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Samuel Fankhauser and Guido Schmidt-Traub

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From adaptation to climate-resilient development

The costs of climate-proofing the Millennium Development Goals in Africa

Samuel Fankhauser[a] and Guido Schmidt-Traub[b]

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Abstract

Socio-economic development and adaptation to climate change are closely intertwined. Adaptation is increasingly described as climate resilient development or development under a hostile climate. In support of this view, this paper calculates the combined cost of meeting and at the same time "climate-proofing" the Millennium Development Goals (MDGs) for Africa. Treating adaptation and development in such an integrated way helps to better understand financing requirements analytically and, more importantly, to implement the requisite measures more effectively as part of an integrated development program. We find that the external financing needed for "climate resilient" MDGs is about forty percent higher than the external financing for the MDGs alone – around $100 billion a year for the next decade, compared with $72 billions a year for the MDGs alone. This estimate is indicative only and based on fairly cursory aggregate cost data. A clear challenge going forward is to apply the integrated adaptation and development frameworks in the form of concrete development plans at the country level.

Keywords: Africa, adaptation to climate change, millennium development goals, economic costs, needs assessment

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[a] Grantham Research Institute and Centre for Climate Change Economics and Policy, London School of Economics and Political Science. Contact: s.fankhauser@lse.ac.uk

[b] Africa Progress Panel and South Pole Carbon Asset Management Ltd. South Pole Carbon Asset Management Ltd has no commercial interests in adaptation projects in Africa. Contact: gschmidttraub@gmail.com

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1. Introduction

Economic development and adaptation to climate change are closely linked, nowhere more so than in Africa. Africa faces the biggest development challenges of any continent (Sachs et al. 2004, Commission for Africa 2005). It is also one of the most vulnerable places to climate change anywhere in the world, even though it has contributed a negligible share of global greenhouse gas emissions. Among the most prominent impacts that may affect the continent are (e.g. Boko et al. 2007, Collier et al. 2008, Müller 2009, Stern 2007, UNCCD et al. 2009):

- a drop in agricultural yields;
- an increase in the number of people at risk of water stress;
- an increase in the exposure to malaria;
- rising sea levels that may severely affect mangrove forests as well as coastal fisheries, and lead to increased severe flooding;

There is a growing awareness, both in the literature and among development practitioners, about the strong connection between adaptation and development. The World Bank (2009a) calls for more climate-resilient development. Stern (2009a: p.75) simply defines adaptation as "development in a more hostile climate". McGray et al (2007) identify a continuum of measures ranging from pure development to pure adaptation - with various shades intermediate steps – that collectively determine a country's vulnerability. Benson and Clay (1998), Dell et al. (2008) and Noy (2009), among others, discuss how different growth paths both affect and are being affected by climate vulnerability. Other authors talk of an "adaptation deficit" to reflect the fact that less well-off societies are less prepared to deal with climate shocks.

Yet in much of the policy discourse adaptation is still treated as a stand-alone issue with little or no links to other development challenges. This artificial distinction is particularly apparent in discussions of adaptation costs and the related debate on adaptation funding, which are both central to a post-2012 climate change regime. All too often analyses of adaptation needs treat adaptation as an incremental activity that is bolted onto a "business as usual" development path (see Agrawala and Fankhauser 2008; Fankhauser 2010, Parry et al. 2009, UNFCCC 2007 and World Bank 2009b on adaptation costs and Müller 2008, World Bank 2009a on adaptation finance). Likewise, the negotiations leading up to the December 2009 Copenhagen summit have largely treated financing for climate change adaptation as distinct from development finance and falling under the purview of Ministers of the Environment (Schmidt-Traub 2009).

Similarly, the main practical instrument to advance adaptation planning in Least Developed Countries under the UNFCCC – the National Adaptation Plans of Action (NAPAs) – are generally developed in parallel to national development strategies, poverty reduction strategies and associated medium-term expenditure frameworks (MTEFs) that form the basis for providing and programming international development assistance (Agrawala and Fankhauser 2008; Osman-Elasha and

Downing 2007). All too often competing interests within governments champion mean adaptation is seen as an "environmental" issue to be kept separate from financing for "development".

1.1 The consequences from separating adaptation and development

The separation between "development" and "adaptation" has understandable political reasons since negotiators aim to distinguish (baseline) development finance from (additional) adaptation finance. Raising adaptation and development finance separately and keeping funds in separate "pots" therefore makes sense. However, from a practical point of view this artificial distinction has several important implications for African governments and their ability to implement effective adaptation programs.

First, at the operational level the lack of coordination increases transaction costs for adaptation measures that require increased investments in existing programs. For example, it would be nonsensical to structure the procurement and distribution of additional insecticide treated bednets for population groups that become newly exposed to malaria as a stand-alone undertaking that is distinct from national bednet distribution campaigns. Wherever possible, adaptation programs need to be developed and implemented as part of existing sector strategies. The synergies are substantial, although they are hard to quantify in monetary terms.

Second, as can be seen from available NAPAs, treating adaptation as a separate issue encourages project-based design and implementation of adaptation measures. The high transaction costs resulting from the small-scale implementation of project-based adaptation measures will yield inferior results, constrain scalability, and thereby fail to make a compelling case for increasing resources for climate change adaptation. Unless such a compelling case is made it becomes highly unlikely that adequate external resources can be mobilized to address the adaptation challenge effectively.

Third, unless adaptation measures are integrated into countries' expenditure and macroeconomic frameworks it is also difficult for finance ministries and central banks to manage the increased inflow of foreign currencies. Only by integrating adaptation measures firmly into a country's development framework can sound macroeconomic management strategies be developed that are necessary for ministries of finance and the IMF to support large-scale increased in external finance.

Fourth, the lack of integration between adaptation and development implies that estimates of adaptation costs and funding needs are incomplete and subject to arbitrary delineations on where development ends and adaptation begins. For example, in one of the better-known estimates of adaptation costs (UNDP 2007) about half of the costs arise from social protection programs, such as cash transfer or employment schemes that mitigate the adverse social impacts of climate shocks. There is no question that important and effective measures to reduce vulnerability to climate change exist in the area of social protection, but many of these measures

would be required even in the absence of climate change. Other cost estimates, such as those commissioned by the UNFCCC (2007), therefore omit "social protection" interventions.

The absence of a clear analytical distinction between adaptation and development strikes at the heart of the current debate about financing for climate change adaptation. A broad consensus exists that funding from rich countries for climate change adaptation in vulnerable developing countries should be "additional" to development finance (see for example Project Catalyst 2009). But without delineating clearly between the financing needs for development and adaptation it becomes impossible to determine how much additional funding is required for adaptation.

1.2 Integrating Adaptation and the Millennium Development Goals in Africa

The aim of this paper is to improve our analytical understanding of adaptation as climate-resilient development, using Africa as an example. Of course, Africa is too large and too diverse for meaningful analysis at the micro-level but it is a good case study to demonstrate the overall trend.

Our starting point is a baseline estimate of future development needs in Africa in the absence of significant changes to the climate in Africa. Such estimates can be derived from available analyses of what it will take to achieve the Millennium Development Goals, the world's shared goals for addressing extreme poverty in all its forms.[1]

When the MDGs were conceived a decade ago, little attention was paid to climate change. At the time several governments resisted the inclusion of climate change and its consequences on development into the Millennium Declaration (UN 2000) from which the MDGs were extracted in 2001. Whether intended or not, the discussion around the MDGs has largely assumed that Africa and other developing regions would experience stable climatic conditions. As a result, existing estimates of the cost of achieving the MDGs (e.g., UN Millennium Project 2005, Bourgignon et al. 2008, Ban et al. 2008) do not include the additional requirement for adaptation or provisions for a more hostile climate. Similarly, sectoral analyses of the cost of achieving individual MDG objectives generally do not include the additional cost of adapting to a changing climate (e.g., Jones et al. 2003).

We then ask how the MDG baseline and implementation strategies have to be revised once we account for climate change. Starting from a qualitative assessment of incremental measures that countries need to undertake in response to climate change, we derive a broad estimate of what it might cost to implement an integrated strategy to achieve the MDGs and adapt to climate change.

We underscore that our Africa-wide results are indicative and require considerable refinement at the country level before they can guide policies. Particularly for

[1] For an overview of the MDGs see UN Millennium Project (2005). An up-to-date list of the MDGs and recent data is available at www.mdgmonitor.org.

adaptation, the estimates are derived from a literature that has well-known analytical shortcomings (see Parry et al. 2009; Fankhauser 2010), which we do not aim to address in this paper.

Our contribution is to combine the analysis of financing needs for development in the absence of climate change, as approximated by the MDGs, with that for climate change adaptation and arrive at an integrated framework. We believe that, data quality notwithstanding, this approach is analytically and methodologically sound. Gradual refinements of our numbers and the filling of remaining analytical gaps will over time lead to a better assessment of the resources Africa requires to meet the MDGs and adapt to climate change.

If replicated at the country level, our approach may also help to address the operational shortcomings that result from treating climate change and development as two separate sets of policy imperatives. In particular, an integrated assessment would allow a clear allocation of responsibilities for core "development" and "adaptation" measures among line ministries. It would also permit the development if integrated macroeconomic management strategies and medium-term expenditure frameworks (see Schmidt-Traub 2009).

Some authors will argue that the integration of development and adaptation should go one step further and also include mitigation, for a comprehensive, low-carbon, climate resilient development strategy. We do not disagree, but to keep the problem tractable our focus is on adaptation and development. Moreover, adaptation and the MDGs rely more heavily on public finance (e.g. Ban et al. 2008) than mitigation, where private finance has an important role to play. Stern (2009b) provides first pointers on how the inclusion of mitigation may change development priorities. A rapidly growing policy literature describes the potential for mitigation measures in Africa and how they can be co-financed through carbon markets (e.g. UNCCD et al. 2009, Schmidt-Traub and Wylie 2009).

The paper is structured as follows. The next section outlines the methodological approach we take and introduces the existing research on which we build. Section 3 details investment needs for achieving the MDGs and adapting to climate change by sector and arrives at an indicative cost figure. Section 4 concludes.

2. A methodology to integrate adaptation and development needs

2.1 Available estimates of adaptation and development costs

In this paper we bring together two strands of the literature. The first strand deals with the resources requirements for meeting the MDGs. The second strand concerns the estimation of adaptation costs. The paper combines the two approaches to derive a joint estimate of the effort required to meet the MDGs in a climate-resilient way.

The first detailed cost estimates for meeting the MDGs were developed by the UN Millennium Project (Sachs et al. 2004; UN Millennium Project 2004, 2005; Bahadur et al. 2006). Building on earlier back-of-the-envelope estimates (e.g., Devarajan et al. 2002) the UN Millennium Project adopted a bottom-up approach that aggregates the costs of individual interventions to achieve the MDGs in each country. Where possible, these authors built on available sectoral needs assessment approaches that employed an intervention-based approach (e.g., Jones et al. 2003.)

An alternative approach to estimating resource needs are general equilibrium macro-economic models, which express sectoral investment functions in a highly aggregate form. These models can be used to understand the interaction across sectors within an economy and to factor in economy-wide constraints, for example in the labor market. Much of this latter work has been developed by economists at the World Bank (Bourgignon et al. 2008, Lofgren and Diaz-Bonilla 2008).

Both approaches have been praised and criticized for their methodological assumptions and use of data. As far as Africa is concerned, though, recent estimates of MDG costs show a remarkable degree of convergence (see UN Millennium Project 2005, Commission for Africa 2005, Ban et al. 2008). While this does not necessarily signify a reduction in uncertainty, it suggests that the discussion may move from the question of how much money is required to how support should be programmed and how the extra resources relate to other spending needs.[2]

There is no such convergence yet on adaptation costs. A 2008 survey by the OECD found that outside coastal protection and some case study evidence, very little is known about sector-level adaptation costs (Agrawala and Fankhauser 2008). Although there as been a flurry of analyses since (most notably, World Bank 2009b and McKinsey 2009) the range of available numbers remains wide. One emerging lesson is that top-down approaches aimed at estimating global adaptation expenditures have severe flaws and may underestimate the true cost of adaptation.[3] So the debate around adaptation estimates is moving towards bottom-up intervention-based approaches – just like the earlier debate on the MDGs.

In the absence of more detailed bottom-up estimates for the cost of climate adaptation, this paper relies on aggregate estimates. In particular, we draw heavily on sector-by-sector assessments conducted by the UNFCCC (2007) and the World Bank (2009b), as well as work by Project Catalyst (2009). These studies were reviewed in Fankhauser (2010) and, although imperfect, provide reasonable sectoral and regional breakdowns. Resource estimates that focus specifically on Africa include AMCEN

[2] We do not discuss here the critical issue of macroeconomic absorptive capacity and countries' ability to design and implement the combined MDG/adaptation programmes..Recent successes in scaling-up interventions, particularly in agriculture, education, health, and infrastructure demonstrate a substantial potential for scaling up. The MDG Africa Steering Group has also concluded that there are no fundamental macroeconomic or programmatic barriers to scaling up.

[3] See Parry et al. (2009) and Fankhauser (2010). Note, though, that a recent World Bank study (World Bank 2009b), published since these assessments were written, claims to provide an upper bound estimate. This appears correct for the sectors covered, but that coverage is incomplete.

(2008) and Stern (2009b). Importantly, Müller (2007) includes estimates for urban water management in Africa – an issue that does not receive enough attention in some of the other studies.

2.2 Integrating climate change adaptation and development

We structure our analysis around the expenditure tables prepared by the MDG Africa Steering Group (Ban et al. 2008).[4] See Table 2. The results presented by the MDGs Africa Steering Group are the most recent estimates for the cost of achieving the MDGs in Africa that we are aware of. They draw on combined research and operational expertise of the African Development Bank, European Union, IMF, OECD, United Nations organizations, and World Bank.

From an analytic perspective, the results presented by Ban et al. offer several advantages:

- *Scalable:* The MDG Africa Steering Group estimates cover the whole of the Africa region, but the sector-by-sector analysis and presentation can be scaled down to national levels, as has indeed been done by the IMF in cooperation with the United Nations (IMF 2008). These later analyses estimate what it would take to achieve the MDGs at a national level.
- *Macroeconomically sound:* The IMF analysis in support of the "Gleneagles Scenarios" shows that it is possible to meet the macroeconomic challenges of maintaining stable exchange rates and controlling inflation in the face of a massive increase in public investments that are largely externally financed.[5]
- *Sector-based:* The results are presented by sectors, which is how governments are organized. This makes it possible to determine how much funding is required for key line ministries, and how such financing could best be programmed, executed and monitored at international, national, and local levels. Critically, a sector-by-sector approach also minimizes the risk of double counting interventions or leaving important gaps in the analysis. At the same time it becomes easier to update elements of the analysis in the light of improved data.
- *Benchmarked:* The analysis uses the MDGs as (reasonably) well defined objectives that serve as benchmarks that can be used to track progress and the effectiveness of interventions.

[4] The MDG Africa Steering Group recently brought together the heads of the major international development organizations under the leadership of UN Secretary-General Ban Ki-Moon to consolidate a consensus view on how the MDGs can be achieved in Africa. Its report and findings are available online at www.mdgafrica.org.

[5] We recognise the deficiencies of MDG needs assessments that rely on adding up sectoral investment needs without integration into a general equilibrium model (see. Bourgignon et al. 2008). Yet, subsequent IMF analyses on the macroeconomics of implementing the "Gleneagles Scenarios" in a number of African countries (IMF 2008) show that the core macroeconomic issues can be addressed and that the overall results presented by the MDG Africa Steering Group are sound.

Next, we identify and quantify key "baseline" development interventions that have been omitted from the analysis of the MDG Africa Steering Group. This includes inter alia the cost of humanitarian assistance and disaster reduction.

We then expand the analysis of the MDG Africa Steering Group to introduce climate change and adaptation. We do this by first identifying qualitatively how countries need to revise and expand their development strategies using interventions that fall into three sets of categories:

1. *"More of the same" at the country level:* In our assessment the vast majority of spending needs for climate change adaptation covers known and proven interventions that will need to be supplied in greater number (quantity effect, e.g., more bed nets against infectious diseases, more investment in water storage) and/or higher cost (price effect, e.g., higher construction standards to withstand more extreme weather events).
2. *New interventions at country level:* In some instances countries will need to invest in new types of interventions, such as climate monitoring and forecast systems or sea walls to protect against rising sea levels.
3. *Regional and global goods:* Finally, key investments needs must be undertaken at regional and global levels (e.g. transboundary ecosystem management, water management, regional agricultural research)

Using available studies on the cost of climate change adaptation[6] and our own analysis we then provide first estimates for the incremental resources required to finance these interventions. Where important gaps exist in cost estimates, these are highlighted together with suggestions for how they can be closed.

The timeframe for our analysis is the coming decade, i.e. the period 2010-2020. This is somewhat longer than the traditional MDG timeframe, but shorter than most adaptation cost estimates. To reconcile the two timeframes we attempt an outline of how development expenditure may evolve over the medium term. Adaptation estimates were scaled back to 2010-20 where we felt this was appropriate.

Adaptation costs are presented as a range, which was derived from using alternative cost studies and parameter assumptions. We do not claim that this represents the full range of uncertainty. Given the quality of the underlying data, a much wider range would not seem unreasonable. Parry et al (2009), for example, have argued that the UNFCCC adaptation cost estimates on which many of our numbers are based might be off by as much as a factor two or three. As argued above, we believe that this uncertainty can and needs to be reduced through bottom-up country-level assessments of the resource needs for integrated strategies to address climate change adaptation and meet the MDGs.

[6] For a discussion of available studies and their shortcomings refer to section 1.2 above.

3. Estimating the cost of climate resilient development in Africa

Our cost estimates for climate resilient MDGs are presented over three tables. The summary results for both MDG and adaptation are shown in Table 1. A sector-by-sector tabulation of the main development and adaptation investments required is provided in Annex 1. Table 2 contains details of the adaptation cost calculations and the assumptions made. For more information about the MDG baseline costs, readers are referred to Ban et al. (2008) and UN Millennium Project (2005).

We use the figures prepared by the MDG Africa Steering Group as a proxy for the "baseline" annual development expenditure during the period 2010-2020 even though the figures were prepared as point estimates for 2010. Our approach is based on two assumptions. First we recognize that on current trajectories Africa will not meet the MDGs by 2015. We thus interpret the MDGs as the "maximum effort" that is practically feasible to accelerate progress in meeting basic needs in agriculture, education, health and infrastructure; and we further assume that the international commitment to make this "maximum effort" will be extended beyond 2015. Second, we assume that any scaling up beyond the level of "maximum effort" assumed in the analysis conducted by the MDG Africa Steering Group will be financed through increased domestic resources and private investment. As a result, the volume of ODA to Africa targeting the achievement of the MDGs in the absence of climate change is assumed constant for the period 2010-2020.

We estimate that climate-resilient development in Africa could require international financial assistance in the order of $100 billion a year over the period 2010-2020. This includes some $82 billion in "baseline" official development assistance[7] and $11 – 21 billion for incremental investments in adaptation. The total is about forty percent higher than the original MDG estimate of $72 billion (Table 1).

The ODA figure reflects the fact that for the development portion substantial co-funding of about $40 billion would be available form national public sources. No adaptation co-funding from national sources is assumed, consistent with the provisions of the UN Framework Convention on Climate Change, which offers adaptation support for least developed countries. Private investment, although central to growth and development in Africa, is not considered in this paper since it cannot serve as a substantial substitute for the public investments required to achieve the MDGs and implement adaptation measures.

The highest MDG expenditure items are for improved health care facilities, the fight against HIV/Aids and new energy infrastructure, which will each require annual investment in excess of $10 billion. The health spending would secure comprehensive primary health care (including child and maternal care), universal access to HIV treatment and the almost complete prevention of malaria deaths (see Annex 1). Energy investment, alongside other infrastructure expenditures, would provide

[7] This "baseline" ODA volume is fully consistent with existing ODA commitments made towards Africa, for example at the 2005 Gleneagles Summit.

improved connectivity, adequate water supply and access to modern energy sources. Less costly, but equally crucial, is education and measures to combat malnutrition, such as school feeding programmes. They are complemented by measures to double agricultural productivity.

The increased incidence of extreme weather events means that disaster management and social protection measures like access to emergency cash move up the priority list for development spending (e.g. Global Humanitarian Forum 2009). A good example of such a measure is the Productive Safety Net Programme in Ethiopia, an employment-based transfer programme for families affected by food insecurity (UNDP 2007). In Table 1 these activities are recorded as "additional development interventions", reflecting the fact that they are primarily developmental in nature even though they were not included in the assessment by the MDG Africa Steering Group.

Resource estimates for humanitarian assistance and disaster relief are difficult to obtain. In 2007 some $7 billion in ODA was spent on development food aid and humanitarian aid (OECD 2009). Since the United Nations appeals for humanitarian assistance are only 51.7 percent funded (Webster et al. 2008), we assume that this figure represents half of actual "baseline" needs of some $14 billion globally. In recent years some two thirds of UN appeals for humanitarian assistance covered Africa, so this would imply some $9 billion per year in baseline needs.[8]

Webster et al. (2008) estimate that humanitarian costs are likely to increase by at least 32% and could rise much faster. If one accepts the lower figure as a conservative estimate for the likely humanitarian impact during the years 2010-2020 then some $3 billion in incremental financing will be required for climate change.[9]

Among the most costly adaptation measures are water investments, which seek to preserve development achievements with respect to water access and sanitation, and investment in rural infrastructure, aimed at maintaining agricultural output. Our estimates are derived from World Bank (2009b). Although broader in scope, they are roughly consistent with Müller (2007), who estimates adaptation costs of $2-5 billion a year for urban water management alone. However, our numbers probably underestimate the costs of climate-proofing buildings, including the upgrade of slum dwellings (Garau et al. 2005).

Assuming that investment in the MDGs and climate change adaptation is successful, the extra burden on nutrition programmes should be modest, despite the fact that climate change is expected to increase the incidence of malnutrition substantially in the absence of policies.

[8] Note that this figure excludes military assistance that is not eligible for official development assistance.

[9] In comparison, Stern (2009b) drawing on UNDP (2007) estimates baseline humanitarian needs at $12 billion a year. Yet, this higher figure probably includes some overlaps with other development areas, so we retain the lower estimate of $9billion per year. Project Catalyst (2009) estimates that humanitarian needs will rise by a mere $0.1 billion in response to climate change, but this estimate seems low.

Protecting education from climate change should also only require modest incremental resources, although there will be some expenditures to climate proof school buildings. Much more noticeable will be the impact on health budgets, in particular spending on malaria protection, which will have to be extended into hitherto unaffected areas.

An important area that has been omitted, both in the original MDG figures and in our extended estimate is the cost of protecting ecosystems. This is despite the fact that the preservation of ecosystem services is crucial for poverty alleviation (see Chomitz 2007, Parry et al. 2009).

The estimate includes a small budget for disaster preparedness, taken from Project Catalyst (2009) and based on data from the Munich Climate Insurance Initiative. The estimate is probably at the low end, and it explicitly excludes the damage caused by extreme weather events. Adaptation estimates are concerned with the costs of reducing impact, but not the residual impacts that cannot be adapted to (Parry et al. 2009).

4. Conclusions and outlook for further work

Development and adaptation to climate change are clearly linked. In least-developed regions like Africa, adaptation is to a large extent climate resilient development or in the words of Stern (2009a) “development in a hostile climate”. This paper supports this view and advances the discussion by estimating the combined cost of meeting and “climate-proofing” the Millennium Development Goals (MDGs) for Africa.

The starting point is the financing table of the MDG Africa Steering Group, which is complemented it by a rough sector-by-sector analysis of additional adaptation needs, using existing aggregate adaptation cost estimates from the World Bank, the UNFCCC and other sources.

We find that the annual cost of “climate proofing” the MDGs is about forty percent higher than the cost of meeting the MDGs alone – about $100 billion, compared with $72 billions p.a. over the next ten years. This is higher than the incremental funding promised under the Copenhagen Accord – $10 billion p.a. for all climate change purposes now, rising to 100 billion p.a. by 2020 – but, depending on how funds are allocated, not dramatically so.

Extra costs arise from having to provide more development support (for example, extra bed nets against malaria), the same support at a higher cost (for example, more expensive infrastructure) as well as altogether new measures (for example, adaptive capacity building). Climate change can also lead to the prioritization of certain measures compared to the baseline development plan (for example, disaster management).

Treating adaptation and development in such an integrated way helps to better understand financing requirements analytically and, more importantly, to implement the requisite measures more effectively as part of an integrated development programme.

Like the original MDG estimates, our analysis is organised along sectoral lines that correspond roughly to the organisational structure of most governments, so that the numbers can be tied to explicit objectives and delivery mechanisms. We believe that it is crucial for adaptation measures to be implemented by the same ministries that are also responsible for the achievement of development outcomes – the departments of health, education, agriculture and so on. In addition the importance of adaptation has to be recognized by the finance and economy ministries that set funding priorities, and the corresponding measures must be incorporated into a single macroeconomic framework.

These cost estimates we provide in this paper are indicative only and imperfect in many ways. They draw heavily on existing top-down analysis of adaptation and MDG costs that are by necessity aggregated and broad. The reliance on existing cost data also creates some inconsistencies in the time frame and other assumptions that underpin the original estimates. A key challenge going forward therefore is to apply the integrated adaptation and development frameworks we propose to actual development strategies at the country level.

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Table 1: Overview of cost estimates ($bn p.a. over the period 2010-2020)

MDG costs by sector ($bn p.a. for 2010-20)		**ODA needs for MDGs**		**External public funding needs for adaptation**
		Cost 2010-20	**of which ODA***	
Agriculture & nutrition	Ag inputs	5.7	4.0	} 1.2 - 2.4
	Rural infrastructure	5.7	4.0	
	Irrigation	0.8	0.8	included in water and sanitation
	Research	0.0	0.0	0.3
	Sub-total	**11.4**	**8.0**	**1.6 - 2.7**
Nutrition & school feeding	**Sub-total**	**5.7**	**4.0**	**0.0**
Education	Primary	7.1	5.0	0.0
	Secondary	4.7	3.3	0.0
	Sub-total	**11.9**	**8.3**	**0.0**
Health	AIDS	17.1	12.0	0.0
	TB	2.9	2.0	0.0
	NTDs	0.9	0.6	0.0 - 0.5
	Malaria	2.4	2.4	} 1.2 - 1.4
	Health systems (incl. maternal health)	14.3	10.0	
	Family planning	1.4	1.0	0.0
	Sub-total	**40.0**	**28.0**	**1.2 - 2.3**
Infrastructure	Energy (incl. regional)	16.0	11.5	} 1.2
	Transport (incl. regional)	16.2	5.4	
	Water and sanitation	7.9	5.8	2.9 - 7.2
	Africa ICT regional network	-	-	0.0
	Trade facilitation	0.4	0.2	0.0
	Sub-total	**43.3**	**23.7**	**4.2 - 8.4**
Statistics	**Sub-total**	**0.4**	**0.3**	**0.0**
SUB-TOTAL: MDG cost		**112.7**	**72.3**	**7.0 - 13.4**
Additional interventions	Capacity building / planning	*Included in sectoral analysis*		0.2 - 0.4
	Coastal protection	0.8	0.8	0.6 - 3.2
	Disaster response	9.0	9.0	3.0 - 3.5
	Ecosystem management	*not assessed*		*not assessed*
SUB-TOTAL: additional cost		**9.8**	**9.8**	**3.8 – 7.1**
GRAND TOTAL		**122.5**	**82.1**	**10.8 – 20.5**

* MDG costs will be met in part from national government budgets. For example, in the case of agriculture it is assumed ODA will cover $8 billion and African governments $3.4 billion of a total budget of $11.4 billion a year.

Table 2: Sources and assumptions on adaptation cost estimates

Adaptation cost assumptions ($bn pa)		Adaptation needs, low		Adaptation needs, high	
		Cost 2010-20	Comment	Cost 2010-20	Comment
Agriculture & nutrition	Ag inputs	0.1	based on UNFCCC (2007) assumption of 2% incremental cost	2.4	World Bank (2009b)
	Rural infrastructure	1.1	based on UNFCCC (2007) / Stern (2007) 20% mark up factor for infrastructure		
	Irrigation	0.0	included in water, below	0.0	included in water, below
	Research	0.3	World Bank (2009b)	0.3	World Bank (2009b)
	Sub-total	**1.6**		**2.7**	
Nutrition & school feeding	**Sub-total**	**0.0**	UNFCCC (2007): 0.33m new cases at $20 each by 2030, scaled	**0.0**	UNFCCC (2007): 0.33m new cases at $26 each in 2030, scaled
Education	Primary	0.0		0.0	
	Secondary	0.0	climate proofing buildings is minimal	0.0	climate proofing buildings is minimal
	Sub-total	**0.0**		**0.0**	
Health	AIDS	0.0	although migration might spread AIDS	0.0	although migration might spread AIDS
	TB	0.0		0.0	
	NTDs	0.0	ignored	0.5	use same multiplier as malaria, below
	Malaria	1.2	UNFCCC (2007): 17.7m new cases in 2030 at $140 each; scaled	1.4	World Bank (2009b)
	Health systems (incl. maternal health)		Diarrhoea included in malaria above	0.4	UNFCCC (2007) for diarrhoea: 50.3m new cases in 2030 at $17 each; scaled
	Family planning	0.0		0.0	
	Sub-total	**1.2**		**2.3**	
Infrastructure	Energy (incl. regional)	0.6	Stern (2007) assumption: 20% of ODA needs protecting at 20% extra	1.2	World Bank (2009b)
	Transport (incl. regional)	0.6	Stern (2007) assumption: 20% of ODA needs protecting at 20% extra		included above
	Water and sanitation	2.9	UNFCCC (2007): 233 bn over 20 years, of which 25% is climate change	7.2	World Bank (2009b)
	Africa ICT regional network	0.0		0.0	
	Trade facilitation	0.0		0.0	
	Sub-total	**4.2**		**8.4**	
Statistics	**Sub-total**	**0.0**		**0.0**	

Cont.

Adaptation cost assumptions ($bn pa)		Adaptation needs, low		Adaptation needs, high	
		Cost 2010-20	**Comment**	**Cost 2010-20**	**Comment**
Additional interventions	Capacity building / planning	0.2	Project Catalyst (2009), lower bound	0.4	Project Catalyst (2009), upper bound
	Coastal protection	0.6	UNFCCC range of $528 -612m for 2030	3.2	World Bank (2009b)
	Disaster response	3.0	Webster et al. (2008)	3.5	Webster et al. (2008)
	Ecosystem management		Not assessed		Not assessed
	Sub-total	**0.9**		**3.7**	

Annex 1: Overview of Main MDG and Adaptation investments

Agriculture, food security and nutrition

Development Results	Key Development Interventions	Risks to Development Results from Climate Change	Incremental Adaptation Interventions to Achieve Development Results
• Sustainable doubling of food yields across Africa to reduce poverty, hunger and malnutrition • Subsistence agriculture progressively transformed into commercial agriculture to accelerate economic growth • Soil health and prevention of desertification • Improved child nutrition and learning outcomes through national school feeding programmes and other nutrition programmes • Adequate provision of micronutrients to populations at risk, including children aged 0–2 years, combined with effective de-worming to ensure nutrient absorption.	• Launch an African Green Revolution within the framework of Comprehensive Africa Agriculture Development Programme (CAADP). Key interventions include providing access to improved seeds, fertilizers and agricultural as well as financial extension services; strengthening land and water management; improving rural infrastructure; strengthening farmers' associations; and increasing access to markets in close collaboration with the private sector. • Support these interventions by reforms of agricultural policies and institutions as well as local purchases of food assistance. • Implementation of soil erosion control (by wind and water) by planting windbreaks and cover crops; improvements in soil fertility with agroforestry systems, cover crops, and conservation of ground and surface water. • Roll out school feeding programmes – using locally produced food – that cover all children in primary school. • Establish comprehensive national-scale nutrition programmes to tackle micronutrient deficiencies (i.e., Iodine, Vitamin A, Zinc, Iron, etc.) with a particular focus on children aged 0–2. Providing take-home food rations will increase incentives for girls to attend schools. • Scale up investment in agricultural research into high-yielding crop and livestock varieties as well as sustainable agricultural practices. Incremental investments need to adhere to the CAADP, in particular its Framework for African Agricultural Productivity (FAAP), and support African research through the Forum for Agricultural Research in Africa (FARA), sub-regional organizations, and centres belonging to the Consultative Group on International Agricultural Research (CGIAR).	• Falling agricultural yields and increasing climate variability will depress farmers' incomes and increase their economic vulnerability to weather-related crop failures. • Increased frequency and severity of weather-induced crop failures (in particular farmers will be vulnerable to the premature failure of rains towards the tail end of the growing season when the impact on crops will be greatest) • Increased frequency and severity of droughts that threaten livestocks and patoralists' assets. • Rising temperatures may propagate pests and animal diseases. • Increased competition over scarce water resources among farmers and pastoralists. • The incidence of famines and malnutrition may rise.	• As part of integrated water resource management strategies, invest in the software and hardware of collecting, storing, distributing and using water for agricultural purposes. In particular, increased water storage will be required – much of it in the form of small-scale infrastructure constructed by farmers that can ensure a successful harvest if rains fail towards the end of the growing season. • Expand irrigation systems and increase efficiency through development of efficient irrigation systems, including drip irrigation. • Expand soil erosion control programs, including the planting of windbreaks and cover crops; improvements in soil fertility with agroforestry systems, cover crops, and conservation of ground and surface water. • Increase expenditure on agricultural research to promote the development of drought-resistant crops as well as germplasm that can withstand higher temperatures. • Expand public programs for the provision of key agricultural inputs, such as fertilizer and improved seeds that can increase farming yields and strengthen the economic resilience of communities. • Strengthen agricultural extension to support the shift towards farming practices that are better aligned with a changing climate. • Expand pest monitoring and control programs, including comprehensive vaccination of livestock • Expand school feeding and other nutrition programs (e.g. targeting pregnant mothers and young infants). • Increase budgets for emergency feeding programs in response to disasters

Education

Development Results	Key Development Interventions	Risks to Development Results from Climate Change	Incremental Adaptation Interventions to Achieve Development Results
• Achievement of Education for All Goals by 2015: o universal primary school completion; o comprehensive early childhood care; o 50 per cent improvement in adult literacy from 2000; o gender equality in education; o improved quality of education; and advancing life-long learning. • Expanded access to secondary, vocational and higher education by 2015.	• Train, hire and retain adequate numbers of teachers for primary, secondary, and vocational schools • Provide and maintain school infrastructure and learning materials • Remove barriers to education that depress demand (e.g. school fees, lack of appropriate hygiene facilities for girls, lack of transport) • Provide effective schooling solutions in post-conflict and humanitarian settings • Design and implement locally appropriate curricula together with continuous monitoring of learning outcomes	• Accelerating urbanization in response to falling agricultural yields will require a faster expansion of urban schooling opportunities • Climate-induced droughts and other humanitarian disasters will increase need for high-cost schooling in humanitarian settings • More frequent extreme weather event will increase wear and tear on school infrastructure	*No major changes required to countries' national education strategies*

Health

Development Results	Key Development Interventions	Risks to Development Results from Climate Change	Incremental Adaptation Interventions to Achieve Development Results
• Widespread access to comprehensive primary health systems that meet demand and supply-side constraints • Universal and free access to immunization and key child survival interventions; • Universal and free access to reproductive health services; • Universal and free access to HIV/AIDS prevention, mitigation and treatment by 2010; • Malaria burden halved by 2010 (from 2000 levels) and malaria mortality reduced to near zero by 2015; • Control of TB through implementation of Global Stop TB Plan of Action; and • Sharply reduced morbidity and mortality from Neglected Tropical Diseases (NTDs) and other diseases prevalent in the country.	• Establish and maintain effective primary health systems, including the provision of o Adequate human resources for the management and provision of health services at all levels, including community health workers; o Adequate access to essential drugs and commodities; o Adequate supply and logistics systems; and o Appropriate infrastructure and equipment • Inter alia, the health systems should provide the following key interventions: o Immunization, neonatal integrated package, integrated management of childhood illnesses o Micronutrient and Vitamin A supplementation o Full range of reproductive health services, including emergency obstetrical care, antenatal care, skilled birth attendants and family planning o Universal and free access to HIV/AIDS ARV treatment, voluntary counseling and testing, prevention of mother-to-child transmission, other mitigation and prevention measures o Directly-Observed Short Treatment (DOTS) and other interventions identified in Global Stop TB Plan of Action o Universal access to long-lasting insecticide-treated bednets, effective anti-malarial drugs (e.g. ACT), and – where necessary – residual indoor spraying. o Treatment and prevention of NTDs	• Rising temperatures may facilitate propagation of pathogens and promote diarrhea. • Increased migration in response to climate change may accelerate spread of TB, sexually transmitted infections and other infectious diseases. • Increased incidence and prevalence of vector-borne diseases (e.g. malaria, NTDs) increase disease burden and undermine economic development.	• Increased investments in prevention and treatment of sexually-transmitted infections, TB, and other infectious diseases. • Provision of long-lasting insecticide-treated bednets to populations who are newly exposed to malaria, expanded residual indoor spraying, and supply of effective anti malarials. • Expand emergency health systems in response to a projected increase in the incidence of epidemic disease outbreaks and other humanitarian challenges.

Infrastructure and trade facilitation

Development Results	Key Development Interventions	Risks to Development Results from Climate Change	Incremental Adaptation Interventions to Achieve Development Results
• Adequate connectivity and infrastructure to increase productivity, ensure low-cost service delivery, and integrate African countries into the global economy through: o Effective regional networks for roads, rail, canals, power pools, and information and communications technology to integrate African economies and to provide landlocked countries with reliable access to seaports; o Adequate rural and urban electrification and access to other modern energy services; o Adequate transport grids, including major expansion of rural feeder roads; • By 2015, halve the proportion of people without access to adequate water supply and sanitation; and • Strengthen national and regional institutions to promote regional integration, regional infrastructure projects and trade facilitation across Africa.	• Plan and build transformational generation and transmission facilities across Africa, and improve the performance of power utilities. • Develop decentralized energy systems to increase access to fuels for domestic cooking and heating, motive power and off-grid electricity. • Expand the construction and maintenance of all-weather roads, including urban road networks • Provide adequate urban infrastructure (slum upgrading, transport, energy, water drainage, sewage, lighting) • Implement national strategies to achieve the water supply and sanitation MDG targets. • Develop regional infrastructure (e.g., road corridors, power pools, multipurpose water infrastructure, information and communications technology), as outlined in the African Union NEPAD Infrastructure Short-Term Action Plan and other regional plans. • Implement the Enhanced Integrated Framework and Aid for Trade to support country efforts to develop their trade capacity and performance.	• Increased intra- and inter-annual variability in precipitation will increase need for water storage for agriculture and domestic water use. • Hydropower generation capacity of existing infrastructure may fall and suffer from increased intermittency. • Rising incidence of extreme precipitation and other weather events will increase wear and tear of transport infrastructure, particularly roads. • Increased flooding in urban areas. • Vulnerability to sea level rise and salt water intrusion into aquifers.	• Expand construction of water storage capacity for power generation and retention of run-off for agricultural and domestic use. • Increase access to deep boreholes and water wells to provide year-round access to clean drinking water. • Expand regional power pools to use available hydropower resources more effectively. • Upgrade existing roads to reduce vulnerability to extreme precipitation event; expand road maintenance operations. • Expand storm water drainage. • Build sea walls, expand flood management systems, and control aquifer discharge to minimize salt water intrusion.

Other Core Development Needs not included in MDG Africa Steering Group recommendations

Development Results	Key Development Interventions	Risks to Development Results from Climate Change	Incremental Adaptation Interventions to Achieve Development Results
• Effective emergency response systems	• National and regional monitoring and early-warning systems for emergency and humanitarian responses.	• Increased likelihood and severity of emergencies and humanitarian disasters	• Strengthen emergency and humanitarian systems
• Environmental sustainability objectives not covered above o Sustainable forest management o Sustainable use and management of watersheds and wetlands	• Implementation of sustainable forest management techniques, forest plantations in appropriate areas to satisfy demand for forestry products, and tree seedlings and other measures to support afforestation. • Institution of Integrated Water Resources Management plans; promotion of reforestation to protect selected catchment areas; and monitoring of wells and groundwater-dependent systems.	• Forests will come under increasing pressure from raising temperatures, and desertification will accelerate in parts of Africa. • The hydrological cycle will undergo profound changes in response to climate change, thus undermining IWRM efforts in many parts of the continent.	• Interventions to protect forests need to be adapted to rising temperatures and possible changes in locally appropriate tree species. *(Large-scale reforestation and avoided deforestation measures fall under "mitigation" and are not considered in this paper.)* • Weather and climate monitoring stations need to be installed and maintained across Africa to provide reliable, real-time meteorological information. • Monitoring of groundwater aquifers will need to be scaled up. *(Other IWRM interventions are considered above)*