Global Climate Change Alliance Support Facility

Training workshops on mainstreaming climate change in national development planning and budgeting

HANDOUT FOR PARTICIPANTS

MODULE 4

Understanding and planning under uncertainty

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MODULE 4 – Understanding and planning under uncertainty

TOPICS COVERED BY THE MODULE:

- Sources of uncertainty.
- Planning in the face of uncertainties.

KEY TOOLS AND APPROACHES:

- Adaptive management.
- Scenario-based planning.

KEY CONCEPTS AND MESSAGES:

Sources of uncertainty

1. *Uncertainty* can be defined as 'an expression of the degree to which a value (such as the future state of the climate system) is unknown. Uncertainty can result from lack of information or from disagreement about what is known or even knowable. It may have many types of sources, from quantifiable errors in the data to uncertain projections of human behavior' (World Bank 2010a: 358). Depending on the origin of uncertainty, it may or may not be possible to attach probabilities to uncertain events – and the possibility of making probabilistic representations of uncertain events, where it exists, is always subject to limits (Dessai & Hulme 2004).

2. *Socio-economic uncertainties* are one source of uncertainty with regard to future climate change. These uncertainties relate to factors such as future population growth, economic growth, land use and land cover, technological choices, societal choices, international relations. They influence the level of future emissions and thus the magnitude of climate change – and also create uncertainties about future exposure and vulnerability to climate change (Jones & Mearns 2004, EEA 2007, IPCC 2007a & 2007d, Olhoff & Schaer 2010).

3. To support estimates of future change (as well as impact and vulnerability assessments), the IPCC has developed a series of GHG emission scenarios (known as *'SRES scenarios'*) based on various assumptions regarding changes in population, technology, and societal development. These scenarios, which reflect socio-economic uncertainties at the global level, result in very different long-term forecasts of emissions. In some scenarios, emissions start decreasing as from 2050, but in other scenarios they keep growing in the second half of this century. Given the time lag between GHG emission reductions and the actual decrease in their concentration in the atmosphere, even under the most optimistic scenarios, atmospheric GHG concentrations (and in particular CO_2 concentrations) will keep increasing for many decades (IPCC 2007a & 2007b).

4. *Climate uncertainties* are another source of uncertainty. Long-term climate change forecasts are generated by *atmosphere-ocean general circulation models* (AOGCMs). These are mathematical representations of the earth's climatic system, which link the atmosphere, ocean, land, and biosphere both vertically and horizontally in a series of 3-dimensional grid boxes that partition the earth into layers and grids. Grid box resolutions are typically in the order of 100-500 km per side.

They simulate future climate change by gradually increasing the level of radiative forcing.[1] Over twenty of such models are used by IPCC experts. Due to the extreme complexity of the climate system, and the use of different parameters and assumptions to model relationships that are still subject to scientific uncertainty, for each considered emission scenario different general circulation models produce different projections of future change – sometimes significantly different ones. As a result, many uncertainties prevail (and will persist) over the evolution of the climate (Jones & Mearns 2004, IPCC 2007a, EC 2009b, Olhoff & Schaer 2010).

5. The main uncertainties in climate change forecasts regard:
   - *temperatures*: all models agree that they will rise, but the magnitude of the increase (globally and regionally) remains much debated;
   - *rainfall*: all models agree that it will increase overall (due to the acceleration of the hydrological cycle under higher temperature conditions), but some regions will get less rainfall and some more, and models disagree significantly on the magnitude and even the direction of change in specific regions;
   - *change in extreme parameters*: changes in extreme parameters are more difficult to predict than changes in average conditions (Jones & Mearns 2004, IPCC 2007a & 2007b, EC 2009b).

6. General circulation models produce projections of future climate change for large areas (e.g. 200x200 km grid scale) – but used alone, do not allow the *downscaling of projections* to local and regional scales (e.g. 10x10 km, 100x100 km). Downscaling requires extra data (local and regional climate variables) and extra modelling efforts. In developing countries in particular, the data needed to downscale higher-level projections of climate change to the local or regional level are often missing. The level of uncertainty is often greater at downscaled levels than at large scales (Olhoff & Schaer 2010, World Bank 2010a, World Bank 2010d).

Planning in the face of uncertainties

7. In the face of such uncertainties, many political leaders and decision makers are tempted to 'wait and see'. However, many scientific and economic experts believe that the *cost of inaction* could be greater than the cost of acting now:
   - Failure to consider *adaptation* measures is likely to result in wasted investment (e.g. building of long-lasting infrastructure in inadequate, disaster-prone locations), and increased vulnerability of the population in the future.
   - Failure to start implementing *mitigation* measures now will lead to greater magnitude of climate change, more harmful impacts, and higher adaptation costs in the future. Due to inertia in the climate system, GHGs will keep accumulating for decades after emissions start to decrease; temperatures will keep increasing for decades or centuries after atmospheric GHG concentrations have stabilised; and sea levels will keep rising for even longer as a result of thermal expansion and the continued melting of ice. Strong action on mitigation by all countries is required <u>now</u> if we are to avoid really disastrous consequences and very high costs (IPCC 2007a, Stern 2007, Economics of Climate Adaptation Working Group 2009, World Bank 2010a).

[1] Radiative forcing 'is a measure of the influence that a factor has in altering the balance of incoming and outgoing energy in the Earth-atmosphere system and is an index of the importance of the factor as a potential climate change mechanism. Positive forcing tends to warm the surface while negative forcing tends to cool it.' (IPCC 2007b – Summary for Policymakers, p. 2).

8. While inaction is likely to have a cost, action may entail co-benefits, in particular developmental benefits, regardless of the scope and magnitude of climate change (or, as far as mitigation is concerned, regardless of carbon prices). Even in the face of uncertainty, some types of measures are justified. In particular:

   - *'No-regret' measures* are those expected to produce net benefits for society even in the absence of climate change (adaptation) or independently of any 'reward' for mitigation (zero or negative net cost at a zero carbon price). Typical examples include investment in agricultural practices that reduce/prevent soil degradation, in water conservation, in access to safe drinking water, in improved primary healthcare services, or in energy efficiency measures.
   - *'Low-regret' measures* are those expected to have a cost for society in the absence of climate change, but an acceptable one in view of the benefits they would bring if climate change turns out to produce significant effects (adaptation) – or to have a low net cost at zero or low carbon prices (mitigation). For instance, the climate-proofing of infrastructure may have a cost but a relatively reasonable one if adaptation benefits are ignored – and may deliver net benefits overall if adaptation benefits are accounted for. From the strict point of view of mitigation, degraded forest restoration is another example of low-regret measure (it has a cost but a relatively low one, that can be more than offset by selling carbon credits even at the current low prices); if environmental and developmental co-benefits are taken into account, this type of measure is very likely to be considered 'no-regret'.
   - *'Robust' measures* are those that produce net benefits or deliver good outcomes across various possible climate change, economic development or carbon price scenarios (rather than just under the 'most likely' scenario). For instance, subject to calculations based on context-specific circumstances, the development of water-efficient irrigation systems to support agricultural production in rainfed systems may turn out to be a robust measure – or even a no-regret one. No-regret measures are a type of robust measures, producing net benefits in the absence as well as in the event of climate change (OECD 2009a, Olhoff & Schaer 2010, World Bank 2010a, World Bank 2010c, World Bank 2010g).

   Note: Examples of no-regret, low-regret and robust measures are provided above to illustrate the concepts, but remember that what is considered 'no-regret', 'low-regret' or 'robust' is context-specific and must be established using cost-benefit analysis or similar approaches.

9. *Adaptive management* is an appropriate approach to planning under conditions of uncertainty. It can be defined as a flexible and pragmatic approach to the management of both social and ecological systems, aimed at continually improving management policies and practices, on the basis of an iterative 'learning by doing' process. In practice, adaptive management uses pilot projects and experiments; their results and outcomes are analysed and lessons learnt are considered before scaling up or adjusting responses. Adaptive management also involves the use of 'robustness' as a decision criterion, the inclusion of safety margins in investment, and preference for reversible/flexible options. It has a long time horizon for planning and capacity building, uses forward-looking scenario analysis and an assessment of strategies under a wide range of possible futures, and (ideally) involves broad stakeholder participation in problem solving and decision making (Peterson et al 1997, Tompkins & Adger 2003, Finlayson & Atapattu 2009, World Bank 2010a).

10. An additional (and complementary) option for planning under uncertainty conditions is *scenario-based planning*, where a 'scenario' is defined as 'a coherent, internally consistent and plausible description of a possible future state of the world' (Berkhout et al 2001: 7). This approach involves the development of a range of scenarios that reflect prevailing climatic and non-climatic uncertainties over a specified time horizon (Berkhout et al 2001, Jones & Mearns 2004, Boyd &

Hunt 2006, Economics of Climate Adaptation Working Group 2009). For instance, as far as climate scenarios are concerned, planners could develop:

- a 'no change' scenario (or baseline) based on the continuation of historical weather patterns;
- a 'moderate change' scenario based on average forecasts of climate change;
- a 'high change' scenario based on the outer range of climate change forecasts (Economics of Climate Adaptation Working Group 2009).[2]

11. Besides changes in climate conditions, scenarios typically describe some of the resulting biophysical and/or socio-economic changes.[3] Socio-economic scenarios based on a range of assumptions unrelated to climate (e.g. on values, on governance, on economic and demographic growth, on technological change, on land use and land cover) are frequently used in combination with climate scenarios for climate impact assessment and for estimating the costs of climate change (Berkhout et al 2001, Boyd & Hunt 2006, EEA 2007).

12. Given the diversity of aspects to be taken into account, *scenario development* should involve key experts with a suitable range of technical and scientific competences – but also other national stakeholders (e.g. government, civil society organisations, local stakeholders, representatives of vulnerable groups); the latter can bring their knowledge of local conditions and existing adaptation mechanisms, and contribute to the understanding of causal processes and the feasibility/acceptability of envisaged adaptation options. To build scenarios, quantitative research methods and consultation can be used in combination, ideally in an iterative manner (Berkhout et al 2001, Jones & Mearns 2004, Finlayson & Atapattu 2009). Two recent World Bank publications (2010e, 2010f) provide detailed insights into participatory scenario development techniques and outcomes in the context of climate change-related economic research.

13. Once scenarios have been designed and the related impacts determined, potentially suitable adaptation or mitigation options can be identified, and the costs and benefits of specific adaptation or mitigation measures can be calculated for each of the chosen scenarios (see Module 7). A comparison of costs and benefits across the various scenarios allows the *identification of 'no-regret', 'low-regret' and 'robust' measures* (Economics of Climate Change Adaptation Working Group 2009). In conditions of significant uncertainty, robustness across a range of scenarios may be a better criterion for decision making than classical, probability-based optimisation (Klein et al 2005, Agrawala & Fankhauser 2008, World Bank 2010a).

14. Various *tools and sources of information* are available to support the building of scenarios:

- Useful information can be found with the help of *knowledge-sharing tools* (e.g. Adaptation Learning Mechanism), and in existing reports, studies and publications (e.g. climate risk profile or other climate projections developed by the national meteorological service, NAPAs, National Communications to the UNFCCC, region-specific chapters of IPCC's 4th Assessment Report).
- There are computerised *data and information provision tools* that generate or present data and information on climate variables (e.g. observations and projections of temperature and

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[2] This is just an example. More or different scenarios may be needed. For example, if there is uncertainty in the direction of change in rainfall, one 'high change' scenario may use the lowest, negative forecast of change in rainfall whereas another 'high change' scenario may use the highest, positive forecast of change. A recent World Bank publication (2010d) provides useful insights into the methodological approach and criteria used for selecting climate change scenarios for the 'Economics of Climate Change Adaptation' studies.

[3] At the global level, socio-economic scenarios may also be used as a starting point to determine emission scenarios and therefore climate change scenarios – as in the case of the IPCC's 'SRES' scenarios.

rainfall), secondary climate impacts (e.g. on the yields of certain crops), and possible adaptation options (OECD 2010a). The World Bank's *Climate Change Data Portal* is an example of such tools.

- Multi-disciplinary expert opinion (on climate-related matters, with the help of the national meteorological service, and also on social, economic and technical matters) combined with local knowledge can support the building of climate change scenarios.

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USEFUL WEBSITES:

Adaptation Learning Mechanism:
http://www.adaptationlearning.net/

World Bank – Climate Change Data Portal:
http://sdwebx.worldbank.org/climateportal/