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FACT SHEET

OVERVIEW

ADDRESSING CLIMATE CHANGE IMPACTS ON INFRASTRUCTURE:
PREPARING FOR CHANGE

ABSTRACT

Infrastructure includes a wide variety of systems that are essential to development priorities—and these assets may be at risk due to climate change. The accompanying set of fact sheets describes the impacts climate change may have on nine categories of infrastructure in developing countries. This overview introduces the common themes related to infrastructure, climate change impacts, and adaptation strategies, and covers the basic terminology and concepts that are used in the fact sheets.

Infrastructure is critical to development program priorities. Because infrastructure can be costly and is often built to last for decades, these assets are uniquely affected by climate change, though impacts will vary across different infrastructure types and locations. It is critical that the potential impacts of climate change be considered as part of overall program and project development. An ongoing process of adaptive management can help decision-makers understand vulnerability, assess climate impacts, identify priorities, and take appropriate adaptation actions.

Infrastructure forms the backbone of society—serving as the foundation for the economic, social, and cultural life of communities and countries. Resilient and reliable infrastructure is essential for the transport of goods and people and the provision of energy, clean water, commerce, communication, and emergency response to disasters. Yet, the risks posed to infrastructure by a changing climate are often not fully considered as these systems are planned, designed, and constructed. Thus, there is an opportunity to give greater consideration to these important concerns.

Infrastructure encompasses a variety of constructed networks and individual structures that are critical elements of vibrant and functioning communities. Infrastructure includes transportation systems, water and waste systems, energy, and communications networks. Often, infrastructure investment is an integral component of a broader development effort—such as food security, agriculture, or public health. This set of fact sheets for nine categories of infrastructure (see box) provides a summary of the impacts climate change may have on these assets in developing countries. The relative importance of different infrastructure types will vary across different regions, countries, and communities.

This overview covers the basic terminology and concepts that are used in the fact sheets, and summarizes the common themes related to infrastructure, climate change impacts, and adaptation strategies. These themes include:

- Importance of infrastructure to developing countries
- Unique aspects of infrastructure in the context of climate change
- Potential impacts of climate change on infrastructure assets and services
- Basic principles for understanding and implementing an adaptive management approach

INFRASTRUCTURE CATEGORIES INCLUDE:

- Transportation
- Potable water
- Sanitation systems
- Solid waste management
- Energy systems
- Information and communications technology (ICT)
- Flood control structures
- Cultural heritage assets
- Buildings

The nine fact sheets discuss these issues as they apply to each infrastructure type and summarize strategies that can be employed to prepare for and adapt to potential climate change impacts.

INFRASTRUCTURE IS CRITICAL TO DEVELOPMENT PROGRAMS

Development programs and priorities often rely on highly functioning infrastructure to deliver services to those in need and achieve program objectives. While infrastructure may not always be a central component, support for infrastructure development and maintenance is woven throughout many development programs. Infrastructure plays an integral role in achieving core purposes in programs such as Feed the Future (FTF); water, sanitation, and hygiene; economic growth and trade; disaster risk reduction; and urban development. For example, by supporting construction of water infrastructure, USAID and other development practitioners provide potable water to communities around the world. Further, a variety of infrastructure—including disaster response infrastructure such as evacuation, delivery, and response routes; communications channels; community shelters; and health care facilities—can save lives and protect communities.

A specific programmatic example is FTF, which is supported by a range of infrastructure services that enable agriculture development. A strong transportation network allows farmers to access seed and sell their produce to intermediate markets; a reliable water supply is critical for irrigation; energy networks support agricultural processing facilities. These and other infrastructure systems are fundamental to the ability of FTF to advance food security.

INFRASTRUCTURE IS UNIQUELY AFFECTED BY CLIMATE CHANGE

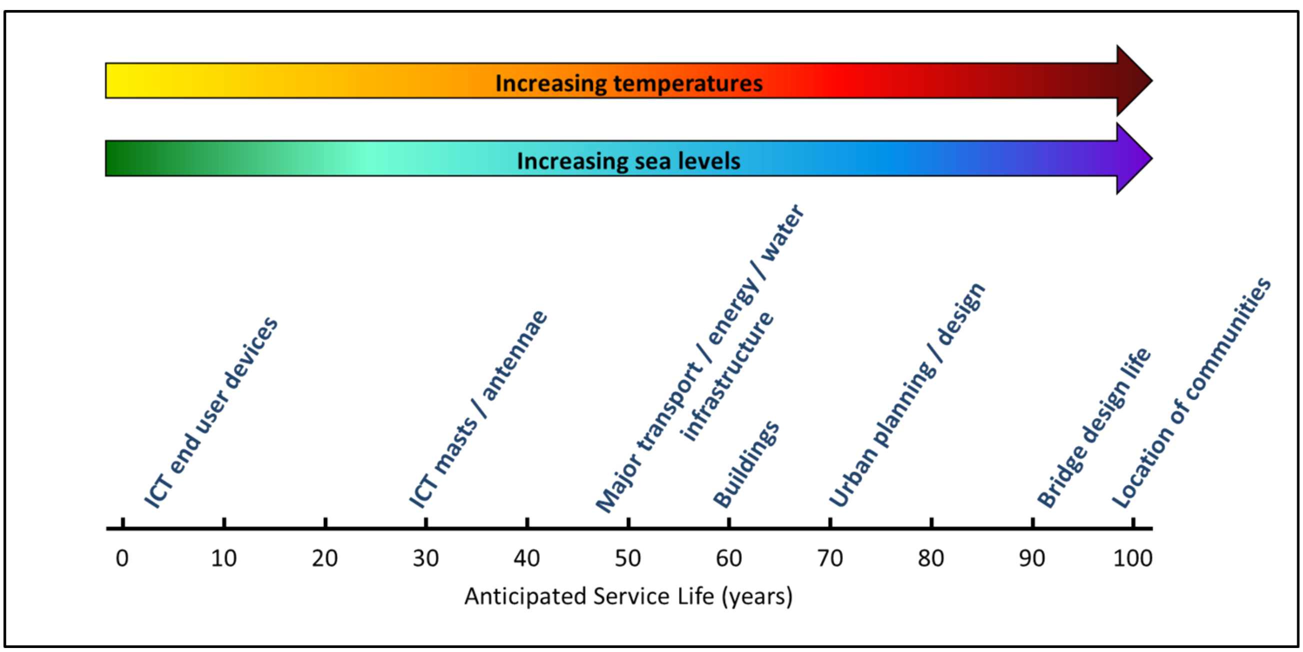
Infrastructure systems are built to last. Once constructed, many types of infrastructure have long lifetimes that span over 20, 50, even 100 years. Some of the most important and useful systems in the world have segments that have lasted more than a century (e.g., railways in India, the subway system in the New York metropolitan area).

While some types of infrastructure are routinely upgraded and replaced, major infrastructure projects—such as bridges, sewer systems, and public buildings—are significant investments that can take many years to plan and build. Once constructed, these systems are often in service for decades and frequently guide local and regional development patterns. ***As a result, the infrastructure decisions made today may affect several generations.*** Because infrastructure and their services are integral to the economic and social vitality of communities and countries—and because they represent major financial commitments and influence development patterns—it is critical that they are designed and maintained to be low-carbon, resilient, and responsive to the impacts of climate change over time. In general, the longer the anticipated service life of infrastructure, the more important it is to incorporate climate change considerations into planning and design (Figure 1).

In addition, much of ***infrastructure is interdependent***. For example, power stations provide energy to help telecommunications systems function, which in turn operate water management systems. Because of this, a disruption in electrical power can have cascading impacts throughout a region. As technology advances, infrastructure is becoming even more interconnected through the introduction of "smart" technologies. For example, use of energy smart grids means that energy infrastructure is reliant on information and communication infrastructure, while the electrification of transportation increases the dependence of transport networks on the power grid. While these advances can support efficiency and reliability across systems, the interdependence of infrastructure underscores the critical importance of using a systems planning approach to avoid and prepare for disruptions, including those due to climate change.

Infrastructure is also uniquely related to climate change in that ***the construction, maintenance, and operations of infrastructure significantly contribute to the problem of climate change itself***. Energy, buildings (especially industrial), and transportation infrastructure and operations are key sources of greenhouse gas emissions. Supporting unsustainable infrastructure may give rise to a lock-in effect, whereby

Figure 1. Service Life of Different Infrastructure Types in the Face of Long-term Climate Change[1]



[1] Adapted from: AEA, 2010. Adapting the ICT Sector to the Impacts of Climate Change: Final Report. http://archive.defra.gov.uk/environment/climate/documents/infrastructure-aea-full.pdf

the influence and dominating factors of the infrastructure in question perpetuates a dependency on fossil fuel use and increases greenhouse gas emissions. This highlights the importance of building sustainable infrastructure that supports low emissions growth.

In developing countries, where a major part of the infrastructure necessary to meet development needs is still to be built, it is essential to consider location, energy use, and connectivity of infrastructure facilities to ensure cost effectiveness, enhanced access, minimal carbon emissions, and increased resiliency in the wake of changing climatic conditions.

THE EFFECTS OF CLIMATE CHANGE ON INFRASTRUCTURE VARY

Climate change is expected to change historical and current climate conditions, including alterations in temperature, precipitation, and sea level, as well as changes in the intensity, variability, and frequency of extreme weather events. Changes in climate stressors will vary across regions depending on specific geo-physical characteristics and other local factors. Further, these changes will have different impacts on different types of infrastructure, depending on the infrastructure function, site, construction, materials, age, and condition. For example, changes in temperature and precipitation will affect fuel extraction capabilities differently than the use of public buildings.

While the direct impacts of climate change on infrastructure warrant significant concern, second and third order consequences may be equally as significant. For example, in certain areas climate change may cause massive migration that will further stress already weak and aging infrastructure in urban areas. As extreme events impact larger areas and populations, information, communication, and technology (ICT) services may be threatened by overuse. Variations in agricultural conditions due to climate change may lead to the relocation of food production, requiring changes in transportation services. Climate change may also increase the need for certain types of infrastructure. For example, climate change is likely to increase the frequency and severity of natural disasters, necessitating additional, more resilient infrastructure for disaster response. Each of the fact sheets provides information on the specific climate impacts that pose the most concern for individual categories of infrastructure.

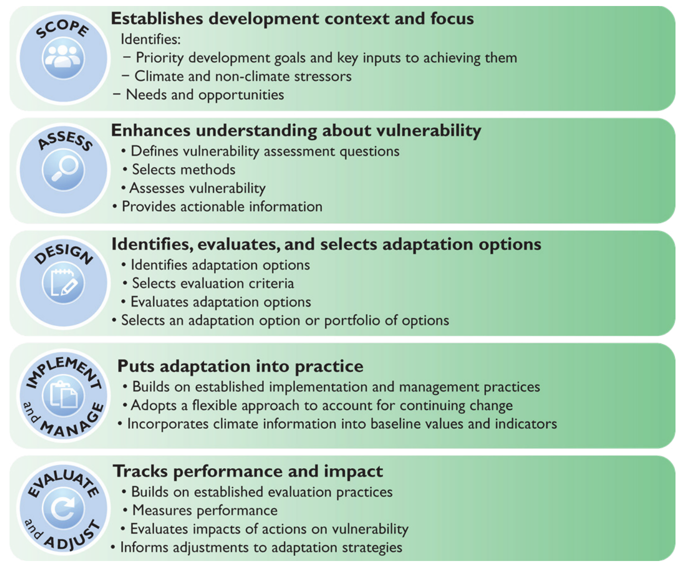
ADAPTIVE MANAGEMENT CAN HELP DEVELOPMENT PRACTITIONERS PREPARE FOR AND MANAGE CLIMATE CHANGE

Climate change impacts on infrastructure should be considered in a wide variety of development decisions. For example, climate vulnerability should be assessed as national development strategies and sector plans are developed. At the project level, the potential impacts of climate change should be considered in numerous program areas, including water resources, food security, and disaster risk reduction.

As described in the accompanying set of fact sheets, there are numerous ways to prepare for and adapt to changing climate conditions. These climate-resilient development strategies can be tailored to specific conditions at the local and regional-level, and designed within practical fiscal and capacity constraints. Integrating climate considerations into ongoing planning and decision-making processes through a climate-resilient development approach can help USAID and other development practitioners ensure the effectiveness and resilience of their investments in programs, projects, and infrastructure.

Climate-resilient infrastructure development is a process that can be accomplished through the five stages described in USAID's Climate-Resilient Development (CRD) Framework (Figure 2).

Figure 2. USAID's Climate-Resilient Development Framework



Managers can enter this process at any point in the cycle, depending on the status of the program or project under consideration. Together, these five stages form an ongoing and flexible process in which managers can include new information (such as improved climate data or changing socio-economic conditions) and test and refine their adaptation responses. For example, in the ***Evaluate and Adjust*** stage of an existing infrastructure project, the manager may uncover climate vulnerabilities that were not considered when the project was conceived. In that case, the manager should return to the ***Assess*** stage to better understand the vulnerabilities, followed by a reconsideration of the ***Design*** stage to identify approaches to address the vulnerabilities. The adaptation strategies that are selected should be implemented according to the ***Implement and Manage*** stage.

The underlying concepts in each of the stages are explained below.

SCOPE: ESTABLISH DEVELOPMENT CONTEXT AND FOCUS

Effectively managing infrastructure services requires an understanding of the larger context, including the role infrastructure plays in supporting development. Managers can develop this understanding by first identifying how the infrastructure services for which they are responsible are intended to contribute to "big picture" development goal(s) such as reduced hunger, increased physical security, or greater economic prosperity. They should also consider how infrastructure services depend upon and interact with other inputs to those goals and the enabling conditions in which those services are being provided.

For example, an irrigation infrastructure project that is intended to address a national goal to reduce hunger should consider necessary inputs to the project and to the overarching goal including: physical (e.g., water availability), natural (e.g., soil conditions), human (e.g., labor availability to utilize the irrigation system), or economic (e.g., wealth to pay for long-term management of the system). The enabling conditions for the infrastructure project also need to be considered. In the previous example, the enabling conditions that will determine the ability of the irrigation project to deliver its intended services in the face of a changing climate may include political factors (e.g., policies permitting water transfers), economic factors (e.g., loans to support increased agricultural production), and social circumstances (e.g., the potential for conflict over re-allocation of water resources under conditions of increasing drought).

Next, managers should consider both climate and non-climate stressors that affect these inputs and enabling conditions. For example, climate stressors such as an increased frequency of heavy precipitation events may exacerbate the ability of a sewer system to minimize downstream pollution. Non-climate stressors such as poor maintenance of the sewage system may also inhibit its effectiveness. While identifying these stressors, managers should also identify any associated needs and opportunities that might inform the design of locally-appropriate solutions.

By quickly understanding the development context in the scoping stage, managers can tailor their approach to the subsequent stages of the Climate-Resilient Development Framework. An effective tactic in the Scope phase that can help to inform the aforementioned considerations is to convene a workshop or series of consultations in which relevant decision makers, stakeholders, and experts come together to identify and refine the understanding of the key development goals that are being served, important inputs and enabling conditions, and climate and non-climate stressors that could affect the project's success. In some cases, that scoping dialogue may reveal vulnerabilities that are already particularly acute and where potential solutions are relatively obvious. In those cases it may be possible to move quickly to the ***Design*** stage to begin to address them. However, in most cases the scoping dialogue's main outcomes will be to help structure an appropriately rigorous vulnerability assessment in the Assess stage, which will be required to inform the design of options to promote climate-resilient development.

ASSESS: ENHANCE UNDERSTANDING ABOUT VULNERABILITY

ASSESS

The potential impacts of climate change vary by location and need to be considered at the regional and local levels. In addition, infrastructure types are differentially vulnerable to climate stressors. Understanding that there is a range of potential futures—with varying climate conditions and associated impacts—is critical to making sound decisions. Using the context developed in the ***Scope*** stage, these climate and non-climate impacts can be integrated into a broad view of all the barriers and constraints that may confront development programs. Deciding which infrastructure issues should be addressed first requires a broad view of the relative significance of different infrastructure components within the context of development goals and organizational resources.

As part of the ***Assess*** stage, practitioners therefore need to both assess vulnerability and set priorities for adaptation.

ASSESS VULNERABILITY

Vulnerability to climate change is defined as the degree to which infrastructure is susceptible to, and unable to cope with, the adverse effects of external climate stressors placed on it. Examples of vulnerabilities specific to each infrastructure type are described in the fact sheets.

Vulnerability is a function of three main components: exposure, sensitivity, and adaptive capacity, with each component affecting overall vulnerability.

Exposure: Exposure refers to the degree to which the infrastructure under consideration (e.g., a port or a wastewater treatment facility) may be subject to climate-related stress. There are two main elements to be considered in exposure: the change in the climate (in terms of the nature, magnitude, rate, frequency, and timing of climate change) and the extent to which that change will have direct impact on a specific infrastructure asset (largely determined by the location of infrastructure in relation to the location of the impact).

Changes in climate can be represented by multi-decade climate scenarios. These scenarios help identify a range of potential changes. Climate scenario information is increasingly available for most regions and provides decision-makers with a basis for assessing the range of impacts that may occur. Climate stressors such as sea level rise, temperature change, and increases in storm intensity then interact with local environmental conditions as well as non-climate stressors, resulting in different impacts in different areas. For example, the impacts of sea level rise on infrastructure will be more severe and cause greater inundation in regions experiencing land subsidence.

Sensitivity: Sensitivity is the degree to which an infrastructure asset or system will be affected or damaged by a climate stressor to which it is exposed. Different infrastructure will be more or less sensitive to the same type and level of exposure. For example, wood can be more sensitive to moisture and wind than cement. As a result, wooden buildings are more vulnerable to floods and hurricanes than cement-based structures.

Adaptive Capacity: In the context of infrastructure, adaptive capacity is the capability or potential to anticipate, prepare for, and respond to potential climate change impacts to an asset, system, or the services that are provided. This includes the ability to moderate potential damages, take advantage of opportunities, or cope with consequences. Core socio-economic drivers—such as access to education and information, wealth, and strong institutions and networks—are often key indicators of resilience and adaptive capacity.

PRIORITIZE NEEDS FOR ADAPTATION

The vulnerability assessment process will inform planners and decision-makers about the projected stressors, consequent climate impacts, and multiple infrastructure systems at risk. Decision-makers can then set priorities for which infrastructure should be addressed first. Adaptation priorities can be selected through a screening process, based on decision-makers' assessment of four key factors:

- ***How critical is the infrastructure to providing a needed service and ensuring lasting program effects?*** Components of an infrastructure network or asset can be evaluated based on factors such as volume of use, the relative importance of different assets to daily or strategic functions, their role in emergency evacuations, and their perceived value to policy-makers.

  It is especially important to consider the role infrastructure plays during disaster response when assessing criticality, since resilient infrastructure is essential to ensuring human safety and protecting lives. Infrastructure used for disaster response often represents the most critical infrastructure within each category, particularly if no backup systems exist. For example, particular aspects of the transportation network are much more critical than others. Not only are bridges connecting islands to the mainland critical in the daily transport of goods and people, they are especially important during emergencies, particularly if no alternate routes exist. In contrast, rarely used roads in locations that have multiple access routes may be less critical. In addition, electricity generators that power hospitals and care-giving facilities are critical in providing medical attention and sustaining life.

- ***How likely is the potential climate impact?*** The extent of future climate change is uncertain and the pathways through which climate change will affect infrastructure are often not well understood. Therefore, it is often difficult to assign quantitative probabilities to specific climate impacts. The use of climate scenarios helps to address this challenge. These scenarios can help identify a range of potential changes and characterize the likelihood of an impact in a particular region. This information provides decision-makers with a basis for assessing the range of impacts that may occur.
- ***How severe will the consequences of the climate impact be? How soon may this occur?*** The severity and timing of climate impacts are important factors in identifying those that warrant the greatest attention for adaptation action. Although some weather events may have a low likelihood of occurring, the resulting damage to infrastructure and loss of life can be so severe that they still warrant adaptation measures. For example, while a 100 year flood defined as 1%-annual-chance flood in a given year may occur very infrequently, it can damage and destroy much of the area's infrastructure and endanger many lives. This type of event can be particularly damaging if disaster response infrastructure is compromised or overwhelmed. Importantly, assets used for disaster response can be affected by the same stressors for which they minor consequences in the short term (although the cumulative impacts of frequent low-consequence events may become serious over time). The anticipated timing of climate impacts is also a key consideration—imminent threats require prompt action, while impacts that are incremental or expected in future decades may allow more flexibility to adjust plans and infrastructure.
- ***What resources are available?*** Assuming constrained funding, technical expertise, and institutional capacity, local decision-makers need to target their resources to a subset of the highest priority needs, based on the three factors above.

DESIGN: IDENTIFY, EVALUATE, AND SELECT ADAPTATION OPTIONS

Once the vulnerability of assets is understood and priority infrastructure is identified, there is a range of actions that can be taken to improve the resilience of infrastructure. Designing adaptation actions is most effective when done as an integral part of program and project development. Illustrative examples of these adaptation actions are outlined in the fact sheets.

A range of options and strategies is available to adapt to, prepare for, and respond to the impacts of climate change. Identification of appropriate options will depend on a number of characteristics, including the impacts faced (particularly, timing and type), the location of the infrastructure asset (on coasts, highlands, river valleys, protected areas, etc.), the interconnectedness of the systems, the socio-economic context, and overall development objectives.

Other factors include the level of resources required to implement the adaptation action, as well as the system-wide impacts and benefits that will result. Some adaptation actions may require little to no resources, while others may be resource-intensive. Economic evaluation may provide helpful cost-benefit or cost-effectiveness information on adaptation options.

Alternatively, some adaptation actions may provide protection against climate change in the short-term but lead to increased vulnerability in the medium- to long-term. Consideration of a range of future scenarios and resulting implications is important to ensuring adaptation actions sustain value into the future. Careful consideration should be paid to the resulting environmental, economic, and social impacts of actions, including the greenhouse gas emissions associated with a particular adaptation action. If thoughtfully designed, adaptation actions can not only reduce the risks of climate impacts to the infrastructure and associated services, they can also achieve important co-benefits, such as "no regrets" actions that benefit communities and support other development objectives regardless of the degree of climate change.

Adaptation actions can be classified as "hard" or "soft." "Hard" actions involve engineered protections or structural changes to existing (or new) infrastructure, including green approaches that use natural or environmentally-focused methods, such as landscape architecture. "Soft" actions focus on policy and regulation changes, training, or educating stakeholders. Adaptation options differ in their timeframes for implementation, lifetime of use, and associated costs. A variety of feasible adaptation actions can often be identified to respond to a specific vulnerability. Examples of actions are presented in each of the fact sheets.

For infrastructure, adaptation actions can be categorized under three main approaches: accommodate and manage, protect and harden, and retreat. While not always the case, the cost of these approaches generally increases as "hard" engineering approaches or site relocation strategies are pursued.

Accomodate and Manage: These options are characterized by their focus on changes in management practices and programs. They consist of updating plans, management policies, regulations, and maintenance and operations activities. Examples include changing the frequency of repair schedules, installing redundant systems to back up a primary system in case of disruption, developing contingency plans, and providing educational and training programs. These actions often can be readily redesigned, based on an evaluation of progress, changing needs, and new information. Appropriate use of these strategies allows decision-makers to manage the level of risk and monitor conditions while deferring more costly construction or relocation approaches; in some instances no additional actions may be required. By adjusting existing practices, accommodation and management strategies can increase resilience, manage climate effects as part of routine activities, or prepare for emergency management if infrastructure does fail.

Protect and Harden: Options under this approach involve structural changes to how an infrastructure system is designed, built, renovated or protected. Protect and harden strategies include actions such as upgrading design standards (e.g., using stronger building materials) and reinforcing or fortifying existing structures (e.g., incorporating extra foundational supports, erecting protective barriers around critical roadways). Other examples of "hard" options include elevating bridges and structures, changing the curvature of drains and roads, constructing levees or sea walls, developing natural areas to provide buffer zones (such as wetlands or replenished barrier islands), and using more resilient building materials. These options can be resource-intensive in terms of the financing, technical, and organizational capacity required. Implementing these actions as part of scheduled plans for upgrades or infrastructure replacement can be most cost-effective. Further, these options tend to be more permanent, making them less able to respond to changing circumstances. In order to avoid maladaptation, long-lasting and expensive infrastructure needs to be particularly well-designed to ensure its resilience under a range of potential climate futures. When possible, designs should allow for flexibility to incorporate future changes or enhancements as warranted by evolving climate conditions (e.g., a seawall that allows for the height to be increased).

Retreat: These strategies seek to reduce the degree of exposure by relocating assets and systems away from exposed locations, such as shorelines, floodplains, and areas at risk of landslides, mudflows, floods or fire. For example, public buildings such as hospitals, disaster-related infrastructure such as evacuation routes and helipads, or other critical infrastructure systems such as power plants, water lines, or telephone sub-stations could be relocated to more protected areas (and away from coasts).

Once a subset of adaptation options has been identified, managers select a course of action. The course of action may be a set of specific actions that are "bundled" to maximize effectiveness in the context of overall development objectives. Factors such as system-wide benefits, funding constraints, stakeholder input, greenhouse gas emissions, and human resource capacity are key considerations in this process. Additionally, timing is an important factor to consider when selecting a course of action. While certain actions may require prompt implementation in order to mitigate imminent consequences, others actions may not be as urgent. If possible, implementation of capital-intensive adaptation actions should be deferred until ongoing monitoring of climate and non-climate stressors helps to reduce the uncertainty associated with the extent and magnitude of climate impacts and the effectiveness of adaptation actions.

The fact sheets provide specific examples of adaptation options for each infrastructure type. Please see USAID guidance, Climate-Resilient Development: A Guide to Understanding and Addressing Climate Change, for further information on how to select, integrate, and bundle adaptation strategies.

IMPLEMENT AND MANAGE: PUT ADAPTATION INTO PRACTICE

Once an individual or suite of adaptation measures is identified, managers proceed with implementing and managing this course of action.

As with traditional development programs, adaptation measures require developing and implementing a clear strategy to ensure adequate capacity, resources, awareness, and education so that these actions achieve their desired goals. This may involve a broad range of activities, including planning, policy development, and resource identification. Structural engineering projects like building adaptation structures or retrofitting facilities may take several years to design and construct. Policy-related adaptation measures may be implemented through existing programs or may require new initiatives. Building stakeholder capacity is often a key component of successful implementation and management of adaptation actions.

EVALUATE AND ADJUST: TRACK PERFORMANCE AND IMPACT

A successful adaptive management approach requires an ongoing process of monitoring and evaluation. This monitoring includes tracking the changing conditions related to the infrastructure and the efficacy of the adaptation actions taken to date. The conditions under which infrastructure provides services are continually evolving: Climate continues to change, environmental conditions shift, populations grow, and economic and development patterns transform. Monitoring these changing conditions is critical to fully understand future challenges to the resilience of the infrastructure. Assessing the effectiveness of existing practices, as well as the adopted adaptation actions in this context helps decision-makers determine what strategies have worked, identify less effective approaches, and plan for next steps.

To understand whether implemented solutions are effective, decision-makers and planners can monitor changing climate and environmental conditions, the condition and performance of infrastructure, and changing community and regional needs.

Monitoring and evaluation are especially important because much of adaptation is proactive, seeking to address and ameliorate climate changes prior to their impacts. The data used to evaluate the likelihood, severity, and consequences of future climate changes are often relatively uncertain. Therefore, adaptation strategies and actions should be designed to respond in ways that are as robust as possible across a range of future climate conditions. The actions should be continuously monitored and evaluated to ensure that they have been implemented well, and that they are appropriate and effective as climate conditions evolve. The adaptation actions can then be adjusted on the basis of the learning that occurs through this monitoring and evaluation.

UNCERTAINTY AND CLIMATE CHANGE

Uncertainty is an inherent part of integrating climate change in infrastructure-related decisions. Sources of uncertainty include:

- Unpredictable human behavior that leads to shifting population and development patterns, change in land and resource usage, technology advances, energy consumption changes that alter emissions of greenhouse gases, governance changes, and many other factors
- Difficulty representing knowledge of physical, human, and ecological processes in models of future changes in climate and vulnerability of infrastructure and associated systems
- Inherent variability of systems, including day-to-day weather or infrastructure systems

These sources of uncertainty can be addressed in decision-making by using a wide span of climate and non-climate scenarios, by accounting for the range of current natural variability (including extremes), and by monitoring changing conditions, including the extent and magnitude of weather-related impacts on infrastructure. These characterizations of uncertainty should be discussed in any communication of modeling results to ensure that they are taken into consideration during decision-making.

NEXT STEPS

By integrating climate resilient considerations into infrastructure-supported programming, USAID and other development practitioners can ensure that programs will achieve sustainable success. This overview has provided an introduction to the basic concepts used in thinking about climate resiliency and adaptation. The accompanying infrastructure fact sheets provide more detail.

In addition to using this suite of information, development practitioners can:

Consult with specialists
Specialists can guide and support climate-resilient program and project development through the provision of technical assistance, guides, and trainings. USAID Missions can receive this information directly through Headquarters (HQ).

Refer to USAID guidance

USAID guidance, Climate-Resilient Development: A Guide to Understanding and Addressing Climate Change, is designed to help development practitioners understand how climate may impact their programs and projects and how these impacts can be addressed to promote climate resilient development. USAID HQ can also provide Missions with USAID-specific reference resources to help mainstream climate change into other USAID programs or design an adaptation-specific program.

Collect preliminary data

To advance the state of knowledge and begin to understand possible climate impacts, vulnerability, and risk to infrastructure, development practitioners can begin collecting data on the types and locations of infrastructure to help assess their criticality, exposure, and sensitivity. The collection of climate data for indicators such as rainfall, temperature, and extreme events is essential for assessing the historical impact of climate variability on infrastructure.

Begin assessing critical programs that are already being designed or are in place

Program staff can begin to analyze which infrastructure systems are critical to program operations and economic growth, to help prioritize actions. When designing new programs or projects, development practitioners should undertake climate risk and vulnerability assessments and consult with specialists for further guidance. Simultaneously, program/project teams should undertake assessments of existing programs and projects and understand the opportunities for mainstreaming climate considerations.

Build capacity in risk assessment and designing adaptation options

Development practitioners can attend adaptation and adaptive management trainings that will guide them through conducting risk and vulnerability assessments and appropriate management strategies. Information is also available through the various climate change-related knowledge portals and online trainings. USAID HQ can provide Mission staff with USAID-specific trainings, guidance, and reference documents.

Begin to integrate measures to address infrastructure climate risk into projects

After assessment activities and training, development practitioners should begin to mainstream climate risk considerations into projects and programs by designing redundancy plans, considering changes in management and operations, and providing guidance to stakeholders on better practices and lessons learned.

ADDITIONAL RESOURCES

Adapting to Climate Variability and Change: A guidance manual for development planning
http://pdf.usaid.gov/pdf_docs/PNADJ990.pdf

Climate One-Stop
http://arcserver4.iagt.org/climate1stop/Default.aspx?mode=modeDataVisualization

SERVIR
http://www.servir.net/

Climate Change Knowledge Portal
http://sdwebx.worldbank.org/climateportal/index.cfm

Climate Wizard
http://www.climatewizard.org/index.html

Climate Change 2007: Working Group II: Impacts, Adaptation and Vulnerability
http://www.ipcc.ch/publications_and_data/publications_ipcc_fourth_assessment_report_wg2_report_impacts_adaptation_and_vulnerability.htm

Climate Change: Impacts, Vulnerabilities and Adaptation in Developing Countries
http://unfccc.int/resource/docs/publications/impacts.pdf

National Communications
http://unfccc.int/national_reports/non-annex_i_natcom/items/2979.php

National Adaptation Programme of Action (NAPA)
http://unfccc.int/cooperation_support/least_developed_countries_portal/submitted_napas/items/4585.php

Assessments of Impacts and Adaptations to Climate Change in Multiple Regions and Sectors (AIACC)
http://sedac.ciesin.columbia.edu/aiacc/

Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation (SREX)
http://www.ipcc-wg2.gov/SREX/images/uploads/SREX-SPMbrochure_FINAL.pdf

Questions, feedback, suggestions, and requests for support should be sent to **climatechange@usaid.gov.**

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