Mainstreaming Adaptation to Climate Change in Agriculture and Natural Resources Management Projects

Climate Change Team
Environment Department

Guidance Notes

Guidance Notes

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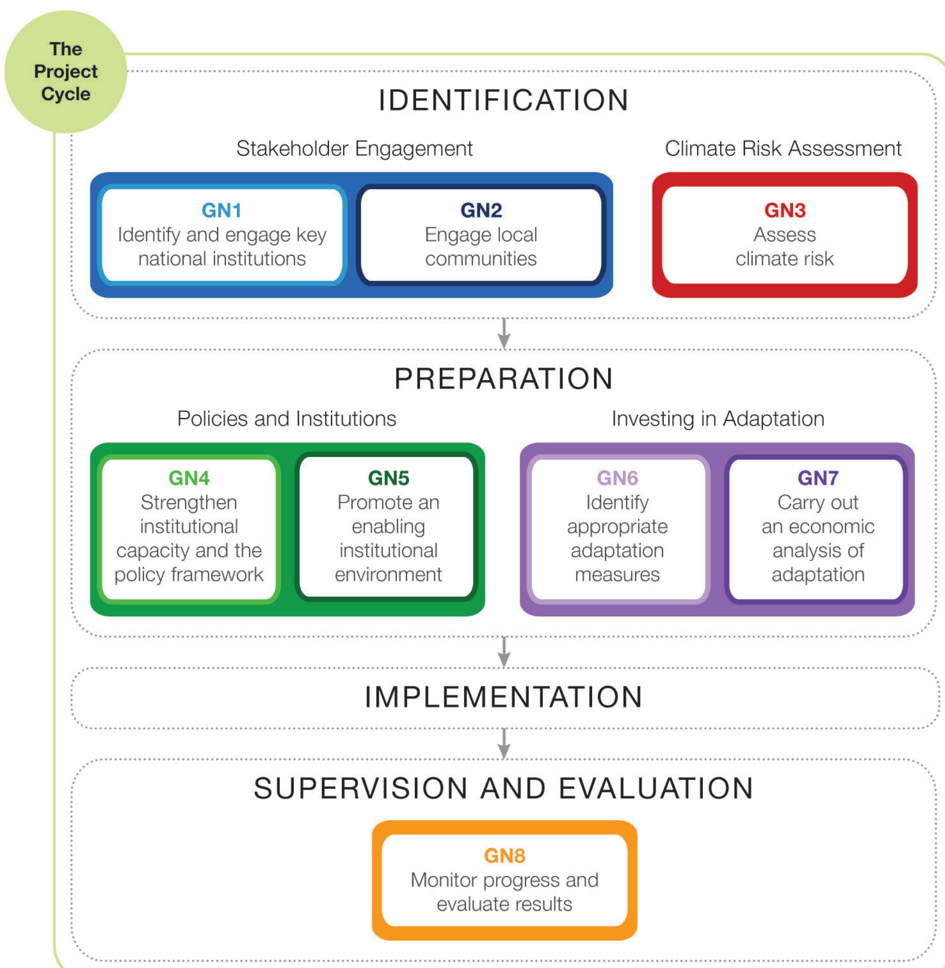
This series presents eight guidance notes (GN1 - GN8) that provide lessons learned, best practices, recommendations, and useful resources for integrating climate risk management and adaptation to climate change in development projects, with a focus on the agriculture and natural resources management sectors. They are organized around a typical project cycle, starting from project identification, followed by project preparation, implementation, monitoring and evaluation. Each note focuses on specific technical, institutional, economic, or social aspects of adaptation.



Guidance Note 6

Identifying Appropriate Adaptation Measures to Climate Change

The objective of this note is to provide guidance on the choice of adaptation responses in the agricultural/natural resource management (NRM) sector. It includes a discussion of key aspects that should be considered in project preparation (including different types of adaptation and levels of "regret" associated with uncertainty of future impacts) and provides resources, such as a menu of sector-specific adaptation options, a discussion of related institutional and technical issues, and project examples.

Contents

Identifying suitable adaptation options

The process of identifying the most suitable *adaptation** options to integrate into a development project in agriculture and/or NRM calls for a series of steps, including:

1. Generation, analysis and access to climate information
2. Assessment of impacts of climate variability and change on agricultural and natural resource systems and livelihoods, considering the interaction of climate pressures with other socioeconomic dynamics
3. Identification and analysis of a menu of adaptation options, taking into consideration uncertainty and different types of adaptation
4. Prioritization and choice of the most suitable adaptation measures for near-term and medium-term planning horizons

However, the fact that the aforementioned steps do not necessarily reflect a sequence to be followed categorically should be kept in mind. For example, the process of identifying adaptation options, especially in the case of *no-regret* adaptation, can be initiated in practice even in the absence of local capacity for climate data generation and analysis. Likewise, a quantitative climate change impact assessment at the local level can be, in some cases, bypassed when a thorough literature review is sufficient to get a sense of climate trends and projections and the associated uncertainty. Still, these steps represent the logical sequence leading to the integration of adaptation into development projects.

1. Generation, analysis and access to climate information

High climate variability in farming environments depresses crop productivity and constrains investment. Increasing climate variability and risk can jeopardize production and is likely to further decrease farmer investment. Hence, knowledge and technology required for adaptation include understanding the patterns of current and projected climate variability. Adaptation practices require data and information on climate and agricultural systems at a spatial scale that is meaningful for planning.

A good understanding of historical trends of climate variables and current climatic variability can provide a sound basis for assessing climate-related risks and identifying measures to reduce them. Future climate projections are essential to ensure that the project not only addresses the

* For words in italics, please see Glossary for definition.

existing *adaptation deficit* but is also suitable to prepare for a change in climate (see GN3 for more details on climate risk assessment).

In many low-income countries, good quality climatic and agronomic data are lacking. Time series of climate information may not be available to planners and farmers, either because monitoring systems do not exist or function properly, or information is not readily coordinated, shared or disseminated.

Given these critical bottlenecks, investments for adaptation should include capacity building, technology and institutional coordination to improve generation, collection and access to key climate data (i.e., on temperature, precipitation and runoff), and to produce climate trends, forecasts and climate change projections. (See Annex 1 for a discussion of climate information for adaptation planning, Annex 2 for a briefing note on data and information management for adaptation, and GN4 for a discussion on institutional capacity assessment for adaptation.)

Investments for the generation of climate-related information for planning and decision-making purposes need to be complemented by investments in customizing information for the final users (i.e., farmers) and in effective dissemination channels. A strong link, including feedback loops between scientists, advisory agents and farmers, is crucial for communicating climate information and facilitating access of local communities to climate data. Seasonal climate forecasts and early warning systems include some of the most useful climate-related information for farmers and rural communities in general.

Seasonal climate forecasts

Seasonal forecasting can greatly assist in managing climate risks in agriculture, particularly in risk-prone rainfed environments, by providing planners and farmers with timely information, which allows them to decide upon and shift to the most suitable coping strategies over short time scales. However, the usefulness of seasonal climate forecasts depends on the capacity of farmers and extensionists to access and utilize climate information and react upon it in a timely manner. Bottlenecks that affect the ability to act on forecast information are the result of limited access to seeds, implements, fertilizer, labor and credit. Input and feedback from forecast end-users and relevant institutions are crucial to ensure that societal needs are addressed. At the same time, forecasts need to be understandable, credible and trusted in order to have a positive impact. This could be achieved by designing participatory farmer workshops that help farmers become familiar with, better understand and use seasonal climate forecasts. The briefing note in Annex 3 provides an overview of the necessary technical and institutional considerations for improving seasonal climate forecasts and identifies specific investments in seasonal climate forecasting that can support adaptation.

Early warning systems

While early warning systems play a crucial role for disaster risk reduction planning and near-term climate risk management, they can also support efforts to reduce vulnerability to medium- and long-term climate impacts with, for example, respect to increasing climate variability and changes in outbreaks of animal diseases. However, early warning systems require both technical and human capacity, public awareness, people-centered policies and institutional coordination in order to be implemented and operated effectively. See Annex 1 for a more in-depth discussion of seasonal climate forecasting and early warning systems.

> As an example, a component of the World Bank project in Kenya, *Adaptation to Climate Change in Arid and Semi-Arid Lands (KACCAL),* finances climate information generation, including improvements in a drought early warning system and dissemination activities. The project also aims to strengthen capacity of national level institutions to better assess and respond to current and future climate risks and promote institutional coordination among currently fragmented agencies managing disaster and climate risk (Annex 4). National stakeholders are trained to further disseminate the generated knowledge to the district and community levels. In particular, the project will facilitate and increase access to tailored climate information for strategic adaptation planning. Examples of knowledge products that will be generated by this project include: (i) district climate risk profiles focusing on enhanced vulnerability assessments that integrate climate information with available natural resource and socioeconomic information; (ii) downscaled climate projections for Kenya, based on past and current climate observations and global and regional climate models; (iii) methodologies and approaches for assessing climate-related risks in investments in arid lands and climate risk screening of community driven development (CDD) micro-projects; and (iv) improvements in the existing drought early warning system through more systematic inclusion of climate information.

2. Assessment of impacts of climate variability and climate change on agricultural and natural resource systems and livelihoods

Agronomic and economic impacts from climate change depend primarily on two factors, namely the rate and magnitude of change in climate variables, and the ability of ecosystems and agriculture to adapt to changing environmental conditions. As a consequence, the assessment of current and future climate-related vulnerabilities on agricultural and natural resource systems may require climatic, agronomic and ecological information even beyond the climatic information discussed in step one. Refer to GN3 and GN7 for tools and approaches to assess climate risks and climate change impacts on agriculture and natural resources, respectively.

Impact assessments at the project level do not necessarily have to be carried out through an analytical model requiring detailed local data, but can, in some cases, also rely on a literature review. However, even in the latter case, data collection is of paramount importance for monitoring purposes (see GN8). Given that different types of data may be required to evaluate/monitor impacts on specific subsectors and areas, the specific information needs should be determined before commencing any data collection activity.

3. Identification and analysis of possible adaptation options, taking into consideration uncertainty and different types of adaptation

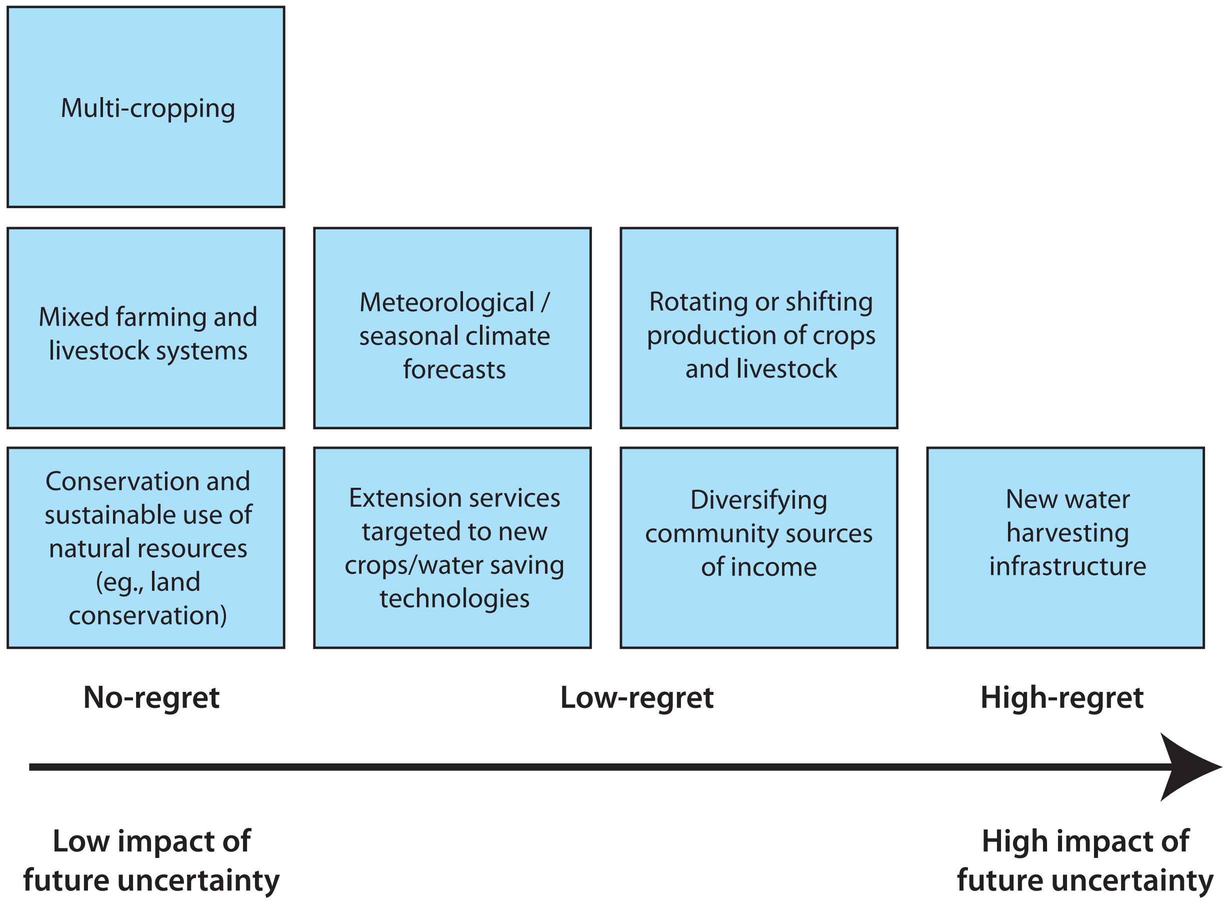
Once climate risks and likely impacts of future climate change have been gauged from the literature or assessed through project preparation studies, adaptation options can be considered. A broad range of adaptation options exists, which could be implemented to manage climate risks in agriculture and NRM. Annexes 5 and 6 provide a brief description of impacts, adaptation options and related technical and institutional considerations for agricultural water management, soil management, sustainable agriculture, pest management and income diversification activities. A series of briefing notes on adaptation needs, measures and relevant investments in the areas of rainfed agriculture, irrigated production systems, rice systems, crop genetic diversity and integrated pest management can be found in Annex 7. Finally, GN2 discusses how to guide local communities in the participatory identification of adaptation options.

Given the broad range of possible adaptation options and the need to pin down specific measures that could be supported by the project, the main aspects to take into account include how uncertainty about future climate could affect project performance and the different modalities and channels by which the project can help adapt to future climate. Some guidance is provided below on these aspects.

a) Adaptation with varying levels of possible "regret"

When deciding on specific adaptation options, the level of uncertainty with which future climate impacts will occur plays a crucial role. As the diagram below shows, adaptation measures can be classified, according to the impacts that uncertainty associated with climate information might have on project risk, into *no-regret*, *low-regret* and *high-regret* investments with increased complexity, costs and risks.

Diagram 1: Consideration of uncertainty in adaptation investments



Adapted from Füssel 2007 and UNDP Adaptation Policy Framework (APF)

No-regret adaptation is not affected by uncertainties related to future climate change because it helps address problems associated with current climate variability, while at the same time, builds *adaptive capacity* for future climate change. Investment decisions for such interventions can be taken without assessing project risks due to uncertainty on future climate. An example of a no-regret intervention would be enhancing provision and dissemination of climate information as well as access to early warning systems by local communities living in flood and/or drought prone areas. No-regret adaptation measures are also needed to close the so-called *"adaptation deficit,"* for example in drylands and other marginal areas (e.g., in India), where underinvestment over the past decades has resulted in a lack of resiliency to current climatic conditions of both natural resources and the livelihoods that depend on them. This adaptation deficit must be taken into consideration at the same time that new challenges, resulting from the new climatic conditions—the "adaptation gap"—are being addressed.

Low-regret adaptation yields large benefits under relatively low risks. An example is the promotion, including through research and extension, training, marketing etc., of drought-resistant cultivars in areas where drought risk is projected to increase. This type of investment is likely to yield positive returns under many future climate scenarios, but incorporates a small risk in the unlikely case that drought risk decreases in the project area in the next decades. A description of World Bank adaptation projects promoting low- or no-regret adaptation options is listed in the resources part of this guidance note.

Both no-regret and low-regret options can be "win-win" options when they enhance adaptive capacity (i.e., they reduce climate vulnerability and exploit positive opportunities), while also contributing to the achievement of other social, environmental or economic outcomes. In addition, synergies between mitigation and adaptation—in particular, soil management measures that increase carbon sequestration, while leading to improved resilience to droughts, lower soil erosion and higher yields—should be encouraged ("win-win-win" adaptation). Soil-based carbon sequestration may in fact become an eligible activity for the generation of emission reduction certificates under a new global climate agreement, thereby generating additional financial incentives for producers to adopt productivity-enhancing practices and technologies, improve climate resilience and store carbon (see GN1, part A, subsection on identifying "entry points" for project examples in which mitigation provides incentives for undertaking adaptation measures.)

High-regret adaptation mainly involves decisions on large-scale planning (e.g., resettlement of a large population) and investments with high irreversibility (e.g., large infrastructure projects such as sea level walls, large reservoirs, etc.). Given the considerable consequences at stake in large-scale planning decisions, and the significant investment costs and long-lived nature of infrastructure, uncertainties in future climate projections must be carefully examined. For example, the engineering design of a large dam should be based on long-term water runoff projections and estimated future water demand, both subject to a high degree of uncertainty.

The differentiation in no-regret, low-regret and high-regret adaptation is not universal, but depends on local circumstances and the time horizon. Measures that are defined as low-regret in one region might have the characteristics of high-regret adaptation in another spatial context. Similarly, a current high-regret option might be considered a low-regret adaptation option in the future, once more information on climate change impacts becomes available.

Why is it important to understand the level of regret within adaptation options?

Being aware of the level of regret is important because different levels of regret have different implications in the realms of climate information, timing of investment, planning horizon, project design, project risk and economic evaluation.

Table 1: Levels of regret and associated implications

	No-regret	High-regret
Consideration of future climate projections	Benefits of no-regret projects are likely to materialize irrespective of how the climate will change, and, as a result, the availability and accuracy of climate information and data is not as crucial as in the case of high-regret options.	High-regret adaptation decisions must be based on data and information on future climate that reflect uncertainties related to climate change.
Timing of investment	No-regret investments can be implemented immediately, as more information on future climatic changes will not influence their desirability.	When considering high-regret options, an important question to be answered is whether to undertake adaptation measures now (sustaining the necessary costs) or wait in order to gain more information on the impacts of climate change. For a further discussion on the implications of timing and uncertainty, see Annex 8.
Planning Horizon	No-regret adaptation decisions (i.e., improved farming practices, crop choices, training and capacity building, etc.) generally have effects in the short-term (1-15 years).	Most high-regret adaptation will have effects in the distant future. For example, new irrigation projects have an average lifetime of 30-40 years and large dams of 60-80 years, and resettlement of communities will have lifelong impacts.

	No-regret	High-regret
Project design	No-regret investments can be treated as standard development projects.	If possible, high-regret projects should be organized in a flexible way and/or multiple phases to allow the projects to adjust once more information on climatic changes becomes available.
Project risk	No-regret options are beneficial and cost-effective regardless of the degree of climate change.	The pay-off of high-regret options depends on uncertain changes in climatic patterns. Thus, local communities may be reluctant to take on and invest in high-regret adaptation options.
Economic Analysis	No-regret investments can generally be evaluated with standard economic approaches, considering specific issues in estimating costs and benefits of adaptation (see GN7).	High-regret investments call for explicit consideration of uncertainty in decision making. Specific techniques should be used (see GN7).

How can uncertainty in high-regret adaptation be dealt with?

Uncertainty can generally be dealt with by using risk management approaches that help assess local vulnerability to current and future climate change, identify options to address climate risks and possibly help begin the process of developing a climate change adaptation strategy (see the UK Climate Impact Program, or UKCIP, in the Resources section). Such approaches require that uncertainty be described using multiple climate and non-climate development scenarios.

For each particular scenario, an ensemble of general circulation models should be considered in order to get a better idea of the level of agreement among projections from different climate models (see Annex 1 of GN3). Uncertainty of projections from different models can be dealt with in different ways. One approach is to count how many models, within the models' ensemble, generate similar projections and use this information to derive a rough indication of probability distributions for future mean climate values (e.g., mean temperature and precipitation), as well as for extremes (e.g., number of five-day precipitation periods and/or number of consecutive dry days). This sort of probability distribution can be used to perform a probability-weighted evaluation of the specific adaptation measures proposed by the project (see GN7). Alternatively, a subset of possible future scenarios can be extracted and considered for "stress-testing" alternative investment options.

The final investment choice will depend on attitude to risk and costs involved. In general, it is essential to seek robust strategies across a range of scenarios, i.e., strategies that perform reasonably well compared to the alternatives across a wide range of plausible scenarios and strategies that can evolve over time in response to new information (see GN7 for a broader discussion on how to handle uncertainty in economic evaluation of adaptation projects).

A conscious decision to *do nothing* could also be made as a result of evaluating conditions of high uncertainty. This may be legitimate and appropriate in the case of low priority impacts or in situations where non-climate factors (i.e., increasing health problems due to high environmental pollution) are the priorities to be addressed rather than a low impact future climate risk (increased precipitation and/or small possibility of increase in floods). It may also be appropriate to *do nothing* for more significant impacts where no obvious adaptation response can be clearly identified or where there are indications that other factors may change future circumstances. However, the decision not to take action should not be the default position, and should only be reached after careful consideration of climate risks and adaptation options. Such a decision must also be continually monitored and reviewed to ensure nothing has changed that requires immediate adaptation action.

(b) Autonomous and planned adaptation

A further distinction among adaptation options is differentiation between autonomous and planned adaptation.

Autonomous adaptation involves actions by farmers, communities and others in response to the threats of climate change perceived by them, based on a set of available technology and management options. Autonomous adaptation is implemented by individuals only if considered cost-effective by those implementing it, i.e., when adaptation is in their own interest (Mendelsohn, 2006). Possible examples include selecting different technologies, changing crops, inputs and management practices suited to the new environment, shifting crop calendars and changing irrigation schedules.

Planned adaptation requires that the local, regional and/or national government also change behavior to fit the new conditions and provide the right incentives to the private sector. For example, if climate change is expected to affect water availability (i.e., runoff) and demand, water harvesting infrastructure can be built and/or water can be reallocated among users according to water-use efficiencies. This may also require the revision of policies and/or institutions at the national, provincial and local levels. The first intervention (water harvesting infrastructure) is an example of a *"hard" adaptation* investment; the second (water reallocation) is an example of a *"soft" adaptation* investment, which alters the circumstances in which private sector decisions are made through modified institutions and incentives.

Autonomous adaptation is a natural or spontaneous adjustment in the face of a changing climate. However, autonomous adaptation of communities and individuals often needs to be encouraged and supported by the right policies and incentives. Planned adaptation, on the other hand, requires conscious public sector intervention and public financial resources. Development projects focus on public investments in adaptation, but often with the objective of facilitating autonomous adaptation. In developing a project, it is always important to consider how planned adaptation may influence the capacities of the private sector and local communities to undertake autonomous adaptation. For example, the implementation of an early warning system can trigger autonomous adaptation actions of farmers reacting to improved climate information.

However, planned adaptation could also bear the risk of promoting private *maladaptation*, including actions that will constrain future options for coping with climate risks. An example is an agricultural project that supports monoculture of a high value crop, with the objective of maximizing efficiency of the irrigation system, water productivity and yields ("more crop per drop") and, ultimately, income generation. Although such a project might be designed taking into account the effects of climate change on the local climate and hydrological conditions, in the absence of insurance against yield losses, it would lower the adaptive capacity of farmers by making their income generation base more volatile. In case of a bad harvest, farmers' income would be greatly affected, i.e., the ultimate impact of the project would be one of increased vulnerability to climate risks.

Examples of adaptation options at the farm level are presented in Table 2 below (see Annexes 5 and 6 for a more detailed discussion on such options).

Table 2: Adaptation options at the farm level

Autonomous coping/adaptation practices
Crop calendar shifts
Planting and harvesting dates, schedules of inputs
Soil and water management changes
Fertilizer use/ land-use decisions
Water use (irrigation efficiency, amount of water, area/crops irrigated, groundwater vs. surface water)
In-farm water storage
In-farm grain stocking
Interactions with livestock management
Crop changes (based on crop suitability/resource availability)
Water intensive vs. non-water intensive
Labor intensive vs. non-labor intensive
Capital intensive vs. non-capital intensive
High value/exports vs. low value/local consumption (staples)
Livestock decisions
Planned adaptation
Generation and dissemination of climate information
Seasonal climate forecasts
Early warning systems
Infrastructure
Water: transport, storage, dams (hydro), irrigation, desalinization, waste water reuse
Agricultural production: storage, transportation
Markets (access)
Land
Water: water pricing, water transfers
Fertilizer, pesticides, seeds, labor
Insurance
Financial
Technology Development
Crop varieties, irrigation technology

Adapted from Padgham 2009

4. Prioritization and choice of the most suitable adaptation measures

In order to prioritize adaptation options, several factors need to be evaluated and assessed under local contexts, and the decision should take into account the following considerations:

- How effective are different adaptation options in reducing vulnerability to increasing climate variability (i.e., more unpredictable weather, shift in rainfall patterns towards fewer and more intense storms, increased frequency and duration of consecutive dry days)?
- To what extent do they help reduce impacts of extreme events (i.e., floods and droughts)?
- How effective are they under different future climate scenarios?
- What are their economic costs and benefits? (see GN7 on economic analysis)
- Are there secondary or cross-sectoral impacts, externalities or co-benefits?
- To what extent are they “owned” by local communities so that project performance risks are decreased? (see GN2)
- To what extent do they address short-, medium- and/or long-term climate change impacts?
- Are there important limiting factors for implementation and sustainability, such as lacking legal, financial, technical and institutional resources? (See GN4 and GN5 for more information on institutional capacity for adaptation and enabling an institutional environment)

GN3 and GN7 provide more information on concepts and methods that support the choice or prioritization from all possible recommended adaptation measures.

Resources

Tools

Computer-based decision-aiding tools

For a comprehensive list of computer-based decision-aiding tools, please refer to Annex 2 of GN3.

Readings

Climate Risks

- IPCC. 2007. *Fourth Assessment Report. Climate Change Synthesis Report.* Ed. Pachauri, R.K. and A. Reisinger. Geneva, Switzerland: IPCC.
- Jones, Roger. 2007. Using climate change information to assess risks. Presentation at IPCC-TGICA regional meeting on integrating analysis of regional climate change and response options, 20-22 June 2007, in Nadi, Fiji.
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  Refer to chapter IV: Regional Impacts and Vulnerabilities to Climate Change.
- The World Bank. 2006. *Managing Climate Risk: Integrating Adaptation into World Bank Group Operations*. Washington, DC, USA: The World Bank.

Impacts of Climate Change and Adaptation in Agriculture

- Adams, R. M., B. Hurd, S. Lenhart and N. Leary. 1998. The Effects of Global Warming on Agriculture: An Interpretative Review. *Journal of Climate Research* 11: 19-30.
- Padgham, Jon. 2009. *Agricultural Development under a Changing Climate: Opportunities and Challenges for Adaptation*. Washington, DC, USA: The World Bank.
- Rosenzweig, Cynthia and Francesco Tubiello. 2007. Adaptation and mitigation strategies in agriculture: an analysis of potential synergies. *Mitigation and Adaptation Strategies for Global Change* 12: 855-873.

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- Fankhauser, Samuel, Joel B. Smith and Richard S. J. Tol. 1999. *Weathering climate change: some simple rules to guide adaptation decisions*. Ecological Economics 30 (1): 67-78.
- Füssel, H-M. 2007. Adaptation planning for climate change: concepts, assessment approaches and key lessons. *Sustainability Science* 2**:** 265–75.

– Mendelsohn, Robert. 2006. *The Role of Markets and Governments in Helping Society Adapt to a Changing Climate. Climatic Change* 78 (1): 203-215.

– OECD. 2009. *Policy Guidance on Integrating Climate Change Adaptation into Development Co-Operation*. Paris, France: OECD.

– UNDP. 2005. *Adaptation Policy Frameworks (APF) for Climate Change: Developing Strategies, Policies and Measures.* UNDP.

– Willows, R. I. and R. K. Connell, ed. 2003. *Climate adaptation: Risk, uncertainty and decision-making.* UKCIP Technical Report. Oxford, UK: UKCIP.

Experts

For experts on identifying adaptation measures to climate change, please contact the climate change team at: climatehelp@worldbank.org

Project Examples

– **Yemen:** *Adaptation to Climate Change Using Agrobiodiversity Resources in the Rainfed Highlands of Yemen (Annex 9).* This project will enhance coping strategies for adaptation to climate change for farmers who rely on rainfed agriculture in the Yemen highlands, through the conservation and utilization of biodiversity important to agriculture (particularly the local land races and their wild relatives) and associated local traditional knowledge.

– **Kenya:** *Adaptation to Climate Change in Arid and Semi-Arid Lands (KACCAL) (Annex 4)* The goal of the overall WB-UNDP project is to enhance the resilience of communities and the sustainability of rural livelihoods threatened by climate change in the arid and semi-arid lands of Kenya. As a contribution to the achievement of this goal, KACCAL's development objective is to increase the capacity of selected districts and communities of arid and semi-arid lands to adapt to climate variability and change. This will be done through: (i) strengthening climate risk management and natural resource base-related knowledge; (ii) building institutional and technical capacity for improved planning and coordination to manage current and future climate risks at the district and national levels; and (iii) investing in communities' priorities in sustainable land and water management and alternative livelihoods that help them adapt to climate risk.

– **India:** *The World Bank project Andhra Pradesh Drought Adaptation Initiative* (AP-DAI) (Annex 10) is the first initiative in India to address the adaptation requirements in dryland rainfed areas where dependency of communities on natural resources for livelihood protection is significant. The AP-DAI supports several no-regret technical solutions to respond to both the *adaptation deficit* and the adaptation gap. Some of these measures, such as the introduction of new drought-resistant crop varieties, have become indispensible solutions for dealing with increased climate variability.

- **China:** *Mainstreaming Climate Change Adaptation in Irrigated Agriculture Project (Annex 11)*
  The project development objective is to enhance adaptation to climate change in agriculture and irrigation water management practices through awareness raising, institutional and capacity strengthening and demonstration activities in a large basin. This would assist in mainstreaming climate change adaptation measures, techniques and activities into the national Comprehensive Agricultural Development (CAD) Program, which is China's largest national investment program in irrigated agriculture.

Glossary

Adaptation

Adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects. Adaptation can be carried out in response to (ex post) or in anticipation of (ex ante) changes in climatic conditions. It entails a process by which measures and behaviors to prevent, moderate, cope with and take advantage of the consequences of climate events are planned, enhanced, developed and implemented. (adapted from UNDP 2005, UKCIP 2003 and IPCC 2001)

[For the purpose of the Guidance Notes, the term adaptation refers only to "planned adaptation" measures. Some development practitioners include a wide range of activities under the term "adaptation" (i.e., natural resource management, improved access to markets, land tenure, etc.) that, although disconnected from climate risk issues, are considered to indirectly decrease vulnerability/increase adaptive capacity. For the purposes of the Guidance Notes, a measure is referred to as "adaptation" only when it is an explicit response to climate risk considerations.]

Adaptive capacity

Ability of a human or natural system to: adapt, i.e., to adjust to climate change, including to climate variability and extremes; prevent or moderate potential damages; take advantage of opportunities; or cope with the consequences. The adaptive capacity inherent in a human system represents the set of resources available for adaptation (information, technology, economic resources, institutions and so on), as well as the ability or capacity of that system to use the resources effectively in pursuit of adaptation. (adapted from UKCIP 2003 and UNDP 2005)

[For the purposes of the Guidance Notes and, in particular, when the focus is on human systems, the terms adaptive capacity and resilience are used interchangeably.]

Adaptation deficit

Failure to adapt adequately to existing climate risks largely accounts for the adaptation deficit. Controlling and eliminating this deficit in the course of development is a necessary, but not sufficient, step in the longer-term project of adapting to climate change. Development decisions that do not properly consider current climate risks add to the costs and increase the deficit. As climate change accelerates, the adaptation deficit has the potential to rise much higher unless a serious adaptation program is implemented.

Autonomous adaptation

Adaptation that does not constitute a conscious response to climatic stimuli, but rather is triggered by ecological changes in natural systems and by market or welfare changes in human systems. Also referred to as spontaneous adaptation. (IPCC 2007)

“Hard” adaptation vs. “soft” adaptation

“Hard” adaptation measures usually imply the use of specific technologies and actions involving capital goods, such as dikes, seawalls and reinforced buildings, whereas “soft” adaptation measures focus on information, capacity building, policy and strategy development, and institutional arrangements.

High-regret adaptation

Involves decisions on large-scale planning and investments with high irreversibility. In view of the considerable consequences at stake, the significant investment costs and the long-lived nature of the infrastructure, uncertainties in future climate projections play a crucial role when making decisions about whether to implement high-regret adaptation measures.

Low-regret adaptation

Low-regret adaptation options are those where moderate levels of investment increase the capacity to cope with future climate risks. Typically, these involve over-specifying components in new builds or refurbishment projects. For instance, installing larger diameter drains at the time of construction or refurbishment is likely to be a relatively low-cost option compared to having to increase specification at a later date due to increases in rainfall intensity.

Maladaptation

An action or process that increases vulnerability to climate change-related hazards. Maladaptive actions and processes often include planned development policies and measures that deliver short-term gains or economic benefits, but can eventually lead to exacerbated vulnerability in the medium to long-term. (UNDP n.d.)

No-regret adaptation

Adaptation options (or measures) that would be justified under all plausible future scenarios, including the absence of manmade climate change. (Eales et al., 2006)

Planned adaptation

Adaptation that is the result of a deliberate policy decision, based on an awareness that conditions have changed or are about to change and that action is required to return to, maintain or achieve a desired state. (IPCC 2007)

Private adaptation

Adaptation that is initiated and implemented by individuals, households or private companies. Private adaptation is usually in the actor's rational self-interest. (IPCC 2001)

Public adaptation

Adaptation that is initiated and implemented by governments at all levels. Public adaptation is usually directed at collective needs. (IPCC 2001)

"Win-win" options

"Win-win" options are measures that contribute to both climate change mitigation and adaptation and wider development objectives, e.g., business opportunities from energy efficiency measures, sustainable soil and water management, etc. That is, they constitute adaptation measures that would be justifiable even in the absence of climate change. For example, many measures that deal with climate variability (e.g., long-term weather forecasting and early warning systems) may fall into this category.

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