THE ECONOMICS OF CLIMATE CHANGE: SUMMARY[1]

- Climate variability already has significant economic costs in Africa. Periodic floods and droughts (extreme events) cause major macro-economic costs and reductions in economic growth.
- Climate change is real and is being observed in Africa Temperatures have risen by almost a degree over the last century, and there have been changes in the rainfall and extreme events.
- The rate of change will accelerate over the next 50 years. By 2050, temperatures in Africa are projected to increase by a further 1.5 to 3ºC, along with changes in rainfall, extreme events and sea-level rise.
- Climate change is likely to lead to potentially large impacts and economic costs. These will be greater in Africa than other regions, because of higher vulnerability and lower adaptive capacity. They could threaten past development gains and constrain future economic progress and development.
- The economic costs of climate change are uncertain. However, economic models indicate that these costs could be equivalent to an annual loss in GDP of 1.5 - 3% by 2030 in Africa.
- Costs include potential threats to coastal zones (sea-level rise), health burdens, energy demand, and in some regions, increased risks to infrastructure, reduced water availability, reduced agricultural yields and loss of ecosystem services.
- There is likely to be a strong distributional pattern of effects, with some regions in Africa affected more than others, and some groups within countries particularly affected.
- In the longer-term (after 2050), the economic costs could be even more significant, with upper estimates that would be unsustainable for a functioning economy. Such high impacts are beyond the limits of adaptation. There is therefore a need for global mitigation, as well as adaptation.
- Adaptation can reduce the economic costs of climate change, but it can not remove them completely. However, adaptation has a cost. The estimates of the costs of adaptation are still emerging and are still very uncertain, but they provide a possible range for adaptation financing for Africa.
- The estimates of adaptation financing needs for Africa indicate a minimum of $1 – 2 billion per year by 2012 - 2015. Estimates of medium-term needs (2030) are typically in the range $2 - 10 billion per year by 2030, though with higher values if humanitarian spend and the current adaptation deficit are included.
- There is a large need for adaptation finance for Africa, and entitlement to substantial funds must be assured. However, this will require the development of effective mechanisms and institutions. There is a need to agree on early next steps, including common negotiating positions, and a future focus.
- There are also existing financing mechanisms for encouraging low carbon development, which could provide large investment flows ($billions/yr) for Africa and provide many wider benefits. However, Africa has not been as successful as others in securing these. This could be addressed through reforms of the current mechanisms such as the CDM and the appropriate design of the emerging new mechanisms.
- Given the scale of impacts, and the large finance flows involved, it essential that finance ministries get involved in shaping the architecture of any future international deal, and of specific financing instruments and funds, to ensure these work for Africa.

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[1] Produced for *Financing for Development, Conference on Climate Change*, Kigali, 21/22 May 2009. By Paul Watkiss (paul_watkiss@btinternet.com). The work presented here was made possible by funding by DFID and DANIDA, UNEP and the EC.

ECONOMICS OF CLIMATE CHANGE: KEY MESSAGES

Policy Brief[2] *By Paul Watkiss*

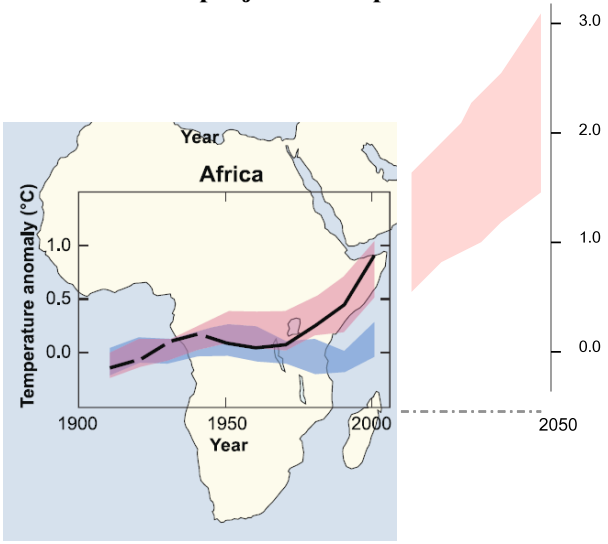
How vulnerable is Africa today?

- Africa has high existing vulnerability. This arises from developmental challenges (including poverty, complex governance, high population growth, a high burden of disease, etc.), high levels of current ecosystem degradation and loss of natural resources, and existing extreme climates which lead to regular extreme events. It also has low adaptive capacity – and a current adaptation deficit to the existing climate.
- Climate variability already has significant economic costs in Africa, with periodic floods and droughts already causing major macro-economic costs, long-term liabilities and reductions in economic growth. For example, in East Africa, major periodic drought and flood years have been found to have economic costs equivalent to almost 10 % or more of GDP, and because of their regular frequency, have long-term impacts on growth[i].

What climate conditions might be expected in the future?

- Climate change is now being observed and measured globally and in Africa. Average global temperatures have risen by almost 0.8ºC over the last century, and slightly higher than this in Africa, with a particularly sharp rise over last 50 years rise.
- These changes can only be explained by anthropogenic emissions (see figure to the right[ii]). There have also been rises in sea level, and changes in the pattern of rainfall, extreme rainfall (floods) and droughts. These trends are very real and are accelerating.
- The rate of change will increase over the next 50 years, probably by more than twice as much as over the entire 20th century. By 2050, average temperatures in Africa are projected to increase by 1.5 to 3ºC (see figure, right[ii]), and then continue further upwards beyond this time. There are also likely to be major changes in rainfall, in terms of annual and seasonal trends, and changes and possible intensification of extreme events related to floods and droughts. While there is wide variation amongst projections, the overall scale of the changes is likely to be dramatic.

Observed and projected temperature in Africa



Source: IPCC, WG1-AR4[ii]

The black line shows the observed (actual) changes in surface temperature in Africa over the past century.

This measurement data is compared with the results of climate models. The models match the pattern of observed values only when greenhouse gas emissions (anthropogenic forcing) are included, shown in pink. The extended pink line shows the future projections of rising surface temperature in Africa over the next 50 years (A1B).

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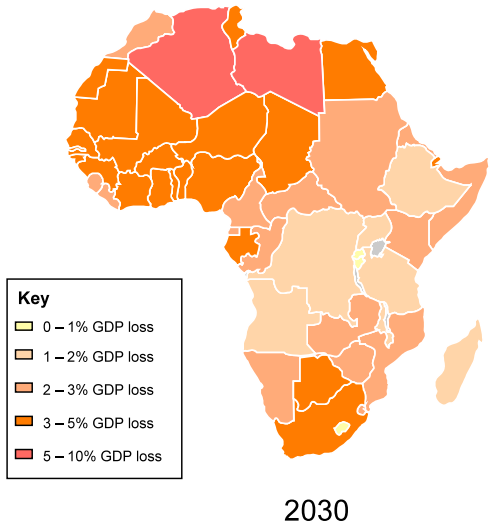
[2] Produced for *Financing for Development, Conference on Climate Change*, Kigali, 21/22 May 2009.
Acknowledgements: This note is based on ongoing studies funded by DFID and DANIDA (*Economics of Climate Change in East Africa*), UNEP (*AdaptCost*) and the EC (*ClimateCost*). Contact details (paul_watkiss@btinternet.com).

What are the potential economic costs of climate change, within the current outlook of development plans?

- Future climate change is likely to lead to potentially large impacts and economic costs. While these effects occur globally, Africa is particularly at risk (vulnerable), due to the large number of areas prone to existing floods and droughts, the number of regions that are already close to tolerance limits in terms of heat or water availability, and low adaptive capacity.
- Africa-wide assessments of the economic costs of potential climate impacts are in progress. While they are preliminary and further work is needed, the emerging message is clear: recent and future changes in climate have dramatic net economic consequences.
- An indication of the potential scale of the economic costs of climate change in Africa can be derived from global integrated assessment models (IAMs). These provide highly aggregated information on potential economic costs using a framework that links emissions, climate change and impacts on the economy, though they use simplified relationships to do this and are not able to capture all of the effects of climate change. They usually include analysis of uncertainty reporting a central value and a range. They indicate the potential scale of costs (see box), reporting that economic costs (central values) could be equivalent to an annual loss in GDP of 1.5-3% by 2030 in Africa:

Integrated assessment models results of the economic costs of climate change in Africa

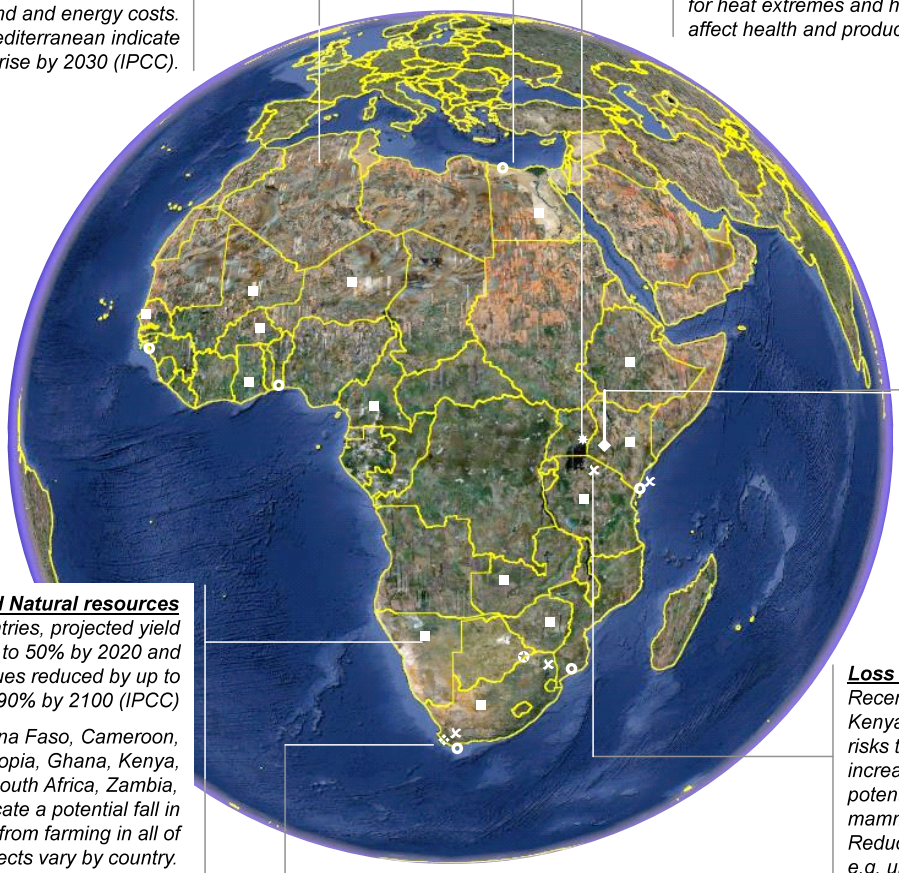
- The PAGE model, used in the Stern review, estimates[iii] that climate change could lead to an equivalent annual loss in GDP in Africa of just under 2% by 2040 (central mean value, including market and non-market sectors, with no adaptation). The upper value (95%) from the model is an estimated 4% GDP annual loss by 2040.
- The FUND model, another global IAM, estimates[iv] that climate change could lead to an equivalent annual loss in GDP in Africa of 2.7% by 2025 (central value, including market and non-market sectors). The model reports large economic costs from change in water resources, health impacts, and energy costs for cooling, but some potential benefits for agriculture. The effects vary strongly with region – as shown (right) in the estimated values for each country in Africa from the FUND model (national version) for the year 2030.
- Note these models reflect a partial coverage of the effects of climate change, and neither captures extreme events (including flooding), cross-sectoral links and socially contingent effects, or the cumulative effects on adaptive capacity.



Annual Costs from Climate Change as a Faction of GDP in Africa in 2030.

Source FUND national model[v].

- Assessment of sectoral bottom-up model results for Africa, at the continental, country or sub-national scale, show concerns in relation to rising sea levels and storm surge risk in coastal zones, a greater potential burden of health, a rise in potential demand for energy for cooling, and in some regions, possible increases in risks to infrastructure from extreme events, declines in water resource availability, and yield reductions for existing agricultural regimes. All of these involve significant economic costs. There are also increasing threats to biodiversity and associated ecosystem services. Highlights of results from recent and ongoing studies are shown in the figure below.



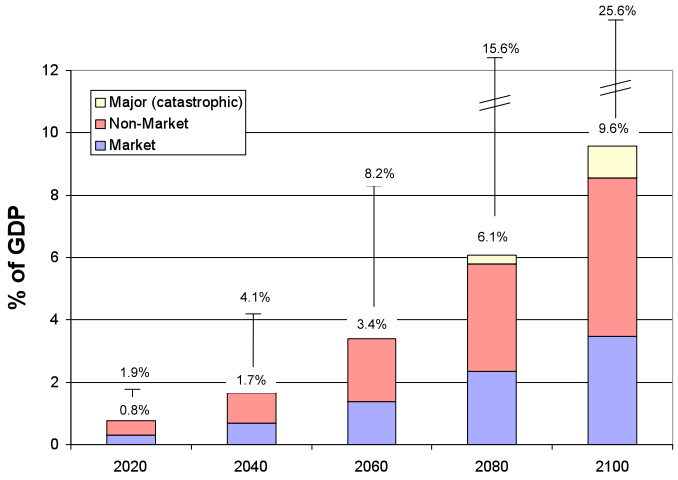
Examples of potential economic effects across Africa. Source Watkiss et al[vi] / GoogleEarth map

- These same studies show a strong distributional pattern of effects, shown in the annex. Some regions will be particularly affected, notably those with existing hot and arid climates where these trends are exacerbated by climate change. In other regions there will be both positive and negative effects, though the balance of these will change over time. However, large net negative effects are anticipated for the continent. Moreover, impacts will affect the poor most within Africa, compounding inequities in health status and access to resources. These are likely to impact upon the ability of national governments to meet strategic objectives, and hinder progress towards poverty alleviation, achievement of the Millennium Development Goals, and pro-poor growth.

What are the potential economic costs on a longer time frame?

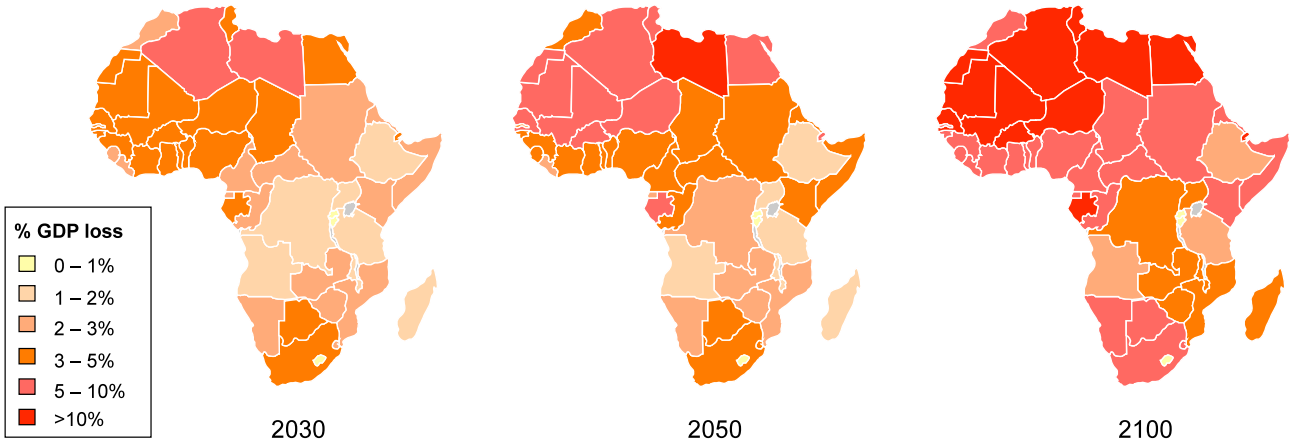
- Many short-term changes (to 2030 at least) are already locked in to the climate system, and they are likely to occur irrespective of any short-term emission reductions. Adaptation will be needed to address them.
- Furthermore, in the absence of a future international agreement on mitigation (a successor to the Kyoto Protocol), the economic costs of climate change will potentially rise much more sharply in the longer term. These long-term and large scale effects are difficult to estimate, and have strong interactions with development pathways as well as increasing uncertainty. Nevertheless, it is possible to explore the potential scale of effects using the IAM results, shown below.

- The aggregated information from some IAMs shows very sharp rises in economic costs under a business as usual scenario. By 2100, the PAGE model[iii] estimates that climate change will lead to an equivalent annual loss in GDP in Africa of 10% by 2100 (central mean value, including market and non-market sectors, without adaptation), with an upper value (95%) equivalent to an annual 25% GDP loss by 2100, shown in the figure below.
- Even with the central estimate of future effects, economic impacts of this magnitude are unsustainable for a functioning economy: at the upper level they are beyond the limits of adaptation. There is therefore a need for global mitigation, as well as adaptation.



Potential Economic costs of climate change in Africa.
Source: PAGE model (no adaptation)[iii]

- Similarly, the results of the FUND model[iv] (national version) show a large potential increase in economic costs over time.



Potential Annual Costs of Climate Change as a % of GDP in Africa over time.
Source FUND national model [v]

What are the costs and benefits of adaptation?

- Adaptation can reduce the economic costs of climate change, though it can not remove them completely. However, adaptation is not free and evidence is only starting to emerge on the costs and benefits. These estimates vary significantly, and there are few validated studies, inconsistent assumptions and incomplete coverage. Nonetheless, they provide a possible range of the indicative adaptation financing for Africa, for input to the discussion of the potential Adaptation Fund.

- The National Adaptation Programmes of Action in Africa identified urgent adaptation needs to avoid impacts, particularly in the agricultural and the water sectors, but also for health, coastal zones and extreme events. Estimates of the African NAPAs that cite costs[vii] are mostly in the range $5 million to $20 million per country, and when added together they total over $300 million.

- Some estimates of the costs of adaptation are emerging. These usually apply top-down methods to estimate the additional adaptation financing needs to make current investments 'climate resilience'. Using such an approach, the AfDB, WB and UNECA[viii] estimated an annual cost of US$ 2 – 7 billion for Africa (around 0.5% of Africa's GDP). Similarly, SEI estimated an annual cost of US $ 0.8 to 6.3 billion per year by 2030[ix]. However, climate resilience is only one of several adaptation needs.

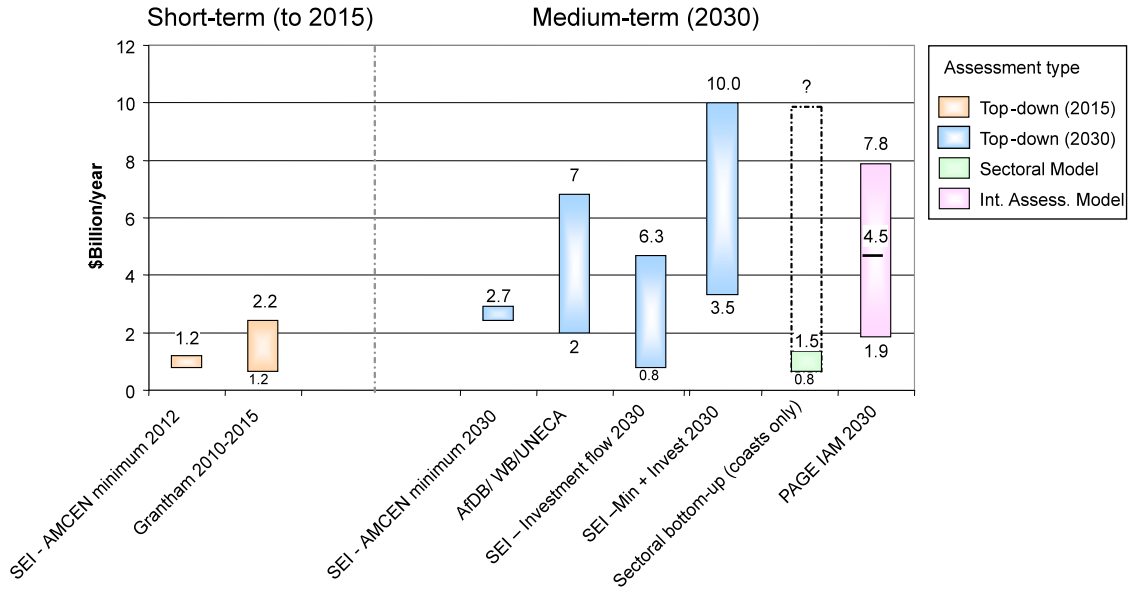
- Work by the SEI, presented at the African Ministerial Conference on Environment in 2008[x], assessed the potential costs of funding early priorities for assessing vulnerability, building capacity, and piloting adaptation, as a precursor step to operational adaptation and climate resilience. It estimated these urgent funding needs at a minimum of US$ 0.8 billion/year, rising to a minimum of $1.2 billion/year in 2012 and $2.7 billion/year by 2030. These steps are additional to the funding of climate resilience.

- At this time, there is relatively little information on bottom-up estimates of the adaptation costs by sector for Africa, and the analysis of the economic benefits of adaptation, the costs of adaptation, and residual damages. Some estimates are starting to emerge in the coastal sector and these indicate costs of coastal protection for Africa at $0.8 to 2 billion/year per 2030, assuming medium to high projections for SLR[xi].

- Information is also available from the aggregated IAMs. The PAGE model[iii] estimates that adaptation could reduce the economic costs of climate change in Africa significantly, from 2% to 1% of GDP by 2040, and from 10% to 7% of GDP by 2100 under a business as usual scenario. Note that there are still large residual damages even with adaptation in place. However, adaptation provides large net economic benefits when compared to the estimated costs of adaptation in the model, with these adaptation costs estimated at $4.5 billion per year (central value) in Africa from 2020 onwards.

- Based on this literature, estimates of the short-term adaptation financing needs for Africa are typically in the range of $1 – 2 billion per year by the year 2012 - 2015. Estimates of the medium-term needs (2030) are typically in the range $2 - 10 billion per year by 2030.

- Most of these estimates use a similar method (looking primarily at climate proofing investment flows) and there are other estimates which include higher values. These have much greater emphasis on hard adaptation for infrastructure and/or include increases in humanitarian spend. They also include studies that include the costs of adapting infrastructure to address the current adaptation deficit, as well as to future climate change.

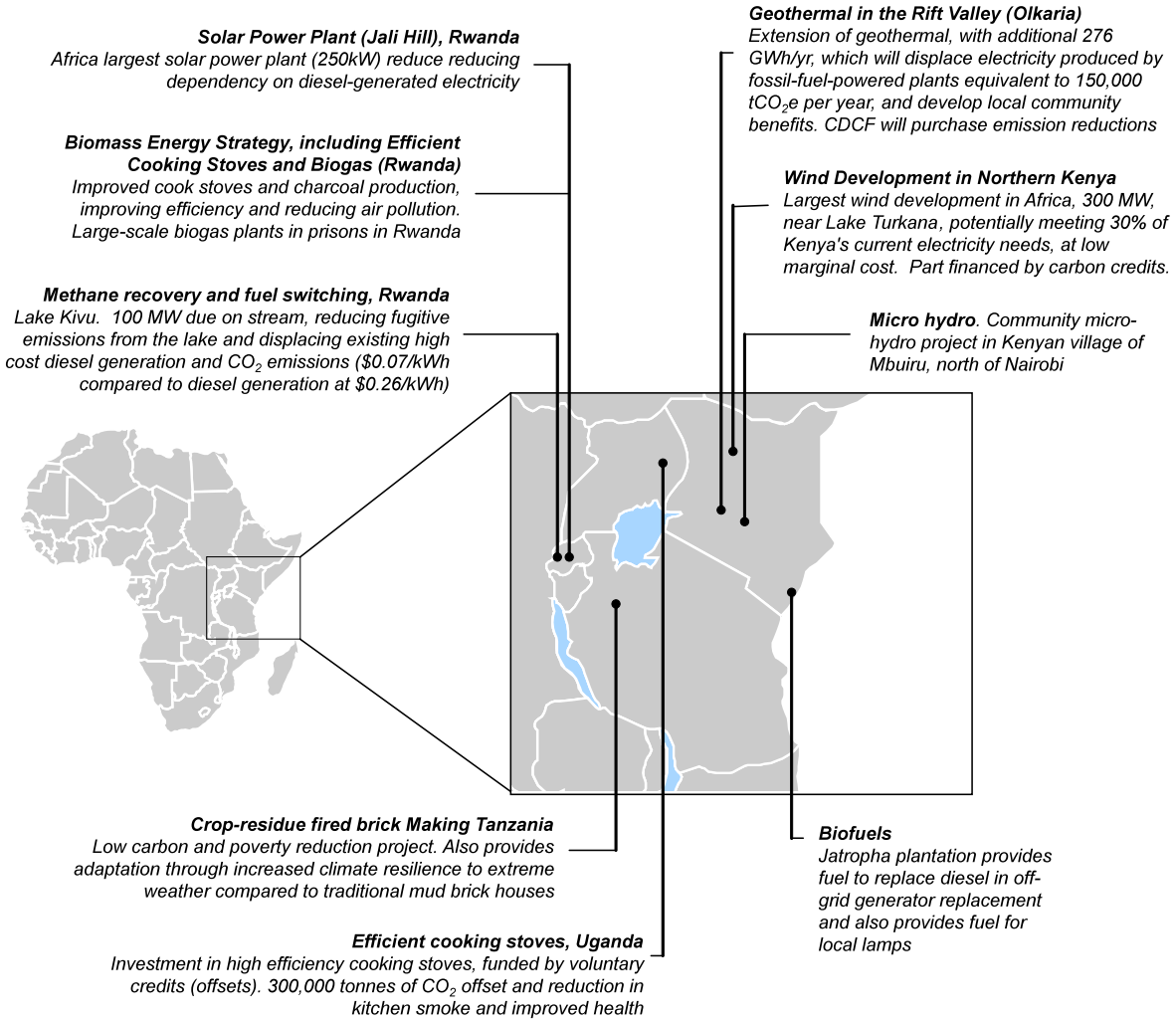


Reported estimates of the costs of adaptation to climate change

- In looking at these funding levels, there will be a need to assess and prioritise action. Economics will play a key role in such analysis, and in the assessment of early adaptation plans. However, our knowledge of the future climate is still highly uncertain and decision making must bear this in mind.
- Following from this, there is a need to prioritise where early action is most effective. This can be considered with a tiered approach. This starts with building capacity and raising awareness of climate change – including in economics, finance and planning – as a necessary precursor to improving current resilience, addressing the current 'adaptation deficit' and preparing for the future.. Early priorities should also identify and implement win-win, no regrets or low cost options, justified by current climate conditions, or based on projected climate change, but involving minimal cost. Finally, it should identify areas where early planning is needed, even in the face of uncertainty. This would include for investments, infrastructure or urban planning with long-life times and where lock-in is a risk, and cases where there is the threat of irreversible effects or potential loss of options, and for major consequences.
- As and when the evidence of climate change and climate change impacts unfolds, other possible adaptation options, which involve higher costs, can be considered. There is also a need to link these adaptation measures with low carbon opportunities, to maximise the potential benefits.
- There is a need to agree on early next steps for progressing adaptation in Africa, including the effort over the next 3 to 5 years. Such steps would include deepening the evidence, improving the information base, and looking at investment costs with long life-times (infrastructure) with both public and private sectors.
- There is a need for African finance ministers to ensure future economic growth is climate resilient, to address the scale of potential impacts outlined above. There is evidence that more flexible economies, particularly those with competitive private sectors, are better able to cope with climate variability and extremes, and to seek out and take advantage of opportunities. Many governments are already following this path, by promoting competition, reducing costs to business, and providing public infrastructure.
- However, in the longer-term, this will also require economies to diversify away from those sectors or activities which are most vulnerable to climate. This will need to include the promotion of manufacturing and services, to create jobs to absorb a declining agricultural labour force.

How does this link to low carbon growth and other finance opportunities?

- There are existing international financing mechanisms for encouraging low carbon development paths in developing regions such as Africa, which potentially involve extremely large-scale flows for investment.
- The Clean Development Mechanism (CDM) currently represents the primary market for carbon finance, followed by the secondary carbon market or Voluntary Carbon Market (VCM). In 2008, total low-carbon investments in developing countries from these markets totalled $22 billion[xii]. However, it has been difficult for Africa to access these funds to date, and the current project-based approaches place high transaction costs on small countries. Nevertheless, following a low carbon development pathway could provide significant economic opportunities for Africa, and is strongly in its own self-interest.
- These low carbon trajectories are particularly important to maximise the planned development across Africa, to ensure future growth avoids getting 'locked' in to high emissions, and to allow maximum potential for capturing financing opportunities now and in the future. Examples of existing and commissioned studies are shown below for East Africa, and demonstrate the practical opportunities and benefits. There is also a need for major energy investment and instruments to better help Africa exploit these least cost and low carbon options.



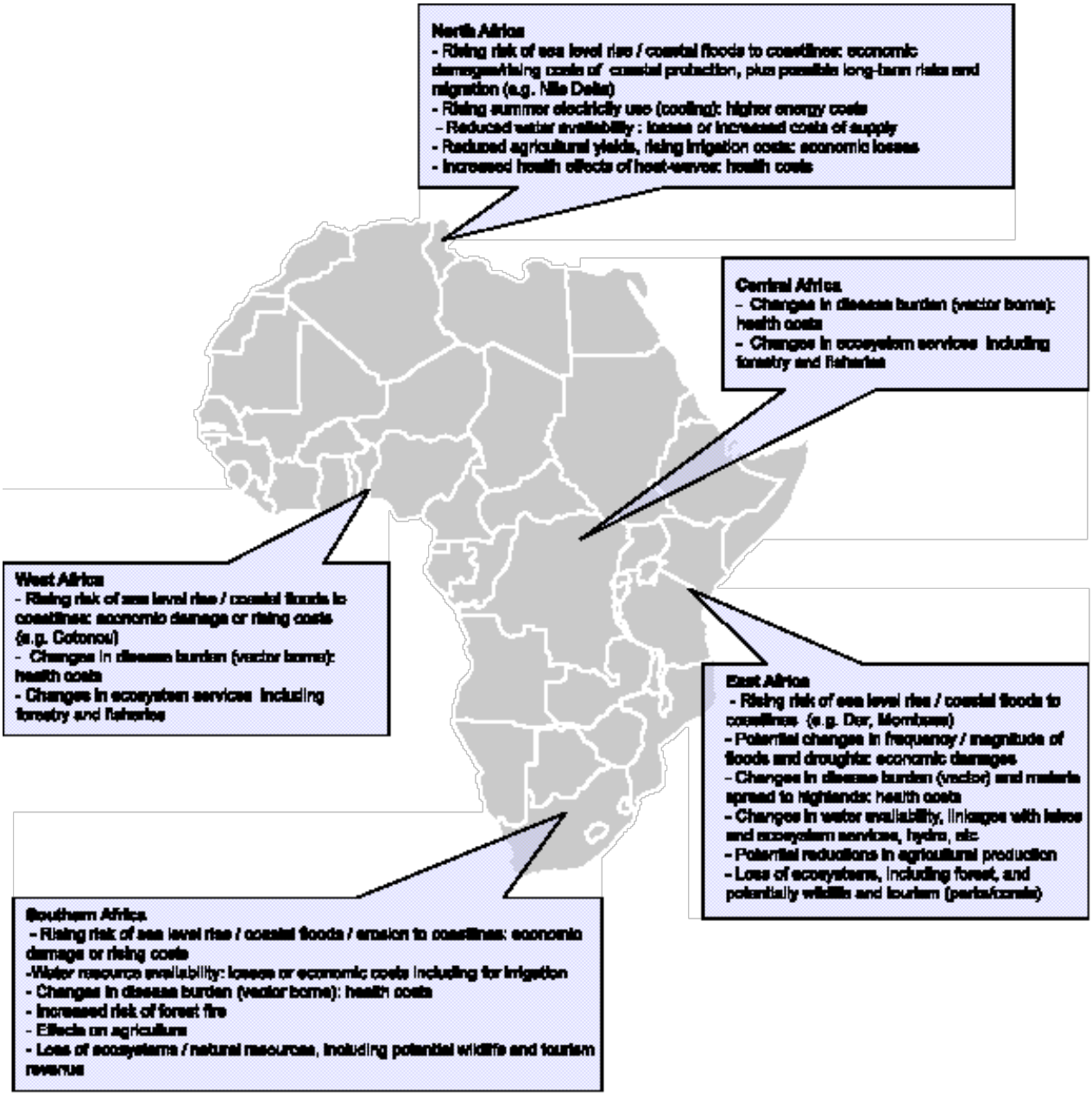
Examples of existing low carbon growth projects in East Africa (underway or commissioned)[xiii]

- There is the potential to implement no regret (win-win) measures across many areas of economic activity, which are available at low cost now, and can improve economic efficiency, as well as delivering low carbon and development objectives.
- In many cases low carbon energy investments have similar marginal costs to fossil alternatives, which are further enhanced by the potential for carbon credits. They also provide important co-benefits from reducing energy imports, enhancing energy security, improving air quality and health, reducing pressures on natural resources, and improving adaptation capability by exploiting synergies.
- There is also a large and untapped potential for low carbon - pro-poor economic growth projects, which can achieve poverty reduction and emission benefits through low carbon energy access programmes.
- In advancing all of these areas, there is an important role for domestic policy (taxation, regulatory, incentives etc) to encourage low carbon technology development, diffusion and deployment. This also includes the reform of fossil fuel subsidies and low electricity tariffs.
- Curbing deforestation is also part of this low carbon pathway, and is now the subject of potential new financing flows (reducing emissions from deforestation and forest degradation in developing countries (REDD)) and also provides protection of natural habitats and ecosystem services.
- There is a need to consider the linkages between adaptation and these low carbon pathways, and exploit the opportunities that arise from considering them together.

What next? How do we move forward?

- There is a need for regional and trans-boundary cooperation and approaches to exploit linkages and address the scale of climate change challenges. Given the scale of these impacts, it is also important for Finance Ministers to start including climate change (and potential impacts) in central and sectoral economic planning.
- There is a large need for adaptation finance for Africa. Entitlement to substantial funds (e.g. through the Adaptation Fund) must be assured, but effective mechanisms and institutions for access and effective use must be developed.
- While there is very large potential flow from low carbon financing, Africa has not been as successful as others in securing current finance flows. Flows could be increased through reforms of the current mechanisms such as the Clean Development Mechanism (CDM), and the appropriate design of the emerging new mechanisms.
- In both adaptation and low carbon financing, Africa needs to put pressure on the international negotiations for a deal that works for the continent. Prospects for influencing this negotiation would be strengthened with common negotiation positions.
- Given the scale of impacts, and the large finance flows potentially involved, it essential that finance ministries get involved in shaping architecture of any future deal. It is also imperative for these ministries to make an input on specific financing instruments, to ensure any financing architecture works for Africa.
- These mechanisms and negotiating positions are discussed further in other briefing papers as part of this series.

Annex: Examples of potential regional effects from Climate Change in Africa



Source Watkiss et al (SEI) vi

NOTES

[i] Numbers derived from Hezron Mogaka, Samuel Gichere, Richard Davis, Rafik Hirji (2005) Climate variability and water resources degradation in Kenya: improving water resources development and management. World Bank working paper; no. 69.

[ii] The main figure is taken from Figure TS.22, from Solomon, S., D. Qin, M. Manning, R.B. Alley, T. Berntsen, N.L. Bindoff, Z. Chen, A. Chidthaisong, J.M. Gregory, G.C. Hegerl, M. Heimann, B. Hewitson, B.J. Hoskins, F. Joos, J. Jouzel, V. Kattsov, U. Lohmann, T. Matsuno, M. Molina, N. Nicholls, J. Overpeck, G. Raga, V. Ramaswamy, J. Ren, M. Rusticucci, R. Somerville, T.F. Stocker, P. Whetton, R.A. Wood and D. Wratt, 2007: Technical Summary. In: Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor and H.L. Miller (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY,USA. It is extended with information from Figure TS.29 of the same reference.

[iii] Run commissioned from Chris Hope, funded by the DFID / Danida project Economic Impacts of Climate Change in East Africa / UNEP funded AdaptCost project/ EC ClimateCost study. The run was for an A2 scenario with 'Stern review' assumptions, without adaptation. Note the values and later graph show mean estimates. The upper values (and upper line on the later graph) show the 95% value. Note that the lower 5% value is not reported or shown on the graph. The model includes three aggregate categories of damage: market, non-market and major events (discontinuities) based on the available literature.

[iv] Run commissioned from the FUND model by David Antoff, funded by the DFID / Danida project Economic Impacts of Climate Change in East Africa / UNEP funded AdaptCost project/ EC ClimateCost study. The run was for the default business as usual scenario with the main FUND model and 'best estimates' and reporting of median value. The model estimates effects on agriculture, energy demand, health, forests, storms, coastal protection, water, and ecosystems. It does not include the effects of extreme events (including inland flooding), major events, or socially contingent events. The estimates include adaptation in some sectors (explicitly for coastal protection, and included for agriculture). The main model reports Africa in two main regions, Sub-Saharan Africa and North Africa, , showing higher initial impacts in Sub-Saharan Africa (3.4% by 2025) compared to North Africa (1.6% by 2025).

[v] This map was produced by Paul Watkiss, based on a FUND national model run commissioned by David Antoff, funded by the DFID / Danida project Economic Impacts of Climate Change in East Africa / UNEP funded AdaptCost project/ EC ClimateCost study. The run was for the default business as usual scenario with FUND 'best estimates' and reporting of median value. Note that the national specific model does give different results to the main FUND model, as they are based on slightly different versions.

[vi] Source: Watkiss et al (SEI) produced by SEI as part of the Google-Earth project, DFID / Danida project Economic Impacts of Climate Change in East Africa / UNEP funded AdaptCost / EC ClimateCost study from the following sources: Agrawala et al, 2004: Awuor et al, 2007: Boko et al, 2007: Callaway et al 2006 : Confalonieri et al 2007 : Dossou et al 2007: Kabubo-Mariara and Karanja 2007; Kurukulasuriya and Mendelsohn 2006; McMichael et al, 2004 : Midgley et al, 2005: Mogaka et al, 2005 : Nicholls and Tol, 2006: Nicholls et al, 2007: Reid et al, 2007, plus DIVA Consortium / the University of Southampton (Nicholls and Brown),. The map is taken from GoogleEarth, and from the SEI weAdapt project.

[vii] Burundi, Comoros, Congo, Djibiuti, Eritrea, Guinea, Lesotho, Madagascar, Malawi, Mauritania, Rwanda, Senegal, Sudan, Tanzania, Uganda, and Zambia.

[viii] van Aalst, M., Hellmuth, M. and Ponzi, D. (2007) Come Rain or Shine: Integrating Climate Risk Management into African Development Bank Operations. Working Paper No 89. African Development Bank, Tunis. Based on the additional financing needed on current investment (ODI, FDI, DFI) to include an adaptation component, working down from a global cost of 'climate-proofing' new investments in developing countries of US$10–40 billion per year. It also estimates that the AfDB will need additional resources of US$300 million/year to safeguard the effectiveness of new AfDB/African Development Fund (ADF) investments.

[ix] Estimate produced by SEI as part of the DFID / Danida project Economic Impacts of Climate Change in East Africa / UNEP funded AdaptCost project. This uses a similar method to UNFCCC approach, looking at the proportion of funds (ODA, concessional finance, FDI, DFI, AfDB new approvals, and ADF new approvals) that are sensitive to climate change, the % of adaptation cost (from Stern Review (2006) and AfDB (2007)), and the data of total investment inflows reported in AfDB (2007).

[x] Scoping Paper for Climate Change Adaptation in Africa. Scoping paper for the Ministerial Session and Expert Group. Segments of the dialogue on climate adaptation African Ministerial Conference on Environment Expert consultation on adaptation: 8 June 2008 Ministerial session: 12 June 2008.

[xi] Runs undertaken by DIVA Consortium / the University of Southampton (Nicholls and Brown), as part of the DFID / Danida project Economic Impacts of Climate Change in East Africa / UNEP funded AdaptCost project. Adaptation costs (beach nourishment costs, basin demand for nourishment, wetland nourishment costs and sea dike costs) are estimated at 1.3 to 2.0 billion/year for Africa by 2030, based on regionalised Africa runs for the A1B medium and A1F1 high scenarios. The analysis is run with and without climate change, with 0.5 billion of adaptation costs in the without scenario (included in 1.3 – 2 billion figure).

[xii] Guy Turner and Douglas Higgins (27 April, 2009), Press Release: Carbon volume up 37% in Q1 2009. Carbon Finance.

[xiii] Figure produced as part of the DFID / Danida project Economic Impacts of Climate Change in East Africa