climate risk, lessons learned and adaptation progress assessments are to be used in regular updates (República de Colombia, 2012).

The Colombian government has stated its intention to incorporate climate change into all planning exercises, from the PND, to regional development plans and the management of water bodies. This approach to mainstreaming adaptation into development planning is being pursued with assistance from United Nations Development Assistance Framework (UNDAF).

2.3 West Bengal

The Indian state of West Bengal is considered highly vulnerable to climate change (Government of West Bengal, 2010). Changes in hydrological conditions are expected to affect rainfall patterns, the onset of monsoon season and increase the frequency and magnitude of extreme events, such as floods. Sea level rise is of particular concern for coastal settlements and ecosystems while riverbank erosion poses threats to food security, livelihoods and income of farmers (Dulal, 2014). Temperature increases are expected to impact agricultural productivity.

More than 70 per cent of the population live in rural areas, and of these over half are involved in agriculture, forestry, fishing or animal husbandry (Government of India, 2010). Districts where agriculture is the main economic activity are also those with the highest incidence of land-poor households. Land degradation, water insecurity and reduced agricultural productivity are some of the factors that are likely to exacerbate the susceptibility of West Bengal to climate change impacts.

A growing concern is urban vulnerability, with the population in urban areas growing faster than in rural areas. The population in Kolkata grew in the last two decades of the twentieth century from 9.2 million to more than 13 million. [1]Kolkata is one of the top cities in India in terms of population density with 24,252 people per square kilometre (Government of India, 2011). By 2070 Kolkata will be among the top Asian cities in terms of population and asset exposure (IPCC, 2014).

West Bengal's approach to climate change is guided by the Government of India's 2008 National Action Plan on Climate Change (NAPCC) and other national and state development goals and associated programmes. Under these guidelines the State Action Plan on Climate Change (SAPCC) was issued in 2010. It is one of the most detailed adaptation plans of any state in India (see Box 2).

Box 2. The adaptation strategy of West Bengal

The State Action Plan on Climate Change (SAPCC) focuses on those key sectors and regions considered to be most vulnerable to climate change and likely to require additional efforts over and above existing central and state programmes and policies.

The plan states that it embodies the consensus view of a range of organisations, including the Indian Meteorological Department, state-level departments responsible for forests, irrigation and waterways, public health, science and technology, private actors such as the Confederation of Indian Industries and various universities and research institutes.

The SAPCC builds on national-level projects such as the Coastal Vulnerability Assessment and the Climate Change Adaptation in Rural Areas of India report, and state-specific assessments including Assessment of Climate Change Vulnerability and Adaptation Options for Kolkata. It puts forward strategies and actions to sustain the productivity of crops, fisheries and horticulture and proposes strategies to strengthen health policy to respond to human health risks from vector and water-borne diseases. Also, the SAPCC outlines for future action key elements of a strategy for mitigation and adaptation in the energy sector and announces the establishment of a Climate Change Institute.

Actions outlined in the SAPCC broadly fall under six analytical categories: develop and disseminate information; conserve and restore resources; build infrastructure; develop or use new technologies; access financial resources; and, enable risk management.

1 Data from indiastat.com, National Human Development Report 2001, and the author's computations using India census data. Functional Classification of Urban Agglomerations/Towns of India 1991, Ministry of Home Affairs, Govt. of India. Data on population by city also from: Thomas Brinkhoff: City Population, http://www.citypopulation.de. The share of urban population to total population for 2001 is from 3iNetwork (2006).

3. Introducing economic development

3.1 Conceptual remarks

The past decades have seen unprecedented changes in the economic structure of developing economies. Economic growth, population growth, technological innovation, and factors like globalisation and urbanisation have combined to alter the fabric of developing economies. These trends are expected to continue, although each country has its own development dynamics and its own development objectives, which reflect societal priorities and the specific socio-economic context.

The rest of this section explores recent economic trends in Colombia and West Bengal, offering a high-level overview of the evolving economic structure of our case study economies. The discussion is structured around the five key objectives of economic development introduced in section 2, that is, contributions to employment, output, public goods, finance and skills.

The two case studies are typical of developing economies, in that both have for decades relied for growth on agriculture and allied activities. [2]As in many other locations these sectors have accounted for a falling share of total output and employment over time. However, public policy continues to encourage investment in these sectors, while adopting some policies to diversify their economies. At the same time we observe a growing reliance of both economies on the tertiary sector. We explore these patterns in more detail in the rest of this section.

3.2 Colombia

The economy of Colombia has expanded steadily over the last three decades and income per capita has almost doubled. In 2013 GDP per capita was US$ 4,376 (constant 2005 US$) up from US$ 2,463 in 1980 (World Bank, 2015). The end of the armed conflict is expected to give the economy a substantial one-off boost (OECD, 2013), but several long-term trends are also in evidence.

The Colombian economy is characterised by a growing services sector and declining agriculture and manufacturing sectors (República de Colombia, 2010b). In 2001, agriculture and allied activities, which include fishing, hunting and forestry, accounted for 22.2 per cent of total employment. By the beginning of the following decade their share had fallen to 16.9 per cent.

Service sectors have exhibited a positive trend in both employment and output. Community, social and personal services, which includes defence and public administration, sanitation, education, research and scientific institutes, and a variety of medical, recreational or cultural services, has accounted for the largest share of employment, over 22 per cent since 1976 in Colombia's main seven cities. Banking, insurance, real estate and business services sectors have played an important role in output growth.

Another area that has grown in importance is mining and quarrying. Most recently the sector has helped sustain the Colombian economy during the global recession, the severe rain and flooding associated with the La Niña phenomenon in late 2010 and early 2011, and from the loss of the Venezuelan market (OECD, 2013).

2 Yet the degree of independence in the setting of development objectives is substantially different. The Indian state of West Bengal is a member of a federation characterized by a strong centre. A key factor in priority setting is via the financial distribution of resources for development purposes, which is done by the Planning Commission generally under a five-year plan period. See Government of India (2010).

The observed trends of the past are summarised in Table 1. Colombia's development strategy aims to reverse the negative trends in agriculture and manufacturing (Box 3), although to what extent this is possible (or made easier by climate change) is an open question.

Table 1. Structural change in Colombia (1983 – 2007)	
Positive trend in output	Mining Construction Trade, hotels & restaurants Transport, storage & communications Financial institutions & real estate
Negative trend in output	Agriculture and allied activities Manufacturing Energy, gas & water
Positive trend in contribution to financial flows	Mining Energy, gas &water Transport, storage & communications
Negative trend in contribution to financial flows	Agriculture and allied activities Manufacturing
Positive trend in employment	Transport, storage & communications Financial institutions & real estate Construction (2000 – 2006/ 7 and 13 cities)* Trade, hotels & restaurants (1976 – 2000/7 cities)
Negative trend in employment	Agriculture and allied activities (2001 – 2012) Manufacturing (1976 – 2000/7 cities)
Note: See Annexes for details. Data are collected for 7 or 13 cities in Colombia. *The period of analysis for some sectors like construction in the case of Colombia implies that periods of instability are not considered. Remarks must consider data limitations.	

Box 3. Colombia's development objectives

Colombia's Plan Nacional de Desarrollo (PND) 2010 – 2014[3] states as amongst the country's main development goals:

(a) **Reverting the negative trend in output and employment in agriculture.** By 2019 agriculture is expected to increase output by 59 per cent to 48,581,239 tons[4] through increased mechanization and new seed varieties, which are expected to promote the adoption of new skills and technologies. As previously mentioned, a further boost to agricultural output may come from a peace deal with the FARC guerrillas, which is expected to have economy-wide advantages (República de Colombia, 2010b).

(b) **A further expansion of the mining sector.** As an engine of growth the PND has set target increases in the production of coal (by approximately 69 per cent) and petroleum and gas (by approximately 43 per cent) by the end of the plan period. Steady growth over the last two decades, mainly from oil and coal exports, has increased the country's reliance on the sector as a contributor of financial resources both from exports and foreign direct investment. Almost 80 per cent of all foreign direct investment to the country in 2009 went into the mining sector (República de Colombia, 2010b).

(c) **Boosting innovation to address a decline in the share of manufacturing in total output that is largely a result of low productivity.** Between 1990 and 2005 natural resource-based activities accounted for more than 50 per cent of value-added (República de Colombia, 2010a). By enabling the country to broaden the supply of high-valued products in its exports basket (República de Colombia, 2010b),[5] the Colombian government seeks to increase the contribution of the manufacturing sector to new technologies and skills.

(d) **A public subsidy to boost housing construction – albeit due to end – together with private-public partnerships in transport infrastructure, in particular roads and railways (*The Economist*, 2014), and targets for urban areas.** The PND is seeking to continue the growth in the construction sector's contributions to output, employment, and the provision of public goods. By 2019 the PND has set targets to increase new housing construction from 560,300 to 1,800,000 and provide access to sanitation from 3.6 to 4.3 million people, among others.

(e) **The creation of an additional 13,000 new jobs and the continued expansion of multi-modal transportation and port, railway, road and airport capacity.** In this way the PND expects the transport sector to continue to play a central role in job creation and attracting investment.

These development goals compare to existing sector trends as follows:

	Sector trend (GDP)	Planned expansion
Agriculture and allied activities	-ve	Yes
Mining	+ve	Yes
Manufacturing	-ve	Yes
Construction*	+ve	Yes
Trade, hotels and restaurants	+ve	
Transport, storage and communications	+ve	Yes

Note: The information in this table comes from Table 1 and Colombia's development plan.
-ve = negative; +ve = positive
* It is important to keep in mind that for Construction the trend is based on data for 2000 – 2006 only.

3.3 West Bengal

Income per capita in West Bengal has increased steadily over time, with a dramatic increase in the past few years – from 47,389 rupees in 2010-11 to 62,831 rupees two years later (Government of India, 2013).

Agriculture and allied activities have been core contributors to West Bengal's economic performance since Indian independence in 1947. Growth in the 1980s was driven by agriculture, which accounts for more than 80 per cent of the agriculture and allied activities sectors (Bhattacharjee, 2005). However, over the past two decades their share of total state output has been in decline.

Since the 1990s the service sector has been the main engine of growth. The average annual growth rate for the service sector during the 9th Five-year Plan was 10.04 per cent, almost twice the average annual growth rate of the secondary sector (Government of West Bengal, 2010). Information technology (IT) and tourism are two service industries that have been targeted by the state government.

The contribution of manufacturing to output has declined since the mid-1980s, although the sector's importance in creating jobs has increased, particularly in rural areas, where the state government has sought to advance food-processing industries alongside unregistered rural industries, such as handloom, jute, tea and sericulture, among others. These efforts are part of the state's commitment to develop a modern industrial sector that can absorb overcrowding in

3 The Colombian government is working on a Plan Nacional de Desarrollo for 2014 – 2018, which has yet to be released. A document detailing the conceptual foundations of the plan can be found at https://colaboracion.dnp.gov.co/CDT/Prensa/Bases%20Plan%20Nacional%20de%20Desarrollo%202014-2018.pdf.

4 Coffee alone accounted for 17 per cent of the value of all agricultural products in 2007, approximately US$2 million. See Lau et al (2011).

5 The Comisión Nacional de Competitividad has outlined a new Visión 2032 in which high value products feature amongst the key drivers of export-led growth. See http://wsp.presidencia.gov.co/sncei/politica/Paginas/vision-2032.aspx.

agriculture and counteract its loss of competitiveness. In the state's vision a modern industrial sector will coexist with a vibrant agricultural economy (Government of India, 2010).

The most important structural trends over the past three decades are summarised in Table 2. Like their peers in Colombia, policy makers in West Bengal are intent on reversing some of them as part of their development agenda (Box 4).

Table 2. Structural change in West Bengal (1983 – 2007)	
Negative trend in contribution to total Net State Domestic Product (NSDP)	Agriculture and allied activities Manufacturing
Positive trend in contribution to total NSDP	Transport, storage & communications Banking & insurance
Negative trend in employment	Agriculture and allied activities
Positive trend in employment in rural areas	Manufacturing Transport, storage & communications Trade, hotels & restaurants
Positive trend in employment in urban areas	Construction
Note: See Annexes for details.	

Box 4. The development objectives of West Bengal

In several state development reports the Indian state of West Bengal has expressed its commitment to:

(a) **Achieving a vibrant agricultural economy.** Important resources and programmes are in place to suggest that agriculture and allied activities is expected to continue to play for years to come a key role in the state economy (Government of India 2010). The focus by the state government on the primary sectors is understandable, notwithstanding environmental degradation and a production structure in the case of food grains that makes intensive use of chemical fertiliser and pesticides, increases costs, erodes the profitability of crop cultivation and leads to a loss of competitiveness. Historically, agriculture and allied activities have contributed to key public goods ranging from food security and environmental services to rural commercial and irrigation infrastructure. Moreover these sectors have attracted state and central government funds for irrigation-related projects, repair, renovation and restoration of water bodies directly linked to agriculture.

(b) **Promoting growth in the manufacturing sector, mainly in the cottage and small-scale sector to help alleviate overcrowding in agriculture.**

(c) **Incentivising growth in producers and consumer services, including IT and tourism.** To this end the state government is promoting Public-Private Partnerships (PPP) to develop tourism infrastructure and a range of attractions.

These development goals compare to existing sector trends as follows:

	Sector trend (NSDP)	Planned expansion
Agriculture and allied activities	-ve	Yes
Manufacturing	-ve	Yes
Trade, hotels and restaurants		Yes
Transport, storage and communications	+ve	Yes

Note: The information in this table comes from Table 3 and West Bengal's development plan.
-ve = negative; +ve = positive

Behind policy choices and sector trends are a myriad of climate vs. development trade-offs. There are likely to be barriers to achieving a closer integration between climate adaptation and development planning, which are context-specific and need to be understood case by case. Additional research is needed on the barriers to integrating adaptation and development planning, some of which relate to capacity constraints and to the profound uncertainty around the combined impact of climate and economic dynamics.

4. Adaptation strategies for dynamic economies

4.1 Conceptual remarks

Climate-resilient development approaches need to recognise not only future climate scenarios but also economic growth and sectoral dynamics, including those that lead to bifurcations towards new activities and/or locations (Hallegatte et al., 2011). This has implications for both development planning and adaptation planning.

Development planning has to recognise that climate change may put development at risk (World Bank, 2013b) and that development objectives may have to be reviewed to account for these risks. For example, a drive to expand agricultural production may have to be scaled down if there is concern about future water availability. Development plans need to factor in climate risks when embarking on such strategies, whilst appreciating that the fruits of development can provide resources for strengthening adaptive capacity (OECD, 2014).

Adaptation planning has to recognise that development trends will alter the nature of climate risks. Adaptation strategies have to anticipate the future economic context in which climate risks will materialise. There is a tendency in adaptation to assume economic structures will remain as they are. Adaptation plans that do not reflect development priorities may put too much emphasis on stagnating or low-priority sectors (such as agriculture) at the expense of rapidly developing parts of the economy, which are the engines of future growth (such as services).

At a more strategic level, adaptation planners need to act on the opportunities, or 'entry points', that development plans provide to integrate climate considerations into the decision process. Many of the investment and planning decisions associated with economic development have lasting consequences for climate risks over the long term. Getting these decisions right from the outset is an important adaptation priority (Fankhauser and Soare, 2013; Fankhauser et al., 2013). The classic example is infrastructure investments, which are long-lived and, depending on their location and design, potentially susceptible to climate risks. Another pertinent example is spatial planning (e.g. coastal development), which also locks in vulnerability profiles for the long term.

In the rest of this section we integrate climate and economic dynamics in our case study economies, using their existing development plans (boxes 3 and 4 above) and sectoral trends (Tables 1 and 2 above). We then examine adaptation strategies (boxes 1 and 2 above) in light of these integrated dynamics.

4.2 Colombia

Colombia has taken an important institutional step towards climate-resilient development planning by assigning responsibility for climate adaptation to the Department of National Planning (DNP) with support of the Ministry of the Environment and Sustainable Development (MADS) and the Institute of Hydrology, Meteorology and Environmental Studies (IDEAM), among others.

The first question to explore is how climate risks might affect Colombia's development ambitions and sector dynamics. Table 3 offers an examination of possible joint economic and climate dynamics by economic sector, presented in terms of the five development aspirations or sector contributions discussed in section 2. The table identifies considerable risks, but also a few opportunities. An example of the former is the negative impact of climate change on

agricultural output, which will exacerbate an existing structural trend in Colombia. An example of an opportunity is the contribution which additional adaptation spending could make to employment, public goods and skills. This is as a result of government programmes and investments to climate-proof new and existing infrastructure and update processes and technologies.

Table 3. Dynamic impacts of climate change on Colombia's economic development

Sector		Possible joint impacts of economic and climate dynamics
Agriculture and allied activities	Output	Climate change impacts are likely to affect agricultural productivity, which would accelerate the ongoing decline in agriculture as a share of total output, and potentially exacerbate environmental degradation.
	Employment	A climate change-induced reduction in agricultural output would also affect farm-level employment, again accelerating an existing trend related to increased mechanisation.
	Financial resources	Lower agricultural outputs due to climate change would be associated with a contraction in financial flows from exports, coupled with an increase in production and resource costs given the need to respond to climate events, enhance productivity, and address environmental degradation.
	Knowledge and Skills	Efforts to maximise yield, perhaps associated with new climate-resistant inputs and processes, would have to be accompanied by a sector-wide upgrade in technical knowledge and skills.
Mining	General	The Colombian government relies on fiscal revenue from the sale of oil and gas to fund investment in infrastructure, education, social services, etc. Therefore, the impact of climate events on mining infrastructure has the potential to alter core developmental programmes and efforts.
	Output	The contribution of mining to output will hinge on the presence of large investors and their willingness to absorb risks from climate-related events. Small, informal mining operations face higher risk.
	Financial resources	The contribution of mining to the balance of payment will hinge on the presence of large investors and their willingness to absorb risks from climate-related events. Small, informal mining operations face higher risk.

Table 3. Dynamic impacts of climate change on Colombia's economic development

Sector		Possible joint impacts of economic and climate dynamics
Electricity, gas, water	Output	We can expect a decline in output as precipitation anomalies impact water availability and existing sources of hydro generation, which in 2012 accounted for 75 per cent of the total electricity generation (Cadena, 2013). In this sense, climate change has the potential to undermine the country's low-carbon development strategy.
	Financial resources	A reduction in profits in the sector, following an increase in costs associated with the relocation of plants, establishment of new plants, and an expansion of the network of transmission lines. Disaster risk response to put additional pressure on financial resources.
	Knowledge and skills	Efforts to deal with increased climate variability, changes in water and other environmental variables would have to be accompanied by a sector-wide upgrade in technical knowledge and skills.
Manufacturing	Output, employment and financial resources	Climate change is likely to be associated with a reduced contribution to employment, output and financial flows given the current predominance of resource-intensive manufacturing. Cost spill-overs from agriculture may trigger additional decreases in contributions.
	Knowledge and skills	Negative trends in output and employment might be counterbalanced by government investment in low-carbon, climate-resilient innovation.
Construction	Output, employment and public goods	The sector's contribution to output, employment and public goods could be maintained as a result of government programmes, investments to climate proof new and existing infrastructure, and post-disaster reconstruction efforts.
	Knowledge and skills	A continued contribution to knowledge and skills as the sector responds to changes in regulation and the environment.
Trade, hotels and restaurants	Output	The growing share of the sector to total output may be at risk if damages from climate events on transport infrastructure establish barriers to trade and increase transportation costs.
	Employment	Damages to tourism-related infrastructure could impact both output and employment in this labour-intensive sector.
Transport, storage, communications	Output and employment	Solid baseline growth in output and employment, potentially reduced where direct damages to transport infrastructure affect the provision of services.
	Knowledge and skills	Accumulation of knowledge, technologies and skills continues, accelerated perhaps if new procedures are put in place to address the risk of climate-related events.
Finance, insurance, real estate and business services	Output and employment	Growth in output and employment to continue with growing demand for insurance and financial resources also from agriculture (República de Colombia 2014). However, a rise in insurance claims in the aftermath of a climate event is expected to impact the sector.

The second question to explore is how development linkages are reflected in Colombia's adaptation strategy. To do so, the adaptation strategies and inputs in the Adaptación Bases Conceptuales (ABC) are grouped into four headings:

(1) Better knowledge and information
(2) Building response capacity
(3) Planning/land use/mainstreaming
(4) Specific adaptation actions.

Among these groupings, providing knowledge and information (1) is a robust priority, which brings about benefits irrespective of how the economy might change over time. The same holds for attempts to building response capacity (2), which includes efforts to move Colombia away from reactive adaptation and towards planned adaptation. Both sets of measures will contribute positively to the accumulation of skills across the economy.

The measures related to land use and mainstreaming (3) are more sensitive to changing economic trends. They strengthen the provision of public goods and address negative environmental externalities, including in fast growing sectors like mining, where the risk profile is evolving rapidly.

There is a rather limited articulation to date of specific adaptation measures (4). Particular attention is given to vulnerable sectors and regions, which, while clearly important, suggests an emphasis on stagnant sectors, such as agriculture and allied activities, rather than the economically dynamic parts of the economy. A more forward-looking adaptation plan would cover in perhaps more detail the sectors that are responsible for generating a growing share of output, employment, financial resources, public goods and skills and technologies. Some of these, such as finance, insurance and real estate, may not currently be amongst the most vulnerable but they are identified as the engines of growth in the PND.

4.3 West Bengal

West Bengal's approach to climate change is rooted in the State Action Plan on Climate Change (SAPCC) of 2010, which in turn builds on a pan-Indian Action Plan on Climate Change. The SAPCC underpins West Bengal's drive toward climate resilient development.

The challenges for West Bengal's economic development arising from climate change are summarised in Table 4, which analyses joint economic and climate dynamics by economic sector. The outlook for the state highlights the extensive role of government policies and investment in counter-balancing the combined impact of economic and climate dynamics. It highlights an ever-growing dependence on financial resources to sustain the current contribution of declining economic sectors, but also to ensure more dynamic sectors do not become more climate sensitive.

Table 4. Dynamic impacts of climate change on West Bengal's economic development		
Sector		**Possible joint impacts of economic and climate dynamics**
Agriculture and allied activities	Output & employment	Downward pressure on output and employment in the sector exacerbated by climate factors as hydrological conditions change and/or temperatures increase, including potential delays in the onset of the monsoon season and erratic rainfall that create flood- and drought-like conditions. System-wide impacts to the rural economy depend on the ability of other sectors to absorb agricultural labour.
	Financial resources	Additional constraints possible as additional financial resources are required to address degradation of seed quality, loss of nutrients in the soil, increased incidence of pests, increased salinity in inland fisheries, etc.
Construction	Output and employment	A positive indirect impact of climate change on output and employment in urban and rural areas through continued investment from central and state governments in infrastructure capacity expansion, retrofitting and "climate proofing".
	Knowledge and skills	Continued skill-development and technology investment, partly related to climate change, from central government guidelines stating that (12th Five-Year Plan) construction must address its negative impact on water use and pollution, materials and energy through the adoption of environmentally friendly and energy efficient building technologies and materials.
Banking and insurance	Output	Continued growth in output, with little impact from climate change, as demand and access to credit continues to improve, also among marginal and small farmers.
	Financial resources	The flow of credit to the sector continues to rise, reducing vulnerability to climate extremes. Demand for credit and insurance expands, as does the supply of funds through initiatives by central and state government and international organisations. Uninsured assets may pose a threat to available resources

To consider the adaptation measures and overall focus of the SAPCC in light of the joint dynamics discussed in Table 4, the set of actions proposed by the SAPCC can be grouped as follows:

(1) Information, monitoring, weather forecasting, research and development, outreach
(2) Resource conservation and restoration – protection and development of water bodies, mangrove restoration, soil nutrition management
(3) Infrastructure for irrigation, flood protection, heat management, storage
(4) New technologies, including new seed varieties, organic alternatives to combating pests, etc.
(5) Financial resources, including access to credit
(6) Risk management, including crop diversification, insurance.

In general, the provision of relevant (1) information together with access to (4) technologies, (5) financial resources and (6) insurance is expected to help individuals anticipate and adapt, enhancing their ability to minimise the negative impact of climate change. These benefits are fairly insensitive and will accrue independent of economic trends.

Given overexploitation, environmental degradation and limited resource management and conservation in the state, actions under (2) that address nutrient-deficient soil, water scarcity and pollution can be expected to attenuate the impact of climate change on output and employment, and potentially contribute new skills and technologies, particularly for the agriculture and allied activities and water sectors.

When we take into consideration sectoral dynamics we find in the SAPCC an absence of measures addressing directly the compounding effect of climate change on sectoral dynamics. First, by focusing on the most vulnerable sectors and regions, the SAPCC does not consider the potential effect of climate change on other sectors such as transport, storage and communications, and manufacturing. Second, by ignoring sectoral dynamics the proposed actions under the SAPCC may delay the transition in economic structure underway. There are other related considerations. The focus of the SAPCC on the most vulnerable sectors and regions means that the actions proposed and resources budgeted do not cover the agriculture and allied activities sectors in their entirety.

Thus the SAPCC does not target directly those sectors that have contributed positively to rural employment: manufacturing; transport, storage, and communications and trade; and, hotel and restaurants. Given that positive trends in rural employment are mostly the result of necessity entrepreneurship and not opportunity entrepreneurship, these are susceptible to both direct and indirect effects of climate dynamics: direct impacts on the self-employed in retail and transport services as temperatures or precipitation anomalies or even natural hazards can promptly erase their livelihoods; and indirect impacts through the joint effect of climate dynamics on the cost of inputs from agriculture and allied activities, and an increase in the number of unemployed.

There is little said on some of the sectors identified in state and national development plans as sources of alternative employment growth: tourism (other than eco-tourism, which is briefly mentioned in the SAPCC), transport, and communication networks. Both climate and economic dynamics suggest that a failure to adapt, for example, communication networks, may undermine disaster risk reduction, as well reducing employment, financial flows and connectivity.

5. Policy conclusions

The pace of economic growth in developing countries has implications for adaptation to climate change. This policy brief has explored these implications using the examples of the country of Colombia and the Indian state of West Bengal. The two cases were chosen for illustrative purposes. The objective was not to develop specific policy recommendations for these particular economies, which would require a much deeper engagement with the domestic context. Instead, we use the case studies to draw more widely applicable policy lessons. Several observations emerge.

A first observation is that development plans are likely to underestimate climate risks. Colombia's attempt to turn stagnating sectors like agriculture and allied activities, electricity, gas and water, and manufacturing into sustainable engines of growth is likely to be more difficult under climate change. There is also a need to prepare growing sectors for extended climate-resilient development. The most dynamic sectors in the Colombian economy are: mining, construction, trade, hotel and restaurants; transport, storage and communications; and, finance, insurance and real estate. Colombia's adaptation plan is general enough to encompass action in all of these sectors. However, their central and growing role calls for more deliberate, targeted consideration.

Second, most adaptation plans underestimate the dynamism of modern economies. This reduces their relevance and effectiveness. Adaptation plans may even hinder development by protecting the status quo (e.g. in situ measures to maintain agricultural output) instead of embracing more transformative forms of adaptation (e.g. attempts to rural diversification). For example, by focusing on currently vulnerable sectors and regions, West Bengal's State Action Plan on Climate Change (SAPCC) ignores the potential effect of climate change on potential growth such as transport, storage and communications, and manufacturing.

Third, rapid economic change offers an opportunity to alter for the long term the risk profile of developing economies with respect to climate change. There is the possibility to build climate resilience into decisions from the outset. The economic structures and the physical infrastructure put in place now will determine risk profiles for decades to come. Adaptation plans need to systematically identify any adaptation 'entry points' that emerge from development strategies, infrastructure investment plans and spatial planning.

Fourth, both adaptation and economic development strategies must be more mindful of potential synergies and climate-risk – development trade-offs. They must do so whilst considering the changing contributions of sectors to employment, output, financial resources, public goods and skills and technologies essential for the functioning of the economic system. One area for such trade-offs could be productivity (for a wider discussion of adaptation-development trade-offs see Bowen et al., 2012). There are cases where productivity improvements come at the expense of higher climate risks. Colombia's Plan Nacional de Desarrollo (PND) has identified agriculture as an engine of growth. Yet, climate change is expected to bring a further decline in agricultural productivity, even if the adaptation strategies proposed under the Plan Nacional de Adaptación al Cambio Climático (PNACC) offer some counterweight to the impacts expected.

A final overarching conclusion is that economic development and adaptation planners need to work together. This will force economic development planners to judge economic sectoral dynamics also in light of climate variability and change. Adaptation planners in turn will be required to factor into their planning the evolving economic system.

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Annex: Economic trends in Colombia and West Bengal

Table A1. Output trends in Colombia

		Average Share			Trend		
	Base Year	1975	1994	2005	1975	1994	2005
	Period	1970 - 1996	1994 - 2007	2001 - 2013	1970 - 1996	1994 - 2007	2001 - 2013
1	Agriculture and allied activities	22.24	13.74	7.22	-0.179	-0.167	-0.171
2	Mining and quarrying	2.76	4.43	6.83	0.121	0.056	0.023
3	Manufacturing industry	21.50	14.58	13.33	-0.128	0.072	-0.166
4	Electricity, gas and water supply	0.99	3.10	3.88	0.012	-0.025	-0.051
5	Construction	3.57	5.54	5.73	0.004	-0.089	0.173
6	Trade, hotels and restaurants	12.34	11.41	11.89	-0.075	-0.036	0.034
7	Transport, storage and communications	8.83	7.96	7.00	0.024	0.093	0.095
8	Banking, insurance, real estate and business services	14.50	17.62	19.31	0.074	-0.060	0.043
9	Social, community and personal services GDP	4.74	19.08	15.80	-0.020	0.037	-0.138

Note: Provisional data from 2003 in both 1994 and 2005 base year series. Provisional data for 1996 in 1975 base year series.
Red = 1 per cent; Green = 5 per cent; Blue = 10 per cent

Source: Banco de la República, PIB (various methodologies and base years), available at www.banrep.gov.co/. Accessed 5 November 2014.

Table A2. Employment trends in Colombia						
	1976 -- 2000 ---- Seven cities -- old methodology		2000 -- 2006 ---- Seven cities -- new methodology		2000 -- 2006 - Thirteen cities -- new methodology	
	Share	Trend	Share	Trend	Share	Trend
Agriculture, mining and not reported	1.70	-0.006	1.62	-0.065	1.86	-0.079
Manufacturing	23.28	-0.227	19.80	-0.094	19.10	-0.090
Electricity, gas and water supply	0.67	-0.004	0.51	-0.001	0.52	-0.003
Construction	6.43	-0.038	4.98	0.148	5.13	0.157
Trade, hotels and restaurants	24.86	0.149	28.13	0.240	29.00	0.223
Transport, storage and communications	6.54	0.034	7.97	0.268	8.14	0.332
Banking, insurance, real estate and business services	7.35	0.106	9.65	0.474	9.03	0.462
Social, community and personal services	25.52	0.031	24.27	-0.979	24.09	-1.028

Note: 2006 data from first quarter only. Red = 1 per cent; Green = 5 per cent; Blue = 10 per cent

Source: Dane, Encuesta Continua de Hogares. Cálculos DNP-DEE.

Table A3. Output trends in West Bengal (Net state domestic product constant prices)									
		Size				Trend			
	Series	1980-81	1993-94	2004-05		1980-81	1993-94	2004-05	
	Period	1980-1/1997-8	1993-4/2002-3	2004-5/2008-9	2004-5/2011-12	1980-1/1997-8	1993-4/2002-3	2004-5/2008-9	2004-5/2011-12
	Agriculture and allied activities	31.9	30.9	22.9	21.5	0.06	-1.08	-1.02	-0.99
1	Agriculture	28.4	27.0	18.4	17.3	0.09	-0.92	-0.92	-0.81
2.	Forestry and logging	0.8	0.7	1.1	1.1	-0.04	-0.04	-0.04	-0.05
3.	Fishing	2.8	3.1	3.4	3.2	0.02	-0.12	-0.06	-0.12
4.	Mining and quarrying	0.5	1.0	1.1	0.9	-0.05	-0.02	-0.10	-0.09
5.	Manufacturing	18.2	15.5	9.0	9.0	-0.30	-0.14	0.02	-0.02
5.1	Registered	10.2	7.1	4.0	4.1	-0.21	-0.12	-0.06	-0.01
5.2	Unregistered	8.1	8.4	5.0	4.9	-0.10	-0.01	0.08	-0.01
6.	Construction	7.8	4.4	7.3	7.0	0.08	-0.02	-0.27	-0.24
7.	Electricity, gas and water supply	0.8	1.1	1.1	0.9	0.02	0.00	-0.12	-0.10
8.	Transport, storage and communications	4.8	6.1	9.5	10.3	0.15	0.05	0.46	0.50
8.1	Railways	0.6	0.8	1.3	1.4	0.00	-0.03	0.03	0.05
8.2	Transport by other means and storage	3.8	3.8	6.0	6.1	0.16	-0.02	0.02	0.04
8.3	Communications	0.5	1.5	2.2	2.8	-0.01	0.10	0.40	0.41
9.	Trade, hotels and restaurants	12.5	12.9	17.2	17.2	0.06	0.22	0.04	0.03
10.	Banking and Insurance	6.8	9.8	7.9	8.3	0.13	0.81	0.57	0.36
11.	Real estate, ownership of dwellings and business services	7.3	6.5	7.6	7.9	-0.04	0.19	0.20	0.19
12.	Public administration	3.6	5.0	4.6	4.7	0.00	0.12	-0.03	0.00
13.	Other services	5.8	6.9	11.7	12.3	-0.10	-0.15	0.27	0.37

Note: Red = 1 per cent; Green = 5 per cent; Blue = 10 per cent

Source: 2004-05 data from Bureau of Applied Economics and Statistics, Government of West Bengal; 1980-81 and 1993-94 data from Central Statistical Office [CHECK]

Table A4 Employment trends in West Bengal						
	State		Rural areas		Urban areas	
	Share	Trend	Share	Trend	Share	Trend
Agriculture and allied activities	40.4	-0.74	39.0	-0.74	1.3	0.01
Mining and quarrying	1.0	0.01	0.4	0.01	0.6	0.01
Manufacturing	20.0	-0.09	8.2	0.08	11.8	-0.17
Construction	4.3	0.18	2.3	0.13	2.0	0.05
Electricity, gas and water utilities	0.4	0.00	0.1	0.00	0.4	0.00
Transport, storage and communication	5.9	0.03	2.1	0.05	3.8	-0.01
Trade, hotel and restaurants	14.8	0.24	5.5	0.09	9.4	0.16
Banking and insurance and real estate, ownership of dwellings and business services	2.3	0.04	0.4	0.01	1.9	0.03
Public administration	3.2	-0.14	0.9	-0.05	2.3	-0.09
Other services	11.8	-0.29	4.2	-0.09	7.6	-0.20

Note: NSSO Rounds used are 38 (1983), 43 (1987-88), 50 (1993-94), 55 (1999-00), 62 (2005-06) and 64 (2007-08)
Source: National Sample Survey [CHECK]

6 Individuals were asked about their employment status during the week the interview took place. This represents a deviation from other surveys.

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