Economic Impacts of Climate Change in Kenya

Project Number CNTR 200707787

Draft Method and Work Plan – For submission to NCC ACC for comment

January 2009

Title	Economic Impacts of Climate Change in Kenya – Method and Work Plan Report	
Client	Department for International Development (DFID) and DANIDA	
Client contract No	Project Number CNTR 200707787	
DEW Point Ref	DEW 7475	
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Amendment record	Version 1	Date:
	Method and Kenya Work Plan (this document)	7th January 2009
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[1] Consortium comprises Harewelle International Limited, NR International, Practical Action Consulting, Cranfield University and AEA Energy and Environment.

Executive Summary

This document outlines the proposed method and work plan for the DFID/DANIDA study on *the Economic Impacts of Climate Change in Kenya*. The objectives of this study are to consider the economic costs of climate change in key sectors (market and non-market), the costs and benefits of adaptation, and the costs and benefits of low carbon growth. The project also aims to use this information to stimulate action within government, private sector and civil society, to provide a body of evidence to support government negotiations for COP 15, and to help build long-term in-country capacity on economic assessments of climate change impacts, adaptation and mitigation.

Priority sectors

A key focus of the study to date has been to agree the priorities and work plan for the implementation phase. To advance this, the study held initial meetings in November 2008 in Kenya to seek in-country priorities. It has also completed a literature review to identify any additional potential priorities.

For Kenya, the 1st National Communication to the UNFCCC shapes in-country priorities, identifying key sectors that are vulnerable to climate change as water, agriculture, energy, transport, tourism, wildlife, and health. Priority projects identified were aimed at improvement of Greenhouse Gas inventories, climate change awareness raising and education, climate change mitigation and adaptation in the energy and transport sectors, promotion of adaptation and mitigation in the tourism and wildlife sectors, the health and public safety sectors, as well as in the coastal zones.

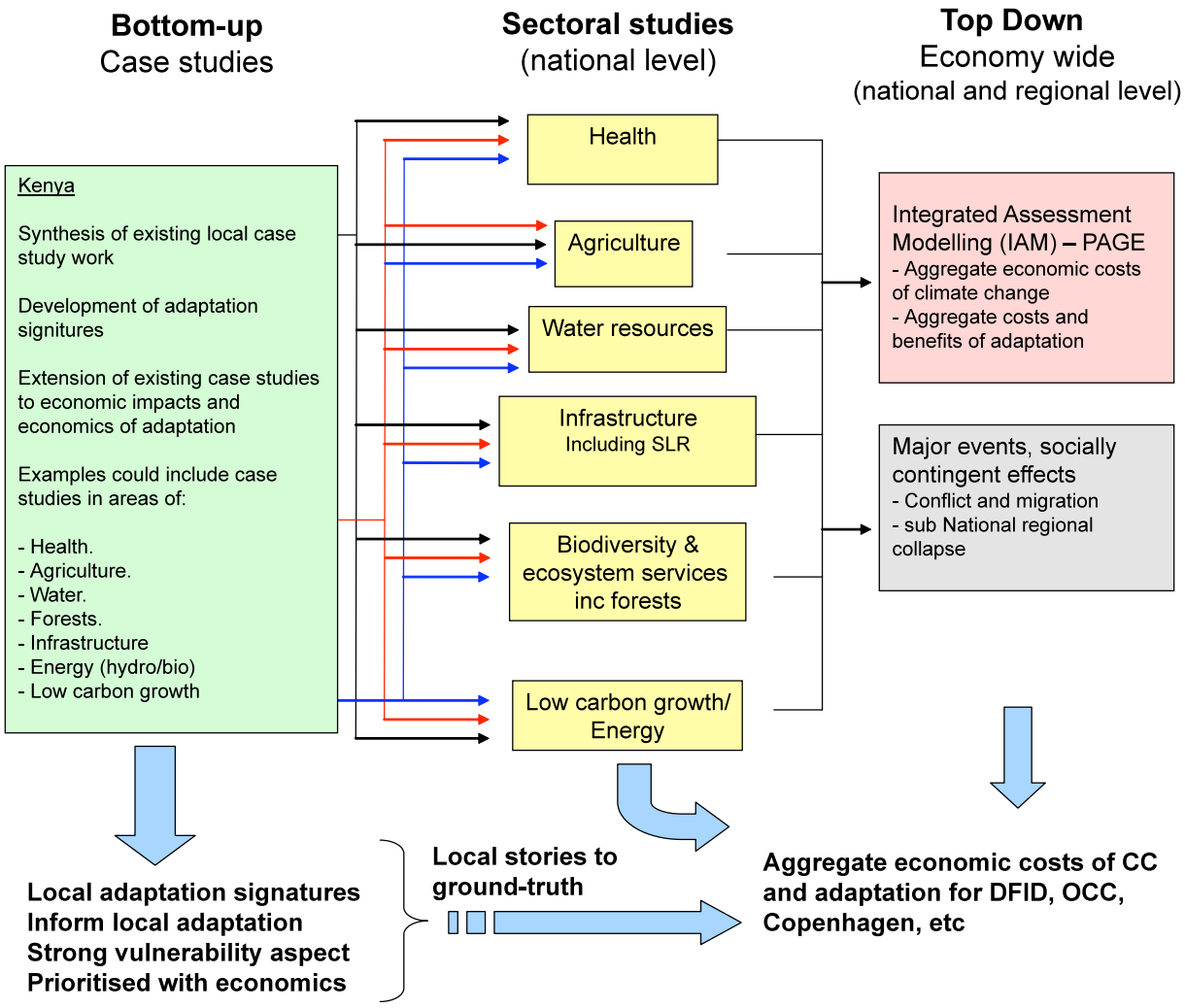
In addition, the project sought views from the NCC ACC (on 14th November) about the study focus, and about engaging in the project. Priority sectors were identified by the group as health, agriculture, water, energy (hydro and biomass); and forestry. Costing of impacts of conflicts over water and pasture under changing climate in Arid and Semi-Arid areas was also identified as an issue for potential study. These priorities have therefore been adopted in guiding the study on the current focus,

The study does propose to consider two additional areas, both of which are important to the project sponsors. The first is the need to consider the potential impact of extreme events (particularly floods, but also drought) on infrastructure. This area is important in relation to future investment and adaptation funding flows. Similarly, there is also a priority to consider the potential for low carbon growth in Kenya, with a focus on growth policies (win-win), development co-benefits, and adaptation –mitigation linkages. A key focus is to highlight the risks of carbon lock-in and future energy challenges, but also identify opportunities in relation to carbon finance.

Methodology

This study has a number of different aims and objectives, each prioritised towards different potential stakeholders. These include aggregated information on the economic costs of climate change, the costs and benefits of adaptation, and the economic costs and benefits of a low carbon growth pathway, but at the same time, data and information to inform local priorities and adaptation. There is also a focus on a partnership project and capacity building in-country. Tackling all of these aims in a single study is challenging, but to address this, the study is proposing a multi-level approach that works at different aggregation levels, and builds-up several lines of evidence in relation to impacts and adaptation. The proposed approach combines top-down aggregated economic analysis and sectoral economic impact assessment (for the region and each country) with bottom-up local or sub-national case studies on vulnerability and adaptation (adaptation 'signatures') to provide local context and inform decision making.

Importantly, the local studies allows consideration of livelihoods, development and poverty alleviation, which would be missed by a high level economic assessment. A schematic of the overall proposal is outlined below. The advantage of this approach is it will combine local 'stories' with more aggregated estimates, and so build up a coherent message for policy makers, and it also allows the team to ground-truth national and sectoral economic analysis with local context. This approach balances the need to focus on economic valuation, which would naturally lead to an impact assessment or integrated assessment based approach, with current in-country assessments which are more typically based on vulnerability assessment, and orientated to inform local short-term adaptation. The multi-level framework proposed for the study allows both approaches to be used (as complements).



The inception phase has also compiled detailed proposals for implementing the above outline and produced a communication and dissemination plan. The proposed implementation phase would start in January, after discussion of the proposed approach, methods, and priorities, and the incorporation of any comments from, the national advisory committee meeting. The study would aim to deliver initial results for July and to be completed for COP15 in December 2009.

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1. Introduction and Aims

This document provides a proposed method and work plan for the DFID/ DANIDA study '*Economic Impacts of Climate Change in Kenya, Rwanda and Burundi'* focusing on the Kenya component of the study. The study has a number of key aims, as set out in the Terms of Reference:

- To assess the potential impacts of climate change on key sectors on the economy and non-market sectors (such as health) so countries can understand what is at stake for them.
- To stimulate government, private sector and civil society actions to develop and implement policies to adapt to and mitigate (depending on international incentives) climate change.
- To provide an evidence base to inform and guide government's negotiation position for COP 15.

It also has a number of indirect aims:

- To further alert public opinion to the urgency of the climate change challenge, and its potential socio-economic impacts
- To stimulate national debate on the economic costs and benefits of a range of possible actions on adaptation and mitigation
- To encourage a regional approach to negotiations and promoting dialogue on shared challenges
- To build local capacity to analyse the challenges
- To highlight areas where further work is required to understand impacts and policy responses to climate change

The work is targeted at policy-makers and influencing constituencies (e.g. civil society / NGOs / private sector) within the participating countries. It will, however, have significant wider relevance in stimulating debate in the region. The project also aims to help enhance engagement both between developed and developing countries, and amongst developing countries, on the issue of climate change, (in particular energy efficiency, carbon markets and adaptation R, D&D). Finally, the project will also work towards a regional understanding of the issues by combining findings from the initial three countries in this study and other work underway elsewhere in the region.

More specifically, the study is to include at a country level, i.e. for Kenya:

- *Impact Assessment*: substantive analysis to develop a comprehensive and quantified assessment of the economic impacts of climate change. The impact analysis should emphasise climate effects both on Kenya's economy and prospects for growth, as well as on the poorer and more vulnerable sections of society (specifically via the MDGs).
- *Costed Options for Mitigation and Adaptation*: analysis of the costs and benefits of climate change mitigation and adaptation in the short, medium and long term, including an assessment of regional interdependence and its consequential multiplier effect. (Time horizons may be informed by country planning processes, e.g. 2020, 2025 and 2030. For adaptation use of the MDG 2015 target may be helpful).

With the country level aim to:

- Alert public opinion to the urgency of the climate change challenge, and its potential socio-economic impact on Kenya;

- Stimulate debate on the economic costs and benefits of action on mitigation (including opportunities for accessing carbon markets and improving energy efficiency and security) and on adaptation (including investments to minimise risks to key sectors of the economy from climate change impacts)
- Stimulate government, private sector and civil society actions to develop and implement policies and programmes that mitigate and adapt to climate change;

This document sets out the proposed methods for undertaking the study, for presentation to the Country Advisor Committee for comment on the 14th January.

Background: The Economics of Climate Change in Africa

The recent IPCC 4th Assessment (WG II summary, IPCC, 2007[2]) makes it clear that the impacts of future climate change will be mixed across regions. It is now commonly understood that most climate change damage (at least in the short to medium term) will be felt in developing countries (e.g. Stern, 2006[3], IPCC, 2007), with Africa the continent of most concern. There are several reasons for this: many of the largest changes are projected to occur in these countries; their economies rely more on climate-sensitive activities; many operate close to environmental and climatic tolerance levels; and their ability to adapt may be limited because of technical, economic and institutional limitations (Tol et al, 2004[4]).

In line with this, economic assessments (integrated assessment analysis) identify particularly high economic costs from climate change in Africa (see Downing et al, 2005[5]). Conservative estimates are that African economies could be facing losses of at least 1–2% of GDP, or US$10–20 billion, annually (quoted in van Aalst et al, 2007[6]) though some sectors will be much more exposed.

Indeed, Africa is already very vulnerable to climate variability and extremes, as evidenced by the impacts of current climate variability and weather extremes e.g. floods and droughts, which in turn affect economic performance, food security, livelihoods of the poor, and assets (both natural resources and infrastructure). An example is included in the box below for Kenya.

The future impacts of climate change will change the pattern of such extreme events, but also lead to change associated with mean temperature change, sea level rise, annual and seasonal precipitation, etc. which will also potentially have significant economic effects.

[2] Parry, M.L., O.F. Canziani, J.P. Palutikof and Co-authors 2007: Technical Summary. Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson, Eds., Cambridge University Press, Cambridge, UK, 23-78.

[3] Stern . N., Peters, S., Bakhshi, V., Bowen, A., Cameron, C., Catovsky, S., Crane, D., Cruickshank, S., Dietz, S., Edmondson, N., Garbett, S., Hamid, L., Hoffman, G., Ingram, D., Jones, B., Patmore, N., Radcliffe, H., Sathiyarajah, R., Stock, M., Taylor, C., Vernon, T., Wanjie, H., and Zenghelis, D. (2006). The Economics of Climate Change. Cabinet Office – HM Treasury. Cambridge University Press.

[4] Tol R.S.J., Downing, T., Kuik, O.J., and Smith, J.B. (2004). Distributional Aspects of Climate Change Impacts. Global Environmental Change, 14 (3) 259-272.

[5] Downing, T. Downing, David Anthoff, Ruth Butterfield, Megan Ceronsky, Michael Grubb, Jiehan Guo, Cameron Hepburn, Chris Hope, Alistair Hunt, Ada Li, Anil Markandya, Scott Moss, Anthony Nyong, Richard Tol, Paul Watkiss (2005). Scoping uncertainty in the social cost of carbon. Final project report. Social Cost of Carbon: A Closer Look at Uncertainty (SCCU). July 2005. Report to Defra. http://www.defra.gov.uk/environment/climatechange/carboncost/aeat-scc.htm

[6] 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.

Box 1 – Current economic vulnerability in Kenya[7]

recent study for DFID reviewed the economic effects of these climate extremes in Kenya (Nyangena, 2008) and demonstrated the importance of these events. It is found that climate extremes have very severe impacts and economic costs. The economic impacts of floods cuts across key sectors of the economy, including agricultural production, industrial processing, manufacturing, tourism, infrastructure, and public health. The total costs arising from 1997/98 floods (from damage to infrastructure and communications, public health hazard, and loss of crops) have been estimated at Ksh 70 billion (~USD 1.0 billion) by the World Bank.

Similarly, droughts affect nearly all sectors of the economy. The recent La Niña-related drought particularly affected the agriculture, livestock, energy, industrial production, and tourism sectors. The costs of the 1999/2000 La Niña drought (on loss of crops and livestock, forest fires, damage to fisheries, reduced hydro-power generation, industrial production, and water supply) have been estimated at Ksh 220 billion (~USD 3.2 billion) by the World Bank.

The repeated pattern of droughts and floods leads to longer lasting effects. On average, Kenya experiences a flood that costs it about 5.5 percent of GDP (Ksh 37 billion; ~USD 0.5 billion) every seven years, and a drought that costs it about 8 percent of GDP (Ksh 53 billion; ~USD 0.8 billion) every five years. This translates to a direct long-term fiscal liability of about 2.4 percent GDP (Ksh 16 billion; ~USD 0.23 billion) per annum. The annualised cost of floods largely arises from capital losses (bridges, roads, etc), indicating steady degradation of its infrastructure because of climate extremes. The annualised cost from droughts largely appears as losses of annual production.

Source: summary of Annex Appendix 5: Economic and Cost-Benefit Analysis of Adaptation Options, prepared by Wilfred Nyangena, School of Economics, University of Nairobi, as part of the DFID screening study.

Africa has high existing vulnerability, and climate change will act upon these, for example (Nkomo et al, 2006[8],Boko et al, 2007[9]) such as:

- Existing developmental challenges such as endemic poverty, complex governance and institutional dimensions;
- The high population growth rate, the prevalence of malnutrition, low literacy rates, a high burden of disease.
- Limited access to capital, including markets, infrastructure and technology;
- Ecosystem degradation and loss of natural resources;
- Complex disasters and conflicts (including environmental disasters such as floods and droughts).
- Poor governance, corruption, conflicts and weak institutions.

Whilst adaptation is needed to address the potential challenges of current variability and future climate change, Africa has low adaptive capacity due to low financial resources, low technical capability, weak institutions and limited awareness of the potential impacts of climate change.

The combined effects (high vulnerability, low adaptive capacity) are likely to be greatest for the poor within Africa, and they potentially exacerbate inequities in health status and access to adequate food, clean water, and other resources. These multiple constraints – linked to low income and poverty – are likely to

[7] DFID Kenya Climate Screening and Information Exchange, see http://www.dewpoint.org.uk/Article.Aspx?ArticleID=901

[8] J. C. Nkomo, Ph.D. University of Cape Town, South Africa, A. O. Nyong, Ph.D. University of Jos, Nigeria, K. Kulindwa, Ph.D. University of Dar es Salaam, Final Draft Submitted to The Stern Review on the Economics of Climate Change July, 2006.

[9] Boko, M., I. Niang, A. Nyong, C. Vogel, A. Githeko, M. Medany, B. Osman-Elasha, R. Tabo and P. Yanda, 2007: Africa. Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson, Eds., Cambridge University Press, Cambridge UK, 433-467.

limit the ability of vulnerable groups to adapt autonomously to climate change, and unless action is taken the effects of existing constraints will be compounded (Stern, chapter 20, adaptation in the developing world). In particular, these constraints pose problems for rural livelihoods, and have potentially wide reaching effects. In turn, these effects are likely to impact upon the ability of country governments to meet strategic objectives, potentially hindering progress towards poverty alleviation and pro-poor growth. There is, therefore a need to increase the resilience of livelihoods, reduce their vulnerability and raise capacity to adapt.

Related to the above, climate change also has implications for the programmes of development agencies as well as for their investments. This is evidenced with the African Development Bank (AfDB) and their portfolio (AfDB, see van Aalst et al, 2007). Climate change could potentially affect the achievement of and long-term progress towards sustainable poverty alleviation and economic development in Africa. Climate change also has the potential to setback development and poverty reduction, threatening the attainment of, or even reversing, the Millennium Development Goals (MDGs).

Recent studies have started to estimate the possible investment in adaptation needed. At a global level, the estimated increase in investment flows needed are some $50 billion to $170 billion a year (UNFCCC, 20007[10]) in the short term (2030), of which $30 billion to $70 billion are anticipated in developing countries.

Sector	**Investment Flow**	**Proportion in developing countries**
Agriculture, forest and fisheries	$14 billion/yr	
Water resources	$11 billion/yr	80% in developing countries
Coastal Zones	$11 billion/yr	Around 50% in developing countries
Human health	$5 billion/yr	All in developing countries
Infrastructure	$8 to 130 billion/yr	Public and private financed infrastructure
TOTAL	**$49 to 171 billion/yr**	**$28 – 67 in developing countries**

Source UNFCCC 2007

For Africa, the global cost of 'climate proofing' new investments (the costs of adaptation) has been estimated (van Aalst et al, 2007) at an annual cost of US$2–7 billion (around 0.5% of Africa's GDP), see below.

Item	Amount per year (billion US$)	Estimated portion sensitive to climate change	Estimated costs of adaptation	Total adaptation costs per year (billion US$)
Official Development Assistance (ODA) and concessional finance	35	40%	10–20%	1.4–2.8
Foreign Direct Investment (FDI)	30	10%	10–20%	0.3–0.6
Domestic Financed Investment (DFI)	200	2–10%	10–20%	0.4–4
Total annual costs of adaptation				2–7

Sources: World Bank, Organization for Economic Cooperation and Development (OECD)/AfDB, United Nations Economic Commission for Africa (UNECA).

Source Van Aalst et al, 2007.

[10] Investment and financial flows relevant to the development of an effective and appropriate international response to Climate Change (2007). United Nations Framework Convention on Climate Change

2. Priority Sectors

During the initial part of the scoping phase of the study (November 2008 to January -2009), the project team has undertaken a series of initial in-country meetings, and a rapid review to identify the potential priorities for the study. A summary of the meetings is written up in the inception site visit document. One of the key aims of this stage has been to identify the priority sectors for the study to focus on.

It is recognised that there is a already a very large body of work in Kenya on current climate variability and vulnerability, on climate projections, and on the potential impacts of climate change. The study aims to build on this considerable information and the associated expertise. However, there has been much less focus to date on the economics of climate change and of adaptation, outside of a few studies looking at specific risks or specific sectors[11].

In order to consider the appropriate priority sectors, the existing material has been reviewed. Much of this material was summarised in the 1st National Communication to the UNFCCC, and this document has shaped in-country priorities, identifying key sectors that are vulnerable to climate change as water, agriculture, energy, transport, tourism, wildlife, and health. Priority projects identified were aimed at improvement of Greenhouse Gas inventories, climate change awareness raising and education, climate change mitigation and adaptation in the energy and transport sectors, promotion of adaptation and mitigation in the tourism and wildlife sectors, the health and public safety sectors, as well as in the coastal zones. The areas of vulnerability identified in the National Communication, and the adaptation responses, were therefore taken as relevant starting points for the current study.

In addition, the outline of this project was presented to the NCC ACC on 14th November. Members were enthusiastic about engaging in the project and providing advise on key case studies that the study should focus on. Priority sectors were identified by the NCC ACC as:

- Health;
- Agriculture;
- Water;
- Energy (hydro and biomass); and
- Forestry.

Costing of impacts of conflicts over water and pasture under changing climate in Arid and Semi-Arid areas was also identified as an issue for potential study. These priorities have therefore been adopted in guiding the study towards the proposed focus.

The NCC ACC meeting also identified other themes:

- Analysis of climate change trends on the various sectors and socio-economic impacts of climate change on various livelihood groups (as planned).
- To collect data back to earlier severe extreme events (e.g. the 1984 severe drought in Eastern Africa).
- To orientate the study to provide policy makers (including in Finance and National Planning Ministries) with concrete monetary figures on costs of climate change and benefits of climate change adaptation and mitigation.

[11] Examples include the analysis of various economic costs from current extreme climate events and economic analysis in some specific sectors (e.g. agriculture).

- For economic scenarios, to look at changing climatic conditions (under business as usual and with integration of adaptation & mitigation) to provide a basis for increased budgetary allocation to the environment in general, and climate change adaptation and mitigation in particular.

- A request to include an action plan for policy makers to respond to the findings of the study. This should go beyond recommendations and would provide direction for the next steps (implementation of desired actions that promote adaptation and mitigation of climate change by policy makers). It was noted that donors are well placed to push for the implementation of the action plan that the project will provide.

Again, these priorities have been included in outlining the proposed work plan for the study.

The one additional area that has been raised in relation to impacts, including by the project sponsors, is the need to consider the potential impact of extreme events (particularly floods, but also drought). This is particularly important in relation to infrastructure, noting that infrastructure development will be essential to achieving the socio-economic development pathway for Kenya as set out in the Vision 2030 document. This area is also important in relation to investment flows and funding. Similarly, there is also a priority to consider the potential for low carbon growth in Kenya, with a focus on growth policies (win-win), development co-benefits, and adaptation –mitigation linkages. A key focus of this part of the proposals are to highlight the risks of carbon lock-in and future energy challenges, but also identify opportunities in relation to carbon finance and adaptation funding flows.

3. Methodological Approach

Overall Study Approach

The official study aims were set out in the earlier introduction section. It is clear from the in-country discussion during the inception meeting that this study has a number of specific (different) aims and objectives, prioritised towards various stakeholders. Addressing all of these aims is extremely challenging. These competing aims are made even more challenging given the extremely tight time-scale of the project (a detailed analysis in 6 months).

To try and address these different aims, the team are proposing an approach that works with different aggregation levels, and builds on different lines of evidence in relation to impacts and adaptation. We believe that it is useful to use a variety of approaches to work up plausible estimates to progress the different stakeholder aims above. Importantly, this involves an approach that adopts different top-down and bottom-up approaches. For example:

- Aggregated economic analysis (top-down), by country and for the region, at a sectoral level. This information will provide relevant material on the overall risks, and likely costs of climate change, the costs and benefits of adaptation, and the costs and benefits of low carbon growth. This will be accompanied by an integrated assessment model (overall economy wide).
- Case studies on impacts and adaptation (bottom-up), along with local in-country studies that build the evidence base. These provide information- rich local narratives. These could focus on providing information in relation to vulnerability, livelihoods and the economy, investigating the ability to meet strategic objectives, local adaptation options, and the implications for poverty alleviation and pro-poor growth.

The advantage of this approach is that it will combine local narratives with more aggregated estimates to build up a clear message for policy makers (i.e. to ground-truth economic studies within the local context).

Study Methodology – Climate Change Risks

The section above outlines the generic approach for the study. However there is still a need to identify the specific methodological approach that should be used. In theory, there are a number of alternative approaches that could be used. The main methods have been based on the classification in the IPCC AR4 (WGII, Chapter 2, Carter et al, 2007[12]), and from this we have identified six broad methodological approaches as options:

- Synthesis.
- Impact assessment.
- Integrated Assessment.
- Risk assessment.
- Vulnerability assessment.
- Stakeholder and participatory.

These are outlined below.

[12] Carter, T.R., R.N. Jones, X. Lu, S. Bhadwal, C. Conde, L.O. Mearns, B.C. O'Neill, M.D.A. Rounsevell and M.B. Zurek, 2007: New Assessment Methods and the Characterisation of Future Conditions. Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson, Eds., Cambridge University Press, Cambridge, UK, 133-171.

Synthesis

The first option is a review process (synthesis), consistent with the IPCC review process itself. This involves an expert team of reviewers drawing together existing studies in a cohesive and consistent way, but not carrying out any additional (new) modelling (though they may use expert interpretation to come to new information). The quantification of impacts and costs is largely dependent on the literature available at the time. These types of assessments provide a qualitative assessment of likelihood based on the reviewers' expert judgment and the consensus views emerging from peer-reviewed literature.

Such approaches have the advantage that by reflecting outputs from a range of studies, possibly using a range of methods, they capture a greater range of uncertainty than would be possible by relying on a single method. The disadvantage is that there may be gaps in the evidence base (though these can be filled by contracting additional pieces of targeted work), and more generally, that there is no guarantee that results across sectors or impact groups will be consistent with each other. This makes subsequent prioritisation of resources for adaptation more difficult.

Impact assessment (scenario based)

This approach aims to assess the likely impacts of climate change under a given scenario and to assess the need for adaptation to reduce any resulting vulnerability to climate risks (Carter et. al. 2007). This approach generally involves starting from climate change and socio-economic scenario data for a number of time-slices and running physical impact models, then assigning economic values to the physical impacts quantified. To date, this approach has not included quantification of probabilities, but can include qualitative judgment of likelihoods. Traditionally, this approach has had a strong sectoral focus. Traditionally, this approach has had a strong sectoral focus. Within this broad approach, a number of variations can be explored, outlined below.

- **The degree to which quantification of impacts is required**. Qualitative analysis has been used effectively in many studies to raise awareness among potentially impacted groups. It also avoids the problems of parameterisation of uncertainties. However, it limits the extent of knowledge on the magnitude of the impact and the appropriate scale of response. Quantitative studies, on the other hand, are able to convey both an order of the uncertainty, and an order of the magnitude of possible impacts under a defined range of climate scenarios. The outputs of quantitative studies may be expressed in a variety of physical metrics – as in the Defra global fast-track studies – or using monetary metrics.
- **The number and type of climate variables considered**. Earlier studies have focused on mean annual temperature and associated sea-level rise, though later studies consider wider climatic variables and additional risks (though this may involve greater uncertainty). Clearly, the more climatic variables that are adopted in an impact assessment, the greater the opportunity to capture a more complete range of possible impacts.
- **The number of climate scenarios and the degree to which they are temporally disaggregated, including treatment of abrupt climate change.** The number of climate scenarios and the degree to which they are temporally disaggregated, including treatment of abrupt climate change. Climate scenarios are used in impact analyses to differentiate between the range of possible climate futures, dependent on potential GHG emission scenarios and climate sensitivity to these scenarios, and uncertainties in the impact analysis. There is a trade-off between the number of scenarios that are used and the resources needed to model the impacts under the range of scenarios. There is also a trade-off between the number of scenarios used and the effectiveness with which the study results can be communicated to potential users. A further trade-off needs to be made between inclusion of low-probability scenarios, such as abrupt climate change, and greater completeness.

- **The treatment of socio-economic scenarios.** Socio-economic scenarios that parallel the climate scenarios can be used to emphasise that possible climate futures will be imposed upon evolving socio-economic conditions. Socio-economic scenarios may be crude, based simply on the population and GDP growth drivers incorporated in the global SRES emission scenarios or more sophisticated, based on wide stakeholder consultation. Whilst they introduce a greater degree of realism to the impact analysis, they also risk complicating the interpretation of the results if the climate and socio-economic change components are not clearly distinguished from each other. Use of socio-economic scenarios is also likely to increase the complexity of the impact analysis.
- **The number, and nature, of sectors and impacts considered.** The impacts to be covered will be, in part, determined by the climatic variables considered, the availability of data to model the climate-impact linkage, and the degree to which stakeholders wish, or are able to, prioritise impacts against each other. Previous national impact assessment studies tend to focus on what are understood to be the most directly climate sensitive sectors. For example, typically water, agriculture, human health, coasts and forests; a small number of impacts judged to be the most important are analysed.
- **The level of geographical dis-aggregation**. Geographical dis-aggregation to the sub-national scale can be undertaken in both qualitative and quantitative studies. Sub-national dis-aggregation is likely to be advantageous in securing greater stakeholder engagement with the study process and outcomes, and is therefore likely to be particularly important in stimulating adaptation action. However, limits to data availability, resource implications, and the particular need to help government prioritise adaptation action, suggests that trade-offs may need to be made – possibly on a sectoral basis.
- **The degree of integration**. The effects of a direct climate change impact (e.g. a reduction in water availability to industrial production from lower summer rainfall) may have indirect effects (e.g. higher industrial product prices in water intensive industry may lead to changes in consumption patterns in other product areas). These may, or may not, be important. However, failure to account for such potential effects may reduce the value of the assessment. Economic linkages, as in the example given may be traced through by use of economic models (input-output models or general equilibrium models). More formalised models require greater analytical complexity.
- **Metrics**. Quantitative assessment may use a variety of physical and/or monetary metrics to communicate the study results. Physical metrics, such as the number of people affected, are extremely useful, though the advantage monetary metric is the direct comparison across impact categories (and related used in certain decision-support tools such as cost-benefit analysis for prioritisation).
- **The nature of stakeholder engagement - which, and for what purpose?** Any assessment can be stakeholder-driven. However, there could be a risk that this limits a study with an overarching steer towards an end policy goal, unless stakeholders are aware of the needs of national policy makers.
- **Presentation/dissemination of results.** This is an important and often overlooked issue. A key finding of the review of the US National Assessment[13] was that more attention should have been given to the integration of the communication strategy in the overall assessment design.

Note many of these above issues also apply to the methods below (though are not repeated).

[13] Morgan, et al (2005). Learning from the U.S. National Assessment of Climate Change Impacts. Environ. Sci. Technol. 2005. 39, 9023-9032.

Integrated Assessment

Integrated assessment is a generic term used to describe the integration of different models or methods within a single analysis. The term is often used in a more specific sense for the integration of a number of climate change impact sectors within a single analytical model. It is different to the more traditional impact assessment approach, as it tends to focus on policy decision making, build in cross-sectoral linkages (though often in a limited way), include adaptation feedbacks (also in a limited way), and provide consistency between sectors.

These integrated approaches include global integrated economic assessment models such as the PAGE and FUND Models. These combine the scientific and economic aspects of climate change within a single, iterative analytical framework. The advantage of these models is that they have an additional element where climate impacts feed back to the socio-economic module thereby linking emissions, climate modeling, climate change impacts and the economy. However, to make analysis manageable, they often use simplified analysis of climate projections (e.g. rather than full-scale climate models) and simplified impact relationships (e.g. rather than sector based models. Such models can also include a more explicit link with impacts, a global scale example of this is the Tyndall Community Integrated Assessment System (CIAS), which incorporates modules representing global-scale and distributed impacts of climate change on natural and social systems so as to ensure feedbacks. There are limited applications of such approaches to dis-aggregated spatial scales, though some are emerging (e.g. the RegIS projects in the UK, Holman et al, 2007[14]).

Integrated assessment can include the use of Computable General Equilibrium Models (CGEMs) (e.g. Bosello, 2008[15]), which look at the market effects of one or more impacts through to other economic sectors via price mechanisms (e.g. higher food prices resulting in lower disposable income and so lower demand for other sectors' outputs). Alternatively, input-output economic models can be used (e.g. Aaheim & Schjolden (2004[16]), to provide inter-sectoral economic linkages via climate change-induced changes in supply or demand.

The principal advantage of these types of integrated assessment is that they represent multi-sectoral and/or multi-impact inter-linkages in a quantitative manner. In addition, the CGE economic models are now moving to automatically include autonomous adaptation through adjustments in market prices. The main disadvantages of integrated assessment models are that they are technically complex to construct, that they often cover a limited number of impacts and linkages, and that they are often considered "black boxes".

Risk assessment

A wide range of studies can be described as risk assessments. These may include qualitative studies which map the magnitude of a particular event against its probability, but also quantified risk assessments.

As with impact assessment (above), quantified risk assessments are based on climate change and socio-economic scenario data and imply some form of physical impact modelling (or at least conceptual

[14] Holman IP, Berry PM, Mokrech M, Richards JA, Audsley E, Harrison PA, Rounsevell MDA, Nicholls RJ, Shackley S, Henriques C (2007). Simulating the effects of future climate and socio-economic change in East Anglia and North West England: the RegIS2 project. Summary Report. UKCIP, Oxford 2007.

[15] Bosello, F. (2008), "Country and sectoral economic implications of climate change impacts: a general equilibrium approach", paper presented at the "University of Venice - European Investment Bank International workshop on impacts of climate change and biodiversity effect", preliminary results of the CLIBIO research project of the Department of Economics, Ca' Foscari University of Venice, funded by the European Investment Bank University Research Sponsorship (EIBURS) Programme 2006, 14 April 2008, Venice, Italy.

[16] Aaheim & Schjolden (2004) An approach to utilise climate change impact studies in national assessments. Global Environmental Change 14 147-160.

understanding of the causal link between climate change and potential impacts). However, they do differ from the impact assessment approach in two main ways. First, risk assessment tends use probabilities related to the occurrence and magnitude of identified impacts. Second, they tend to work with alternative metrics for assessment, in which estimated risks are compared with a pre-defined limit of tolerable or acceptable risk (i.e. probability-magnitude combinations), for example, consistent with a breach of physical thresholds or socio-economic coping ranges.

Risk based methods have the advantage that as probabilistic-based approaches they introduce more representation of the likelihood of impacts. The exceedence of tolerable risks also gives a strong priority for action. However, the definition of what are and what are not tolerable risks, is in itself challenging – not least because these are often based on social values and are subject to previous experience, perception, etc. They therefore vary between communities, societies, or countries. One of the key downsides of such an approach is the significant data and resource requirements.

A number of climate risk assessments have been carried out at an organisational level, though there are also national level studies e.g. for Australia (Howden & Jones, 2004[17], for a risk assessment of impacts on Australia's wheat industry). Risk based approaches can be used with valuation, when a monetary value is adjusted to give expected values i.e. the monetary value of impacts multiplied by probability weights (e.g. see HMT green book, 2007[18]). This can also be tied into the definition of impact magnitude, and into the criteria used to define acceptable risks.

Vulnerability assessment

Perhaps more than any other area, definitions of what constitutes a vulnerability assessment vary widely (e.g. see Levine and Tirpak, 2006, who found very different interpretations, both of vulnerability and vulnerability assessment[19]). Perhaps most usefully (in the context here), vulnerability assessment can be seen as the inverse of the impact assessment approach (above). Instead of the starting point of the assessment being the climatic stimulus – as with impact assessment – for vulnerability assessment it is the system itself. Thus, the approach first assesses a number of indicators of vulnerability (both non-climate and climate-related vulnerability), starting at the present day, and then adds in climate and socio-economic trend data/scenarios to determine how these indicators could change in the future, on their own and relative to other (non-climatic) risk factors.

Traditionally this approach has been strongly linked with mapped outputs, and there is current interest in developing combined indicators of vulnerability. A large number applications of the method have been in the Least Developed Countries assessments (e.g. with the NAPAs), though some OECD national assessments (e.g. Sweden, US NAS) often use a terminology to describe their national assessments as vulnerability assessments.

An important distinction of the impact assessment approach described above is that vulnerability assessments asses the system's ability to respond (to reduce vulnerability), by describing its adaptive capacity. At a national level, this description has – to date - focused on generic indicators such as income, education and health and sector-specific indicators relating to institutions, knowledge and technology

[17] Howden M. and RN Jones (2004) Risk assessment of climate change impacts on Australia's wheat industry. Proceedings for the 4th International Crop Science Congress, 2004

[18] HMT (2007). The Green Book. Appraisal and Evaluation in Central Government Treasury Guidance. Her Majesty's Treasury. London:TSO.

[19] Vulnerability is defined by IPCC AR4 as: Vulnerability is the degree to which a system is susceptible to, and unable to cope with, adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of the character, magnitude, and rate of climate change and variation to which a system is exposed, its sensitivity, and its adaptive capacity.

(Adger et. al. 2007[20]). The principal purpose of vulnerability assessment is therefore to inform wider development plans and strategies (regional, sectoral etc.) through ensuring that all risks – climatic or non-climatic – are considered and given appropriate weighting.

Vulnerability assessment has the advantage of identifying social groupings susceptible to climate change on a more disaggregated basis than impact assessment typically allows. This also usually brings a much greater focus on inequalities in the analysis, and distributive effects. In paying more attention to current socio-economic conditions and, in particular, capacity to adapt, vulnerability assessment is also more able to focus on the likely near-future adaptation needs of society, and potential limits. The principal disadvantage of the techniques is that formal methods are not yet standardised. Furthermore, there is no recognised procedure for quantifying many of the assessment outputs, and making them easily comparable. Finally, there are no obvious ways to link into economic valuation (although seen from an alternative perspective, monetary valuation serves as a single crude measure of what vulnerability analysis is able to describe.)

Stakeholder and participatory

Stakeholder consultation normally runs through all of the above approaches. However, it is possible to orientate a study so that a participatory effect more directly assesses the impacts or risks, rather than through the use of expert or modelling assessments as above. As an example, regional partnerships have progressed stakeholder-led regional impacts assessments and in some cases adaptation action plans. The approach has proved useful as a scoping study stage, building adaptive capacity and raising awareness of the issues. However in most cases the participatory approach does not produce a consistent and scientifically robust evidence base covering all impacts and sectors. The key problem with this type of approach is the difficulty in applying it to a national level assessment. This is because conflicting needs of different stakeholders, can lead to inconsistent approaches and gaps, and because of different stakeholders may not adequately focus on national level priorities.

Summary

The options are summarised in the table below. What is clear is that a focus on assessing the economic costs of climate change is likely to require an impact assessment based approach (though could also include integrated assessment). However, it is also highlighted that this focus generally conflicts with local country assessments, which have adopted vulnerability assessment as the primary approach, and is the form of much of the existing information base.

[20] Adger W. N., Agrawala, S., Mirza, M. N. Q., Conde, C., O'Brien, K., Pulhin, J., Pulwarty, R., Smit, B. and K. Takahashi, (2007) Assessment of adaptation practices, options, constraints and capacity. Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson, Eds., Cambridge University Press, Cambridge, UK, 133-171.

Summary of Approaches

	Strengths	Weaknesses
Synthesis	Reflect outputs from a range of studies, possibly capture a greater range of uncertainty	Limited by availability of the current information and gaps in evidence, lack of consistency between studies.
Impact Assessment	Builds on relatively high degree of sophistication in existing studies over an increasingly wide range of impacts. Potential for use of common money) metric.	Little attention given to current impacts and adaptation in existing studies
Vulnerability Assessment	Centres analysis strongly within existing socio-economic conditions and decision-making structures	Lack of common metrics mitigates against cross-sectoral/regional prioritization. Valuation extremely difficult.
Risk Assessment	Probabilistic approach allows weighting to be given to likelihoods of impacts occurrence.	Extra dimension of complexity may significantly increase resources required for analysis.
Integrated Assessment	Realism significantly increased by recognition of cross-impact and cross-sectoral linkages.	Extra dimension of complexity may significantly increase resources required for analysis.
Stakeholder / direct participatory	Stronger elements of building adaptive capacity and raising awareness	Does not produce a consistent and scientifically robust evidence base covering all impacts and sectors

Adaptation

From Impacts to Adaptation

An important aspect of any study is to feed into adaptation needs over a range of policy and planning horizons for specific activities and regions. This requires a focus on adaptive capacity and the adaptation measures required to improve the resilience or robustness of a system exposed to climate change, rather than treating adaptation as an output whereby the evaluated risks prompt the identification of possible adaptation options that currently exist to mitigate specific risks or vulnerabilities.

This is an important issue, particularly as several studies in the literature identify why impact driven assessment may have been of limited use in informing adaptation policy. These reasons include (Füssel and Klein, 2006; Burton et. al. 2002[21]):

- Insufficient consideration of more pressing immediate and short term policy issues;
- Insufficient knowledge of future climate conditions on the scale relevant for adaptation decisions
- Insufficient consideration of the full diversity of adaptation options in most climate impact models;

[21] Burton I., Huq, S., Lim, B., Pilifisova O. and E. L. Schipper (2002) From Climate Assessment to Adaptation Priorities: The Shaping of Adaptation Policy. Climate Policy, 2, 145-149
Füssel H. M. and R. J. T. Klein (2006) Climate Change Vulnerability Assessments: An Evolution of Conceptual Thinking. Climatic Change 75: 301-329

- Insufficient consideration of the factors determining the adaptation process itself, including adaptive capacity;
- Insufficient consideration of the key actors and of the policy context for adaptation.

As identified in Nkomo et al, 2006, the need for a vulnerability approach to assessing the implications of climate change in Africa, as opposed to adopting the bio-physical impacts approach, is needed because the vulnerability to climate variability and change is stacked upon existing vulnerability, such that the impacts of climate variability and change are greatly exacerbated. Nkomo also reports that most studies that have assessed the impacts of climate change in Africa have used large-scale GCMs which provide very little information that is of practical use to decision makers on the precise extent and impacts of climate change, especially for any specific location within a country in Africa. The few regional impacts are largely on Southern Africa where considerable capacity exists for regional climate modeling. It is acknowledged that making predictions of future climate change in Africa is problematic due to Africa's complex climate and the lack of data on the current climate to feed into models.

An important priority in choosing the methodological option is therefore to ensure that the choice facilitates the most effective adaptation decision-making. Some interim conclusions are:

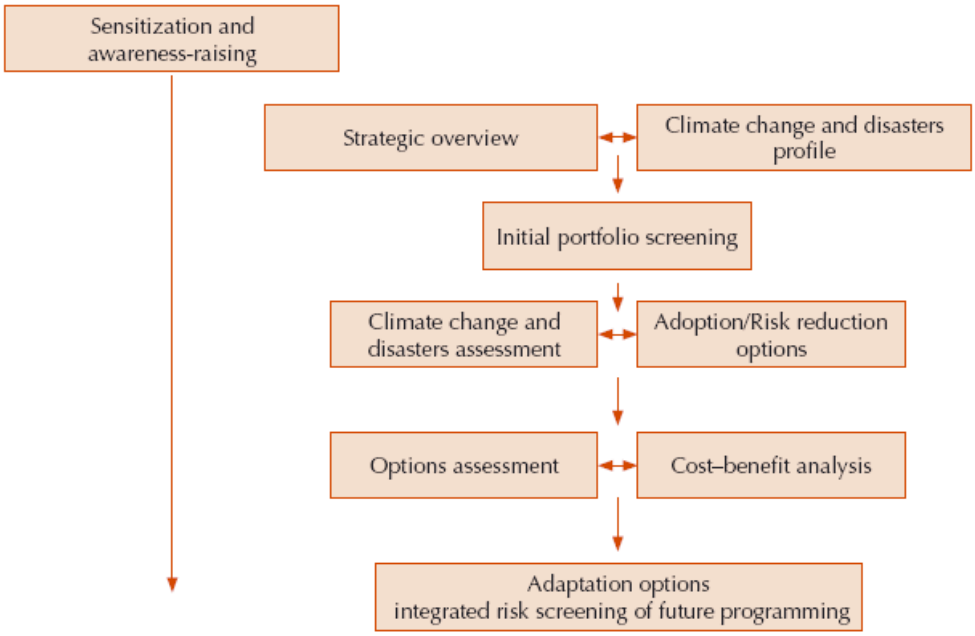
- The greater attention that vulnerability assessment gives to current variability and adaptation and its anchoring within local scale decision making processes suggests that this aspect should be given some consideration. Stakeholder participation, which is well-developed in such assessment, is integral.
- For national-level decision making, the extent to which lower disaggregated scale analysis can easily be scaled-up or aggregated will be an important consideration.

The primary purpose of climate change adaptation assessment is to assess the adaptation needs in relation to climate change impact risks over a range of policy and planning horizons for specific activities and regions. Specific risk management processes that have been developed within generic frameworks may be relevant, see e.g. UNDP (2005)[22]. These risk management processes have been designed with the assessment of adaptation options principally in mind. It is well-known, however, that the availability and feasibility of current and future adaptation options is contingent on the social and ecological capacity to adapt. Furthermore, future adaptation options – particularly in the medium to long term – are likely to differ from those currently known or available, thus rendering assessment of current options rather limited. As a consequence, alternative assessment approaches may be considered.. Technical Paper 7 in UNDP (2005) shows that investment in adaptive capacity can be assessed in a similar way to adaptation options. Key components include:

- Scoping and designing an adaptation project, i.e. what is the adaptive capacity priority of the project and what is the specific capacity enhancement goal?
- Assessing current vulnerability, i.e. what adaptive capacity already exists to reduce current vulnerability to recurrent climate risks?
- Assessing future risks. What capacity will societies have to adapt to future hazards?
- Formulating an adaptation strategy. What measures, policies and strategies enhance adaptive capacity and encourage autonomous adaptation?
- Continuing the adaptation process. How can efforts to enhance adaptive capacity be sustained and improved over time?

[22] UNDP (2005) Adaptation Policy Frameworks for Climate Change: Developing Strategies, Policies and Measures. Cambridge University Press. Cambridge

This has been considered in formulating the proposals here. Finally, i is also worth reporting that the specific approach taken by DFID's ORCHID process, currently applied in Bangladesh, has straightforward portfolio screening as an initial step, but then continues to assess changing risks and adaptation options through a systematic process, including economic analysis.



The Economics of Adaptation

The focus of the current study is on valuation, i.e. on economic costs and benefits. Adaptation has a cost, e.g. as defined in the TAR as the "*cost of planning, preparing for, facilitating and implementing adaptation measures, including transition costs*", but also a benefit, expressed as "*the avoided damage cost or the accrued benefits following the adoption and the implementation of adaptation measures*".

In simple terms, if the economic benefits of adaptation such as the reduction in climate change impacts (or the potential positive consequences) outweigh the costs, then there are net benefits. If not, then this potentially leads to mal-adaptation. This can be expressed in the stylised framework in the figure below. Note that while adaptation reduces impacts, it does not generally reduce them entirely.

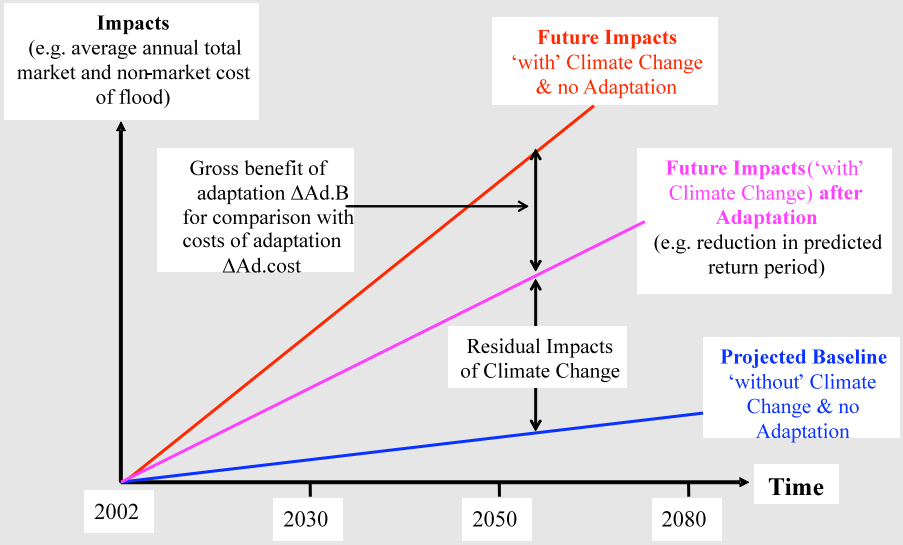
This overarching principle is important because resources need to be allocated efficiently between different adaptation strategies and between adaptation and mitigation strategies. This can be done only if costs and benefits of the different options are clearly determined. However, there is a need to balance this simplistic approach with the other aims of adaptation policy (and some potential short-comings in narrow short-term cost-benefit analysis).

Several studies have shown that there is a low evidence base for the economics of adaptation. The IPCC AR4 reported the literature on adaptation costs and benefits as '*quite limited and fragmented'* (Adger et al, 2007in IPCC WGII[23]), and the OECD study on the 'Empirical estimates of adaptation costs and benefits'

[23] Adger, W.N., S. Agrawala, M.M.Q. Mirza, C. Conde, K. O'Brien, J. Pulhin, R. Pulwarty, B. Smit and K. Takahashi, 2007: Assessment of adaptation practices, options, constraints and capacity. Climate Change 2007: Impacts, Adaptation and Vulnerability.

(Agrawala and Fankhauser, 2008[24]) found little quantified information on the costs of adaptation, except in a few sectors (e.g. coasts). Moreover, the studies that do exist were found to be mostly in OECD regions, with the evidence base for Africa particularly low. There are some economic studies which consider current climate variability (e.g. flood or drought responses), but these do not include future climate change – where there are much fewer studies and those which exist are mostly scoping in nature (one exception being the more comprehensive work of Callaway et al (2006[25]) on the Berg river).

The Economics of Adaptation



Stylized analytical framework for costing climate adaptation

Adapted from Boyd R. and A. Hunt (2006[26]) Climate Change Cost Assessments Using the UKCIP Costing Methodology. Report for Stern Review.

The approach first identifies the impact of the socio-economic signal (in blue), and then combines this with the additional impact of climate change to give overall future impacts (in red), illustrated in relation to a change in return period and the impacts of flood. It then assesses the net reduction that adaptation can achieve. Adaptation reduces the total impacts to the pink line below, but it does not completely removal all impacts. The gross benefits of adaptation are the impacts avoided, but there will still be residual impacts of climate change (the cost of climate change impacts, after adaptation). These gross economic benefits of adaptation (ΔAd. Benefits in the figure above) are compared against the economic costs of adaptation (ΔAd.costs).

The previous DFID Kenya assessment[27] also considered the role of economics in adaptation. It reported that given the uncertainty of the future climate in any one location, lower cost options, particularly 'no

Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson, Eds., Cambridge University Press, Cambridge, UK, 717-743.

[24] Agrawala, S. and Fankhauser, S. (Eds.) (2008) Economic Aspects of Adaptation to Climate Change: Costs, Benefits and Policy Instruments. OECD

[25] Callaway, J.M., D.B. Louw, J.C. Nkomo,M.E. Hellmuth and D.A. Sparks, 2006: The Berg River Dynamic Spatial Equilibrium Model: A New Tool for Assessing the Benefits and Costs of Alternatives for Coping With Water Demand Growth, Climate Variability, and Climate Change in theWestern Cape.AIACC Working Paper 31, The AIACC Project Office, International START Secretariat, Washington, District of Columbia, 41 pp. [Available online at http://www.aiaccproject.org/]
Mac Callaway, Molly Hellmuth (2006). Climate Risk Management for Development: Economic Considerations. A Concept Paper for the Stern Review. http://www.hm-treasury.gov.uk/media/6/7/stern_review_supporting_technical_material_molly_hellmuth_231006.pdf

[26] Boyd, R and Hunt, A (2004). Costing the impacts of climate change in the UK: overview of guidelines, UKCIP Technical Report. UKCIP, Oxford, July 2004

regret' options that improve current climate resilience and have wider ancillary benefits, will be more economically attractive than adaptation options that involve large sunk costs (infrastructure) whose levels of future benefit are difficult to ascertain. Activities that build capacity are especially attractive, as, in addition to being less costly than infrastructure solutions, they are a necessary precursor to improving current climate resilience (address the 'adaptation deficit'). Adaptation programmes and policies that are effective at addressing climate change impacts where the type and degree of magnitude is as yet imperfectly understood will require a sequential approach informed by a gradually improving evidence base. The following stepwise approach to programmatic adaptation will optimise economic effectiveness:

- Start by building capacity and awareness of climate change. Plans should initially focus on identifying and testing a range of adaptation actions based on current levels of knowledge, and on building capacity to analyse climate and climate impact trends and projections;
- Identify and start implementing early adaptation activities, concentrating on *win-win*, *no regrets* or *low cost* options, justified by current climate conditions (i.e. improving current climate resilience), or based on projected climate change, but involving minimal cost;
- As and when the evidence of climate change and climate change impacts unfolds, other possible adaptation options, which involve higher costs, can be considered. These may include technical options (e.g. hard adaptation). This kind of adaptation action will require a more detailed analysis and appraisal, which will consider the costs and benefits of adaptation, and carry out a sensitivity analysis against levels of climate change uncertainty, so as to prevent mal-adaptation.

It is highlighted that not all decisions need take on board climate change. An initial screening process should be part of programme planning, which considers the potential risks of climate change, including the economic consequences (where this includes the wider social effects). For some decisions, more formal risk assessment procedures are needed, e.g. where there is a high sensitivity to future climate change, which could aim to qualitatively balance potential costs and economic benefits. However, even then the outcome of decisions may be an acceptance of the potential risks weighed against other social and economic objectives, rather than necessarily a reduction in expected damages through adaptation. This may mean that responses to illustrative climate change risks might be to do nothing (now), or more likely adopt a minimum level of risk management (as in the staged approach above), which is likely to be a more economic rational approach, rather than adopting an extreme, and high cost, adaptation response.

As highlighted by van Aalst et al, 2007[28], many of the most effective measures to adapt to future climate change coincide with those that can reduce vulnerability to current climate risks. Therefore there is a focus on the integrated management of current climate variability and extremes with adaptation to climate and this climate risk management approach offers immediate benefits to economic development in Africa, as well as longer term security in the face of changing climate.

Finally, a number of issues are highlighted in the economic assessment of adaptation, and in relation to the proposals for the current study:

- Outcomes of economic analyses are highly sensitive to the assumptions and uncertainties. This is particularly true for projected combinations of socio-economic and environmental scenario futures. Since probabilistic information for the futures of natural and human systems are unavailable, model outputs are the subject of deep uncertainty and need to be grounded in and complimented by local experiences. For these reasons, the overall costing analyses of climate change can be based on the outputs of a suite of economic tools and methodologies. This approach features a robust combination

[27] DFID Kenya Climate Screening and Information Exchange, see http://www.dewpoint.org.uk/Article.Aspx?ArticleID=901
[28] 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.

of micro-level case study analyses exploring communities' climate exposure and resiliency capacity, seated within sectoral integrated impact assessment, and complemented at a macro-scale with information from macro-level computable general equilibrium (CGM) models.

- *Analysis must consider both market and non-market costs, in physical impacts as well as economic metrics*, i.e. recognising that sectors such as health or ecosystem services may be poorly captured in existing studies, and particularly in economic valuation. Moreover, it is important that studies do not focus only on economic outputs, but also consider physical impacts and distributional (inequality) aspects, otherwise there is a danger of missing important effects on vulnerable groups, e.g. the economic contribution from rural livelihoods maybe low, but they may be dis-proportionately affected by climate change.
- *The value of information is in making a decision*, rather than employing other approaches such as cost benefit analysis, risk assessment, scenario development and decision evaluation as endpoints in their own right. Analysis of relevant impacts information, and economics of adaptation, is a necessary starting point for stakeholder engagement for costing climate adaptation options.
- The development of *appropriate communication tools* to encourage consensus among stakeholders on adaptation options requires shared information and participatory techniques focused on exploring synergies, conflicts and raising awareness around potential adaptation pathways.
- *Adaptation is a process of social and institutional learning* that is relevant for specific contexts, and producing adaptation outcomes and processes that are robust against a wide range of future situations. This applies as much in economic terms. It recognizes the need for on the ground adaptive capacity and often competing stakeholder goals. Effective adaptation equips people and institutions alike to cope with a wide range of contingencies. Learning is achieved through rolling re-assessments that account for changing conditions. The aim is to integrate climate change and climate change adaptation in 'good enough' practice in risk management that promote resiliency over high risks, high rewards strategies.

These concepts are included in the potential use of 'adaptation signatures', outlined below.

Adaptation Signatures

Exploring economic valuation of climate change

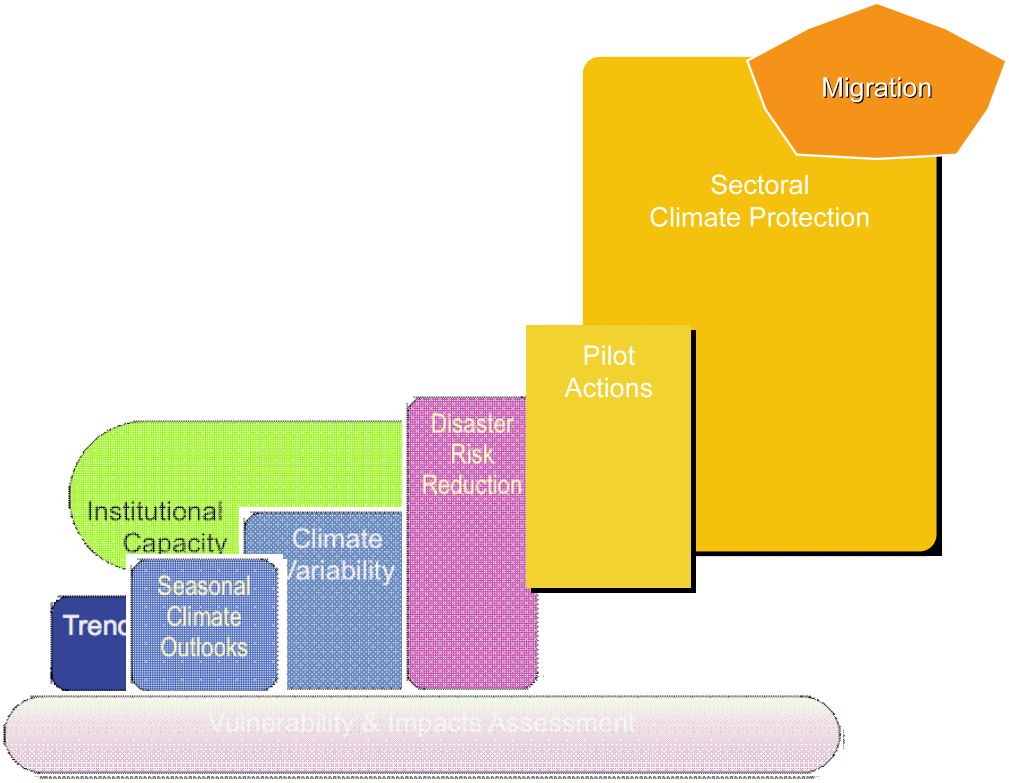
One approach to understanding climate change adaptation is to focus on a typology of adaptation responses. For instance, many of the NAPA projects are direct investments to improve livelihood security, through income diversification, education and social mobilisation. Other NAPA projects fall into a general category of increasing institutional competence to assess vulnerability, monitor climate changes and support adaptation decision making.

While overlapping in practice, these are distinct approaches to adaptation: each involves with different stakeholders and decision frameworks, responds to climate change in somewhat different ways, from reducing current vulnerability to increasing risk-resilience in the future, and entails different costs and finance, as well as benefits and outcomes. This collection of attributes is termed a signature--recalling the use of the term in multi-variate statistics as revealing a characteristic profile in complex data sets as well as the unique signature that would be employed in specific situations.

We propose to develop a typology of such adaptation responses, or signatures, to explore the different costs of climate adaptation. The signatures will be developed at a conceptual level based on secondary sources, such as the NAPA profiles and international adaptation data bases (including the Adaptation

Layer in Google Earth that the weADAPT group released in Poznan). Importantly, the unique signatures of local communities and national action plans will be documented through participatory exercises and engagement with key stakeholders.

The baseline is formed by an understanding of current vulnerability and prospective impacts. This is reasonably widespread at least for initial screening, but probably not all that expensive. Using climate information (especially but not only seasonal climate outlooks) and expanding the capacity to cope with current climate variability is worth-while in itself, but also provides additional benefits through the anticipation of climate change. Disaster risk reduction bridges between coping with current conditions and the potential (and increasingly expected) increase in future hazards. A simple adjustment to trends in climate resources should be ongoing at the margins of climate (e.g., growing crops at higher elevations). Full sectoral protection is expensive, even if carefully targeted at the highest at-risk infrastructure and economic activities. Finally, migration is a planned strategy already being utilised, that may be increasingly essential.



Copyright: weADAPT group

Toward adaptation signatures

Key: The width of each type corresponds to the coverage within a country and economy. The height is the relative cost of each type of project. Of course, these are only illustrative, guiding informally by early work in East Africa. The 'flow' from left to right partly reflects timing, but should not be taken as prescriptive. The 'baseline' of current vulnerability is connected to the first set of projects that are ongoing now related to current climate conditions and trends. Projects 'above the baseline' are those that principally have benefits only if climate changes (and in the expected directions). For such projects, 'additionality' is more clear than for the projects that are already in demand in current conditions.

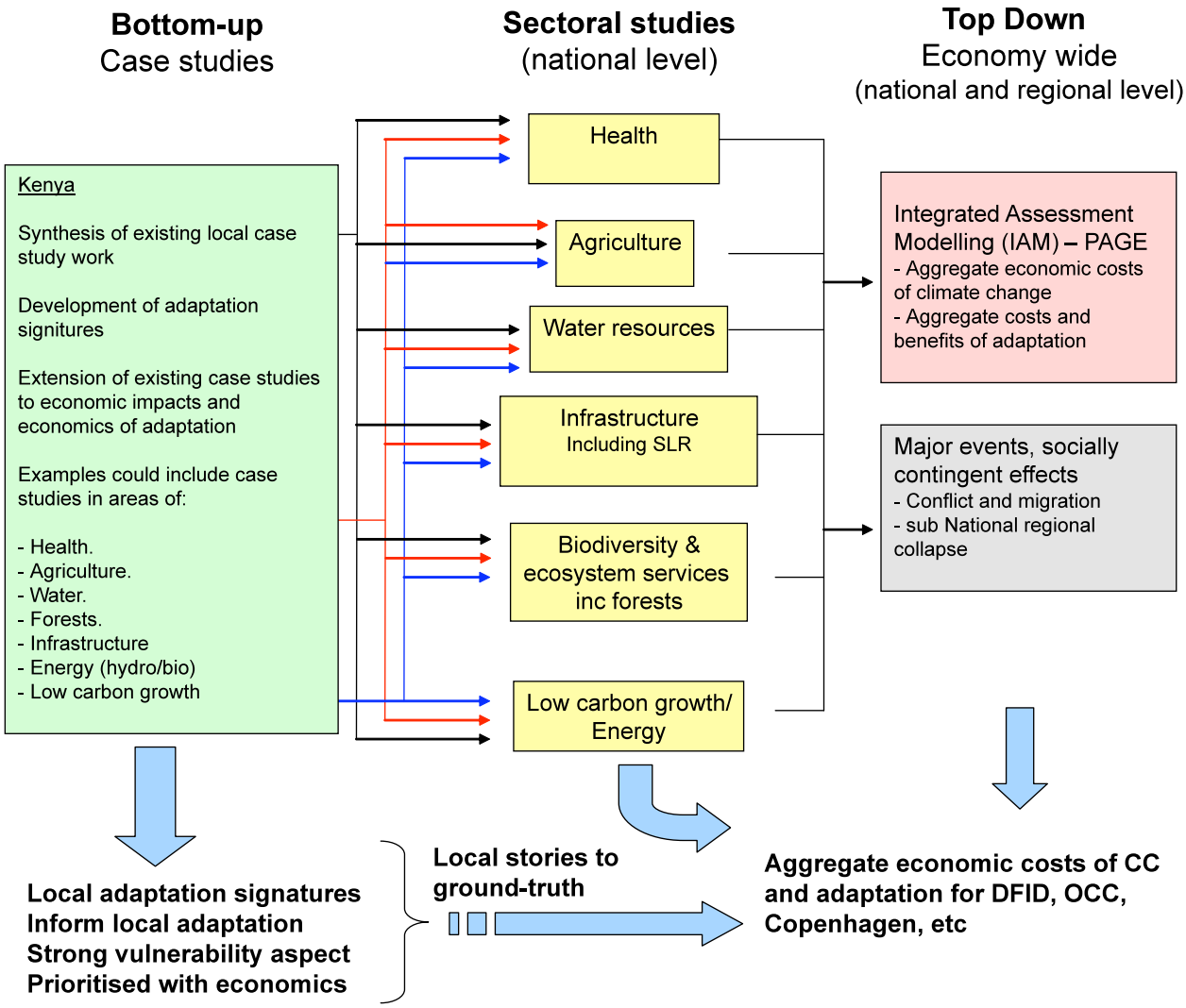
Further documentation of the approach is being developed:

- Elaborated definitions of adaptation signatures and illustrative case examples.

- Specific examples of adaptation signatures in East Africa, drawing upon the adaptation layer in Google Earth that is in development in 2008. The typology of signatures is one axis for icons in Google Earth--the other is the sector concerned.
- Outline of costing methodology for each signature: this will be explored further in projects underway.

Overarching framework

The overall framework proposed is outlined below, showing how the linkages will provide the necessary information to meet the study aims.



4. Implementation Phase Proposals

The implementation phase is comprised of a number of key tasks. Related to the overall project framework in the previous chapter, these are:

A) Aggregate top down analysis (including regional estimates).

B) National sectoral economic studies.

C) Bottom-up case studies.

There is also an additional major task undertaking a synthesis of the study findings:

D) Policy recommendations

The inception work plan is set out below.

A) Top Down Aggregate Assessment

The part of the study will develop aggregate regional and country estimates of the economic costs of climate change, and the costs and benefits of adaptation. It will primarily use the information from the national studies to feed into an aggregate integrated assessment tool (the PAGE model). However, it will also undertake some scoping analysis to investigate potential large-scale tipping events, including at sub-national level, for the region.

Integrated Assessment (aggregate)

This task will assess the aggregated economic costs of climate change and costs and benefits of adaptation. It is proposed to use the PAGE model, run by Chris Hope, as this was the model used in the Stern review. The model can be configured to provide estimates of the total cost of climate change in future periods (with or without global mitigation), and the costs and benefits of adaptation, at different aggregation levels. At present, the model has Africa as one region, but it is proposed to work up an East Africa region in the model, and if time, specific country dis-aggregation.

The current model would be run initially with the current default parameters for the Africa region. This would provide initial results to provide broad headline values for March (e.g. for the Finance Ministerial Meeting in Rwanda). The study would then update and re-run the PAGE model with the results from the national sectoral studies, as these are finalised at the end of the study. These aggregate values would be used for headline estimates for the preparation of material for the African Environment Ministerial Meeting (July) and to provide briefing material for the Copenhagen (December) COP meeting. The task will also compare to other integrated assessment models (FUND, CIAS).

It was agreed at the London meeting that there was not time to extend the study to consider wider economic modelling, i.e. using either input-output analysis or computerized general equilibrium modeling (CEGM). However, the team will investigate other possible relevant models (e.g. the World Bank input-output model for Kenya, the IIED assessment for the agricultural sector in Tanzania, other IIED models on the natural resources sector in Africa) to review if these could provide any indicative estimates of wider effects, particularly in key sectors such as agriculture.

Proposed team members: Chris Hope, Paul Watkiss, Alistair Hunt, IIED, local partners.

Adaptation limits, Tipping Points and Socially Contingent Effects

One of the key issues driving international concerns on climate change is the potential for large-scale irreversible events, so called tipping points (see Schellnhuber et al 2005[29]). These are associated with certain temperature threshold levels, though the exact levels which might trigger these events are not known. These events are largely missing from the global aggregated costs of climate change, or at least poorly covered, and were identified as important at the Stern team Hong Kong workshop. These events, and major uncertainties around significantly higher levels of climate change, are also increasingly important in the debate on the economics of climate change (see Wetizman, 2008[30]). A number of these large-scale effects are potentially relevant for East Africa (though this list is not exclusive), notably:

- Higher scenarios of sea level rise from the onset of rapid melting of the Greenland ice sheet, collapse of the West Antarctic ice sheet. The IPCC AR4 WGII states that there is medium confidence that at least partial deglaciation of the Greenland ice sheet, and possibly the West Antarctic ice sheet, would occur over a period of time ranging from centuries to millennia for a global average temperature increase of 1-4°C (relative to 1990-2000), causing a contribution to sea-level rise of 4-6 m or more[31].
- An increase in the El Nino Southern Oscillation, which would have a major impact on the East African climate.
- The risk of extreme climate sensitivity, i.e. beyond the upper central range[32] and the risk of sub-national or even national economic collapse for the region.

Most of these effects are longer term (post 2100). However, they are scenarios that go beyond the limits of adaptation, and are potentially very important in the context of the justification for international mitigation.

The study will first undertake a small review and scoping exercise to investigate these effects. It will review the potential major events in the literature and identify those relevant for East Africa, and comment on the potential timing. It will then undertake some sensitivity analysis to scope out the potential effects, including a focus on sensitive sub-national regions.

The task will also explore the potential for socially contingent effects, defined as large scale dynamics related to human values and equity that are very poorly represented in damage estimates based on marginal cost values, e.g. regional conflict, migration, famine and poverty. This will explore the potential for sub-national large-scale events (e.g. humanitarian crisis from climate), based on the information generated from the national sectoral studies and local case studies.

Proposed team members: Tom Downing, Jillian Dyszynski, in country partners.

[29] Schellnhuber et al (2005). Avoiding Dangerous Climate Change. Editor in Chief Hans Joachim Schellnhuber Co-editors Wolfgang Cramer, Nebojsa Nakicenovic, Tom Wigley, Gary Yohe. Cambridge University Press, 2005. ISBN: 13 978-0-521-86471-8

[30] Weitzman, Martin L. (2008). On Modeling and Interpreting the Economics of Catastrophic Climate Change Martin L. Weitzman January 14, 2008. http://www.economics.harvard.edu/faculty/weitzman/files/modeling.pdf

[31] The complete melting of the Greenland ice sheet and the West Antarctic ice sheet would lead to a contribution to sea-level rise of up to 7 m and about 5 m, respectively.

[32] Climate sensitivity is the equilibrium warming expected with a doubling of CO_2 concentrations. The Third Assessment Report of the IPCC concluded that the range was 1.5 to 4.5 °C with a best guess of 2.5°C – the Fourth Assessment Report (2007) concluded that the 'best guess' is 3°C, with a range from 2 to 4.5°C.

B) National sectoral analysis

The national sectoral studies will focus on providing economic estimates of the costs of climate change, the costs and benefits of adaptation, and the benefits of low carbon growth scenarios. The key steps are:

1. Climate science and socio-economic data projections.
2. Impacts and adaptation analysis, covering the mix of sectors and impacts of Sea level rise and costal zones, Health, Agriculture, Infrastructure, Water, other economic sectors (Energy and Tourism), Biodiversity and Ecosystem Services. This will include consideration of adaptation signatures for each of these sectors.
3. Analysis of low carbon growth scenarios.
4. Synthesis of results and policy recommendations.
5. Dissemination and communication.

These taks are discussed below.

Climate projections

The task will first examine existing climate science available nationally and in the EAC region. A key part of the approach will be to recognise the assumptions and uncertainties in forecasts and how they can affect subsequent results. To enable this, we propose to:

- Review the existing climate projections, for example in the Kenya 1st National Communication, from the wider number of projections developed in-country, and in recent literature sets (e.g. the previous DFID study for Kenya, the recent UNDP Climate Change Country Profiles for Kenya).
- Overlay the map of climate station data included in weADAPT climate change explorer tool and scenario archive. A separate overlay would highlight the range of envelopes for future climate scenarios.
- Work with our prospective partners to develop a common understanding of the key issues, demonstrate the regional data sets, and develop a participatory agenda for the main implementation phase.

The task will compile an inventory of existing information, baseline vulnerability in AWhere, based on initial climate envelopes for selected climate stations in each country. The team will also work with local climate teams as part of this tasks, with ideally one of the in country partners having a major involvement in this task. We also plan to use in country and international experts to provide review.

Proposed team members: Tom Downing, Fernanda Zermoglio, Ruth Butterfield, in country partners.

Socio-economic projections

The future effects of climate change are strongly influenced by socio-economic change. The emission scenarios that drive the climate change are themselves driven by assumptions regarding population, technological change and economic growth. However, non-climate scenarios also determine the vulnerability of social and economic systems to climate change in the future (i.e. when climate change occurs). They describe the changes in the “stock at risk”, with respect to size, and subsequent sensitivity to climate change, adaptive capacity and vulnerability.

Future socio-economic scenarios result in a change in vulnerability or exposure, even in the absence of future climate change. To illustrate, the future impact of extreme events such as floods or storms will be determined by the increased wealth of individuals and assets (driven by socio-economic growth) but also changes in exposure from land-use changes. In some cases, socio-economic changes may even affect the sign (+/-) of damages. There are also strong linkages between socio-economic development and adaptation. As an example, income and wealth are important in adaptive capacity. Note that there are also major uncertainties in future socio-economic trends, which affect the magnitude and probability of any potential impact.

An important part of the study is therefore to develop specific socio-economic scenarios for the three countries. There is far less experience of using socio-economic scenarios in vulnerability, impact or adaptation assessments. However, any assessment is seriously flawed if it does not include them, as this implies that projected future climates will take place in a world similar to today. It is also important as it allows the subsequent analysis to split out the 'net' impacts attributable to climate change, rather than the 'gross' impacts due to the combination of 'climate + socio-economic change' (as any future impacts due to socio-economic change alone would have occurred anyway in the absence of climate change), noting that adaptation responses need to address the combined 'gross' effect of climate and socio-economic change together.

The study proposes to build on the existing IPCC Special Report on Emission Scenario projections (SRES), and data, and look to build up bottom-up scenarios consistent with the planned development pathways for each country, particularly including the Poverty Reduction Strategy Paper (PRSP) for each country, and the Vision 2030 (Kenya). It will also consider various programmes that might reduce vulnerability in the near future, e.g. WHO programmes on health protection.

Related to this, the study will also consider scenarios of environmental quality, and current and future degradation of environmental assets, i.e. rather than just considering these as static resources that will remain constant in the future.

Impacts and economic costs

The main part of the work plan is to assess the economic costs of climate change, and the costs and benefits of adaptation for the three countries. Where possible the study will assess physical impacts as well as economic values, and adopt a spatial mapping platform /GIS (AWhere) to use and display relevant country information. Consistent with the overall terms of reference, this will consider the short, medium and long term.

The approach by sector is outlined below. Note that whilst the sectors are those which are critical to livelihood security and/or those which currently support economic development as measured by GDP, there is a need to undertake analysis based on climate change variables and analysis methods. Furthermore, a level of dis-aggregation will be undertaken (based on geographical based approaches) that also allows the presentation of data at a sub-national level, so that 'regions' within a country can be highlighted. Where differences exist between these sub-national 'regions' these will be highlighted in the results.

The work will be undertaken by partner teams in-country working with UK based experts. We also propose in country workshops to build up impact assessment, identify adaptation options and costings.

Coastal zones and sea level rise

The physical impacts and economic costs to the coastal areas in Kenya arising as a result of sea level rise and flooding from storm events will be assessed, building on existing work (Orindi and Adwera, 2008). The DIVA database and model produced from the DINAS-COASTS DG research project (DINAS-COAST Consortium, 2007[33]) is proposed for use. The DIVA database also includes analysis of adaptation. The strategies include coastal defences (e.g. physical barriers to flooding and coastal erosion such as dikes and flood barriers); realignment of coastal defences landwards; abandonment (managed or unmanaged); measures to reduce the energy of near-shore waves and currents; coastal morphological management; and resilience-building strategies. The model (outlined below) includes the direct cost of adaptation to sea level rise and estimates the optimal levels of protection (based on cost-benefit analysis). This allows for consideration of the costs (for example, coastal protection), and the benefits of adaptation (for example, reduction in impacts) under different scenarios.

Proposed team members: Robert Nicholls (to run DIVA) with support from SEI, and in country partnership teams.

DIVA; the Dynamic and Interactive Vulnerability Assessment Tool

The DVIA tool, produced by the EU-funded DINAS-COAST Project (Dynamic and Interactive Assessment of National, Regional and Global Vulnerability of Coastal Zones to Climate Change and Sea-Level Rise) (DINAS-COAST Consortium, 2006). DIVA contains two major components: 1) A detailed global database with biophysical and socio-economic coastal data mapped to more than 12,000 coastal segments defined on natural, administrative and socio-economic characteristics (Vafeidis *et al.*, 2004). 2) An integrated impact-adaptation model, allowing the interaction between a series of modules that assess biophysical and socio-economic impacts of sea-level rise, including the potential effects and costs of adaptation.

It is possible within DIVA to obtain estimates of the physical impacts of sea-level rise on coastal areas and their direct economic costs both in terms of damage and several user-selected adaptation measures, under different scenarios of sea-level rise and socio-economic development. DIVA allows all the major direct impacts of sea-level rise (erosion, increased flood risk and inundation, coastal wetland loss and change, and salinisation) to be quantitatively evaluated in physical terms, and monetarised. Adaptation is an explicit part of the model and a range of adaptation options can be explored together with their costs, including options from no protection to total protection, together with an estimate of the economically-optimal response using cost-benefit analysis.

Health

Methods are available to estimate the aggregate physical effects of climate change from vector borne disease (e.g. as adopted in WHO global burden of disease, McMichael, 2004[34]). It is proposed to use a combination of such methods within a GIS framework to look in detail at each of the specific countries, employing specific local and vulnerability mapping (e.g. vector borne disease risk, quantification of impacts based on regional response functions), but also to compare them to other models used (e.g. the

[33] Vafeidis, A.T., Nicholls, R.R., McFadden, L., Tol, R.S.J., Hinkel, J., Spencer, T., Grashoff, P.S., Boot, G. & Klein, R.J.T., 2007 A New Global Coastal Database For Impact And Vulnerability Analysis To Sea-Level Rise. Journal of Coastal Research, accepted.

[34] McMichael, A.J., Campbell-Lendrum, D, Kovats, R.S., Edwards, S., Wilkinson, P, Edmonds, N, Nicholls, N., Hales, S., Tanser, F.C., Le Sueur, D., Schlesinger, M, Andronova, N. (2004) Climate Change. In Comparative Quantification of Health Risks: Global and Regional Burden of Disease to Selected Major Risk Factors. Edited by Majid Ezzati, Alan D. Lopez, Anthony Rodgers and Christopher J.L. Murray. World Health Organisation. http://www.impetus.uni-koeln.de/malaris/literature/hoshen_and_morse_2004.pdf

Liverpool malaria model, Hoshen and Morse, 2004[35]). The analysis will also be extended to estimate the economic costs (cost of illness, lost time at work, WTP to avoid pain and suffering)) associated with these impacts. Some recent studies have considered the potential direct and indirect costs of health care (e.g. Bosello et al, 2004[36]) and show that these are likely to be relatively large for Africa. Estimates of the costs of various adaptation strategies will be identified and scoped, and the potential benefits in terms of the reduction in impact assessed and monetised. While the focus will be on vector borne disease, the analysis of diarrhoeal diseases (which are highly sensitive to climate) will be assessed, and potentially also heat and cold related mortality and morbidity, and the potential risks of disasters caused by extreme weather events coastal floods, inland floods and landslides.

It highlighted that there is much less quantified analysis on the benefits of adaptation policy (in reducing impacts), though it is clear that many adaptation methods are simply extensions of existing good public health protection measures.

Work will be undertaken to focus on the regional context to derive more specific analysis. The assessment will also have lots of cross-sectoral links, for example, in relation to the water sector and access to safe water; agricultural production and food availability; health risks following extreme events.

Proposed team members: Sari Kovats (London School of Hygiene and Tropical Medicine) with support from SEI Alistair Hunt (valuation), and in country partnership teams

Agriculture

Agriculture is a climate sensitive sector and one of the key areas for analysis. The proposals are to look at several approaches, but mostly likely to use the data/GIS maps from the Stanford/NCAR (FAO CropWat model[37], to undertake analysis of crop impacts (change in yield and area for multiple crops) at aggregated scale. Alternative approaches will also be considered, to look at the potential envelopes around production, including the existing economic assessments in the region (Kabubo-Mariara and Karanja, 2007 [38]), and consideration of local studies (see also task C later). The assessment will link through to economic costs through the use of crop prices. The potential to link these to wider sectoral and international crop price models will also be explored.

The study will also build on the considerable amount of work on adaptation responses in the agricultural sectors. For instances, within the agricultural sector, these strategies range from the development and deployment of early warning systems, better agricultural management systems, improved crop cultivars, better and more efficient irrigation systems and good grain storage systems. It will identify a range of options, work up costs estimates, and scope out the potential benefits of adaptation. It is proposed to take this forward through a local workshop with regional agricultural experts.

Proposed team members: Tom Downing, Ruth Butterfield, Muyeye Chambwera (IIED), in country partnership teams.

[35] A weather-driven model of malaria transmission Moshe B Hoshen and Andrew P Morse. Malaria Journal. http://www.impetus.uni-koeln.de/malaris/literature/hoshen_and_morse_2004.pdf
[36] Bosello, F., Roson, R., and Tol, R.S.J. (2004). Economy-Wide Estimates of the Implications of Climate Change: Human Health. Research Unit Sustainability and Global Change FNU-57, Hamburg University and Centre for Marine and Atmospheric Science, Hamburg.
[37] http://www.fao.org/nr/water/infores_databases_cropwat.html
[38] Kabubo-Mariara, J. and F. K. Karanja (2007) "The Economic Impact of Climate Change on Kenyan Crop Agriculture: A Ricardian Approach" http://www.ceepa.co.za/docs/cdp12.pdf

Water Availability, Resources and Quality

Water resources are important for some regions of the three countries, and have potential effects across sectors (e.g. due to the multiple uses of water, and direct and indirect economic benefits). This task will analyse water resources and availability, using the Global Water System Partnership Digital Water Atlas[39] which contains multiple scenarios and has results on line. These data sets will be complemented with African observatory runs, to frame the potential risks. The potential for a more detailed catchment level assessment will also be explored, with the potential use of the WEAP model, which has been applied in Kenya[40].

The task will also consider the potential economic costs of changes in water resources. Changes in water demand strongly depend on economic growth and societal development, as well as patterns of demand change from other sectors, and the socio-economic assumptions can dramatically alter resources and price effects (as with the Callaway et al study in South Africa regarding water demand[41]). The potential adaptation options will be considered, and costed, i.e. for development plans (from community based responses, drought responses, and engineered options) and the potential benefits they provide quantified where possible. It will also consider cross-sectoral linkages, with assessment of hydroelectric resources, agricultural production and irrigation, health sector analysis (in terms of water quality), and ecosystem services and tourism.

Proposed team members: Tom Downing, Ruth Butterfield, Alistair Hunt in country partnership teams.

Built environment and Infrastructure (extremes)

The task will look at extreme events particularly focusing on flood events, and the potential for infrastructure damage. It will also consider other extreme events including drought (linked to water resources above) and heat extremes. The analysis will consider each of the three countries. The proposal is to first identify critical infrastructure and vulnerability, including consideration of transport infrastructure (roads, bridges, airports, ports), energy infrastructure (including hydropower and thermal plants and transmission and distribution systems), water and sanitation systems, and coastal defence. The study will then develop estimates of the potential risks to this infrastructure, building on the type of analysis undertaken by the study team previous (e.g.ABI, 2005[42]) on the costs of extreme events. This approach considers the current level of impacts on infrastructure and consider future analogues of the change in extremes, in combination with socio-economic development. There is already some data on the costs of extremes (floods and droughts) in Kenya[43]. The analysis of adaptation costs and benefits will be included as part of this task. This will also investigate the linkages with investment (and climate proofing of infrastructure investment).

Proposed team members: Alistair Hunt, Paul Watkiss, Tim Taylor, in country partnership teams.

Energy

The energy sector analysis will be built up as part of the low carbon growth task below. The specific effects of climate change will consider the potential effects on energy supply (particularly hydro resources – linked to the water analysis above), but also energy demand and cooling from increased temperatures.

[39] see http://atlas.gwsp.org.
[40] http://www.weap21.org/index.asp. The model has been used in Kenya, see A. van Loon, P. Droogers, "Water Evaluation and Planning System, Kitui Basin - Kenya," Project WatManSup: Integrated Water Management Support Methodologies for Turkey and Kenya, Report no 2, November 2006. see http://www.futurewater.nl/watmansup/results.html
[41] . http://www.hm-treasury.gov.uk/media/6/7/stern_review_supporting_technical_material_molly_hellmuth_231006.pdf
[42] ABI, 2005, Financial risk of climate change. Association of British Insurers, London, UK,
[43] World Bank Working Paper No. 69, 2006

Biodiversity and Ecosystem Services including Forestry

Climate change is likely to have a significant impact on biodiversity and the viability of ecosystem services. Changes to biodiversity may have economic impacts on other sectors such as agriculture, health, tourism and water sectors. The quantification, and especially valuation, of biodiversity and ecosystem services is challenging. The task will consider potentially significant changes to the natural environment from climate change and map these over the region, at an aggregated level, building on existing work in the region (e.g. UNEP[44]). These changes will be isolated from those brought about by existing climate variability and socio-economic change.

One particular focus will be on forestry. This will be linked with the low carbon growth and reducing emissions from deforestation and forest degradation in developing countries (REDD), see task below.

The value of the changes will then be assessed using a variety of economic techniques including implementation of the production function approach which will capture the use values from the agricultural sector, alternative water users, tourism etc. The integration with other sectors in impact assessment will, then, be recognised.

The assessment will then consider adaptation costs, derived from adaptation options that have a cross-sectoral perspective. Other economic values (e.g. non-use) will be represented as far as is possible, and will rely on stakeholder value elicitation. In addition, as ecosystem services payments become more significant in international climate change adaptation mechanisms the potential for developing country involvement in ecosystem service payments such as carbon offsetting or compensation schemes increases. The study will investigate such areas.

Proposed team members: Alistair Hunt, Tim Taylor, Tahia Devisscher, Muyeye Chambwera (IIED), in country partnership teams.

Adaptation

In each of the sectors above, the project will consider the adaptation costs and benefits, using the where possible the same methodological framework. This will be easier for some sectors (e.g. coasts, where adaptation costs are already included in the modelling framework than others). For all sectors, the study will also progress analysis around the adaptation signatures approach, using the typology outlined in the previous chapter, and developing up adaptation options and costs by sector and type of adaptation, using involve local experts and workshops. Finally, the study will use the information from the sectoral analysis, and from national accounts, and develop updated estimates of the costs of adaptation, building on the previous UNFCCC studies on investment flows, to provide specific values for each country and for the region.

Proposed team members: Alistair Hunt, Tim Taylor, Paul Watkiss, Ruth Buuterfield, Muyeye Chambwera (IIED), in country partnership teams.

Energy, Low Carbon Growth and Carbon Finance Opportunities

This task will cover the energy sector and low carbon growth pathways. At the London meeting, it was agreed that while the focus of the overall study is on impacts and adaptation, it also needs to have a significant component dedicated to low carbon growth. The aim of this task is to investigate the benefits of low carbon growth policies (and adaptation-mitigation linkages), negative cost options, and development co-benefits (win-win), rather than focusing on mitigation.

[44] http://www.unep.org/roa/Projects_Programmes/Biodiversity/Activities/index.asp

The analysis will consider the potential emissions from future energy, land-use and agriculture, building on the national communication, and look at forecasts with alternative future scenarios, including a scenario consistent with the relevant Vision documents to 2030. It will also consider an alternative scenario focusing on low carbon growth scenarios and development. One key issue here will be to consider the planned development in each country consistent with the relevant Vision documents, and the implications for emissions levels and negotiations, for example, in Kenya, the 2030 vision to be a middle income country has implications for future negotiations. As part of this work, the study will consider the related issues, and especially the potential barriers, that are relevant for low carbon growth scenarios, e.g. in relation to local grids, and relevant in country experts, as well as considering the options to ensure future growth trajectories avoid getting 'locked' in to high emissions, i.e. future energy challenges.

As part of the low carbon scenarios, a full scale marginal cost curve analysis is outside the resources of the study, but it was proposed to scope out the potential for such a curve, and consider a few points along the curve, e.g. the consideration of energy efficiency, low cost renewables, etc, particularly focusing on development options that avoid carbon lock-in.

The task will also include consideration of ancillary benefits. These include air quality and energy security. Air pollution has a number of important impacts on human health, as well as on the natural and man-made environment. The reduced air quality (including indoor air quality) from cleaner energy sources has a large potential benefit for health improvements. This is particularly important because of the use of low grade fuels for winter heating and also cooking. The task will consider these potential benefits, and look at possible approaches for quantifying the potential health benefits and assessing in terms of economic benefits. Importantly, these benefits accrue immediately and locally. In addition, low carbon technologies have the potential for reducing imports of energy fuels, and improving energy security. There is a considerable literature on energy security aspects, related to both security and diversity of supply (including disruptions, fuel price shocks, substitution costs in diesel generators – etc), macroeconomic effects from imports, and energy security externalities, and this will be considered to compile the potential benefits of low carbon growth scenarios.

The task will also investigate adaptation-mitigation linkages, including both synergies and conflicts. The task will also consider the implications of energy demand changes from temperature (cooling).

The task will also consider relevant aspects in relation to low carbon finance opportunities. The task will consider issues around forest, and deforestation and degradation, linking through to ecosystems services sector analysis above (and also wider issue of land use change), but also opportunities for carbon investment flows. It will consider the necessary country capacity that will be needed to be potential part of any future market in relation to REDD, and where this also might be useful as capacity for adaptation[45], as well as income generation and sustainable livelihoods. It will also include consideration of other financing (e.g. renewables) through CDM opportunities and the voluntary. The task will include discussion with relevant stakeholders, noting the potentially different groups that may be relevant (e.g. Department/ministry of energy, as well as the emission estimates from Department/ministry of environment).

Proposed team members: Paul Watkiss, Alistair Hunt, Tahia Devisscher, Adriaan Tas, in-country teams.

[45] For example, in November 2008, Common Market for Eastern and Southern Africa (COMESA) Ministers of Agriculture and Environment declared to advocate the expansion of eligible categories to benefit from carbon credits and other international incentives in the post-2012 treaty to include sustainable land management, including sustainable agriculture, sustainable forest management, afforestation and reforestation, reduced emissions from deforestation and forest degradation, thereby enabling "greener agriculture" and promote agricultural productivity in a way that improves resilience and adaptation to climate change. See also http://www.environment.go.ke/index.php?option=com_content&task=view&id=3&Itemid=1

C) Local Case Studies

A focus on local case studies is important for a number of reasons:

- The case studies provide information-rich, local narratives, which can ground the sectoral studies with practical examples, and thus link the different parts of the overall framework.
- These local studies allow a greater focus on existing vulnerability, and also local adaptive capacity and local adaptation options. This is important in identifying distributional effects, existing climate vulnerability, and because adaptation is often local in nature (and can be advanced more cost-effectively at local level).
- They allow consideration of the non-formal economy (which is omitted in the aggregate economic studies).

The choice of studies will be determined by available information, existing studies, and in-country priorities. The study will undertake a number of activities within this task, that will link with the sectoral analysis above.

1) Review and synthesis of existing case studies.

2) To build on a number of existing case studies, and extend them to assess economic effects, and costs and benefits of adaptation.

Review and synthesis of existing case studies

This part of the work will collate the existing case study information and synthesis the results. These will be used to help provide specific context for the national sectoral studies. The task will start with a detailed literature review, and discussion with relevant in-country institutions. It will consider the priority areas identified in each NAPA and investigate relevant information. The review material will then be used to compare against the national sectoral assessments, highlighting additional issues (e.g. informal sectors), but also looking to assess the robustness of the national assessments.

Extending existing case studies with economic analysis

The second part of this task will be to progress a number of case studies and assess the economic costs of climate change, and the cost and benefits of adaptation. A number of potential case studies have been identified. As illustrative examples, the future case studies could include:

- Extending the seasonal forecasting and agriculture studies in Kenya. Local partner African Economic Research Consortium (AERC, Nairobi), Gilbert Ouma, University of Nairobi and ICPAC.
- Extending the soil conservation / ecosystem services studies in Kenya. Local partner Wilfred Nyangena University of Nairobi.
- Extending the Mombassa (a port city, and the second largest city in Kenya) sea level rise study (Orindi and Adwera) towards economic valuation.

Additional possible case studies might include:

- Health case studies on vector borne disease
- Rural agriculture and rural livelihoods.
- Water resources or desertification (e.g. Arid and semi-arid lands in Kenya)

- Etc

It is anticipated that around five case studies could be undertaken, the number determined by the available information and complexity. The studies would be used to provide specific case study examples to complement the main national assessments. They would also be used to compare the robustness of the national assessments, through scaling up the local studies (scoping the implications at national level) and comparing against the national estimates.

Proposed team members: Tom Downing, Jillian Dyszynski, Adriaan Tas, in country partners.

D) Policy Recommendations

The information from the above tasks will be compiled to produce an overall summary, i.e. a synthesis of the study by country and overall. The information from the tasks above and the synthesis will be used to provide policy recommendations: at country level.

This will include a summary of the economic costs of climate change, the costs and benefits of adaptation and low carbon growth. It will also provide key messages in relation to the need for (urgent) action, to reconfirm the need for action, but also the potential win-win options and opportunities. It will highlight key barriers and how these could be overcome.

Proposed team members: Tom Downing, Paul Watkiss, in country partners.

Project Management

Study deliverables

The proposed study deliverables are outlined below:

Deliverables (D2.1): report outlining climate and socio-economic projections.

Deliverables (D2.2): Initial output of results for Copenhagen COP 15.

Deliverables (D2.3, 2.4, 2.5): A report which sets out clearly:

- Environmental, economic, social and other impacts of climate change.
- The costs and benefits of adaptation.
- The costs and benefits of low carbon growth.
- Appropriate policy recommendations on the above.
- Other recommendations as relevant based on work undertaken (e.g. these might relate to institutional/coordination aspects, capacity issues, ongoing research and analytical priorities, knowledge management and communication etc)

Deliverables (D2.6: A regional report, highlighting the regional impacts and policy implications.

Linkages with other studies

There are a number of other studies which are undertaking similar analysis, in other regions, and the project team highlights that links should be made with these studies. These include:

- **The Defra Stern team studies of Regional Economics of Climate Change Studies (RECCS)**. There are five mini-Stern assessments currently underway, looking at regional economic studies of climate change (Mexico, Brazil, SE Asia and C. America).
- **The EC ClimateCost Study**. SEI is leading a major EC Research project which is undertaking economic studies for Europe, China and India. This includes sectoral expert teams, and could be a very useful link for providing sectoral input and modelling.
- **The World Bank Adaptation Study**. The World Bank is undertaking a study focusing on the economics of adaptation in 6 countries (probably Ethiopia, Mozambique, Vietnam, Ghana, India, and Peru). It would be extremely useful to share information with this team.
- **UNEP: AdaptCost**. UNEP have asked for further assessment and capacity building in Africa on the cost of climate adaptation, with work led by Tom Downing.
- **Google Foundation: Kenya**. SEI is exploring how risk communication and adaptation information might be deployed using the Google technology. A key feature is documenting the use of information in climate policy planning at several levels, from national awareness and development plans to community based adaptation strategies.
- **UNITAR, Defra: ACCCA and ETC, DGIS: NCAP**. The SEI and weADAPT collaborators have led technical support to several adaptation programmes in developing countries, including ACCCA and NCAP. This active collaboration has resulted in many of the lessons learned and developments in data sets and tools pioneered by the group being made available through the weADAPT.org platform.

Contact will be made with these research groups, and sharing of information and knowledge exchange is planned. Of particular relevance will be the sharing of draft outputs from the study (by sector, and overall) with the Stern team early in the implementation phase, and again as final results emerge. This will be important in ensuring the consistency of this study with the other Stern RECCS, and providing a means for participation and review.

Timing and sequencing

An initial analysis should be ready by March 2009, including key sectoral information, which will begin to show stakeholders the implications of climate change on their economy.

Prioritised impacts and cost-benefit analysis will be completed by end June 2009, for presentation and discussion in each country and at regional level during July 2009.

Policy recommendations and options will then be examined and the entire project completed by the start of August 2009.

Implementation Phase (2009)

		12/01/09	19/01/09	26/01/09	02/02/09	09/02/09	16/02/09	23/02/09	02/03/09	09/03/09	16/03/09	23/03/09	30/03/09	06/04/09	13/04/09	20/04/09
Inception																
Climate Analysis																
Socio-economic analysis																
	Deliverable 2.1.						X									
Sectoral analysis																
Policy recommendations																
Deliverables	Initial findings Deliv. 2.2								X							
	Final findings. Deliv. 2.3, 2.4 ,2.5															
	Regional rep. Deliv. 2.6															
Meetings and dissemination																
	Country meeting Kenya	X	X													
	Training workshop															

		27/04/09	04/05/09	11/05/09	18/05/09	25/05/09	01/06/09	08/06/09	15/06/09	22/06/09	29/06/09	06/07/09	13/07/09	20/07/09	27/07/09	03/08/09
Inception																
Climate Analysis																
Socio-economic analysis																
	Deliverable 2.1.															
Sectoral analysis																
Policy recommendations																
Deliverables	Initial findings Deliv. 2.2															
	Final findings. Deliv. 2.3, 2.4 ,2.5										X					
	Regional rep. Deliv. 2.6											X				
Meetings and dissemination																
	Country meeting Kenya												X			
	Training workshop															