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Tracking adaptation and measuring development

Nick Brooks, Simon Anderson, Jessica Ayers,
Ian Burton and Ian Tellam

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As adaptation to climate change becomes the focus of increasing attention and the target of significant spending, there is a growing need for frameworks and tools that enable organisations to track and assess the outcomes of adaptation interventions. This paper presents a coherent framework for climate change adaptation programming, including potential indicators, or indicator categories/types, for tracking and evaluating the success of adaptation support and adaptation interventions. The paper begins with a discussion of some of the key issues related to the evaluation of adaptation, and outlines some of the main difficulties and constraints with respect to the development of adaptation indicators. Next, an evaluation framework is proposed and indicator categories or "domains" are identified. Lastly, key conclusions are provided and a theory of change is outlined that shows how development and use of the framework could lead to more effective adaptation investments for climate resilient development.

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Executive summary

THE SCALE OF CLIMATE CHANGE ADAPTATION investments demands robust assessments of the expected and actual returns. We need to know how effectively adaptation keeps development on track and equally importantly how equitably adaptation costs and benefits are distributed.

Adaptation initiatives may be placed into three broad categories: addressing the existing 'adaptation deficit'; managing incremental changes in climate-related risks; and proactively addressing the more profound longer term manifestations and impacts of climate change by transforming or replacing existing systems and practices.

Most climate change response evaluation frameworks essentially assume that adaptation can and will 'neutralise' the impacts of climate change, enabling development to meet targets that were originally set without any reference to the potential impacts of climate change – in other words, targets set under assumptions of a stationary climate. Such frameworks underestimate the potential need for transformative change.

Current adaptation policy and practice are often short-sighted. They largely focus on improving the ability to cope with current climate variability, and on 'climate proofing' development investments to address incremental changes in existing climate-related risks, in the near term. The need for transformational change is demonstrated in the scientific literature but is only referred to rhetorically in climate change programmes that struggle to shift from business as usual strategies.

Climate change is changing the contexts in which development takes place by changing the nature and intensity of climate-related risks, and through the impacts of evolving climate-related risks on people's vulnerability. Current development interventions that fail to address climate change, and current climate change interventions that fail to appreciate where business as usual cannot be secured through incremental adaptation, are likely to result in unintended consequences including 'maladaptation'. Developing countries will need to track these consequences and consider how policies and service delivery act to support or undermine adaptive capacity at different levels. Longer-sighted, more context-specific approaches that address changing risk contexts and that allow for flexible responses to uncertain changes in climate and unintended consequences of development interventions are needed for planning, implementing and assessing adaptation to climate change.

An 'open source', rather than a proprietary, approach to the development of a framework for adaptation evaluation is proposed here. The purpose is to co-produce and promote an approach that will enable a variety of actors, including developing country governments and other bodies within developing countries, to formulate, implement and evaluate climate change policies and actions.

We propose an approach to the evaluation of adaptation 'success' that combines assessment of how well climate risks to development are managed by institutions ('upstream' indicators), with assessment of how successful adaptation interventions are in reducing vulnerability and keeping development 'on track' in the face of changing climate risks ('downstream' indicators). The aim here is to provide a framework that defines indicators' categories or 'domains' that can be tailored to specific contexts, rather than a 'toolkit' for monitoring and evaluation that prescribes particular indicators.

This approach combines capacity-related indicators with indicators of vulnerability and the assessment of development outcomes under climate change. The approach also addresses issues of moral hazard and information asymmetry. By looking at how climate risk is managed by authorities and linking this with the vulnerability of and development outcomes experienced by the climate vulnerable poor, the framework shows whether and how the adaptation needs of marginalised groups are addressed, and what safeguards are in place to prevent maladaptation.

The following domains for indicators are proposed to evaluate the extent to which climate risk management is integrated into development processes, actions and institutions:

- The use of climate and monitoring and evaluation (M&E) information in policy and programme design.

- How well national systems conduct climate risk management functions.
- Proportion of development initiatives that are climate-proofed.
- Mechanisms for targeting the climate vulnerable poor.
- Institutional frameworks of regulatory and legislative support of adaptation.
- The effectiveness of macro-economic management for climate resilience.

Suggestions for measures of the developmental impacts of adaptation include:

- Numbers of beneficiaries of climate change adaptation interventions (either absolute or in terms of proportion of national or other population).
- Coverage of climate change adaptation interventions.
- Numbers of people experiencing reductions in vulnerability, represented by movement from more vulnerable to less vulnerable category/score in key indicators that are defined in particular contexts.
- Value of assets and economic activities protected or made less vulnerable as a result of adaptation interventions.
- Benefit/cost ratios of adaptation options identified/implemented.

A number of issues have been identified for further attention. These are:

- The indicators proposed above are not intended to substitute for indicators and processes at the country or project level, which are tailored to local contexts. Nor are they intended to be comprehensive. They are designed such that they can 'sweep' existing frameworks and approaches in order to present an aggregate picture of overall progress.
- The extent to which existing M&E processes allow the proposed framework to be implemented needs to be assessed.
- Work remains to be done on evaluating and proving impact, both in terms of specific livelihood outcomes, and in proving causality between upstream and downstream interventions.
- The costs associated with defining baselines and indicators in national contexts need to be front-loaded into adaptation investments; it is worth investing up-front to ensure that the evidence base exists to support meaningful evaluation.
- Climate adaptation funds' M&E and results-based frameworks might be improved by incorporating concepts and nationally-developed indicators for both climate risk management and climate-relevant/specific development and vulnerability indicators.
- Work is needed to establish baselines: this should be viewed as an opportunity to build local analytical capacity to assess climate risk. Such capacity building should be included in the design stage of baseline development.

High level qualitative intermediate indicators to capture transformative outcomes and impacts, are required. For example, indicators on policy levers that give incentives for low carbon, climate resilient action by governments, private sector and civil society, and indicators of increased climate foresight in planning by governments.

The next steps for this work will involve the application of the framework to adaptation initiatives in particular national contexts, and the development of theories of change to link upstream and downstream evaluation and indicators. In the national case studies, the quality and scope of existing baselines will be assessed and gaps identified, ways of applying the adaptation framework will be piloted, recommendations for application of the framework across adaptation programming will be generated, and support from among partners for moving towards a common approach to measuring progress and adaptation effectiveness will be sought. The framework's **purpose is to ensure that adaptation investments lead to climate resilient development,** and the **goal is that development trajectories are maintained despite climate change effects.**

1 Background and framing issues

1.1 Introduction

AS ADAPTATION TO CLIMATE CHANGE BECOMES THE focus of increasing attention and the target of significant spending, there is a growing need for frameworks and tools that enable organisations to track and assess the outcomes of adaptation interventions.

This paper suggests a coherent framework for climate change adaptation programming, including potential indicators, or indicator categories/types, for tracking and evaluating the success of adaptation support and adaptation interventions.

The paper begins with a discussion of some of the key issues related to the evaluation of adaptation, and outlines some of the main difficulties and constraints with respect to the development of adaptation indicators. Next, an evaluation framework is proposed and indicator categories or 'domains' are identified. Lastly, key conclusions are provided and a theory of change is outlined that shows how development and use of the framework could lead to more effective adaptation investments for climate resilient development.

1.2 Background

1.2.1 Rationale for the development of a new adaptation results framework

There is currently intense interest among governments and development organisations in the development of results and monitoring and evaluation (M&E) frameworks for adaptation. Existing and emerging frameworks tend to focus on two aspects of adaptation. The first of these is the capacity of institutions, government and civil society to understand climate change and to integrate adaptation into decision making. These elements are to be assessed in terms of the existence of policy, institutional and other mechanisms that seek to promote knowledge and action on climate change. The second aspect is the extent to which climate adaptation keeps development 'on track'. This can be assessed through the use of regular development indicators applied to populations or areas that are judged to be at potential risk from climate change. This approach, based on assessing broad societal 'adaptive capacity' on the one hand, and development outcomes on the other, is evident in the results frameworks developed for the Pilot Programme on Climate Resilience (PPCR) and the Adaptation Fund (AF), which are discussed in more detail in Annex 2.

> *"Progress on the achievement of climate adaption objectives can be estimated by setting, calibrating and measuring / quantifying **development** indicators (i.e. the levels of key parameters that change over time) closely correlated to the objectives."*

among these are the long timescales over which many aspects of climate change (and hence much adaptation) will unfold, and the problems of how to evaluate the impacts of adaptation interventions on development outcomes in the face of rapidly evolving stresses and risks that change the contexts in which development takes place (the 'shifting baseline' problem).

Existing and emerging results frameworks such as those mentioned above address these problems to a very limited extent, if at all. For example, where such frameworks seek to measure adaptation success in terms of the achievement of intended development outcomes, the way in which such 'success' will be attributed to adaptation interventions is unclear. Furthermore, there is often no attempt to 'normalise'[1] and 'contextualise'[2] measures based on development outcomes with respect to shifting climatic baselines and changing risks – the assumption is simply that adaptation can/will 'neutralise' the impacts of climate change, enabling development to meet targets that have been set under implicit assumptions that the climate is essentially stationary.

1 Essentially this means calibrating data representing or derived from different contexts so that they may be compared. In the case of changing baselines, normalisation might involve the adjustment of data to account for trends and different means. For example, for "excess" mortality to be compared for two episodes of climate extremes, underlying levels of mortality will need to be known so that the excess mortality can be assessed in terms of deviations from the what would be expected under average or "usual" conditions.

2 Overly technocratic approaches to adaptation can "decontextualize" adaptation by ignoring the wider ecological, human and social contexts within which adaptation occurs, and within which it succeeds or fails. Failure to place risk and adaptation within their wider contexts (e.g. the wider contexts of social and economic change that mediate vulnerability to food insecurity in the face of drought) can result in risk being misunderstanding and adaptation being ineffective (Lacey, H. and Lacey M.I., 2010, in Bhaskar et al, 2010).

A further problem with many existing results frameworks, and with current adaptation policy and practice as a whole, is that it focuses almost exclusively on improving the ability to cope with current climate variability, and on 'climate proofing' to address small incremental changes in existing climate-related risks in the near term. There is very little discussion of longer term changes, for example qualitative changes in climatic conditions, the emergence of new and unfamiliar risks, and impacts that cannot be addressed through very generalised actions such as livelihood diversification, seasonal forecasts, weather-based insurance, and better management of natural resources.

These shortcomings in existing adaptation practices and associated results frameworks highlight a need for new approaches that:

1. Address the problems associated with assessing adaptation using indicators of development outcomes, when the timescales associated with climate change impacts may be too long for such indicators to give a representative picture of adaptation outcomes.
2. Address the problem of how to assess adaptation against a changing climate-risk baseline, that will require either normalisation and contextualisation of development outcome indicators with respect to change exposure to risk, or the use of other indicators such as those representing vulnerability rather than development outcomes.
3. Move beyond the currently dominant view of adaptation as coping with existing climate variability and 'climate proofing' business-as-usual development against incremental changes in existing risks, to allow adaptation interventions to address different types of climate change-related risks that will operate on different timescales, and permit a range of responses from addressing current climate variability, through climate proofing existing development, to transformational change to address more challenging manifestations of climate change.

The approach presented here addresses points (1) and (2) above by proposing evaluation based on a combination of capacity-related indicators and vulnerability indicators, the latter of which represent an intermediate assessment step between the assessment of capacity and the assessment of development outcomes under climate change (Figure 1). It is proposed that indicators of development outcomes are employed where practical, but that this is pursued in an opportunistic manner where circumstances permit development indicators to be 'normalised' with respect to the climatic baseline, or to compare outcomes associated with similar climate risk/exposure contexts occurring at different times (e.g. similar climatic extremes before and after the implementation of adaptation interventions).

Addressing point (3) above – transformational change[3] – could also be achieved through the approach set out here using indicator-based assessments of the extent to which the management of climate risks to development meet the scale of the challenges into the medium and longer terms by sequencing and synchrony of local adaptation actions and climate risk management functions, plus counterfactual-based assessments of development outcome trajectories. A key consideration here would be the extent to which interventions designed to secure development in the near to medium term are designed to be compatible with potential longer-term interventions (e.g. by avoiding mal-adaptation in the longer term and providing a foundation on which future adaptation can be built. See Box 2 for a definition of maladaptation).

"Adaptation can be assessed by looking at how risks to development are managed, and how climate effects arrest development outcomes"

The approach proposed here also addresses the moral hazard and information asymmetry issues related to the planning and implementation of adaptation interventions. The climate vulnerable poor need to be aware of the ways authorities are managing climate risks that affect their development. By looking at how climate risks are managed by authorities, and by linking this with the vulnerability of and the development outcomes experienced by the climate vulnerable poor, the framework can assess whether and how the adaptation needs of marginalised groups are addressed, and what safeguards are in place to avoid 'maladaptation'.

"Current adaptation policy and practice is short-sighted – it largely focuses on improving the ability to cope with current climate variability, and on 'climate proofing' to address small incremental changes in existing climate-related risks in the near term.

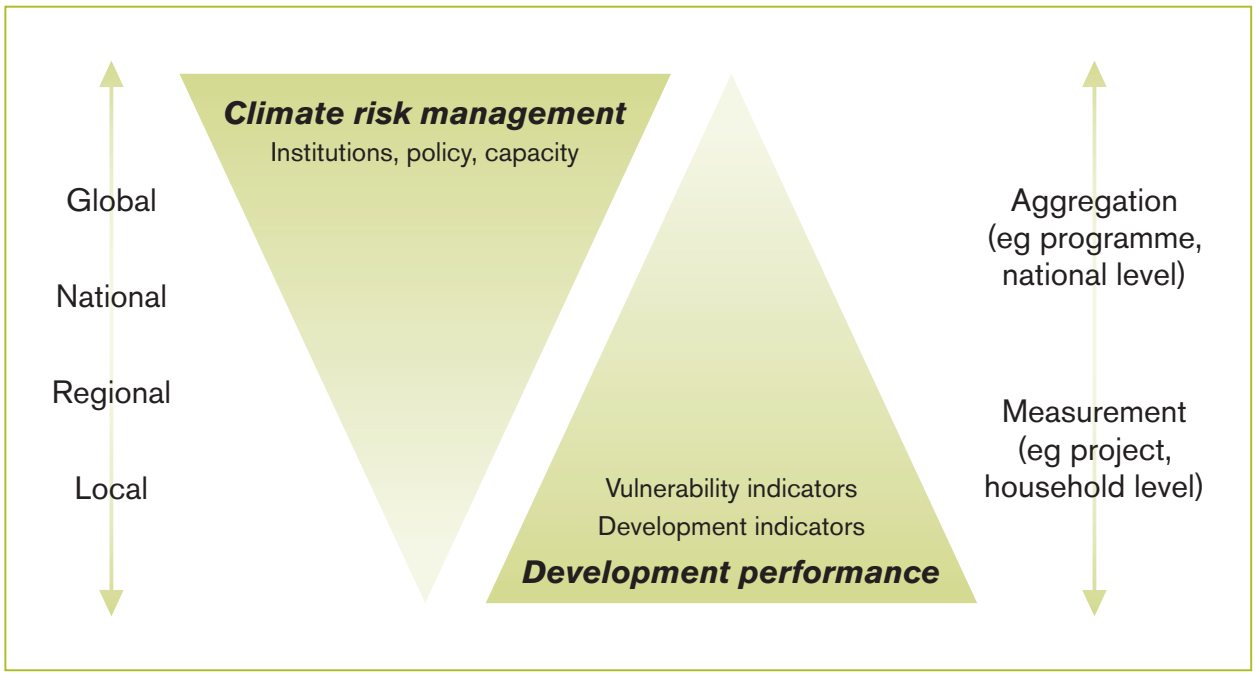
Longer-sighted, normalized and contextualized approaches are needed for planning, implementing and assessing climate adaptation."

This paper represents a first step towards the development of a coherent framework for the evaluation of adaptation, and is intended to stimulate discussion among the communities of adaptation and development practitioners.

No one organisation will or should have a monopoly of adaptation evaluation knowledge. An 'open source' approach to adaptation evaluation is proposed here, based on dialogue and the sharing of knowledge and lessons. This approach should be inclusive, bringing together individual practitioners, donor agencies, international bodies, and representatives (e.g. from governments, NGOs, CSOs) of developing countries where adaptation interventions will be implemented. A key goal of this process should be the development of

3 It should be noted that the programmes of the Climate Investment Funds (http://www.climateinvestmentfunds.org/cif/) have set transformational change as high level objectives.

Figure 1
Schematic representation of the evaluation framework proposed here, in which 'upstream' assessment of the capacity of institutions to undertake effective climate risk management is matched with assessment of 'downstream' assessment of the impacts of interventions of vulnerability and the extent to which such interventions keep development 'on track'



mechanisms through which developing countries can evaluate their own progress on adaptation and what outside agencies offer in terms of support to adaptation. This should lead to greater capacity within developing countries to independently formulate, implement and evaluate climate change policies and actions.

1.2.2 Criteria for evaluating adaptation

A number of authors have addressed the question of what constitutes 'successful' adaptation. For example, Yohe and Tol (2002) frame adaptation in terms of efficacy, feasibility and acceptability. Stern (2006) uses similar criteria of efficiency, effectiveness and equity, while Adger et al. (2005) propose evaluating adaptation in terms of effectiveness, efficiency, equity and legitimacy. The criteria of technical and institutional sustainability[4] is noticeably absent from the list above.

*"An 'open source' rather than a proprietary-approach to the development of frameworks for adaptation planning will be most effective. The goal is that developing countries can **independently** formulate, implement and evaluate climate change policies and actions."*

While studies such as those listed above provide us with a set of criteria with which to assess adaptation, they say little about processes of adaptation, or how these processes are likely to be linked to, and mediated by, the ways in which climate change manifests itself. Adaptation and climate resilience encompass a wide variety of measures, processes and actions, operating at different temporal and spatial scales, and this diversity needs to be reflected in any framework for the evaluation of adaptation. The 'missing' criterion of sustainability[5] should be included in any such framework to ensure that adaptation to near-term hazards and associated risks is compatible with adaptation to longer-term changes in climate. This issue is discussed in more detail below, in the context of a discussion of different 'types' or 'categories' of adaptation, and of how these relate to issues of timescale.

"Successful adaptation keeps inclusive development on track."

risks is compatible with adaptation to longer-term changes in climate. This issue is discussed in more detail below, in the context of a discussion of different 'types' or 'categories' of adaptation, and of how these relate to issues of timescale.

Within international development contexts, it is reasonable to propose that successful adaptation secures inclusive development in the face of climate change that might otherwise undermine it. In other words, success in adaptation keeps development 'on-track'. The implication of this

4 i.e. the continuation of benefits after a specific intervention (e.g. a project) has ended, and the need for outputs and outcomes to continue to be viable into the future, for example under changed climatic conditions. A key aspect of sustainability in this context is that interventions that deliver adaptation in the short-term (e.g. irrigation to make up for reductions in rainfall) do result not result in longer-term "maladaptation" (see Box 2).

5 A definition of "sustainability" in the context of adaptation evaluation is provided in Table 1 below.

conclusion is that standard development indicators may have a role to play in assessing the success of adaptation.

However, evaluating adaptation may also involve assessing its impacts on the vulnerability or sensitivity of individuals, settlements, populations and societies (as well as the natural systems on which they depend) to hazards associated with climate change, or evaluating how adaptation has affected outcomes associated with such hazards (e.g. numbers of people killed or economic assets lost in climate-related disasters). Evaluation of vulnerability as opposed to more 'conventional' development outcomes provides a potential means of assessing the impacts of adaptation interventions in the face of changing risk contexts, for example as associated with changes in the nature of climatic extremes and other climate-related hazards. As a result of such chances, the measurement of development indicators before and after an intervention may need to account for the effects of changing risk contexts or baselines in order to give an accurate picture of the impacts of the intervention. These issues are discussed in more detail below.

A further consideration in adaptation and its evaluation is that of justice and equity, with regard to whom is targeted by, and benefits from, adaptation. For example, should the purpose of an adaptation intervention be to deliver incremental reductions in vulnerability for as many people as possible, or to transform the lives of the most vulnerable? Such questions have implications for the design and targeting of adaptation interventions, as well as for the evaluation of their success (see Box 1).

In summary, the criteria likely to be most important in the evaluation of adaptation include

- Feasibility
- Efficacy/effectiveness
- Efficiency
- Acceptability/legitimacy
- Equity
- Sustainability

These criteria are explored in more detail at the end of Part 1 of this paper.

Box 1

Utilitarian versus egalitarian approaches to adaptation

A key issue for adaptation, and for adaptation evaluation, is whether interventions are based on a 'utilitarian' or 'egalitarian' approach.

A utilitarian approach is one in which interventions seek to benefit the largest possible number of people, to ensure maximum 'efficiency', for example in terms of beneficiaries per unit of investment. A utilitarian approach is likely to result in adaptation interventions being targeted at countries or regions with large populations. As a result certain smaller countries, regions and populations, that may face significant climate change risks and have very real adaptation needs, may be neglected.

An egalitarian approach is one in which adaptation interventions seek to deliver assistance to those who are in most need of it. This might result in interventions being targeted at the most vulnerable sections of a population, and such groups may represent minorities, meaning that fewer people benefit from assistance.

Whether a utilitarian or egalitarian approach to adaptation is taken will have implications for evaluation, and for the type of indicators used in evaluation. 'Numbers of beneficiaries' may be appropriate for a utilitarian approach, but this indicator alone will not tell us much about the efficacy of adaptation and will be of limited relevance if an egalitarian approach is adopted. An egalitarian approach will require good baseline data so that the 'most vulnerable' may be identified and targeted by adaptation assistance.

In practice it is likely that both egalitarian and utilitarian approaches will be employed, and these approaches may be combined in individual interventions. It is not the intention here to advocate one approach or the other, but to stress the importance of transparency regarding which approach is employed. Such transparency is necessary in order to ensure clear links between adaptation objectives and evaluation of the efficacy of evaluation, and to ensure that appropriate indicators are used in monitoring and evaluation.

1.3 Types of adaptation and implications for evaluation

Adaptation encompasses an enormous range of activities and processes, and will vary greatly from context to context. Adaptation can be broken down into three broad categories as follows:

1 Addressing the adaptation deficit[6], i.e. increasing the capacity of human societies and the systems on which they depend to cope with and recover from the impacts of existing climate variability.

2 Adapting to incremental changes in existing climate-related risks, i.e. increasing the capacity of societies to cope with extremes and variability in order to accommodate increased variability and more frequent and severe extremes.

3 Adapting to qualitative changes in climate and climatic and environmental transitions, i.e. transforming or replacing existing systems (e.g. livelihood systems, economic, systems, etc) in order to ensure that development is viable and sustainable under future climatic and environmental conditions that might be quite different to those pertaining today, and in the face of new risks that might be associated with the emergence of new climate hazards.

Many, and perhaps most, existing "adaptation" projects/interventions fall into category 1, focusing on the building of resilience to address problems associated with existing climate variability, or addressing environmentally destructive, unsustainable or "maladaptive" development (Box 2).

Box 2
Maladaptation

Maladaptation occurs when development activities inadvertently increase vulnerability to climate change, or result in 'lock-in' to patterns of development that might be unsustainable under future climatic conditions, increasing the risk of economic and wider societal disruption. Typically, maladaptation occurs when longer term climatic and environmental change and variability is ignored in development planning. This may result in development strategies being developed under implicit or explicit assumptions of climatic stationarity (e.g. assuming current climatic conditions will continue indefinitely), or that current levels of key resources such as water will be sustained into the future when climate change will in fact alter the availability of such resources. The OECD (2009: 49) defines maladaptation as "business-as-usual development which, by overlooking climate change impacts, inadvertently increases exposure and/or vulnerability to climate change. Maladaptation could also include actions undertaken to adapt to climate impacts that do not succeed in reducing vulnerability but increase it instead"

The concept of 'climate proofing' is associated with categories 1 and 2, but does not address category 3; climate proofing tends to involve modifications to existing or planned development ('business as usual' development) to 'protect' it from climate change and its manifestations, which are typically interpreted as being changes in the frequency and severity of extreme events.

Adaptation associated with category 3 is the category of adaptation that is most likely to require 'transformational change', and this category is largely absent from discussions of climate change and development. While addressing the existing adaptation deficit may help to build capacity to cope with and adapt to incremental changes in climate, and perhaps even more profound longer term changes, the extent to which this is the case is a matter for debate and will depend on context.

The above three categories of adaptation are summarised in Table 1, which also provides examples of the types of activities that might be associated with each category. It is recognised that there will be some overlap between these adaptation categories in terms of the nature of adaptation measures; for example, livelihood diversification may help to reduce poverty in existing contexts of high climatic variability (category 1), but will also be important in helping people to spread risk in the face of increasing climatic variability and uncertainty (category 2).

Successful adaptation to climate change will require actions spanning all three of the categories above. While addressing the adaptation deficit and climate proofing are necessary, and indeed vital, if development is to be secured in the face of climate change, these approaches represent only part of the 'solution' to climate change in the context of adaptation. A much more comprehensive 'climate risk management' (CRM) approach will need to be taken, particularly in the medium to long term, as the increase in global mean surface temperature approaches 3° C and then 4° C, as currently appears likely by the latter part of the 21st century (e.g. Anderson and Bows, 2008). While addressing the adaptation deficit and climate proofing may keep many aspects of development 'on track' in the near to medium term, these interventions may be maladaptive in the longer term if the potential need for transformation change is not addressed (e.g. where expansion of agriculture based on irrigation will be sustainable in the near to medium term but will be unviable in the longer term due to reductions in water availability, resulting in 'lock-in' to unsustainable development that could make economic and agricultural systems vulnerable to catastrophic collapse). The lifetimes of large infrastructure projects may extend into the longer term, and into periods characterised by profound changes in the nature of climate hazards and in the distribution of climate-sensitive resources.

Success in the identification of adaptation options and in their evaluation depends on an understanding of the relationship

6 See Ian Burton (2004) Climate change and the adaptation deficit. Adaptation and impacts research group, Meteorological Service of Canada, Environment Canada. Occasional paper 1, November 2004

Table 1
Adaptation categories, types and examples

Category of adaptation	Type of action	Examples
Addressing the adaptation deficit	**Resilience building**	■ Livelihood diversification to reduce poverty in context of climate variability ■ Crop insurance, seasonal forecasting, other agricultural innovation including irrigation ■ Early warning systems for DRR
Adapting to incremental changes	**Climate proofing**	■ Upgrading of drainage systems to accommodate greater runoff due to more intense of precipitation ■ Adapting cropping systems to shorter growing seasons, greater water stress and heat extremes (e.g. through crop substitution, irrigation, new strains) ■ Improving DRR systems to cope with more frequent and severe extremes
Adapting to qualitative changes	**Transformational change**	■ Phased relocation of settlements away from areas at existential risk from sea-level rise ■ Shifts in emphasis in large-scale economic activity away from areas/ resources threatened by climate change (e.g. away from water-intensive agriculture, climate-sensitive tourism, high-risk marine resources, to less sensitive activities) ■ Transformation of agricultural systems from unsustainable (under climate change) intensive rain-fed or irrigated agriculture to lower input e.g. pastoral or agropastoral systems.

between the three categories of adaptation described above. Crucially, measures to address the current adaptation deficit (category 1) need to provide a solid foundation for adaptation to incremental changes in climate hazards and risks (category 2). Measures under both categories 1 and 2 need to be compatible with longer-term adaptation needs. Another way of framing this issue is in terms of compatibility across timescales; measures to adapt to current climate risks or near-future changes in climate need to be compatible with longer-term adaptation measures, and avoid maladaptation. Such a framing of adaptation would address the hitherto neglected criterion of sustainability, in terms of the longer-term efficacy of adaptation and the complementarity of adaptation interventions across timescales.

Box 3
Conclusions regarding adaptation and development

In a recent paper Fankhauser and Burton (2011) ask what 'good adaptation' in developing countries would look like. They argue that (a) the current preoccupation with additionality makes the integration of adaptation and development harder, and (b) the best use of climate finance in the short term may be for 'soft', less tangible developmental activities that increase adaptive capacity. Building a minimum level of adaptive capacity everywhere is central to efficient, effective and equitable adaptation, and yields immediate benefits irrespective of future climate regimes. Drawing on these conclusions for the assessment of adaptation effectiveness, and the preceding discussion, we consider that:

- Climate change adaptation should 'keep development on track' – as such development indicators can be used to demonstrate this, provided the use of such indicators addresses the problem of how changing risk contexts might distort 'before and after' assessments based on such indicators.
- 'Climate proofing' development, and making development more resilient, are important parts of adaptation.
- However, adaptation needs to go beyond the climate proofing of existing development plans, and climate proofing needs to be placed within wider climate risk management frameworks.
- Adaptation deficits exist now - demonstrating the inadequacy of current development; escalation of climate change effects towards a 4°C world mean adaptation gaps will widen.
- Becoming climate smart will require development to be transformed rather just 'climate proofed' in many instances.

M&E of adaptation therefore has to measure how well climate risk management for development is done, and how well development performs under increasing climate challenges.

While addressing the adaptation deficit and 'climate proofing' for incremental changes are urgent priorities in the near term, and while the need for transformational change is likely to increase as the magnitude of climate change and the severity of its impacts accelerates over the course of the 21st century, adaptation categories 1 to 3 do not map simply onto progressively longer timescales. For example, there are likely to be contexts in which climate proofing against incremental changes in existing risks is sufficient to secure adaptation into the medium to long term, and contexts in which transformational change is necessary in the near term.

The above considerations indicate that any framework for evaluating adaptation should attempt to capture how well climate risk management (CRM) is integrated into development. This will enable the potential for successful longer-term adaptation (i.e. the adaptive capacity of institutions and governance regimes) to be assessed where the timescales associated with adaptation mean that it is impractical to assess the outcomes of specific interventions (e.g. projects, programmes, budget support, other assistance) retrospectively on the timescales over which evaluation is carried out.

1.4 Key issues in the evaluation of adaptation

1.4.1 No single metric for adaptation

Unlike climate change mitigation, the success of which ultimately may be measured in terms of a single metric such as greenhouse gas emissions avoided or atmospheric greenhouse gas concentrations, there is no easily definable single metric for adaptation. This is due to the fact that the functions and goals of adaptation will be different in different contexts. For example, adaptation interventions might seek to reduce mortality from sudden-onset climate-related disasters, improve agricultural productivity and nutrition, facilitate relocation and migration, make infrastructure more robust in the face of climate-related stresses, improve water use efficiency in the face of reduced water availability, transform livelihood and economic systems, preserve natural resources and ecosystems, and so on.

1.4.2 Timescales associated with climate change and adaptation

Ultimately, the success of adaptation will only be apparent over time and in retrospect, once sufficient data and evidence have been gathered to determine whether adaptation interventions have achieved their intended results. This is particularly true of adaptation initiatives intended to address longer-term changes in climate that will take many years or decades to unfold.

To a certain extent this problem may be addressed by evaluating processes and mechanisms associated with the development of (i) capacity and preparedness to confront longer-term adaptation issues at the institutional level, and (ii) flexible and resilient systems, institutions, and governance that allow societies to respond to climate change and to uncertain and evolving risks. However, the evaluation of institutions and systems as resilient, flexible and prepared does not guarantee that adaptation outcomes will be as intended. Such 'top down', institutional, and capacity-related assessment therefore needs to be complemented with assessment of outcomes where such approaches are feasible (e.g. where the outcomes from two similar extreme events occurring before and after the implementation of adaptation measures intended to reduce the impacts of such extremes may be compared). Where adaptation outcomes (e.g. sustained agricultural productivity in the face of long-term climatic desiccation, or ability of settlements to cope with long-term sea-level rise) cannot be measured directly because of timescale issues, one approach is to assess the impact of adaptation interventions on vulnerability, as represented by appropriate indicators, discussed in more detail below.

1.4.3 Vulnerability, and vulnerability indicators

There are many different definitions of vulnerability; it is defined here in terms of the factors that make individuals, populations and natural and human systems more or less likely to experience adverse outcomes when exposed to an external stress, in this case a climate-related hazard[7]. Vulnerability may therefore be seen as comprising societal and other (e.g. local environmental) factors that mediate the outcomes of climate-related hazards, and that act to reduce or amplify the impacts of such hazards (Box 4).

> *"Indicators that can demonstrate that adaptation interventions have reduced vulnerability will play a key role in the evaluation of adaptation interventions, and represent an intermediate step between the evaluation of institutional changes designed to facilitate adaption and the evaluation of whether development outcomes have improved."*

One of the main goals of adaptation interventions will be to reduce vulnerability to hazards associated with climate change. Vulnerability metrics will therefore be crucial to assessing the success of adaptation. Vulnerability indicators will need to be selected carefully, and will vary according to context and the climate (change) hazard(s) with which adaptation is concerned. Vulnerability indicators are likely to include some familiar development indicators (e.g. related to poverty), as well as additional or 'new' indicators specific to particular climate risk contexts (Brooks et al., 2005). Indicators

7 A climate-related hazards are defined here as physical manifestations of climate change or variability that have the potential to result in adverse impacts. See the glossary in Annex 1 for further discussion of climate-related hazards.

that can demonstrate that adaptation interventions have reduced vulnerability will play a key role in the evaluation of adaptation interventions, and represent an intermediate step between the evaluation of institutional changes designed to facilitate adaptation (e.g. processes associated with capacity building), and the evaluation of whether development outcomes (e.g. increased productivity, reduced disaster losses, etc) have improved. Where adaptation is pursued through measures targeted at institutions and governance mechanisms, the evaluation of vulnerability might tell us something about the 'downstream' impacts of such measures on vulnerable populations.

Box 4
The concept of vulnerability

The glossary of the IPCC Fourth Assessment Report (AR4) defines vulnerability as "a function of the character, magnitude and rate of climate change or variation to which a system is exposed, its sensitivity, and its adaptive capacity" (IPCC, 2007: 883). This definition was also in the glossary of the IPCC Third Assessment Report (TAR). However, Chapter 18 of the TAR also contains an alternative definition of vulnerability, as the "degree to which a system is susceptible to injury, damage or harm (one part – the problematic or detrimental part – of sensitivity)" (Smit and Pilifosova, 2001: 894).

These two definitions are mutually incompatible, and reflect very different conceptualisations of vulnerability. One sees vulnerability as a function of sensitivity, while the other views it as a component of sensitivity.

The principal definition in the IPCC glossary is very similar to long-established definitions of risk, in which the risk experienced by a system is viewed as a function of (i) its exposure to an external stress or hazard, and (ii) its sensitivity or vulnerability to that hazard. In the context of climate change, a hazard is a physical manifestation of climate change or variability, which might be a short-lived climatic extreme or perturbation, or a longer-term change in climatic conditions. The IPCC glossary definition is sometimes described as defining 'biophysical vulnerability' in order to distinguish it from other definitions (e.g. Brooks, 2003).

The definition in Chapter 18 of the TAR reflects the concept of vulnerability widely used in the natural hazards literature, in the field of disaster risk reduction, and in the social sciences in general. This conceptualisation, in which vulnerability is seen as arising from the internal properties of a system or society/population, enables us to address the factors that drive vulnerability to climate change-related hazards and associated outcomes even in the absence of detailed information about the "character, magnitude and rate of climate change", provided we have a general grasp of what sort of hazards and (potential) outcomes we are concerned with. Such definitions are sometimes described as referring to 'social vulnerability' so as to distinguish them from the definition in the IPCC glossary (e.g. Brooks, 2003).

The framework proposed here, for the development of indicators to evaluate adaptation, is one in which the *risk* of a certain adverse developmental outcome is viewed as a function of the exposure of a system or population to a *hazard* with the potential to trigger that outcome, and the *vulnerability* of that system or population with respect to the hazard in question. Risk therefore results from the interaction of hazard and vulnerability such that "hazards combined with vulnerability can result in disasters" or other adverse outcomes (Kolmannskog, 2009).

Many factors, particularly those associated with poverty, will make people vulnerable to a range of hazards and associated outcomes. However vulnerability does not necessarily map directly onto poverty, and the factors that make people vulnerable to one particular hazard (e.g. drought) or outcome (e.g. food insecurity) will not necessarily be the same as those that make them vulnerable to other hazards (e.g. storm surges and flash floods) and outcomes (e.g. death, injury or loss of economic assets) (Brooks et al., 2005). When addressing vulnerability, we therefore need to be careful to talk about the vulnerability of a particular system/population/group to a particular type of hazard, with respect to a particular outcome or set of outcomes. Vulnerability to climate change will be a function of vulnerability to the suite of potential hazards (both short-term and long-term) and outcomes associated with climate change.

Vulnerability will be influenced by social, economic, political, cultural and environmental factors, and vulnerability indicators will need to capture the key drivers of vulnerability that represent the most important subset of these factors. Within a system or population, vulnerability will vary as a result of differentiated physical exposure and many other factors (e.g. social status, health, livelihood diversity, financial assets, etc). Vulnerability to hazards that unfold over periods of time sufficient to allow people to respond and adapt to change will also depend on *adaptive capacity*, which itself will be influenced by a host of factors such as access to financial and other resources, ability to move and migrate, and so on.

1.4.4 Shifting baselines and attribution

The motivation behind adaptation efforts (ostensibly at least) is the need to help people, institutions and societies at large secure development in the face of changing climatic conditions. Except where interventions are intended to address the adaptation deficit, adaptation will by definition take place against a shifting climatic and environmental baseline. Even where the focus is on helping people cope better with existing climatic variability, climate change is likely to result in an evolving baseline of climate-related hazards and risks. This shifting baseline presents a challenge for evaluation, as it has the potential to act as a confounding factor in the assessment of development and adaptation interventions. For example, in order to understand the impacts of an intervention intended to reduce mortality from climate-related disasters, it would not be sufficient to track mortality alone. A more-or-less 'stable' mortality rate might suggest that a society's ability to cope with climatic extremes that trigger disasters is not improving, if it is assumed that the nature and frequency of such extremes remains constant. However, if such extremes are becoming more severe and/or frequent, a stable mortality rate might indicate 'successful' adaptation measures that prevent increased mortality in the face of worsening climate hazards.

Another example might be the evaluation of a project or programme that provides cash transfers and other forms of micro-credit to poor subsistence farmers, with the goal of encouraging agricultural investment and innovation to increase crop yields and diversify livelihoods on the one hand, and invest in children's education on the other. If increasing drought frequency and severity result in a decline in productivity and an increase in food prices, some or all of the additional financial resources provided might be used to offset productivity losses, and/or absorbed by increased household expenditure, rather than for investment in agriculture and education as intended. These additional financial resources might be vital in helping people cope with deteriorating climatic conditions. However, if the deteriorating climatic baseline is not acknowledged in the evaluation process, the intervention may be classified as a failure, and support withdrawn. In contrast, if the shift in baseline conditions is taken into account, support might be increased or modified to address the intensification of climate-related risk.

The above examples illustrate the need for evaluation metrics to be 'normalised' with respect to changes in baseline conditions related to climate change, and also for contextualisation in the context of other changes (such as global or regional economic changes that may influence people's vulnerability to hazards and their adverse outcomes[8]).

This is especially important for any evaluation that might be based on standard development indicators related to factors such as poverty, health and education, all of which might be adversely affected by the impacts of climate change. However, it is also important for more 'climate-specific' vulnerability indicators, as the impacts of climate change may be associated with increases in vulnerability (e.g. where climate change constrains or reduces livelihood options).

Indicator-based evaluation therefore needs to be supported by monitoring of climatic and environmental (and other, e.g. economic) trends, so that 'confounding' factors may be identified. This is vital if the true impacts of development and adaptation interventions are to be identified, and robust and effective adaptation strategies, policies, plans and measures developed.

The normalisation of evaluation metrics with respect to changing climatic and environmental baselines is likely to be problematic, and will depend on the availability of data at relevant temporal and spatial scales, and also on the availability of the technical capacity and resources required for the analysis and interpretation of such data. Issues of precisely how individual indicators should be normalised with respect to changes in climatic and related variables will not be trivial. These problems mean that reductionist approaches to attribution are likely to be impractical in many cases. There will therefore be a need for quantitative indicators to be complemented by qualitative assessments, based on techniques such as structured interviews and participatory vulnerability assessments, that can help those responsible for adaptation interventions understand the mechanisms and pathways via which such interventions are translated into impacts, and how these impacts are mediated by other factors such as climatic and environmental trends. In this context, 'narratives' that describe changes in climate hazards and their consequences, the factors that make people vulnerable to these hazards, people's experiences and perceptions of risk, and how these are affected by development and adaptation interventions, will play an important role in understanding and evaluating adaptation.

1.5 Synthesis: implications for adaptation evaluation criteria

The above discussion is most relevant to the evaluation criterion of efficacy/effectiveness, but is also relevant to the criteria of efficiency and equity. Table 2 below outlines conclusions that can be drawn from the preceding discussion regarding each of the criteria for the evaluation of adaptation.

8 For example, changes in global commodity prices might result in increased food prices locally that make smallholders more vulnerable to food insecurity associated with drought, but constraining their ability to purchase foodstuffs in order to compensate for lower productivity.

Table 2

Implications for adaptation evaluation criteria

Criterion	Implications for adaptation evaluation
Feasibility	The feasibility of adaptation interventions will depend on a variety of factors, the most important of which are likely to be technical feasibility, the existence of sufficient management capacity for formulation and implementation, and cost (or benefit/cost ratio). In any adaptation context, once climate vulnerability assessments have been made the intervention is likely to begin with the identification of a number of potential adaptation measures or options, which are then prioritised. It is during the prioritisation phase that the feasibility of different options will be assessed.
Efficacy/ effectiveness	The way in which the effectiveness of adaptation interventions is assessed will depend on the context in which such interventions are designed and implemented. However, based on the above discussion, effectiveness might be assessed based on (i) the impact of an intervention at the institutional level, e.g. in terms of preparedness, resilience or adaptive capacity, (ii) the impact of an intervention on the vulnerability of individuals, groups or other entities, or (iii) the impact of an intervention on outcomes, where such outcomes can be measured (e.g. on mortality, health or poverty outcomes). All of the above three ways of assessing effectiveness may employ indicators, related to (i) processes associated with institutional change, (ii) factors associated with vulnerability to climate change-related hazards, and (iii) development (or e.g. disaster) outcomes. Where assessment of effectiveness is based on vulnerability or development indicators (and particularly the latter), the effects of changing climatic and environmental baseline conditions will need to be accounted for, and quantitative indicator data will need to be complemented by qualitative information addressing attribution of vulnerability or development outcomes to interventions
Efficiency	Efficiency is most likely to be assessed in terms of the ratio of benefits to costs, and this might be achieved by combining data relating to effectiveness (e.g. measures of the extent to which vulnerability has been reduced or outcomes improved) with financial data relating to the cost of any particular intervention.
Acceptability/ legitimacy	The acceptability of an intervention will be a subjective matter best evaluated through engagement with a range of stakeholders representing all those likely to be affected by the intervention. Issues related to transparency and accountability are particularly important in this context.
Equity	The extent to which an intervention may be seen as equitable might be assessed in a variety of ways, each of which will have objective and subjective elements. Equitable interventions might be seen as those that provide the greatest degree of assistance to the poorest. In the context of climate change and adaptation, equity might depend on the extent to which an intervention targets the most vulnerable populations or individuals. Equity will also require that adaptation interventions do not result in the (further) marginalisation of certain groups (e.g. those already disadvantaged or particularly vulnerable), or in increased inequality. These risks can be addressed through the incorporation of safeguards and screening processes into evaluation. Equity might also extend to considerations of responsibility for anthropogenic climate change, with populations and countries characterised by a combination of high exposure and vulnerability to climate change-related hazards, and low historical responsibility for emissions, being seen as most "deserving" of adaptation assistance. The subjective nature of this issue means that the manner in which it should be adopted within evaluation efforts requires careful consideration.
Sustainability	This evaluation criterion is commonly separated into technical and institutional aspects. To what extent the intervention maintains its technical relevance to the problem it addresses – crucial when the is a shifting baseline. But also, how well the institutions involved can continue to operate the intervention. In the context of adaptation to climate change, sustainability requires that: ■ Adaptation interventions are compatible with environmental sustainability as usually defined (i.e. are not environmentally destructive, or seek to minimise environmental disruption – this might also mean that adaptation should not contribute significantly to greenhouse gas emissions). ■ The benefits of adaptation interventions will continue after the termination of the projects and programmes under which they are implemented. ■ Interventions designed to deliver adaptation benefits in the near-term do not increase vulnerability or drive maladaptation in the medium to long-term. ■ Interventions can be managed by mandated organizations into the medium and long terms. The above risks can be addressed in a similar way to the risks associated with the potential for projects to result in marginalisation, via screening and the introduction of safeguards, which might be based on a set of criteria which must be met in order to minimise the risk of maladaptation or increased vulnerability. Institutional sustainability requires assessments of the extent to which mandated organizations are dependent on outside assistance to manage and implement interventions over an appropriate time period.

2 The evaluation framework

2.1 The conceptual approach

FOLLOWING ON FROM THE ARGUMENTS PRESENTED in Part 1 of this paper, a framework is proposed that seeks to provide a means of answering the following question, which are the starting point for the evaluation of adaptation:

1. To what extent have adaptation interventions resulted in the integration of climate risk management into development policy and planning, or enhanced existing climate risk management capabilities?
2. To what extent have adaptation interventions increased the ability of individuals, communities and institutions to development and pursue their own adaptation strategies and measures (building adaptive capacity)?
3. To what extent have adaptation interventions reduced the vulnerability of individuals and households to hazards associated with climate variability and change?
4. To what extent have adaptation interventions increased the resilience of key sectors and natural/managed systems on which human populations depend?
5. To what extent have adaptation interventions helped to keep development 'on track' with respect to existing development targets such as those related to the MDGs, where climate change and variability act to make the achievement of these targets more difficult?

These questions are relevant across scales, and the proposed framework is intended to be applicable at a variety of levels, from the project level to the level of international programmes and adaptation funds. At the programme or fund level application of the framework will require the aggregation of results from sub-components (e.g. individual projects).

The framework for adaptation evaluation proposed here is based on a twin-track approach that combines (1) evaluation of the extent to which CRM is integrated into development processes, actions and institutions, and (2) evaluation of development performance in the context of climate change, based on development and vulnerability indicators. This twin-track approach is illustrated graphically in Figure 2 (a more detailed version of Figure 1), and the two tracks or elements of the approach, and the links between them, are described in more detail below.

Once again, it emphasised that what is being presented here is a 'framework' for evaluating adaptation, and not a 'toolkit' for M&E. The framework will need to be operationalised in any given adaptation evaluation context, with each track being translated into a set of processes that are appropriate to the specific context in question. Track 1 may be seen as representing the evaluation of 'upstream' climate risk management interventions, with Track 2 representing the evaluation of 'downstream' vulnerability and development outcomes. These two tracks will involve the following elements.

Track 1 - Integration of climate change into policies & institutions:

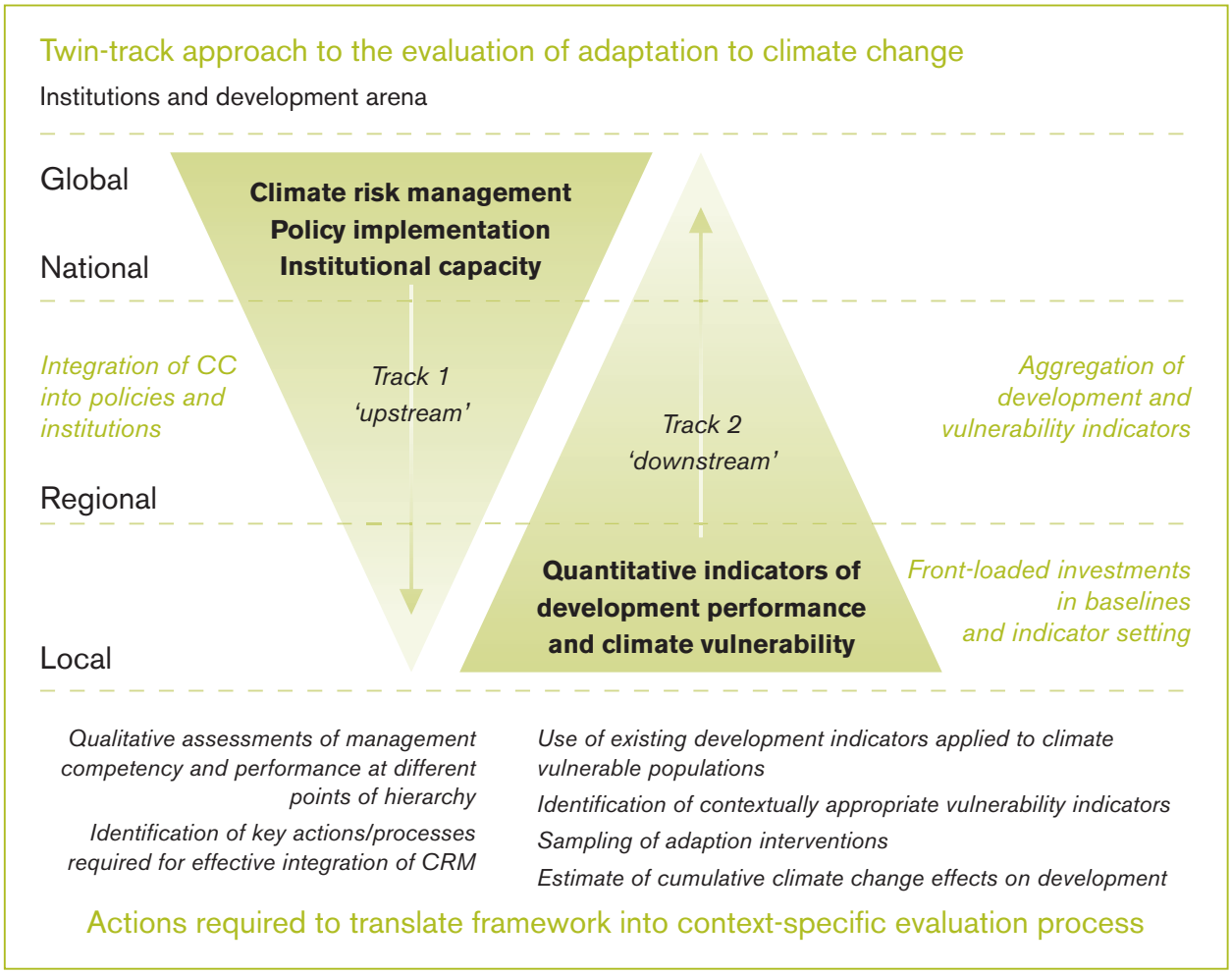
- Qualitative assessments of the management competency and performance at different points of hierarchy will be made.
- Climate risk management by key national to local authorities will be assessed.
- The extent of CRM policy implementation will be tracked
- Institutional capacity for CRM will be examined.

Track 2 – Identification, assessment and aggregation of development & vulnerability indicators:

- Quantitative indicators of development performance and climate vulnerability of the climate vulnerable poor will be identified. Front-loaded investments in baseline and indicator setting may be necessary.
- Where possible existing development indicators will be used and applied to climate vulnerable populations.

- Protocols for collating baseline and monitoring data will be prepared to guide implementation.
- By tracking changes in the developmental status and vulnerability of the climate vulnerable poor it will be possible to estimate the costs climate effects to these groups, and the costs and benefits of adaptation.
- By aggregating across adaptation interventions estimates of accumulative climate effects on development will be made.

Figure 2
Twin track approach to climate adaptation evaluation



By combining the evaluative information generated through both tracks, the effectiveness and general 'success' of the adaptation intervention selected for evaluation will be assessed. This theory-based evaluation approach will correlate the effectiveness of CRM with development outcomes and changes in vulnerability. This will be achieved through the development of theories of change appropriate to specific development and adaptation contexts (e.g. through studies of the drivers of vulnerability in those contexts), and by the development of narratives of change that link interventions to outcomes (e.g. through structured interviews with stakeholders).

The framework identifies broad categories of indicators (what we might term 'high-level' indicators) that will need to be operationalised in different contexts, rather than presenting prescriptive 'off the shelf' indicators to be used in all contexts. This is particularly important for indicators of vulnerability, which is highly contextual in nature; while a 'universal' indicator might be proposed that measures, for example, numbers of people moving from one vulnerability category to another, these categories will need to be defined at the local level based on context-specific indicators that capture the key drivers of vulnerability, which will vary according to developmental, environmental, climate risk, and project contexts.

2.1.1 Evaluation based on the integration of climate risk into development (Track 1)

The integration of climate risk management (CRM) into development processes, actions and institutions is a vital step in ensuring that climate change considerations are 'mainstreamed' into development (e.g. in strategies, policies, programmes, plans, etc).[9]

The approach set out here enables adaptation to be evaluated at the level of institutions and governance, under Track 1 of the framework. The entities responsible for formulating and implementing development will also be responsible for creating the conditions that are necessary for adaptation to take place. Assessment of the extent to which institutional environments and governance (e.g. in the form of legislative and regulatory frameworks) drive climate resilience and adaptation is one way of addressing the problems associated with the potentially long timescales associated with the unfolding of climate change and adaptation outcomes (i.e. where these are longer than project or evaluation timescales), and with attributing particular development outcomes to specific adaptation interventions.

Such assessments must be based on sound evidence that the actions taken at this level lead to, or are likely to lead to, increased resilience and reduced vulnerability of those systems and populations that are exposed to the manifestations of climate change (i.e. climate change hazards). This evidence might take the form of case studies examining the impacts of specific interventions (e.g. pilot studies), analogues from other countries or regions (with the case made as to why these analogues are relevant and appropriate), or stakeholder consultations. A vital component of any such assessments will be a sound understanding of risk contexts and drivers of vulnerability.

Assessment of CRM integration or mainstreaming is likely to be largely qualitative in nature, and might follow a 'certification' type approach. For example, such assessment might focus on criteria related to whether or not particular actions have been taken and whether or not specific mechanisms (e.g. for screening policies for climate change risks) are in place[10].

2.1.2 Evaluation based on development and vulnerability indicators

Evaluation of development performance under climate change will assess changes in real-life development outcomes resulting from adaptation interventions. This will involve the use of standard indicators of development performance, for example indicators related to poverty, health, education, and so on, applied to populations facing challenges from climate change related hazards - the climate vulnerable poor. These indicators will provide information on whether development is on-track, for example with respect to targets such as those associated with the MDGs and national development strategies. These indicators will need to be complemented by information on changing climate-related hazards and risks, to address the issue of shifting climatic and environmental baselines that might skew evaluations and result in a false picture of how development (and adaptation) interventions are performing. As discussed above, development might have to 'work harder' to deliver outcomes in the face of climate change, and failure to meet targets may result from confounding factors associated with climate change that offset development gains, rather than any inherent flaws in development processes.

Standard indicators of development performance will go only so far in assessing the impacts of adaptation interventions. A more direct way of assessing the impacts of such interventions will be to evaluate how they have affected vulnerability within specific risk contexts (e.g. vulnerability to food insecurity in the face of increasing drought among rural populations). Such assessments may be achieved using indicators tailored to specific drivers or elements of vulnerability that are targeted by adaptation interventions. Such context-specific vulnerability indicators will be more relevant to the evaluation of adaptation than generic development indicators. Indicator data collected before, during and after the implementation of an adaptation intervention will enable changes in vulnerability to be tracked (e.g. changes in household livelihood diversity, non-farm income, access to weather-related insurance, etc). Once key vulnerability indicators have been identified, it is possible to assess changes in vulnerability based on these indicators. This approach, in which localised, highly contextual indicator data are converted to unit-less scores that allow changes in vulnerability to be assessed in a semi-quantitative manner, would enable numbers of people experiencing a reduction in vulnerability to be aggregated across different contexts, and different countries (Box 5). The score-based approach also allows aggregation across different indicators within any given context (e.g. by adding or averaging scores across indicators for each household or other 'unit of exposure').

Box 5
Conversion of indicator data to unit-less scores

An adaptation project might seek to increase livelihood diversity and non-farm income in order to reduce household-level vulnerability to drought and food insecurity. Data on non-farm income per household could be gathered, and the range of incomes recorded divided into quintiles (highest income minus lowest income divided by 5). Households could then be assigned a score of 1 to 5 according to the quintile in which they fall. Households moving up by one or more quintiles would be interpreted as experiencing a reduction in vulnerability, enabling donors to assess how many households (and by extension individuals) had seen a reduction in vulnerability as a result of the adaptation intervention, provided the issue of attribution could be addressed satisfactorily.

9 See for example the AC-EPOC (2010) Policy Guidance on Integrating Climate Change Adaptation into Development Cooperation. Development Assistance Committee (DAC) Environmental Policy Committee (EPOC).

10 Assessing the extent to which climate risk management is being applied to development processes, actions, and institutions corresponds approximately to a set of actions DFID has defined as 'Building Blocks' in its Adaptation Programming Strategy.

An approach based on the conversion of vulnerability indicator data to unit-less scores can be applied to vulnerable communities or communities that are recipients of development aid in order to track the impacts of adaptation interventions in a 'bottom-up' fashion, complementing the 'top-down' approach outlined above for the evaluation of integration of adaptation into development processes and actions at the institutional level. The vulnerability indicator approach will be relatively time and resource intensive (requiring drivers of vulnerability to be identified and data relating to these drivers gathered), but offers a way of assessing the impacts of adaptation actions on the ground through empirical evidence.

2.1.3 Attribution of outcomes to interventions

The 'downstream' indicator approach outlined above for Track 2 will need to be supported by analysis that addresses the issue of attribution. Theories of change will need to be developed to link reductions in vulnerability to improved CRM, in order to understand the mechanisms and pathways through which the integration of CRM into development processes, actions and institutions leads to more climate resilient development (and hence reduced vulnerability), compared with baseline or counterfactual situations in which no such integration action is taken.

An understanding of these mechanisms and pathways should inform the design of adaptation interventions; attribution analysis will involve both ex-ante and post hoc assessment to verify the assumptions behind the interventions and to confirm that the desired impacts are being achieved, or to identify reasons why these assumptions are not valid and desired impacts are not being realised. Qualitative studies involving surveys, interviews and the development of narratives of changes based on the experience of stakeholders (and particularly the targets of adaptation interventions), will all play a role in attribution analyses.

2.2 Proposed indicators

A number of 'high-level' indicators are proposed for evaluating adaptation, many of which will need to be operationalised by translation into context-specific indicators relevant to particularly situations. 'Upstream' indicators represent progress on the integration of climate risk management into development processes, actions and institutions. 'Downstream' indicators represent the impacts of adaptation interventions of development 'on the ground' in terms of impacts on development outcomes and vulnerability.

The proposed indicators overlap to a certain extent with existing results frameworks such as those developed for the Pilot Programme on Climate Resilience (PPCR) and the Adaptation Fund (AF), which are discussed in more detail in Annex 1. A third category of indicators relating to adaptation outcomes, and based on an opportunistic approach to evaluation, is also discussed.

More work needs to be done to link upstream and downstream indicators through theories of change that address issues of attribution. While downstream indicators are likely to present more challenges than upstream indicators in an operational context, downstream indicators take us further towards measuring the ultimate impact of adaptation, and have greater communications value that upstream indicators. Country driven pilot studies will be required to establish causal links between upstream interventions and downstream outcomes.

2.2.1 Climate risk management indicators (Track 1)

The following indicators are proposed to evaluate the extent to which climate risk management is integrated into development processes, actions and institutions:

- The use of climate information (and M&E information) in policy & programme design (e.g. policies and programmes informed by evidence of emerging climate trends and scenarios of future climate change).
- How well the components of the national system conducts National Adaptive Capacity functions (with reference to, for example, the World Resources Institute National Adaptive Capacity framework[11]).
- Proportion of development initiatives that are modified compared to a 'business-as-usual' case in order to make them more climate-resilient
- Mechanisms for targeting the climate vulnerable (e.g. for carrying out climate risk assessment and vulnerability assessment and using the results of such assessments to inform development policy and practice).
- Institutional framework of regulatory and legal support plus macroeconomic management for climate resilience (e.g. requirements for certain types of development initiative to be subject to screening for climate change-related risks).

2.2.2 Climate relevant development/ vulnerability indicators

Assessment of reductions in the vulnerability of human populations to climate change related hazards and risks as a result of adaptation interventions will be at the heart of adaptation evaluation, as discussed above. However, this may be complemented by a number of other measures of the impact of adaptation. The following indicators are proposed:

- Numbers of beneficiaries of CC interventions (i.e. numbers of people benefiting from projects or project components that address climate change issues, e.g. through integration of measures to promote resilience or reduce climate change-related risks).
- Coverage of CC interventions (proportion of portfolio that

11 http://pdf.wri.org/working_papers/NAC_framework_2009-12.pdf

includes measures to address climate change).

- Numbers of people experiencing reductions in vulnerability, represented by movement from more vulnerable to less vulnerable category/score in key indicators (based on variety of context specific indicators converted into scores that can be aggregated across contexts).
- Value of assets and economic activities protected or made less vulnerable as a result of adaptation interventions (e.g. based on capital assets with reduced physical exposure compared with business-as-usual scenario, turnover of businesses incorporating adaptation measures resulting from projects, etc).
- Benefit/ cost ratios of adaptation options identified/ implemented (based on ratio of value of assets and productivity made less vulnerable to adaptation expenditure).

2.2.3 Opportunistic indicators

While the ultimate impacts of adaptation may not be apparent over the lifetime of specific interventions (e.g. projects) and associated evaluation processes, there may be certain circumstances under which the impacts of adaptation interventions on development outcomes can be assessed empirically. This might be the case where two similar extreme climatic events, of comparable magnitude, occur before and after adaptation interventions have been undertaken. An example of such an intervention might be the construction of storm shelters or the introduction of early warning systems to reduce vulnerability to death or injury associated with risks from storm surges. If similar magnitude storm surges occur before and after the implementation of such measures, mortality outcomes might be compared for these events. If a reduction in mortality is seen, further evidence will be required in order to attribute this reduction to the adaptation interventions, and this is likely to take the form of stakeholder consultations combined with local knowledge and expertise to generate qualitative evidence that reveals the extent to which outcomes may be associated with interventions.

Opportunistic indicators will always be additional and complementary to climate risk management and vulnerability indicators, but can provide valuable information on adaptation outcomes where circumstances permit their use.

3 Conclusions

The approach described above is by no means a 'magic bullet' that will solve the wicked problem of assessing what constitutes 'good' adaptation, and it is not intended as such. Rather, it is a work in progress that represents a first step towards the development of a coherent framework for the evaluation of adaptation, and is intended as a contribution to the discussion on this topic among the communities of adaptation and development practitioners. At this juncture, the following conclusions can be drawn:

The indicators proposed above are not intended to substitute for indicators and processes at the country level, which are tailored to local contexts. Nor are they intended to be comprehensive. They are designed such that they can 'sweep' existing frameworks and approaches in order to present an aggregated picture of overall progress towards adaptation goals.

The extent to which existing M&E processes allow the proposed framework to be implemented needs to be assessed.

Work remains to be done on evaluating and attributing impacts, both in terms of specific livelihood outcomes and demonstrating causal relationships between upstream and downstream processes.

The costs associated with defining baselines and indicators in national contexts need to be front-loaded into adaptation investments; it is worth investing up-front to ensure that the evidence base exists to support meaningful evaluation.

Climate adaptation funds' M&E and results-based frameworks might be improved by incorporating nationally-developed indicators that track climate risk management on the one hand, and climate-relevant development and vulnerability indicators on the other hand.

Work is needed to establish baselines: this should be viewed as an opportunity to build local analytical capacity on climate risk. Such capacity building should included in the design stage of baseline development.

4 Next steps

THE NEXT STAGE IN THE DEVELOPMENT OF THE adaptation evaluation framework described above is to pilot the framework in a number of development and adaptation contexts. It is intended to operationalise the framework through pilot studies in a number of countries (probably 5 countries in total). The strategy for undertaking these pilot studies is outlined in Figure 3, which also indicates the intended goal and outcomes associated with the development and operationalisation of the framework in a schematic representation of a theory of change.

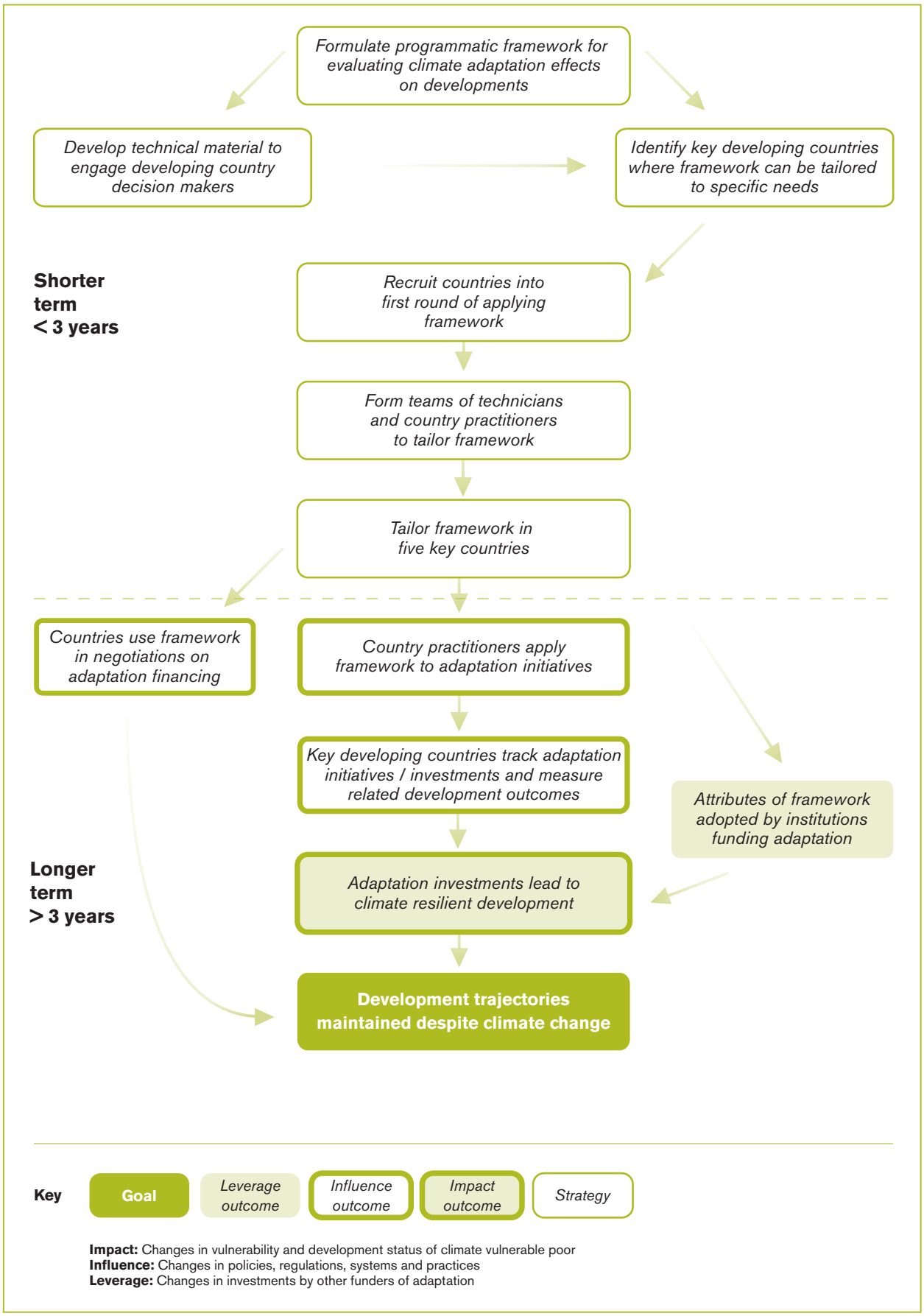
The piloting of the framework in a number of national contexts will involve a number of country-driven processes to translate the framework into nationally appropriate evaluative mechanisms. These processes will include:

- Assessments of the quality and scope of existing baseline data/information
- Agreement on the adaptation interventions to be used for the piloting of the framework
- Negotiation of ways to introduce the framework in the context of the selected adaptation interventions
- Agreement on the scale and size of the sampling (e.g. proportion of a programme, project or other initiative to be evaluated) for each track
- Translation of 'high-level' indicators into locally relevant indicators, particularly for vulnerability indicators

The piloting of the framework is expected to be completed within 3 years. The results of the piloting (assessed at the end of the pilot studies and possibly at certain stages within the pilot period) will be publicised with the aim of informing the wider debate on how to evaluate adaptation, for example in the context of the Green Climate Fund and other funds for adaptation investments. From the national case findings recommendations for the application of the framework across adaptation programming will be generated.

The further development and piloting of the framework, and the results generated, will be employed alongside insights from other comparable initiatives to leverage support from among development partners for moving towards a common approach to the evaluation of adaptation to climate change.

Figure 3
Theory of change for tracking adaptation and measuring development work



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Annexes

Annex 1 Glossary

Adaptation

Adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities.

Adaptive Capacity

The IPCC defines adaptive capacity as "The ability of a system to adjust to climate change (including climate variability and extremes) to moderate potential damages, to take advantage of opportunities, or to cope with the consequences." However, adaptive capacity may be viewed as a property of individuals as well as systems (where a system may be a natural system, a social system, an institution, a community, and so on).

Hazard

A climate-related hazard is a physical manifestation of climate change or variability. Such hazards include:

- short-lived, sudden onset events (i.e. climate extremes including phenomena such as wind storms, storm surges, intense precipitation and runoff events),
- longer-lived but transient events (e.g. droughts, heat-waves),
- long-term changes in average conditions, such as changes in average temperature or rainfall, increases in sea-level, changes in seasonality or other manifestations of climate variability
- Qualitative changes in climatic or environmental conditions that might be associated with 'abrupt' climatic or environmental transitions at various scales (e.g. changes in monsoon behaviour, catastrophic landscape changes associated with glacial outbursts or extreme floods).

Climate change may also result in the emergence of new hazards in certain areas. For example, in 2004 the first ever recorded South Atlantic tropical storm ('Hurricane Catarina') made landfall in Santa Catarina province in Brazil. This storm formed in an area predicted by a global climate model to become a centre of tropical storm formation in the 2070s. While no further such hazards have occurred in this region, Hurricane Catarina is illustrative of the potential for new hazards to emerge in certain parts of the world.

Resilience

The term 'resilience' as used here is closely related to the concept of resilience as used in the field of ecology, and as employed by the IPCC, which defines resilience as "The ability of a social or ecological system to absorb disturbances while retaining the same basic structure and ways of functioning, the capacity for self-organisation, and the capacity to adapt to stress and change." (Glossary of Working Group II, IPCC AR4, 2007)

Risk

Risk results from the interaction of hazards and vulnerability, with the risk of a particular outcome (e.g. a sudden-onset disaster such as a rapid population displacement or the breaching of flood defences, or a slow-onset disaster such as a famine) being a function of the likelihood of occurrence of a hazard that acts as a 'trigger' event (e.g. a storm surge or drought), and of the vulnerability of the system or population exposed to the hazard and its immediate physical consequences.

Vulnerability

Vulnerability is defined here as resulting from the set of diverse factors that determine the ability of an individual or system to cope with, absorb and recover from the manifestations of climate change and variability.

Annex 2 Comparison with other results frameworks

RESULTS FRAMEWORKS HAVE BEEN DEVELOPED to evaluate adaptation by several bodies. The most comprehensive such frameworks currently available are those associated with the Pilot Programme for Climate Resilience (PPCR) and the Adaptation Fund (AF), which are discussed in more detail below. Tables A and B summarise the results and indicator frameworks for the PPCR and AF respectively.

The Pilot Programme for Climate Resilience (PPCR) results framework

The PPCR is part of the Climate Investment Funds (CIFs), which aim to assist developing countries to integrate climate change concerns into national development planning.[12] The PPCR framework (Table A) groups results into three categories: (i) transformative impacts, (ii) catalytic replication outcomes, and (iii) PPCR outcomes and outputs (the largest category). Transformative impacts (category i) are associated with indicators based on standard development indicators, including environmental indicators such as those relating to land degradation, with a focus on areas most affected by climate change. Catalytic replication outcomes (category ii) focus on institutional and investment outcomes of the PPCR. PPCR outcomes and outputs (category iii) include institutional and investment outcomes, but also encompass measures of development outcomes in the face of climate change.

Categories (ii) and (iii) of the PPCR results framework include indicators that overlap with the climate risk management indicators proposed in this report for adaptation evaluation. The indicators of development outcomes in the PPCR framework face the same problems of timescale and changes in climatic and environmental baselines that are outlined above in this report. The PPCR Results Framework acknowledges the problem of timescale, and makes the following statement in relation to this issue:

"The target and baseline column is still blank and can only be filled in close cooperation with the MDBs and particularly the country teams. As mentioned above some of these indicators have very different time frames. Baselines might only be established in the medium-term (1-2 years) and a true impact reporting is probably not possible for a significant time span (10-15 years)."

The problem of how to assess development performance in the face of changing climatic and environmental baselines, described in detail earlier in this report, is not addressed in the PPCR framework. The PPCR framework acknowledges the need to address vulnerability in order to promote climate resilience, and vulnerability assessments are referenced in the framework as among the activities that should be pursued to indicate that climate resilience is integrated into development planning and practice. However, vulnerability indicators do not appear to be included explicitly under project-level indicators, which focus on more 'downstream' development outcomes.

Source: PPCR Results Framework, p. 8.

12 www.climateinvestmentfunds.org/cif/

Table A
Summary of results and associated indicators in the PPCR results framework[13]

PPCR RESULTS FRAMEWORK	
Results	**Indicators**
Transformative impacts	
Improved quality of life of people living in areas most affected by climate change	HDI score (country), MDG indicators, % of people classified as poor and food insecure in most affected regions, mortality and economic losses from climate extremes
Increased climate resilience in economic, social and eco-systems	EWSs, changes in land degradation, social protection, insurance, credit access, livelihood diversification, etc
Catalytic replication outcomes	
Improved institutional capacity to respond to climate variability and change	No. and quality of policies introduced/adjusted to address climate change, quality of participatory panning processes, adaptation monitoring, decision-making incorporates climate information
Scaled-up investments in climate resilience and their replication	Climate resilient investments (no. and value), evidence of lessons learned and increased capacity to manage climate resilient investments
Replication of PPCR in non-PPCR countries	No. of countries and sectors applying climate proofing and climate resilience principles and sharing through PPCR, countries replicating PPCR approaches
PPCR outcomes and outputs	
Improved integration of resilience into country development strategies, policies, plans, etc	Degree to which planning integrates climate proofing and vulnerability assessment, integration and dissemination of CRM, budget allocations take account of climate change
Increased capacity to integrate climate resilience into country strategies	Evidence of cross-sectoral mechanism to address climate variability and change, evidence of ministries/agencies taking lead in updating strategies
Increased knowledge of climate change, variability, impacts in govt., private sector, civil society, education sector	Coverage of climate risk analysis and vulnerability assessments based on current scientific evidence
Increased capacity to withstand/recover from climate change and variability	Project-level indicators including e.g. reduced impacts & losses, continuity of climate-sensitive services (e.g. water, infrastructure)
Enhanced integration of learning/knowledge into climate resilient development	Relevance & quality of knowledge assets (publications, studies, platforms, etc) created, evidence of use of knowledge and learning
New and additional resources for climate resilient development	Leverage factor of PPCR funding, financing from other sources

13 Based on information in: Pilot Programme for Climate Resilience (PPCR) Results Framework, PPCR/SC.7/7, 28 October 2010. Meeting of the PPCR Sub-Committee, Washington DC, 10 November 2010. Climate Investment Funds.

The Adaptation Fund results framework

The Adaptation Fund (AF) is a financial instrument under the control of the Parties to the United Nations Framework Convention on Climate Change and its Kyoto Protocol (KP). The AF finances adaptation projects and programmes in developing countries that are Parties to the KP[14].

The AF indicators share a number of similarities with those of the PPCR framework, addressing issues such as the extent of integration of adaptation and resilience-building measures into national development strategies, policies introduced or adjusted to address climate change risks, and so on. There is a greater explicit emphasis on the impacts of adaptation on populations and the systems on which they depend (e.g. ecosystems, health systems, infrastructure), assessed through quantitative indicators referring to factors such as numbers of projects, numbers of institutions targeted/affected by interventions, numbers of adaptation actions takes, and number of assets strengthened.

Vulnerability/resilience of populations is addressed by three of the AF indicators: % of households with more secure access to livelihood assets, % of population with sustained climate-resilient livelihoods, and number of households with more secure access to livelihood assets. The first and last of these measure the same outcome in different ways, and all are concerned with the livelihood aspects of vulnerability. The additional guidance on these indicators suggests that they are defined in more detail at the project level, and that changes in access are measured on a 1-5 scale, echoing the scoring approach suggested for vulnerability indicators in this report. As in the case of the PPCR framework, the role of vulnerability assessments is recognised (in indicator 1.1).

The AF results framework also assesses exposure (e.g. number of people affected by climate variability, defined as those suffering losses as a result of climate variability) and development/adaptation outcomes (e.g. reduced number of people suffering losses from extreme weather events). The latter type of indicator is associated with the problems of assessing outcomes over evaluation timescales that might be too short to be representative of the relevant aspects of climate variability and of climate trends, and the problems of assessing the impacts of interventions against a shifting climatic baseline, as discussed above.

Discussion and comparison of results frameworks

Overall, the AF indicators suggest a focus on addressing the adaptation deficit and climate proofing development for incremental changes in existing risks. The AF focus is very much on livelihoods and general resilience, and appears to be relatively short term, focusing on 'protecting' existing practices and systems in the face of evolving, but historically familiar, risks. There is little in the AF framework to indicate that it recognises the potential need for transformational change.

The PPCR framework has a stronger focus on the mechanisms through which adaptation is integrated into development planning and practice, and is potentially more able to accommodate issues of transformational change.

Both the PPCR and AF frameworks propose assessing the success of adaptation in terms of improved development outcomes in the face of climate change. However, neither framework explains how improved outcomes from climate variability and extremes will be demonstrated where variability and extremes are evolving (the problem of 'normalising' outcomes with respect to climatic baselines as discussed above). The PPCR framework acknowledges that assessing changes in such outcomes might not be feasible over the relatively short timescales likely to be associated with projects and evaluation processes, but does not propose any means of addressing this issue.

Both the PPCR and AF frameworks highlight the role of vulnerability assessments, and both suggest assessment using indicators that are may be viewed as proxies for vulnerability. However, the treatment of vulnerability is somewhat indirect in both cases, and neither framework offers a framework for addressing vulnerability, or addresses the relationship/distinction between vulnerability indicators and standard development indicators at the project level.

The indicator framework proposed in this report shares similarities with the PPCR and AF results frameworks. However, it differs from them in its specific use of vulnerability indicators as an explicit means of addressing the problem of how to assess the impacts of adaptation 'on the ground', given that the ultimate impacts of adaptation on development outcomes might not be apparent on the operational timescales of adaptation projects and associated evaluation mechanisms. Outcome indicators are separated from vulnerability indicators, with the former being viewed as complementary to the latter where circumstances permit their use. The framework presented here further differs from those of the PPCR and the AF by acknowledging and addressing problems associated with changing climatic baselines. It also provides an explicit framework for combining 'top-down' institutional indicators with 'bottom-up' vulnerability indicators, which is absent in the PPCR and AF approaches.

14 www.adaptation-fund.org/

Table B

Adaptation Fund standard indicators[15]. The AF results framework contains more detailed guidance on each of the indicators listed here[16]

Indicators used in the AF results framework	
1	Relevant threat and hazard information generated and disseminated to stakeholders on a timely basis
1.1	No. and type of projects that conduct and update risk and vulnerability assessments
1.2	Early warning systems developed
2.1	No. of targeted institutions with increased capacity to minimise exposure to climate variability risks
2.2	Reduced number of people suffering losses from extreme weather events
2.1.1	No. of staff trained to respond to and mitigate impacts of climate related events
2.1.2	Percentage of population covered by adequate risk reduction systems
2.1.3	No. of people affected by climate variability
3	Percentage of targeted population aware of predicted adverse impacts of climate change, and of appropriate responses
3.1	No. and type of risk reduction actions or strategies introduced at local level
4.1	Development sectors' services (health and social services) responsive to evolving needs from changing and variable climate
4.2	Physical infrastructure improved under climate change and variability-induced stress
4.1.1	No. and type of health or social infrastructure developed or modified to respond to new conditions resulting from climate variability and change (by type)
4.1.2	No. of physical assets strengthened or constructed to withstand conditions resulting from climate variability and change (by asset types)
5.1	Ecosystem services maintained or improved under climate change and variability-induced stress
5.2	No. and type of natural resource assets created, maintained or improved to withstand conditions resulting from climate variability and change (by type of assets)
6.1	Percentage of households and communities having more secure (increased) access to livelihood assets
6.2	Percentage of targeted population with sustained climate-resilient livelihoods
6.1.1	No. and type of adaptation assets (physical as well as in terms of knowledge) created in support of individual or community livelihood strategies
6.1.2	No. of households with more secure access to livelihood assets
7.	Climate change priorities are integrated into national development strategy
7.1	Number of policies introduced to address climate change risks or adjusted to incorporate climate change risks

15 As presented in: Project Level Results Framework and Baseline Guidance Document, AFB/EFC.3/3 December 9 2010, Ethics and Finance Committee Third Meeting, Cancun, 13 December 2010 (Agenda Item 3), Adaptation Fund, p. 30.

16 The table presented here is reproduced exactly as it is presented in the original source including ordering and numbering of indicators. The source has since updated the table to better explain the numbering and ordering of indicators. An updated version can be found here http://adaptation-fund.org/document/1232-project-level-results-framework-and-baseline-guidance-document (p.4).

Annex 3 From incremental to transformational change

Climate proofing and additionality - limitations

Most existing 'adaptation' interventions focus on (i) environmental rehabilitation (e.g. of coastlines to reduce vulnerability to flooding and storm surges), (ii) measures to make societies and communities more resilient in the face of hazards associated with climate variability (e.g. livelihood diversification), or (iii) measures to reduce vulnerability to incremental changes in climate-related risks (e.g. rezoning of coastal development to address sea-level rise and increased coastal flood and erosion risks).

These approaches are often described as constituting 'climate proofing' of development, based on the (often implicit) assumption that existing economic activities and patterns of development can be sustained in the face of climate change through modifications to existing plans, practices and systems that increase resilience in the face of climate change, but which enable these plans, practices and systems to remain in place while retaining the same fundamental characteristics and delivering the same outcomes (e.g. services, products, etc). This assumption that existing systems and practices (and by extension, existing modes and patterns of development) can be made more resilient through incremental modification is closely linked with the concepts of resilience and additionality. Resilient systems are those which manage to retain the same basic structure and ways of functioning, and the goal of 'climate resilient development' is to ensure that the systems on which human populations depend exhibit resilience in the face of climate change. Additionality presupposes that this can be achieved by 'adding' adaptation measures to existing or planned development actions and interventions, and that these measures are associated with additional costs over and above those associated with 'business as usual' development.

While the approach described above may be successful in many instances, it cannot be assumed that all existing development can be 'climate proofed' in this manner. Climate change (and other environmental constraints) may mean that some development is fundamentally unsustainable because it will not be viable under future climatic conditions. In such cases, 'climate proofing' may result in costly failures or in maladaptation that makes societies less resilient to future climatic shocks, increasing the risk of system, or even societal, collapse. Where this is the case, climate proofing through incremental modifications to existing plans, practices and systems, based on the concept of additionality and resilience (at least of existing systems), will need to be replaced by adaptation strategies based on more fundamental changes to the way development is pursued.

Hypothetical examples of transformational change

An example of transformational change might be a semi-arid monsoonal region in which rainfall is currently sufficient to support widespread rainfed agriculture that constitutes the principal economic activity, but in which rainfall is projected to decline in the future, and in which monsoon instability has the potential to lead to a catastrophic collapse in rainfall due to geographic shifts in rainfall zones. In the near-term, rainfed agriculture might be sustained through 'climate proofing' based on better soil and water conservation and expansion of irrigiation, in order to address increased water stress resulting from reductions in annual rainfall, increased rainfall variability, and greater evapotranspiration driven by higher temperatures. However, such a strategy may not be viable in the longer term if rainfall declines and evapotranspiration increases to such an extent that groundwater levels decline to a point at which irrigation is no longer viable (due to reduced recharge, greater evaporative losses, and increased abstraction). Ultimately agriculture might simply become unviable in such a region, at least on the scales previously practices.

Under such circumstances, a 'transformational' approach to adaptation will be required. Such an approach might involve a variety of strategies and measures, including support for a transition from agriculture to herding, the identification of any areas in which agriculture might still be practiced (e.g. oasis and riverine areas and areas with locally elevated water tables), and the facilitation of migration (both internally to 'refugia' and externally in the form of out-migration). The facilitation of migration would require the identification of potential destination areas and the development or expansion

of supporting infrastructure in these areas, as well as programmes to integrate migrants into host communities.

Other examples of transformational change might include (i) the restructuring of local, regional or national economies away from dependence on natural resources or activities under existential threat from climate change (e.g. threatened fisheries, water-intensive activities in areas under severe water stress, forests), (ii) the large-scale restructuring of agricultural systems based on transitions to new types of crops better suited to changed climatic conditions, (iii) the phased relocation of settlements and economic activities away from areas of extreme climate risk or that are under existential threat from processes such as sea-level rise, (iv) the development of new water sources on regional scales, for example based on large-scale desalination of sea water and the distribution of fresh water through large infrastructure projects, and (v) the development of areas where climate change provides new opportunities (e.g. expansion of viable agricultural zones due to changes in rainfall and temperature at high altitudes and high latitudes).

Transformational change and growth

Current development is driven by the need for economic growth, which in turn is predicated on increases in productivity and efficiency in, and the commercialisation of, key sectors such as agriculture (Brooks et al., 2009). While there is an urgent need to promote growth in developing countries in order to generate the financial resources required to pay for development, growth can only be secured if it is based on sound assumptions. Since the emergence of development in the 1950s, the pursuit of growth has often been based on the implicit assumption that the environment is static on timescales longer than a few years, and on the assumption that models of development and economic growth can be applied universally in very different environmental and social contexts.

The African Sahel provides a good example of where a focus on growth through increased efficiency and productivity in the agricultural sector led to adverse development outcomes, and was ultimately self-defeating. Development policies in the 1950s and 1960s encouraged the expansion and intensification of agriculture, and the conversion of lands that were seen as under-utilised and potentially productive to commercial agricultural production (Cooper, 1997). However, the 1950s and 1960s were unusually wet (Brooks, 2004), and many of these lands were historically marginal, and unsuited to agriculture under more 'normal' conditions. Historically, these agriculturally marginal or unsuitable areas had provided grazing for mobile pastoralists, particularly during dry periods. The conversion of these lands to agriculture was unsustainable in the longer-term, and when the unusually wet period of the mid-20th century ended in severe drought in the early 1970s agriculture in these areas either collapsed or required large investment in irrigation (Parker, 1991; Heyd and Brooks, 2009). During the drought of the 1970s, as in subsequent periods, mobile pastoralists forced out of other areas by drought sought refuge in areas that had previously been uncultivated but that had been converted to agriculture in the 1950s and 1960s (Parker, 1991). Pastoralists were seen as 'encroaching' on agricultural lands, and conflicts between herders and farmers increased (Parker, 1991).

The failure of agriculture and the collapse of pastoral livelihoods during the drought of the 1970s resulted in an estimated 100,000 or more deaths, the loss of millions of livestock, migration of the destitute to urban centres, increased poverty, and widespread societal disruption (Swift, 1977; Hill, 1989; Keita and Henk, 1998). While drought acted as the trigger for these outcomes, development policies that sought to impose universal models of growth through increased agricultural efficiency and productivity, but which failed to consider whether these models were appropriate or sustainable in the environmental context of the Sahel, made populations more vulnerable to drought and helped to precipitate famine, destitution, dislocation and conflict (Brooks et al., 2009; Heyd and Brook, 2009).

The Sahel therefore acts as a cautionary tale of the dangers of pursuing growth through agricultural 'modernisation' that does not address the potential for long-term (decadal-scale) changes in climate to affect the viability of agricultural production in different areas. Climate change means that decadal-scale changes in rainfall that affect the productivity and viability of agriculture are likely to become more pronounced in many areas. In such areas, economic growth cannot be secured simply by seeking to maximise agricultural production and efficiency without attention to how climate change might affect the viability of agriculture (and of different types of agriculture). New models will be required that balance the drive for growth with the need for resilience and flexibility in production systems. These new models will need to consider the role of redundancy in production systems, so that failure of production in one area does not have catastrophic consequences (e.g. setting aside certain areas for pastoral use even in extended periods during which these areas might be agriculturally viable). While this might mean slower growth over the short term, this should be balanced by more predictable and sustainable growth in the longer-term.

Resilience in the face of uncertain changes in climate on timescales of decades will require the development of systems and models that incorporate concepts of risk spreading and redundancy, and which take a longer term view of growth and productivity than is currently fashionable. This will require a move away from the current paradigm based on rapid growth in the short term through the maximisation of production under current environmental and climatic conditions. While some may argue that such rapid growth is required to deliver urgently needed development benefits as soon as possible, if such growth increases vulnerability to climate variability and change these benefits will not be sustained, and any gains may be short-lived.

One of the most profound transformational changes required for development to confront climate change, particularly in areas where climatic and environmental conditions are, or are expected to become, marginal and highly variable, is the rethinking of current ideas about growth and how to achieve it.

For references, see reference list in main text.

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The series is open to the submission of papers by IIED staff and partners, and in exceptional circumstances by others doing research that is directly applicable to IIED's strategy and approach. Two types of papers will be considered: first, 'pre-publication' drafts of research or review articles that are intended to be subsequently published in a refereed journal, conference or book publication; second, innovative technical papers that are not necessarily intended for subsequent review and publication.

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All papers submitted to the series should adhere to the following style guidelines:

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- Research articles should present and discuss findings from a piece of original research. Research articles should include an introduction (including a research question or hypothesis), a description of the methods, an explanation of the results, and a discussion of the relevance of those results.
- Review articles should discuss and assess the state of knowledge in a particular field.
- All articles must be fully referenced using the Harvard system of referencing.
- Authors are encouraged to use visuals (tables, boxes, figures, photographs). All photographs must be sent in jpeg format. We may not be able to publish all visuals in colour.

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Climate Change

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