1. Introduction
This paper surveys the existing literature on the climate change financing requirements of developing countries in the two UNFCCC categories of mitigation and adaptation. The reported estimates are based on the current state of play in estimation exercises.

2. On the variety of estimates of global financing requirements for mitigation
Let us start with a brief discussion of estimates of total global financing requirements for mitigation. A plethora of assumptions and projections explain the great variety of global financing requirements.

Global studies of financing needs are classified as top-down estimates.

Formal modeling, including the application of so-called integrated assessment models, is critical in these exercises, with the notable exception of the McKinsey abatement curve approach.

It can be difficult to undertake a direct comparison of the results because of a variety of emission reduction targets.

Some well-known estimates, such as those of the World Bank, are syntheses of existing estimates.

Practically by design, formal modeling approaches generate minimum financing requirements. They are conservative of money. The financing needs they indicate should be interpreted as close to minimum requirements.

One pattern from these exercises is that financing requirements increase in the outer years because of the built-in model increases in the size of economy and its complexity, not to mention projected population size increases.

Table 1 summarizes some key examples of mitigation financing needs at the global level (including both developed and developing countries). This is not a comprehensive review of the studies but it reflects the key contrasts and approaches involved.

3. Mitigation needs of developing countries
The UNFCCC (2009) expert group on technology transfer indicated that at the global level an additional $300 to $1,000 billion2 a year until 2030 in financing is required for technology development and diffusion, mainly to transform energy systems. Thus, research and development expenditures in the developing countries has been excluded in this estimate.

The expert committee indicated that the developing country share of the global additional financing need would range from $182 to 505 billion per year.

In its World Development Report in 2010, the World Bank (2010b) suggests that the incremental mitigation costs for developing countries would be $140 to $175 billion a year over the next 20 years in order to participate in meeting a global emissions target of 450 ppm. This World Bank estimate is based on a survey of existing studies.

The same report suggests that developing countries would have associated financing needs in order to meet the required level of investments, in the range of $265 to $565 billion a year (Table 2). Financing needs represent

* This is an updated and revised version of the notes that accompanied Mr. Montes’ powerpoint presentation at the “First Workshop on Long-term Finance” of the United Nations Framework Convention on Climate Change in Bonn, 9-11 July. The author is solely responsible for all errors, opinions and analyses. Email: montes@southcentre.org.
upfront costs for the installation of alternative energy sources, for example. Because many clean investments have high up-front capital costs, followed later by savings in operating costs, the incremental financing requirements tend to be higher than the lifetime investment costs reported in mitigation models, and the difference could be as much as a factor of three.

It is important to point out that there are two main areas in energy technological transformation from which the largest financing requirements in mitigation come from: (1) energy supply and (2) energy efficiency. The first area is that of transforming energy supply away from fossil fuels, including the required changes in infrastructure and electrical grids which these other energy sources require. For example, wind power provides intermittent electricity and the grids have to be modified to deliver a steady level of power to end-users. UNDESA (2011) estimates that the incremental (above business-as-usual) investment required for this transition is $1,000 billion a year.

The second critical part of a global strategy of mitigation will have to be obtained from improved energy efficiency of factory equipment, cars, appliances, heaters, and other modern conveniences. UNDESA (2011) estimates that $800 billion per year, globally, will be needed to finance research and deployment of new production methods and appliances. The policy effort will require providing predictable and facilitated access to new technologies for the developing countries.

The same study (UNDESA 2011) estimates that $1,800 billion per year, globally, beyond business-as-usual, will be needed to finance the required energy transformation. The study also indicates that of the global total, developing countries will require $1,100 billion a year to undertake the needed energy transformation, including $1,080 billion for energy supply and $20 billion for agriculture investment (Table 2).

Bottom-up mitigation financing estimates

India

India’s Centre for Science and the Environment (CSE 2010) focused on the six most emissions-intensive sectors to determine India’s low carbon growth options.

These sectors are power, steel, aluminum, cement, fertilizer, and paper.

The study consisted of detailed technical analyses and addressed the costing of options to change the production approaches of each sector.

The study indicates that after an easy start, later phases of low carbon growth paths are increasingly difficult and costs would thus increase through time.

For the most important sector, power generation, a low-carbon strategy could reduce emissions in India cumulatively by 3.4 gigatons (Gt) by 2030-31 (CSE 2010). The additional cost of generating power from renewable technologies in the low-carbon strategy over business-as-usual until 2030-31 is estimated at 8,470 billion rupees (US$203 billion) at 2010 constant prices, or about $10 billion a year (Table 3).

This means an average cost of 2,500 rupees, or $60 per tonne of CO2 emissions avoided. The cost is therefore many times the price of carbon credits traded on the European Climate Exchange either under the Clean Development Mechanism (CDM) or the European Union Emissions Trading Scheme. “This means that the CDM cannot pay for the transition to low carbon in the power sector in India, and a new international mechanism will be required to fund the transition” (CSE 2010, pp. 36-37).

While the UNFCCC (2009) suggests that a large majority of the emission reduction potential in developing countries can be realized at a cost of below $25 per tonne of carbon, the CSE (2010) obtains a cost of $60 per tonne for the Indian power sector, so payments through a carbon trading regime would not be able to finance the needed level of mitigation.

China

At the end of 2009, China announced that it would reduce CO2 emissions per unit of GDP by 40 to 45 per cent by 2020 compared to 2005 levels.

The 2009/10 China Human Development Report (UNDP 2009/10) undertakes a scenario-based evaluation of China’s low carbon development choices. Achieving substantial emissions reductions while sustaining economic growth will require significant rates of incremental investment.

The study used the PECE (Programme of Energy and Climate Economics) Technological Optimization Model, with 2005 as base year, and targets for 2020, 2030, and

<table>
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<th>Table 2: Developing Country Mitigation Financing Needs: Some Estimates</th>
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<tr>
<td>World Bank 2010b: with associated financing costs:</td>
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<td>UNDESA (2011): energy supply agriculture</td>
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<td>total mitigation</td>
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induced natural disasters can therefore be seen as a consequence of inadequate adaptation (Parry et al. 2009).

UNFCCC (2007)’s sector-by-sector study of adaptation costs suggested that global costs are in the order of $49-171 billion a year. Adaptation costs to developing countries were estimated to be in the order of $27 to $66 billion a year. This estimate has been found to be grossly underestimated (see below).

The World Bank’s adaptation cost estimates indicate a range of $75 to 100 billion per year. Within the $102 billion annual adaptation cost based on a wetter weather scenario, the World Bank estimates that $29 billion are needed for East Asia and the Pacific, $23 billion for Latin America and the Caribbean, $19 billion for Sub-Saharan Africa, $17 billion for Europe and Central Asia, and $4 billion for the Middle East and North Africa.

A team of scientists (Parry et al. 2009), led by Martin Parry, the former IPCC co-chair of the working group on impacts, vulnerabilities, and adaptation, comprehensively evaluated available estimates for adaptation, including the UNFCCC secretariat study (UNFCCC 2007). (See Table 4 in the next page.)

The Parry et al. (2009) study finds that the UNFCCC seriously underestimated adaptation financing required because it left out several sectors (mining, manufacturing, energy, retail, finance, tourism) and understated the costs in the sectors it covered by two to three times.

Parry et al. (2009) recognized the reality of damages from extreme natural events that adaptation investments cannot prevent – either because it is physically impossible or it is not economically feasible. For these kinds of cost damages, Parry et al. (2009) use the term “residual damage”. Dlugolecki (2007, p. 11), in a study undertaken for

<table>
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<th>Table 3: Bottom-Up Mitigation Needs</th>
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<tr>
<td>As in macro-studies, pattern of increasing cost as economy grows</td>
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<tr>
<td><strong>India</strong> (Centre for Science and Environment 2010)</td>
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<tr>
<td>6 key sectors: power, steel, aluminum, cement, fertilizer, and paper</td>
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<td>$10 billion a year for power sector alone</td>
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<td><strong>China</strong> (Human Development Report 2009/10)</td>
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<td>2010-2050: $ 240 – 355 billion a year depending on emission ambition</td>
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<tr>
<td><strong>Emission Control Scenario</strong></td>
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<tr>
<td>2030</td>
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<td>2050</td>
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UNFCCC, suggests that the annual economic losses due to weather-related damage were $200 billion in the period 2000-06 in a medium case scenario. He also estimates that the economic losses will increase to $955 billion in year 2030 (at 2006 values). He also cites another study that in 1987-2003, donor aid has covered less than 10 per cent of the financing of disaster losses in developing countries and that this was generally used for emergency relief and not reconstruction (Dlugolecki 2007, p. 14). If we conservatively take half of the annual $200 billion loss as that suffered by developing countries, then we can estimate an annual loss of $100 billion in the 2000-06 period. The losses would have increased from this level in the present post-2010 period, and thus $100 billion is an underestimate.

**Estimate of the total adaptation requirements**

Using the analytical ideas from Parry et al.’s (2009) analysis, and the Dlugolecki (2007) study, one could derive a range of reasonable estimates for annual adaptation financing needs for developing countries. Therefore, given the above, an estimate of the total adaptation costs could be derived from the following:

- Take the upper end of the UNFCCC 2007 range, and multiply it by two - the lower end of the two to three times underestimate factor suggested by Parry et al. (2009) and recognizing that even the upper end of the range excludes adaptation costs for mining, manufacturing, energy, retail, finance, and tourism (Table 4).

- Parry et al. (2009) suggests that protecting ecosystem services worldwide would cost $65 to 300 billion. One could take one-half of the upper part of the range, as the cost applicable to developing countries.

- For the residual damage costs, our estimate as explained above is $100 billion annually.

Using this method, an estimate of developing country total adaptation costs would be around $380 billion a year, in round figures (Table 4). It should be noted that this estimate is on the conservative side and the actual costs are likely to be higher.

**Table 4: Estimates for Adaptation Costs in Developing Countries**

(refer to text for assumptions and details)

<table>
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<th>Estimate Description</th>
<th>Cost</th>
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<tr>
<td>Two times of upper end of UNFCCC (2007) study estimate</td>
<td>$132 billion a year</td>
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<tr>
<td>Half of upper end cost of protecting ecosystem services</td>
<td>$150 billion a year</td>
</tr>
<tr>
<td>Residual damage estimate</td>
<td>$100 billion a year</td>
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<tr>
<td><strong>Total</strong></td>
<td><strong>$382 billion a year</strong></td>
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5. Conclusion

This survey of estimates of the costs of climate related actions in developing countries shows that a financing level of $100 billion a year by 2020 is an underestimation compared to what is required by developing countries.

The annual cost of mitigation (including associated financing costs) is estimated by the World Bank as $265-565 billion a year over the next 20 years (Table 2); while UNDESA estimates present mitigation requirements of $1,100 billion per year.

Regarding adaptation, the earlier estimates by the UNFCCC (2007) secretariat have been shown to be an underestimate by a later comprehensive study (Parry et al. 2009). If the economic losses from weather-related events are also taken into account (as “residual damage”), the adaptation financing requirements of developing countries can conservatively be estimated at $380 billion a year.

Therefore, total adaptation and mitigation financial requirements of developing countries could well add up to at least $1,000 billion a year at the present time. This does not include costs of preparing national communications, scientific development, data collection, building institutions to address climate change, education and training and other aspects of capacity building.

End note:

2 UNFCCC (2007) had earlier suggested that $200-211 billion is needed globally in one year (2030) in order to reduce emissions worldwide by 31.7 Gt CO2e (CO2 equivalent). Developing countries would require $65 billion of this annual amount to reduce emissions by 21.7 Gt (or 68 per cent share of global emissions). In an updated estimate (UNFCCC 2009, p. 56) the original value is indicated to be an underestimate, because the $200-210 billion covers only the initial capital cost of new physical assets and the use of known technologies. It does not factor in the costs of the development and use of new technologies, capacity building, and the creation of an enabling environment. The report also recognizes that the cost of additional investment needed in 2030 has gone up from the original report (for example the cost of reducing energy-related CO2 emissions is 170 per cent higher in a 2008 report than in the 2007 report). However, UNFCCC (2009) does not provide a new estimate of overall mitigation costs.
References


