

5. Monitoring and evaluation

Forest managers may need to carry out additional monitoring to guide their climate change adaptation and mitigation actions. Changes to existing monitoring systems may be required, depending on: whether the government requests additional information to inform national adaptation and mitigation programmes and reporting to the UNFCCC; the adaptation and mitigation actions the manager has chosen to carry out; and whether the forest manager's existing monitoring system is sufficient to supply new information needs. Monitoring both the effects of climate change and the effectiveness of management responses is central to the adaptive management approach (i.e. learning from experience by experimenting with different management schemes). Those engaged in climate change mitigation activities that require the measurement, validation and reporting of mitigation benefits will also need to monitor changes in forest carbon and, in many cases, the social and environmental impacts of activities. These additional monitoring requirements could be a significant burden for forest managers who may, however, be able to use existing databases, criteria and indicator processes and forest certification schemes as a framework for monitoring.

The climate change-related methods used by forest managers will depend on the risk and vulnerability of the forest resources, the financial and technical resources available, and the spatial scale of the operation. Large-scale industrial forest managers tend to have more comprehensive inventory systems, including permanent sample plots and possibly remote sensing capabilities. Managers with smaller FMUs, and community forest managers, tend to have simpler monitoring systems, ranging from field inventories to systematic observation and the more informal collection of information.

Irrespective of the scale of monitoring required, forest managers should involve local people and traditional methods using participatory approaches. Local communities may not have received suitable training and are likely to have varying skills, expertise, societal roles and interests.

Once the need to monitor is recognized, the question of what to monitor must be addressed. Monitoring for adaptation purposes will require the collection of data on indicators of climate-induced impacts (e.g. on forest productivity, forest health and forest pests – see Chapter 4). Many of these data will normally be collected in standard forest inventory systems.

For biodiversity, the ideal species for monitoring are those that are expected to be vulnerable to climate change and that are also easy to census. Ideally, such species will also be species of special concern.

For water monitoring, dry season base flows and suspended sediments during periods of low flow might be the most appropriate indicators, and macro-invertebrates in streams can serve as good indicators of ecological integrity.

For fire susceptibility, monitoring fuel loads and moisture content are the first steps in assessment.

Social factors related to vulnerability and the benefits of adaptation measures are unlikely to be included in standard forest inventories. Forest managers required to provide such information should develop social indicators that can be monitored, either by their own systems or by the use of other sources of data (e.g. census data or rural development databases maintained by government).



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A forest ranger takes soil samples at Megeni Kitasha in the Rombo District in Moshi, the United Republic of Tanzania. Under climate change, forest managers may need to carry out additional monitoring to guide their climate change adaptation and mitigation actions.

⁵ www.climate-standards.org

Forest monitoring in response to climate change

MONITORING	OPTIONS
What to monitor?	<p>Climate variability and climate change</p> <hr/> <p>The most significant impacts of climate change on forests and people, especially the most vulnerable of these</p> <hr/> <p>The impacts of the measures taken in response to climate change. Prioritize actions, beginning with the most relevant</p> <hr/> <p>Ongoing relevant research in the area (i.e. local) and further afield</p> <hr/> <p>The data, human (e.g. knowledge and skills) and financial resources required to respond to impacts</p> <hr/> <p>The dissemination of research results, best practices and lessons learned from climate change actions</p> <hr/> <p>The development, revision and implementation of policy measures</p>
How to monitor?	<p>Establish the baseline and indicators to record changes</p> <hr/> <p>Record changes, including possible reasons for changes</p> <hr/> <p>Define the boundaries of the forest area to be monitored</p> <hr/> <p>Integrate additional monitoring needs into existing inventory or other monitoring systems</p>
When to monitor?	<p>Establish fixed timelines for monitoring (e.g. 2 or 3 years). These may be revised:</p> <ul style="list-style-type: none"> • when there are observed changes in climate, or when a policy changes • if change is occurring rapidly and the impacts are significant. <p>If the forest area is within a carbon market project, carbon monitoring will be needed about every 5 years</p>
Who should monitor?	<p><i>Changes in climate:</i> researchers; forest officers; forest agencies; forest managers; communities; local NGOs; meteorological departments (local, subnational and national); agricultural and extension officers; agricultural organizations (e.g. crops and livestock, water resources); wildlife management authorities; local and state authorities</p> <hr/> <p><i>Significant climate change impacts:</i> researchers; district forest officers; forest agencies; forest managers; communities; local NGOs; meteorological departments (local, subnational and national); agricultural and extension officers; agricultural organizations (e.g. crops and livestock, water resources); wildlife management authorities; local and state authorities</p> <hr/> <p><i>Impacts of the measures taken:</i> researchers; district forest officers; forest agencies; forest managers; communities; local NGOs; agriculture and extension officers; agricultural organizations (crops and livestock, water resources); wildlife management authorities; local and state authorities</p>

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MONITORING	OPTIONS
	<p><i>Current research:</i> researchers</p> <hr/> <p><i>Policy frameworks:</i> researchers; district forest officers; forest agencies; forest managers; communities; local NGOs</p>
<p>Cost of monitoring?</p>	<p>Governments must invest in basic weather monitoring. Other costs can be shared among forest owners, forest managers and other stakeholders in the area</p> <hr/> <p>Evaluate different monitoring approaches for cost-effectiveness</p>

Forest managers who need to report on mitigation actions or who are endeavouring to access carbon markets (e.g. projects under the Clean Development Mechanism or REDD+) will need to monitor forest carbon. In particular, such forest managers will have monitoring–verification–reporting obligations to demonstrate the additional carbon benefits of their management. They will also need to provide evidence that the action does not result in carbon-releasing activities beyond the boundaries of their management areas (i.e. leakage) and that any carbon stocks lost in a project area (e.g. from timber harvesting or forest fire) are replaced (i.e. permanence). Access to carbon markets can be improved by demonstrating the delivery of social and environmental benefits from activities that reduce emissions of GHGs – the Climate, Community and Biodiversity Alliance⁵ has developed standards for this purpose. The need to demonstrate social and environmental benefits from mitigation projects and to provide assurances that such projects do not have negative impacts will often require additional monitoring. In regard to biodiversity impacts, for example, particular species or populations may need to be monitored.

Managers may also need to monitor impacts on social factors, such as equity, effectiveness and efficiency (i.e. cost–benefit analyses that include consideration of the distribution of costs, risks and benefits), and on vulnerable groups, such as indigenous people, forest communities and women.

Growing concern about the unintended consequences of management actions implemented for climate change mitigation means that managers should be vigilant in their monitoring of social and environmental parameters. They should also watch for developments in climate change policy and laws that will affect management and their reporting to government. Forest managers should also stay up to date with ongoing relevant research.

Monitoring expertise is often available locally (e.g. community-based management). In many cases, innovative arrangements will have to be put in place that incorporate local expertise and that can be supported by other institutions (e.g. local and regional governments and institutions). In some cases (e.g. for forest carbon monitoring for mitigation projects), some aspects of monitoring will need to be outsourced (e.g. to organizations with specialized laboratories or to academic institutions with undergraduate

and graduate researchers). Where possible, expert knowledge from academic, practitioner and resource-user communities should be combined to increase monitoring power and provide the resource management platform needed to face climate change threats. No matter who is doing the monitoring, managers need to be closely involved to ensure that it satisfies real needs and is cost-effective. In all cases, there are substantial advantages in coordinating with other forest managers and other institutions in a given region.

Just as important as monitoring the outcomes of climate change-related management is a thorough assessment of the mechanisms through which the outcomes are being achieved and how they vary in different contexts (e.g. forest type, forest tenure and type of threat). Impact evaluation will greatly enrich the capacities of forest managers to understand and react to factors that increase the risks and vulnerabilities of the forests for which they are responsible.



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*An entomologist deploys a trap to monitor the presence of gypsy moth, *Lymantria dispar*, near Fort Collins, United States of America. Monitoring both the effects of climate change and the effectiveness of management responses is central to the adaptive management approach.*



A forest officer measures the diameter of a tree in Nicaragua. Robust forest monitoring and reporting systems are key aspects of forest-based responses to climate change.