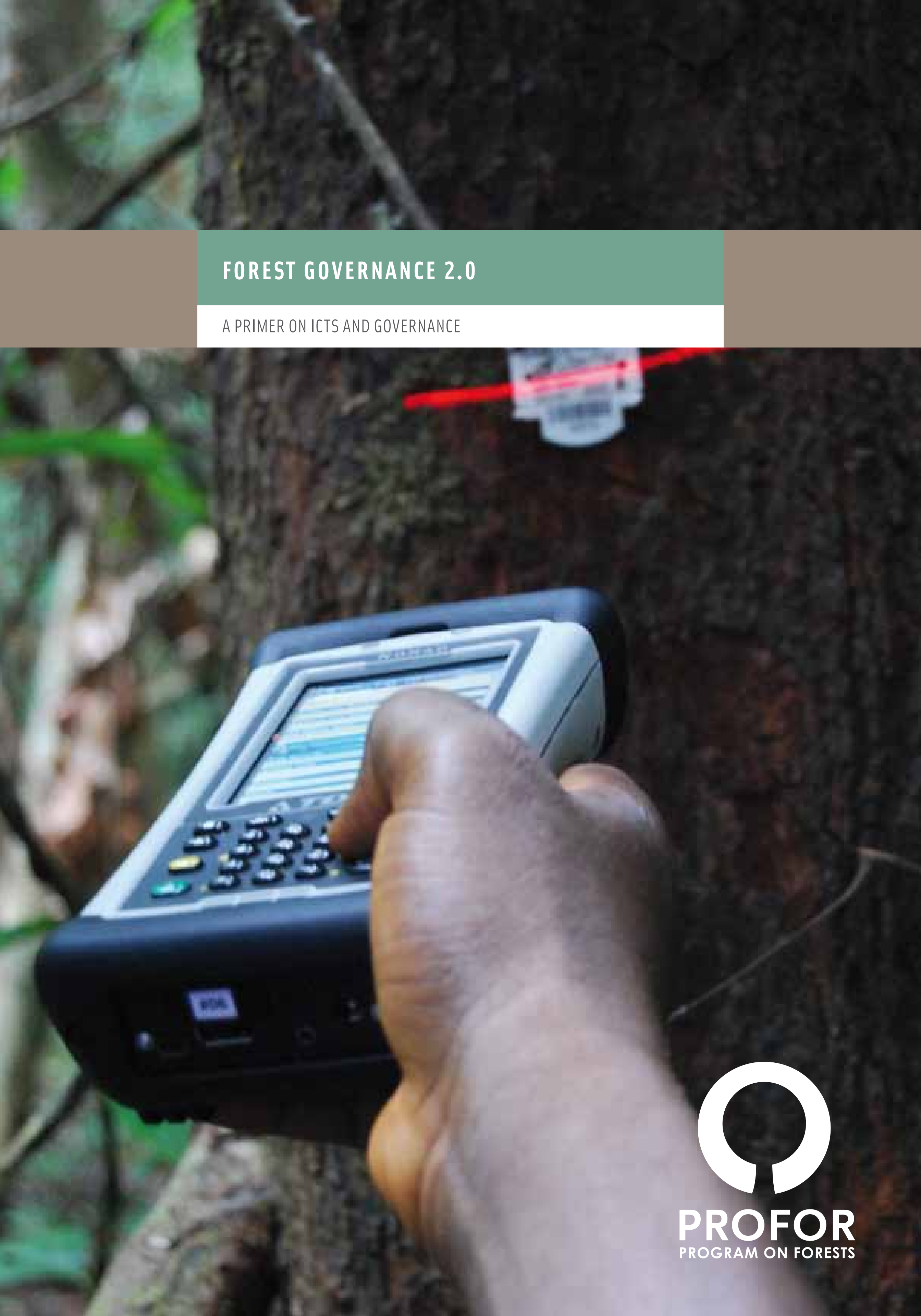
FOREST GOVERNANCE 2.0

A PRIMER ON ICTS AND GOVERNANCE



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A PRIMER ON ICTS AND GOVERNANCE

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EXECUTIVE SUMMARY

Ever since societies began to understand that human activities have an impact on forests, assessing the best way to manage them has been a topic of discussion. The nature of the discourse has changed over the centuries, but the interaction of human activity and the state of the forests has always been at the core. Over time, it has become increasingly obvious that if the sector is to be sustainable, forest management must involve those who live in the forests as well as those who derive their livelihoods from forests.

Legality and good governance in the forest sector are essential for economic benefits, livelihoods, and environmental sustainability. This has been a central theme in global forest policy since the late 1990s, when both producer and consumer countries began to implement policies and programs to curtail illegality and promote good governance in the sector. The recent focus on reducing emissions from deforestation and forest degradation (REDD+) to mitigate climate change has made the issue of governance even more salient.

At the same time as forest governance was emerging as a major issue, the global community was experiencing a fundamental change in information management: technological development led to huge advancements in computer technology, information networks, and telephone technology. The emergence of affordable personal computers, followed by the exponential expansion in the use of mobile phones and the Internet, transformed information management in the 1980s and 1990s. Technology has had a huge impact on governments, businesses, and civil society. The Internet and mobile telephony have changed the underlying principles of information management and knowledge sharing.

Access to information services continued to increase rapidly in the 2000s: in 2009, mobile phone penetration in developing countries reached 57 percent. Technological change often takes place at the same time as institutional reforms when state-owned monopolies are commercialized or privatized and competition among service providers is introduced. Increased access to communication and information technologies has led to the development of e-government and e-governance initiatives, such as ICT (information and communication technology) applications for interactions between governments and citizens. The increased use of technology has improved public access to information. Despite the expansion of service networks, a digital divide still exists—information services are expensive for the average consumer in developing countries, although ICT costs show a declining trend.

The Internet and the mobile phone revolution have played an important role in global development and poverty reduction. In the late 1990s, global attention began to focus on how ICTs can be used to promote global development goals. There has been increasing interest in finding ways to use ICTs to meet the challenges of the Millennium Development Goals (MDG) agreed on by the UN General Assembly in 2000.

In this report, we review the experiences and lessons learned in the use of ICTs to promote forest governance. It identifies ways we can apply modern technology to meet the challenges of improving forest governance to achieve sustainable forest management. The report focuses on institutions, how they interact with key stakeholders, and how we might strengthen their performance in improving governance.

USE OF ICT IN FOREST GOVERNANCE

Currently, many initiatives use technology to improve forest governance. In this assessment, we attempt to determine how ICT applications can be used to improve the five main dimensions of forest governance identified in the World Bank's analytical framework for forest governance (2009a). The five dimensions, with some sample ICT applications, are:

- Pillar I: transparency, accountability, and public participation
  - e-government services and open government applications
  - advocacy campaigns through text messaging and Internet social networking sites
  - community radio
  - crowd sourcing—mapping for the people, by the people
  - collaborative and participatory mapping.
- Pillar II: stability of forest institutions and conflict management[1]
- Pillar III: quality of forest administration
  - online staff training
  - real-time fire alerts
  - forest cover and carbon stock assessment with remote sensing
  - wildlife tracking
- Pillar IV: coherence of forest legislation and rule of law
  - prevention (crime mapping, corruption hotlines)
  - detection (timber tracking, chain of custody systems, checkpoints, satellite images, GPS surveillance, red flag detection)
  - suppression (crime databases, case management systems)
- Pillar V: economic efficiency, equity, and incentives
  - online timber sales
  - logistics
  - REDD+ payment management

In the past, much of the work on ICT in the forest sector has focused on inventories and computerization of administrative tasks. Several factors have created a demand for a more integrated approach in management information systems—working only within the forest sector and with forest administration is no longer feasible. The three main interlinked drivers of change are:

1. Technological change and convergence: Technological change enables stakeholders to explore data from anywhere in the world and collaborate with others.
2. Increased openness, transparency, and participation: The forest sector can no longer work in a vacuum; it must share information with all stakeholders.
3. National e-strategies and e-development programs: Many countries have set up programs to develop e-government and information management across the public sector and national economies. Forestry influences other sectors and vice versa; in information system development, a whole-of-government approach is required to ensure that appropriate links are built in.

COMMON ELEMENTS FROM THE FIELD EXAMPLES

With proper planning, mobile and Internet applications can be used to improve various aspects of governance. And these systems can be combined with others to provide a full set of services for the general public and forest professionals. But technology alone is not adequate—two factors are crucial for long-term sustainability. First, project design must be appropriate and focused on meeting demand. Second, operational and maintenance issues must be addressed; for example, power supply (e.g., for recharging laptops, mobile phones, and PDAs (personal digital assistants), spare parts (e.g., replacement batteries), and service.

Experience shows that ICTs work well for some aspects of governance, but their use must be linked with institutional demand and systematic assessment of governance needs. Much of the current practice—particularly in developing countries—is based on relatively small pilot interventions financed by donors or nongovernment organizations (NGOs). Increasing ICT use in public administration may improve productivity and efficiency, but for technological applications to provide all the expected benefits, their use must be linked to wide-scale institutional reform. So far, this has not often been the case.

Users are willing and able to use new technologies, but they need the right incentives and knowledge of the service. Even models that are fully functional from a technical perspective may fail to deliver or perform below expectations if users are not aware of them or do not have the right incentives. It is essential that clients are able to provide feedback and are genuinely involved. Wide availability of forest sector information—for example, through Web sites—contributes to public consultations and inclusive decision making. Even limited dissemination is beneficial; if authorities make information available to the media and NGOs, it can benefit the public. ICT applications can be adapted for accessibility across language and literacy barriers, through the use of icon-based interfaces, touchscreens, and simpler software. However, users still need to be aware of the service and motivated to use it.

Technology can make existing systems more efficient and previously unfeasible activities possible. Both incremental improvements and transformational changes are possible with ICT applications. Applications such as remote sensing and geographic information systems (GIS) allow us to do things better or reengineer existing processes, while information collection and distribution to and from large groups of users (e.g., through crowd-sourced maps) would not be possible without ICTs. In incremental improvements, problems are often accurately identified through practice. Transformational models require innovation and even some guesswork: the problem must be properly identified before it can be solved. One must take a venture capitalist approach and accept a higher failure rate in transformational pilots, but the potential returns can be very high.

Some services are consumer driven and can become financially self-sustaining, while others are public goods and must be financed from public sources. Most examples in this study are from externally funded or public sector programs, although many ICT applications are being developed for mobile banking, market services, and other commercial services. Much attention has been paid to the financial sustainability of these services and how the costs of setting them up and running them can be recovered from clients. The situation is different in forest governance. For example, law enforcement is a public good and should be financed from public resources, not funded by user fees. Assessment of the financial sustainability of public goods and services must include public funding and cover other gains besides just cash revenue. For private services, the situation is different; there, conventional business calculus can be applied. However, this does not exclude providing targeted subsidies; for example, to the rural poor to enable them to use mobile banking.

Applications that rely on mobile phones, radio, and the Internet can be deployed quickly and with minimal technological support. In many cases, the underlying technology exists and only the applications need to be developed. Many technological applications in the forest sector have been developed on existing platforms as the result of demand-driven innovation. These applications are used in a number of ways to increase public participation and surveillance of forest areas, to monitor fires, and to reduce human-wildlife conflicts in protected areas. In fact, not all applications are new: the radio is one of the earliest ICTs to be deployed in development communication and continues to be one of the most ubiquitous.

USING ICT TO IMPROVE FOREST GOVERNANCE

Building on the recent ICT and e-governance development, and experience from country reports and other examples, we have identified 10 key principles to consider in developing ICT interventions for forest governance.

1. *Be familiar with national ICT policies and e-readiness. Projects can be developed in countries with low readiness, but they must be designed accordingly.*

   Readiness is an essential factor to ensure that e-services can be used and that investments in new systems will result in the desired outcomes. In designing forest sector ICT applications, one must understand the status of national readiness and the development trajectory. Existing and potential capacity must be mapped and applications must match capacity. Development programs might include components to strengthen e-readiness in partner forest organizations. Such efforts must be fully aligned with national e-government development strategies. Particularly in environments with weak capacity, systems might be developed independently of each other and national government e-strategies not followed.

2. *Define the problem clearly, assess the information needs, and compare possible solutions.*

   Defining the problem is a fundamental requirement for any project, and ICT projects are no exception. ICTs are tools; by themselves they do not ensure that the problem will be addressed. Before choosing a technological solution, one must properly identify the underlying processes. The objective is to find the most cost-efficient and feasible solution. Mobile and Internet applications provide many benefits, but traditional communication channels also may be appropriate. Particularly in environments where access to information networks and electricity is limited, low-tech solutions may be preferable. If no systematic feedback systems are required or the information is not time-sensitive, posters, community meetings, and radio can be effective.

3. *Determine the best entry points and the appropriate technology.*

   The assessment of e-readiness guides the choice of applications in a given environment. In ICT, gradual introduction of new services based on existing ones may be the best approach. If the new systems are aimed at the general public and extensive end-user training cannot be provided, they should be based on known and familiar user interfaces.

   Another decision in selecting entry points is the type of technology to be used. Technology choice depends primarily on existing capacity: mobile phones and even smart phones are much more common in poorer developing countries than Internet-connected computers.

4. *Design culturally appropriate and relevant applications.*

   The services provided must be locally adapted and relevant, and must meet the requirements of the target audience. The key is to ensure that applications do not require language skills that are not widely available. Particularly in areas with low literacy rates, e-applications need to form part of a more extensive service package in which nonliterate users can access the information through various agents that help them with the applications, such as public agencies or NGOs.

   Local innovation hubs are important to ensure that design is culturally appropriate. Working at the local level ensures that applications are responsive to local needs and that people actually use the models being developed. End users should be involved in the design of the systems.

5. *Involve end users and publicize the service.*

   It is not enough to set up new systems—the target audience must be aware of them and of their benefits. New applications must be actively disseminated, which might be of particular concern to public sector agencies that have little experience in marketing. Both traditional rural dissemination approaches and more commercially oriented marketing, even advertising, will help ensure that the target audience is aware of the new possibilities.

6. *In designing projects, consider costs, long-term financial sustainability, and scalability.*

   Many pilot studies and applications are funded and subsidized by international donors, NGOs, or national governments. However—particularly for commercial services—the long-term sustainability of an application will depend on end-user participation and out-of-pocket expenditures to purchase various IT services.

   So far, most pilot models have focused on building technological knowledge and experience. Very few projects have focused on the financial sustainability of the models. In fact, comprehensive information is not available on the investment costs of many applications. To be sustainable, programs must consider scaling-up and replication costs.

7. *Address data security and privacy issues, and develop risk mitigation measures to prevent misuse of technology and inaccurate data.*

   Using ICTs to track illegal activities can facilitate better law enforcement, but the opposite is also true. Loggers and wildlife poachers might intercept communications between forest authorities and voluntary informers, and text messages can be used to deliberately mislead law enforcement agencies. Law enforcement bodies must be prepared to counter disinformation, must have resources comparable to those of criminals, and must be capable of investigating criminal activities.

   In ICT applications developed to encourage public participation in forest law enforcement (e.g., hotlines for reporting corruption, illegal logging, or poaching in the forest sector), it is of paramount importance that the identities of sources—and thus their personal safety—are protected.

8. *Ensure the existence of adequate information on the resource (e.g., forest inventories and resource assessments) or the ability to improve data collection.*

   The existence of adequate data to process in the system is a precondition for transparent information sharing. No investment in technology can overcome a lack of data. But these investments do not have to be sequential; in most cases, it is possible collect inventory information while developing ICT applications.

9. *Identify stakeholders (e.g., indigenous peoples, women, and the rural poor) and try to ensure their participation; avoid elite capture.*

   The forest sector has diverse stakeholders with various level of competence. Large enterprises, senior management, and technical specialists in forest administrations and international NGOs are better informed than members of rural and indigenous communities, who may have little formal knowledge of the sector and poor or no access to information networks. Even within communities, access might be unequal—elites might have some access and knowledge, while women and poor people are excluded. To avoid the exclusion of key stakeholders, any system development plan should include comprehensive stakeholder/client mapping to assess the information needs and the best way to provide information services.

10. *Ensure buy-in from forest authorities and other stakeholders.*

    Ensuring adaptation of an e-governance agenda in forest agencies might require strong normative guidance from national e-government programs and agencies. Financial incentives also help. Increased use of new technology is often driven by efficiency gains and cost savings. If these can be clearly analyzed and connected to the new system, agencies will have incentives to stay engaged and expand the use of ICT.

    Many NGOs and international organizations are developing innovative models, but if the right authorities are not involved, the new systems will have limited value, especially if their operators do not have access to relevant information and data. Donor-funded projects sometimes equip project implementation units with modern hardware and software, while the departments they will deal with remain poorly equipped. For wide-scale ICT reform, relevant agencies must be upgraded to allow them to participate in the new systems. This requires adequate investment funding to upgrade hardware, develop systems, and build human capacity.

ABBREVIATIONS

ALOS	Advanced Land Observation Satellite
ASEAN	Association of Southeast Asian Nations
BMIS	business management information system
BOT	build-operate-transfer
CDM	clean development mechanism
CI	Conservation International
CI Earth/Mobile/World	Control Intelligence Earth/Mobile/World (proprietary software)
CFA franc	Communauté financière d'Afrique franc
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
CLAS	Carnegie LandSat Analysis System
COC	chain of custody
COMIFAC	Central African Forest Commission
COP	Conference of the Parties
CSO	civil society organization
CVC	Central Vigilance Commission (India)
DFID	Department for International Development (UK)
DRP	Development Radio Partners
ETC	Ethiopia Telecommunication Corporation
EU	European Union
FAO	United Nations Food and Agriculture Organization
FCPF	Forest Carbon Partnership Facility
FIP	Forest Investment Program
FIRMS	Fire Information for Resource Management System
FLEG	forest law enforcement and governance
FLEGT	Forest Law Enforcement, Governance and Trade
FMIS	forest management information system
FORMA	Forest Monitoring for Action
FORMIS	Management Information System for Forestry Sector (Vietnam)
GIS	geographic information system
GLIN	Global Legal Information Network

GPS	global positioning system
IBP	International Budget Partnership
ICR	implementation completion report
ICT	information and communication technology(ies)
ICT4D	information and communication technologies for development; also, ICT4D Collective
ILWIS	Integrated Land and Water Information System
IPF	Intergovernmental Panel on Forests
IT	information technology
ITU	International Telecom Union (UN)
ITTO	International Tropical Timber Organization
IVR	interactive voice response
LiDAR	light detection and ranging
M&E	monitoring and evaluation
MARD	Ministry of Agriculture and Rural Development (Vietnam)
MDG	Millennium Development Goals
MODIS	moderate resolution imaging spectro-radiometer
MRV	monitoring, reporting, and verification (for REDD+)
NASA	National Aeronautics and Space Agency
NGO	nongovernment organization
OBI	Open Budget Initiative
OPEX	operational expenses
OSS	open source software
PC	personal computer
PDA	personal digital assistant
PFM	public financial management
PoC	push to talk on cellular
Poi Mapper	Point of Interest Mapper
PROFOR	Program on Forests
REDD+	Reducing Emissions From Deforestation and Forest Degradation
RFID	radio frequency identification
RPP	readiness preparation proposal
RS	remote sensing
SAS	software as service
SMS	short messaging service (text messaging)
SPOT	Satellite Pour l'Observation de la Terre (Earth Observation Satellite)
TIST	The International Small Groups and Tree Planting Programme

UNDP	United Nations Development Programme
UNESCO	United Nations Education, Scientific and Cultural Organization
UNFCCC	United Nations Framework Convention on Climate Change
UNFF	United Nations Forum on Forests
UNODC	United Nations Office on Drugs and Crime
UN-REDD	United Nations Collaborative Programme on Reducing Emissions From Deforestation and Forest Degradation in Developing Countries
USAID	United States Agency for International Development
VoIP	Voice over Internet Protocol
VPA	voluntary partnership agreement
WCO	World Customs Organization
WSIS	World Summit on Information Society
WWF	World Wildlife Fund

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1 INTRODUCTION

THE CHANGING LANDSCAPE OF FORESTRY AND INFORMATION MANAGEMENT

Forest governance, institutions, and the best way to manage forests have been topics of discussion ever since society started to understand that management practices have an impact on forests. The nature of the forest discourse has changed over the centuries, but the interaction of human activity and the state of forest resources has always been complicated. Even the legend of Robin Hood is essentially one of forest governance: access to resources, equitable benefit sharing, and accountability in decision making. Ever since the concept of scientific forest management emerged in Europe in the 1800s, forest governance has depended on the quality of information, knowledge management, and the capacity to process information. Since forests began to have economic value as a resource and raw material base, humans have understood that it is not enough to know only the key biological parameters; forest managers need to have economic, social, and technological knowledge to manage their forest estates effectively, sustainably, and profitably. The two underlying issues in forest management are how to deal with the relevant institutions and how to manage information.

Civilizations and societies have been built on issues related to institutions, information, and knowledge, and seeking the best ways to collect and disseminate knowledge has been the driver behind institutional change on many occasions. Until recently, public administrations were often concerned about how *not* to disseminate information—how to keep it from reaching affected people and communities. "Information management" was often more about controlling the flow of information rather than ensuring that people have access to as much public information as possible. In many sectors, including forestry, directly affected people were considered objects of public policy rather than active stakeholders who need to be heard.

The situation has changed dramatically in the past few decades. In forestry, it has been increasingly understood that if the sector aims for sustainable outcomes, it must actively involve not only forest managers, but the people who live in and derive their livelihoods from forests. Without genuine participation of the affected people, the sector will underperform and will not be able to provide optimum social, economic, and environmental services. This is true at the national level in forested countries and in the development of international forest policy.

In the past few decades, reform needs have been identified in forest law enforcement and governance (FLEG), along with the wider recognition that good governance, law enforcement, and anticorruption activities are the basis of global development. This recognition is a surprisingly recent phenomenon—until the mid-1990s, corruption was considered a "transaction cost" to be dealt with at the national level rather than a fundamental development issue.[2]

The global interest in good governance has led to sector-specific initiatives. In forestry, the first global programs against illegal logging and other governance failures were launched in the late 1990s. In the next stage, producer and consumer countries launched joint programs to improve enforcement and governance.

As governance issues were being redefined in the forest sector, the global community experienced a fundamental shift on another front. Technological development since the 1970s had led to sweeping changes in computer technology, information networks, and telephone technology. The emergence of affordable personal computers, followed by the exponential expansion of mobile phone use and the Internet, transformed information management in the 1980s and 1990s. This transformation had a huge impact on governments, businesses, and civil society. The Internet and mobile telephony changed the underlying principles of information management and knowledge sharing so much that the environment in which we now operate is called the knowledge or information society.

The Internet and the mobile phone revolution played a major role in global development and poverty reduction. The concept of information and communication technologies for development (ICT4D) originated in the 1950s, but it was not until the late 1990s that global attention focused on how ICTs could be used to promote global development goals (Heeks 2008). Since then, interest has grown in finding ways to use ICTs to achieve the Millennium Development Goals (MDG) agreed to by the UN General Assembly at its Millennium Summit in 2000.

The first milestone was the UN-sponsored World Summit on Information Society (WSIS), which was held as a two-stage event in Switzerland (2003) and Tunisia (2005). The summit drew global attention to the opportunities for achieving the MDG through the use of ICT. At the same time, it emphasized the need to overcome the digital divide between countries and among various groups (social, ethnic, gender) within countries. The WSIS emphasized that meeting the development challenges through ICT is not only about technology but requires the inclusion in the ICT4D agenda of a wide range of issues related to access to information, freedom of expression, and respect for human rights.

Changes in information management brought by the Internet and the enormously improved access to telephone services have fundamentally changed the landscape for the forest sector as well. Digitization of information enables not only improved efficiency and productivity in all organizations—both public and private—but also activities that would have been impossible with more conventional technologies. Development has led to increased dependence on technology in all walks of life. As Heeks (2008) says in his justification for the ICT4D agenda: "Economic, social, and political life in the 21st century will be increasingly digital, and those without ICTs will be increasingly excluded. We might also give a micro-level answer: Ask poor communities or look at how they spend what little money they have; not always, but sometimes, they prioritize the ICT option."

The growing importance of ICTs and advanced knowledge management has been widely recognized but not extensively studied. Much of the work has focused on forward-looking descriptions of how technology could change the ways governments and societies function, and most studies are individual cases of innovative practice rather than comprehensive sector-wide reviews.

In the forest sector, the use of technology is perhaps most advanced in remote sensing and the use of computers in forest inventories. National forest inventories are very data-heavy and require extensive remote sensing data. These data are increasingly in digital format rather than conventional aerial photographs, and geo-referenced data are used in forest management planning in many industrialized countries. However, in other areas of forest governance—such as law enforcement, transparency and accountability, and stakeholder participation—the use of technology is much less advanced.

OBJECTIVES AND STRUCTURE OF THE REPORT

In this report, we study the experiences and lessons learned on the use of ICT to promote good forest governance, and identify ways modern technology can be applied to meet the challenges of improving forest governance and achieving sustainable forest management. We believe that countries and their development partners can make their forest governance reforms more effective and inclusive through the use of information management and technology. The main focus in the report is on institutions—how they interact with stakeholders and how their performance can be strengthened. We are trying to fill the gap in which experiences from various forest governance pilots are not widely shared.

We do not cover forest inventories or technical resource assessment; extensive literature on these topics is available from various national and international research institutions and the UN Food and Agriculture Organization (FAO). We do not present all possibilities and current uses of ICT in forest governance. Our goal is to demonstrate the range and diversity of approaches, and the feasibility of using technology to promote forest governance.

The report's framework is based on the five pillars of forest governance identified by the World Bank (2009a) and summarized in **box 3**: (1) transparency, accountability, and public participation; (2) stability of forest institutions and conflict management; (3) quality of forest administration; (4) coherence of forest legislation and the rule of law; and (5) economic efficiency, equity, and incentives.

The report covers both "small" and "big" ICT. Small and more affordable ICT applications are often based on consumer devices for which the underlying technology is available ready-made from commercial sources. These devices can be used to interact with the public and in professional applications. The big ICT dimension includes professional applications that are tailor-made and often system-based and expensive. An interesting aspect of our discussion is how these two dimensions of ICT can be combined and the level of technological convergence.

We can also view ICT according to the time horizon in which outcomes are expected. New tools to fight forest crime or forest fires are likely to yield positive outcomes quickly through improved enforcement, and tools to improve economic efficiency should also be able to deliver positive outcomes fast. On the other hand, increasing transparency and community participation is a long-term process—longer engagement is required to build capacity. We discuss the difference between short- and long-term benefits.

The report is targeted to a diverse audience. It demonstrates to forest authorities, particularly in developing countries, how they can use innovative solutions to promote administrative efficiency and how transparency in the sector will improve development outcomes. The report does not try to provide solutions for specific problems, but it demonstrates the extent to which information management is an essential part of sector reform. Development professionals dealing with forest governance can use our findings in consultations with partner countries and to help plan interventions. Specialists in ICT4D can use the report to study applied experiences in a specific sector. Finally, by identifying gaps and development needs, we hope the report leads to additional innovation by service providers and appliance suppliers.

The report begins with a discussion of recent developments in the governance discourse to set the stage and show how the definition of forest governance has evolved. We then describe recent developments in access to ICT services, particularly in rural areas, and how information is used in the forest sector. There has been much concern about in-country digital divides; while they still exist, the past few years have seen an unprecedented increase in access to technology in rural areas.[3] This is a precondition for any attempt to introduce ICTs in forest governance. We go on to describe ICT applications in various sub-elements of forest governance. In the last section of the report, we summarize our findings and pave the way for future action.

Three country studies were prepared for this report. The studies from Finland, Ghana, and Uganda are available for download at http://www.profor.info.

BOX 1. ICTS, INNOVATION, AND KNOWLEDGE

Information and communication technology (ICT) includes hardware, software, networks, and media for the collection, storage, processing, transmission, and presentation of information (voice, data, text, images), as well as related services. ICT can be split into information and communication infrastructure and IT (information technology), which refers to the hardware and software of information collection, storage, processing, and presentation.

In this report, ICTs include computers, satellite phones, handheld computers and personal digital assistants (PDAs), remote sensing (RS), geographic information systems (GISs) and global positioning systems (GPSs), radio frequency identification (RFID) tags, smart cards, and community radio.

For an invention to become a useful innovation, some criteria need to be met, and it must lead to changes in people's behavior. Innes and colleagues (2005) identify five principal attributes of innovation:

1. Advantage is the most important element of innovation; it must be advantageous to people in terms of financial benefits, convenience, prestige, and so on.
2. Compatibility is the extent to which the innovation is attuned to the values, experiences, and needs of the people who apply it.
3. Complexity is the extent to which the innovation is seen as complex or difficult to apply.
4. Trialability measures the ease with which people can try out the innovation. Risk-averse people tend to prefer partial changes that can be reversed if the expected outcomes do not materialize.
5. Observability—the benefits of the innovation must be easily examined.

The definition of "knowledge" has been a subject of debate throughout history. We see knowledge as an end result of data collection and information management. By using knowledge derived from information, stakeholders can make rational choices on how to use and manage forests. Using knowledge requires that objectives of action and decision making are identified, and information is used to achieve these goals.

Sources: World Bank Global ICT glossary guide (http://go.worldbank.org/5KY24GL580); Innes, Green, and Thomson 2005.

2 FRAMEWORK AND ELEMENTS OF FOREST GOVERNANCE

This section defines good governance and explains why good governance and anticorruption are important factors for development. It then focuses on forestry and how the governance discussion has evolved in this sector. Finally, it introduces the conceptual framework of five pillars of governance that provides the basic structure for the rest of the report.

GOVERNANCE AS A DEVELOPMENT CHALLENGE

Good governance is a vital ingredient in development and sustainable resource management (Collier 2007). Investments in sustainable development yield better outcomes in a better governance environment. Governance refers to how authority is applied in the management of a country's affairs (**box 2**). This includes both legislation and the regulatory system ("as planned") and their implementation ("as built" or "as operated"). But good governance—or the lack of it—is not the only driver of development outcomes in a country or sector. Issues such as technical capacity, adequacy and quality of the resource base, investment financing, geography, and access to markets all have an impact. In the case of forestry, if a country has a poor resource base, one cannot assume that forests can become a major driver of national development. Ample evidence exists showing that even in forest-rich countries with good market access, the forest sector does not become a driver for national development, economic growth, and poverty reduction if the management of the sector is plagued with corruption and poor governance. The situation is similar for all natural resources, both renewable and extractive. In fact, Collier and others have argued that the existence of valuable natural resources actually can undermine democratic governance and public accountability, and destabilize societies. Collier (2007, 2010) calls this phenomenon "the resource curse." In some conflict-prone countries, such as Liberia and Cambodia, forest looting has been used to lengthen conflicts and support illegitimate governments or insurgents; but this phenomenon has more to do with ongoing conflict than with forestry as the driving force behind it.

The word "governance" covers all dimensions of how public officials and institutions deal with stakeholders. The United Nations Develop Programme (UNDP) and the Asian Development Bank expand the definition to include the private sector, NGOs, international partners, and all other actors that influence how resources are used and decisions are made. This definition is particularly important in forestry, where public policies (e.g., those dealing with forests, land management, climate change, private sector development, and rural development) are closely linked to private sector activities and (partial) private ownership of the resource. Households and private citizens are also objects of public policies and decisions about resource use.

BOX 2. DEFINITIONS OF GOVERNANCE

The World Bank governance and anticorruption strategy defines governance and corruption this way: "Governance and corruption are not synonymous. Governance refers to the manner in which public officials and institutions acquire and exercise the authority to shape public policy and provide public goods and services. Corruption is one outcome of poor governance, involving the abuse of public office for private gain."

The United Nations Development Programme defines governance as "…the exercise of political, economic and administrative authority to manage a nation's affairs. It is the complex mechanisms, processes and institutions through which citizens and groups articulate their interests, exercise their legal rights and obligations, and mediate their differences."

The Asian Development Bank defines it as "…the manner in which power is exercised in the management of a country's social and economic resources for development. Governance means the way those with power use that power."

Sources: McCawley 2005, World Bank 2007.

Improving governance in a given sector, such as the forest sector, requires changes in how authority over and management of the resource is organized and implemented. Much of the discussion and many public sector reforms aim to improve the *supply* of good governance. This top-down approach incorporates actions to improve the quality of public administration, public financial management (PFM), and anticorruption work at all levels.

The bottom-up approach is to strengthen the *demand* for good governance, which means strengthening accountability and transparency to enable better oversight of the public sector. Improving the quality of governance means improving the quality of public services through stronger accountability relationships between state and nonstate actors, and between service providers and beneficiaries. To be effective, reforms must be backed by willingness and by appropriate tools to ensure positive outcomes. There are always some unknown factors, and reforms aimed at improving local empowerment and demand for good governance might ultimately lead to new types of elite capture. NGOs can act as guardians of good governance if the public sector is unable or unwilling to supply it. However, the nongovernment sector has its own governance challenges in terms of both corruption and transparency in decision making.[4]

There is no single right way to improve governance, but it is useful to address governance challenges in a way that allows an operational and actionable approach to reform. This can be done by selecting a theme that is addressed across the society (e.g., anticorruption, PFM, public sector reform) or selecting a sector in which reforms are needed and outcomes can be achieved and monitored (e.g., forestry and the extractive industries).

EVOLUTION OF THE GOVERNANCE DEBATE IN THE FOREST SECTOR

Poor governance in the forest sector has been a concern for several reasons. Forest crime—such as illegal logging, arson, poaching, or encroachment—is a severe problem. In many countries, corruption in the forest sector (e.g., in concession allocation and revenue collection) and rent seeking have led to the loss of public revenue and diminished the reputation of forest agencies in the eyes of the public. Criminal activities have created an uneven playing field for the legitimate private sector because of price undercutting and unreliable access to forest resources. The unpredictable business environment has also led to short-term profit maximization and discouraged socially and environmentally responsible long-term investments in the forest sector.

Poor governance in the forest sector is an impediment to achieving optimum development outcomes in the sector. In developing countries, an estimated 1 billion rural poor depend at least partially on forests for their livelihoods, and about 350 million live in and around forests and are heavily dependent on them for economic, social, and cultural needs. Forests ensure the sustainability of environmental services such as biodiversity conservation, carbon sequestration, and watershed protection. All these services are at risk if forests are not managed in a sustainable manner or governance is poor. For example, forests can play an important role in climate change mitigation, but these expectations cannot be met if forests and rural landscapes in general are poorly managed. Thus, all schemes to reduce emissions from the Reducing Deforestation and Forest Degradation program (REDD+) emphasize the fundamental importance of good governance.

In developing countries, illegal logging on public lands causes estimated losses in assets and revenue in excess of US$10 billion annually, more than eight times the total official development assistance dedicated to the sustainable management of forests. As much as US$5 billion is lost annually to governments owing to evasion of taxes and royalties on legally sanctioned logging (World Bank 2006). In a study prepared for the Australian government, after deduction for consumer benefits, the combined net market costs (financial costs to legal producers) and nonmarket (environmental and social) costs were estimated globally at US$15 billion a year (Center for International Economics 2009). In addition to financial and economic costs, the equity impact of poor forest governance and illegality is notable. These rough global estimates give an idea of the magnitude of the problem but mask country-specific variations.

Tree stumps. Indonesia.
Photo: Curt Carnemark/ World Bank

Despite the grim global estimates, the situation has improved in some countries. For example, a recent Chatham House mapping

(Lawson 2010) reports that illegal logging has fallen more than 50 percent in the past 10 years in Cameroon, the Brazilian Amazon, and Indonesia. Imports of illegal wood to consumer and processing countries are down almost a third from 2004.

The forest sector has seen many initiatives to promote sustainability. The 1990s saw the emergence of multilateral initiatives such as the Intergovernmental Panel on Forests (IPF) and the UN Forum on Forests (UNFF). The private sector also established certification schemes for sustainable forest management, such as the Forest Stewardship Council in 1993. These initiatives to promote sustainability—and, indirectly, legality—were seen as a way to address the most pressing concerns in global forestry. For example, it was hoped that curtailing illegal logging would advance the broader governance agenda and increase revenues in forest-rich countries.

Governance reform is a very sensitive issue, and global dialogue is often complicated by the view that reform is a matter of national sovereignty. In this environment, the legality of trade in global forest products was seen as an issue in which consumer and producer countries could join forces to improve the rule of law in the forest sector. Several regional initiatives have emerged in which the governments of client and producer countries, the private sector, civil society, and international development partners are cooperating to improve forest governance. Often—but not always—such cooperation takes the form of regional and subregional political processes, such as the ministerial conferences in Bali (2001) for Asia, Yaoundé (2003) for Africa, and St. Petersburg (2005) for Europe and Central Asia. These processes have created a regional momentum for governance reform and have led to tangible efforts (e.g., in the Association of Southeast Asian Nations, ASEAN) to promote field-level implementation.[5] Increasingly, good governance is seen as a key enabling factor for successful REDD+ initiatives.

Other international policy initiatives include the G8 Action Programme on Forests (1998) and the U.S. President's Initiative Against Illegal Logging (2002). The EU's FLEGT (forest law enforcement, governance and trade) action plan was approved in 2003, followed by a regulation establishing a licensing scheme for imports from third countries to the EU markets in December 2005. In 2010, the European Parliament and Council approved the EU Timber Regulation, which makes all imports of illegally harvested wood and wood products to the EU illegal. The regulation will become effective in March 2013 (European Council 2005, 2010).

To help producer countries meet EU regulations, the EU has been negotiating bilateral voluntary partnership agreements (VPAs) with producer countries to establish national licensing schemes that will ensure the legality of exports to the EU markets. The VPA licenses will provide fast-track legality assurance that the timber is in compliance with EU requirements. Exporters in countries that focus on EU markets are especially motivated to pursue VPAs. The European Union is supporting FLEGT- and VPA-related capacity building in many countries and has become a major donor for country activities to promote good forest governance (European Commission 2007).

Individual consumer countries have issued national legislation aimed at curtailing imports of illegal timber. In the Lacey Act (2008), the United States made it illegal to import plants harvested in violation of national legislation of the producer country. Australia is introducing similar legislation (Center for International

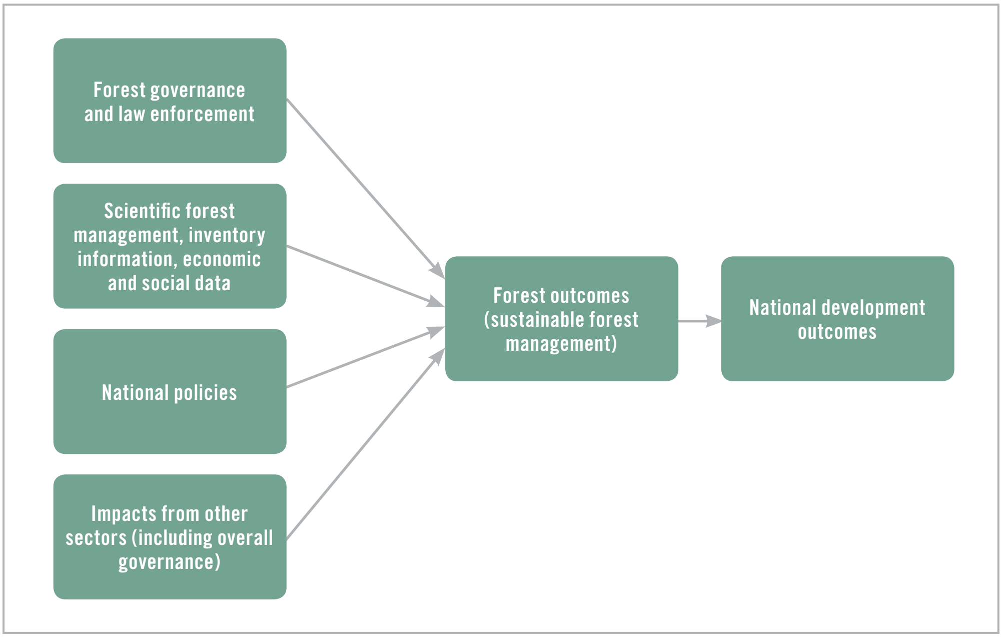
Economics 2009). Both countries also support forest law enforcement in producer countries as part of their development cooperation. And international organizations have recognized the importance of illegal logging and related trade as a part of international criminal networks. INTERPOL's environmental crime program covers illegal wood products, and the World Customs Organization (WCO) and the United Nations Office on Drugs and Crime (UNODC) have specific, albeit small, programs covering illegal trade in wood and wildlife. The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) is specifically geared toward controlling trade in wildlife, but it also covers a few timber species. FAO and the International Tropical Timber Organization (ITTO) have active programs to help member states curtail illegality and improve governance in the forest sector.

In developing countries, community rights to and ownership of forests is a major governance issue. The complexity of overlapping management and legal systems (legal pluralism) persists in many countries. Lack of clarity regarding ownership of forest lands, obscure forest laws dating back to colonial eras, and lack of open dialogue between the state and its citizens are all manifestations of poor governance (Castrén 2005). Colonial rulers often defined forests as *terra nullius*—land without human occupation or a recognizable government—which paved the way for large-scale state ownership of forest lands in many countries (Palmer and Bulkan 2010). State ownership is a major issue of disagreement between indigenous and forest-dependent communities and national governments in many countries, especially in Latin America. Land ownership has evolved over time and depends on political structures.[6] It takes many hues even in one country. For example, in India, forests are governed under dual jurisdiction between federal and state governments and with different degrees of decentralization of management to communities (World Bank 2006b). Thus, the governance debate in the sector is not only about ensuring the legality of timber but also about the rights of communities to the resources and about benefit sharing among stakeholders.

Even considered legal actions may lead to unsustainable management of resources—good governance and legality do not always deliver sustainability. And the opposite holds true: not all technically illegal activities are unsustainable. Forests are used in many diverse ways, and overlapping and competing claims may be attached to them. Development outcomes in forestry depend on many factors both inside and outside the sector (**figure 1**).

Some aspects of illegal logging are clear-cut, so that illegal logging and outright timber theft are usually easily defined as a crime. However, most countries have complex legislation—laws may conflict, and illegality is not always easy to define. Thus, when the European Union is negotiating a VPA with a producer country, they must begin with a lengthy process of agreeing on the definition of legality; that is, the legal requirements that will form the basis of verification.

FIGURE 1. KEY ASPECTS OF SUSTAINABLE FOREST MANAGEMENT



Source: Authors.

FRAMEWORK FOR FOREST GOVERNANCE

Many countries have recently made commitments to reform their forest sectors. While some countries have been able to improve governance and reduce illegal logging, country-specific reforms have not always been successful. Some high-quality, small-scale pilot projects have developed methodologies, but these projects have seldom been scaled up, leading to a "missing middle" in forest governance: neither macro-level political processes and analytical work on fostering good governance nor field-level pilot activities have led to sustainable country-level reform processes. To overcome this gap, the World Bank developed a conceptual framework for forest governance. The framework consists of five building blocks or pillars, each with subcomponents (**box 3**) (World Bank 2009a) .

Some of the framework's components measure the political will and capacity of a country in forest governance, while others deal with specific approaches and systems. In this report, we analyze each principal component and assess how information management and ICT can be used to promote that dimension of forest governance. Obviously, governance cannot be promoted by knowledge management and technology alone; fundamentally, it is a matter of political choices and the capacity to implement those choices. The mere introduction of information technology will not necessarily lead to reforms and good governance if the overall environment is not conducive. However, as reforms are initiated, efficient and transparent information management is an essential tool for implementing those reforms. Where reforms have not yet been well established, improving the transparency and technical quality of administration can strengthen the constituency for change. In a number of cases, increased access to information has led to processes aimed at reforming the sector.

BOX 3. BUILDING BLOCKS OF FOREST GOVERNANCE AND THEIR PRINCIPAL COMPONENTS

Pillar I: transparency, accountability, and public participation

- transparency in the forest sector
- decentralization, devolution, and public participation in forest management
- accountability of forest officials to stakeholders
- accountability within the forest agencies

Pillar II: stability of forest institutions and conflict management

- general stability of forest institutions
- management of conflict over forest resources

Pillar III: quality of forest administration

- willingness to address forest sector issues
- capacity and effectiveness of forest agencies
- corruption control within the forest sector
- forest monitoring and evaluation

Pillar IV: coherence of forest legislation and rule of law

- quality of domestic forest legislation
- quality of forest law enforcement
- quality of forest adjudication
- property rights recognized/honored/enforced

Pillar V: economic efficiency, equity, and incentives

- maintenance of ecosystem integrity—sustainable forest use
- incentives for sustainable use and penalties for violations
- forest product pricing
- commercial timber trade and forest businesses
- equitable allocation of forest benefits
- market institutions
- forest revenues and expenditures

Source: World Bank 2009a.

3 THE ROLE OF ICT: INFORMATION MANAGEMENT, DEVELOPMENT, AND GOVERNANCE

Access to information technology and networks has improved exponentially in the past two decades, particularly in developing countries. This has led to increasing focus on how information and communications technology can be harnessed to meet the Millennium Development Goals. One impediment is the high—though constantly declining—cost. ICT provides an opportunity for innovation in the effort to make public administration more responsive. Access improved first in urban areas but has spread to rural areas, which is a precondition for using technology to improve forest governance.

The importance of information in the forest sector is widely recognized, but until recently institutional reforms did not reflect a systematic approach to information management. An increasing number of information system development projects are targeting the forest sector; however, integration and convergence with other public information systems remains a challenge.

EMERGENCE OF ICT IN DEVELOPMENT

The expansion of ICTs in developing countries has created interest in using these technologies to promote development. We know that developing countries can make a "technology leap"—moving from old and insufficient technology to state-of-the-art technologies without going through the intermediate steps developed countries experienced. The exponential increase in access to phone services is a good example. Globally in 1997, there were 0.3 mobile phone users and 0.1 Internet users for each fixed-line connection. In 2008, the ratios were 3.2 and 1.2, respectively (ITU 2009). In developing countries, the change has been even faster. For example, in 2007 in Sub-Saharan Africa, the number of mobile phone users was over 10 times the number of fixed lines, and even the number of Internet users was twice that of fixed-line connections (ITU 2008). In 2009, mobile phone penetration in developing countries reached 57 percent (ITU 2010).

At the end of 2007, there were about 1.1 billion fixed telephone lines and 3.3 billion mobile phone subscriptions worldwide; the customer base is estimated to be over 3 billion.[7] The huge increase is mostly due to the expansion of access to mobile phones in developing countries; their share of the world total increased from 30 percent in 2000 to almost 70 percent in 2007 (World Bank 2009b). The increase has been facilitated by technological change and institutional reforms in which old state-owned monopolies have been commercialized or privatized, and competition among service providers has been introduced. The growth rates for Internet use have also been very high (**table 1**).

TABLE 1. NUMBER OF INTERNET USERS BY REGION, 2000 AND 2007

REGION	2000	2007	ANNUAL GROWTH
	– users per 100 people –		
East Asia and Pacific	1.9	15	32%
Europe and Central Asia	2.6	21	31%
Latin America and Caribbean	3.8	27	30%
Middle-East and North Africa	0.9	17	51%
South Asia	0.5	7	44%
Sub-Saharan Africa	0.5	4	32%
Developing country average	2	13	28%
World average	7	22	11%

Source: Based on ITU, World Telecommunication/ICT Indicators database quoted in World Bank 2009b.

Increased use of technologies has increased public access to information and led to the development of e-government and e-governance initiatives to improve interaction between governments and citizens.[8] While e-government services through the Internet were well intentioned, the lack of access to computers and the Internet in many rural areas initially slowed progress of these services. However, the introduction of mobile phone services has transformed the landscape, making technology more accessible to people and expanding the possibilities for the use of ICTs in development.

The phenomenal growth of mobile phone use shows that there is a vast unmet demand for access to information, which is the single most important reason for the expansion of ICT applications in developing countries. The demand for information comes not only from the educated urban population but also from rural and nonliterate populations. Both the public and private sectors are using mobile phones to bring services to rural areas, and people are willing to pay for these services.[9] Farmers in many countries are paying to access the latest information on agriculture (e.g., weather updates, which crops to plant) and markets (e.g., price information for crops). In areas where it would have taken several days for extension agents to reach a village, the farmer can now access that information in a matter of minutes. Public sector service delivery in the areas of health, education, and governance is also being improved through mobile phone applications. For example, users can access information on health issues through text messages, receive reminders to take their daily medicine, check the authenticity of medicine, send a complaint to authorities about the lack of drinking water, or monitor the attendance of teachers in schools. Where the government does not encourage public dialogue, improved communication technology and access to information enable citizens to challenge the government's position (Rametstariner, Vahanen, and Braatz 2005).

RURAL ACCESS TO TELECOMMUNICATIONS AND INFORMATION TECHNOLOGY

Offline devices such as stand-alone computers, PDAs, and many mobile data collection devices can be used even when they are not connected to a network. The main requirement is access to electricity and, for mobile devices, occasional access to a phone, WiFi, or cable network for uploading or downloading information. Recent developments have enabled off-grid charging of laptops and mobile phones. For example, in India, rural entrepreneurs turn their bicycles into dynamos to charge mobile phone batteries. Solar chargers are also being developed, as well as mobile phone network base stations for off-grid use. These can be run by wind, palm oil, or solar power (Muente-Kunigami and Navas-Sabater 2010, and **box 4**).

Telecommunication networks expand outward from urban areas, where most public and private sector institutions and more affluent consumers are located. In many developing countries, urban areas are already well covered, and operators are developing new business models to serve rural and lower income areas. This effort has been buoyed by the introduction of low-cost technologies that better serve the new clientele, as well as changes in regulations and market structures. Well-functioning markets have expanded their services, but a need exists for public sector interventions to cover easily excluded segments of society. The public sector does not have to actually provide the services, but it must support the expansion of these services through appropriate legislation, regulation, and, if necessary, subsidies.

BOX 4. ETHIOPIA: SOLAR-POWERED EXPANSION OF MOBILE NETWORKS

The Ethiopia Telecommunications Corporation (ETC) develops and maintains information and communications network infrastructure for Ethiopia that is capable of supporting voice, data, and video services equitably across the country while allowing high-capacity digital connectivity to the rest of the world. Since 2004, ETC has invested in mobile networks with fiber optic backbone and has installed approximately 300 sites in the northern and central parts of the country. Half of these sites are located in hard-to-access rural areas that have no electrical supply.

Because Ethiopia is close to the equator in one of the sunniest parts of the world, solar power solutions based on photovoltaic cells converting sunlight into energy have been chosen to power the base station sites as well as the transmission node sites for the fiber optic backbone. The network supplier planned and built more than 50 solar-powered autonomous sites, which include battery banks that ensure power for at least three days in case of cloudy or rainy weather.

To minimize the cost of ownership, autonomous sites powered by renewable energy were deemed most appropriate. Although the initial cost of solar panels was higher than the cost of a diesel generator, this was offset by the low operational expenses (OPEX). While the OPEX of a diesel generator are driven by fuel prices as well as the many site visits required for refueling and repair, solar panels require nothing but occasional cleaning to operate for many years without a single failure.

Source: http://www.nokiasiemensnetworks.com.

Bundled services can allow private providers to improve their outreach. For example, Voice over Internet Protocol (VoIP) services—which combine broadband with voice calls—are an effective business model for expanding service to low-income areas and thin markets. Regulators have been able to address these new business models even if it has meant dismantling old state-owned monopolies. Governments have not only allowed deregulation and increased competition but have made investments in basic telecommunication infrastructure to improve access in both urban and rural environments (Muente-Kunigami and Navas-Sabater 2010).

Access to information services in rural areas is a precondition for successful forest-related ICT application. In addition to forestry, other sectors have benefited from improved information services in rural areas (see **box 5**). Muente-Kunigami and Navas-Sabater identified various options that can be used to enhance service delivery in rural and low-income areas, such as stimulating institutional demand for the services. Creating a credible demand base by enhancing public sector demand lessens the risk for private operators and encourages them to expand their services. This approach is particularly relevant in the forestry context, where expanding the use of information networks in the public sector creates a critical mass of demand for expanding services in forested areas. This approach—viewing the public sector as a "client of last resort"—was behind the expansion of nationwide mobile phone networks in Nordic countries in the 1990s (Castells and Himanen 2002).

Despite the expansion of service networks, information services remain expensive for the average consumer in developing countries, although the costs are declining. The average cost of ICT services dropped 15 percent in one year (2008–2009): the cost of fixed broadband connection dropped most dramatically (42%) while telephone services saw more modest declines (25% for mobile services and 20% for fixed services). Variation among countries is huge; generally, a positive correlation exists between low costs and overall ICT development in a country. Fixed broadband, and consequently many Internet services, remains beyond the reach of the average consumer in developing countries. In 2009, the average cost of fixed broadband was more than the average monthly income in 28 countries (**table 2**).

Access to information services in rural areas has improved with the establishment of telecenters, public Internet access points, cyber cafés, and multipurpose centers. Initially, these centers were primarily established through donor programs; currently the management models vary from purely private (e.g., cyber cafés) to centers run by NGOs and schools. The donor-supported programs had a hard time ensuring the financial sustainability of their centers and providing clear evidence of their development impact. The result has been the development of sustainable business models that offer the right mix of services and employ cost-efficient technologies. For government centers, the challenge is to find the balance between government objectives and market demand. The centers must be tailored to local conditions and demand. Centers established by government line agencies tend to focus on delivering sector-specific services—a financially unsustainable model in thin rural markets. Cross-sectoral multipurpose centers are more likely to be able to develop an appropriate mix of services and reach a wider audience (Hanna 2010).

BOX 5. ICT APPLICATIONS IN AGRICULTURE, RURAL HEALTH, AND BANKING

E-Choupal : ITC (India) Limited's Internet-based agribusiness model

E-Choupal is a successful rural agribusiness model using the Internet to serve farmers in India. It is an initiative of a large private sector company–ITC Limited–that deals in agricommodity processing and export. In the model, about 6,500 Internet kiosks (e-choupals) were set up in villages to allow farmers to deal directly with the company while providing free extension services on prices, crop-specific issues, and weather information to the farmers. Farmers were selected from the village community, trained, and designated as *sanchalaks* (coordinators) to manage the kiosks. Farmers are free to decide whether to sell to ITC or at government auctions.

Farmers who sell directly to ITC through e-Choupal realize at least a 2.5 percent higher price for their crops than they would receive through the government auction system because of lower transaction costs. ITC benefits from lower net procurement costs (about 2.5% lower) owing to savings on commissions and transport costs. It also has more direct control over the quality of procurement. The sanchalak earns a fee on all the purchase and sales transactions handled through e-Choupal. It is estimated that nearly 4 million farmers use the kiosks, which serve around 40,000 villages.

Sources: http://www.echoupal.com; http://www.nisg.org, National Institute for Smart Government 2004.

MANOBI: Internet and wireless services for Senegalese fishermen and farmers

MANOBI's innovative Internet and wireless services use Wireless Application Protocol and short messaging service technology via cell phones to provide Senegalese fishermen with up-to-date weather reports and market price information. The fishermen also can use interactive technology to input fish stock information for marketing purposes and to log their departures and estimated return times, so that local fishing unions can be alerted if boats fail to return on time.

Through the MANOBI multichannel gateway, the project is able to produce information in a form readily available to fishermen. The fishermen were trained to use the WAP network to retrieve the information. Market prices are updated in real time, enabling fishermen to find out the latest prices as soon as they return from the sea. In some cases, this information has enabled them to land on a different beach to secure a higher price from middlemen. The service requires users to buy a WAP-enabled cell phone, available locally for US$90, plus a $30 SIM card. MANOBI estimates that it takes about two minutes to access the data services, at an average cost of around 180 CFA franc (US$0.29) a minute.

MANOBI provides a similar service for small Senegalese farmers growing fruit and vegetables. This service has more than 300 subscribers and has enabled farmers to secure higher prices for their crops. Farmers access real-time price information on WAP-enabled mobile phones. Both middlemen and farmers use the service to stay abreast of price fluctuations in the markets.

Source: http://www.sustainableicts.org/infodev/Manobi.pdf.

BOX 5. ICT APPLICATIONS IN AGRICULTURE, RURAL HEALTH, AND BANKING *(CONT.)*

Health care monitoring of HIV patients

Cell Life, a nongovernment organization based in Cape Town, South Africa, created its Aftercare program to work with the national public health system to provide home-based care for HIV/AIDS patients receiving antiretroviral therapy (ART). Each patient is visited by an Aftercare worker, who relays information about the patient to the Cell Life servers, where a care manager monitors the patient's progress. The program has been successful in increasing the rigor of patient monitoring, which is one of the challenges for HIV/AIDS, where patients on ART need nursing care.

Source: Kinkade and Verclas 2008.

M-Pesa: mobile banking

The application in Kenya of mobile phones for banking allows people who do not have access to regular financial services to establish and access accounts. Expansion of banking services through cell phones has made a fundamental difference in the way the poor are viewed by banks and other companies.

M-Pesa (the "M" is for mobile phone, and Pesa is the Swahili word for money) is a platform for making small-value electronic payments using mobile phones. Although M-Pesa customers earn no interest on the balances in their accounts, many use them to build small amounts of savings. Since its inception in March 2007, M-Pesa has attracted 9.5 million customers—over 40 percent of Kenya's adult population. The service is meeting the need for secure, low-cost money transfer.

M-Pesa was originally conceived as a means of handling microcredit disbursements and repayment, but focus groups revealed a much broader demand for transferring money around the country—many Kenyans live and work in Nairobi or other cities, while their families remain in the village. M-Pesa charges for sending or receiving funds but not for depositing funds. Customers can send money to people who do not have M-Pesa accounts but do have access to a mobile phone. Money is debited from the sender's account and the recipient receives a code via text message that he or she can use to claim the debited amount at any M-Pesa store. M-Pesa is used for various person-to-person payments and for payments to businesses that are part of the network. The most common use is to pay electric bills, but other businesses are beginning to see M-Pesa's advantages.

Source: World Bank, http://go.worldbank.org/4ROJ7XWUP0.

(For more examples of ICT applications, see the forthcoming World Bank ICT and Agriculture Sourcebook.)

TABLE 2. COST OF ICT SERVICES IN SELECTED COUNTRIES (% OF GROSS NATIONAL INCOME)

RANK	COUNTRY/REGION	ICT PRICE BASKET	FIXED TELEPHONE	MOBILE TELEPHONE	FIXED BROADBAND
		– monthly basket cost % of gross national income –			
1	Macao, China	0.23	0.30	0.09	0.30
6	United States	0.40	0.32	0.39	0.50
9	United Kingdom	0.57	0.64	0.44	0.63
11	Canada	0.58	0.53	0.51	0.71
12	Finland	0.59	0.46	0.33	0.97
128	Ghana	31.36	6.84	7.63	79.60
152	Uganda	50.33	28.29	22.71	555.35
159	Myanmar	58.18	4.92	69.61	155.40
160	Togo	58.52	38.39	37.16	558.39
161	Niger	67.58	47.01	55.74	966.90

Source: ITU 2010.

INFORMATION MANAGEMENT AND THE PUBLIC SECTOR

The increased use of ICT in public administration can also be linked to a wider structural change in how public administration works. ICTs can be used along with more responsive governance to serve the public as a stakeholder group rather than just as a customer to be satisfied, or even controlled. The use of ICTs can make decision making more dispersed yet, at the same time, more informed and transparent. However, many of the benefits of ICT and responsive governance will require a new kind of expertise and the development of more sophisticated knowledge management systems. Reforms will also require development of organizational climates that encourage openness and participation rather than control (United Nations 2005).

E-governance has been expanding rapidly, and there are many pilot programs at both the sectoral and national levels. Often e-governance initiatives are based on a national development strategy in which reformed and adapted governance is implemented through innovative technology applications and models. Systematic and innovation-based e-governance reform is more fundamental than just computerizing administrative tasks. It requires (1) the will to reform the way the government functions, (2) innovation in applications and organization, and (3) finding ways to share common platforms across the administration to provide a unified, customer-centric, and service-oriented government. Structural changes in both technology and governance are often based on innovations or changes in the way we solve problems (Innes, Green, and Thomson 2005).

Innovations and the development of e-governance do not happen on their own; they are often the result of deliberate government policies and programs. Programs are typically launched and implemented in two ways: (1) as integrated, centrally led, top-down programs; or (2) as trial-and-error, bottom-up initiatives in which pilots are run and successful applications are then scaled up. Both models have their pros and cons (Hanna 2008).

Knowledge management deals with how information can be used to make better decisions. Rauscher, Schmoldt, and Vacik (2007) observed that while technological development has made huge steps forward in the past few years, natural resource management in particular has not seen a similar improvement in knowledge outcomes, owing to inadequate changes in institutional processes or inadequate education of people. This phenomenon is common in the public sector, where broad changes are more difficult to implement than in the private sector. It has led to a situation in which organizations are not able to effectively use information and or even disseminate it efficiently within the organization.

And while e-governance allows for efficient collection and dissemination of information, it does not always change the basic parameters of governance; in fact, new technologies can facilitate poor governance. At the field level, illegal operators can easily be warned of enforcement activities being planned by authorities. The country report from Uganda describes how illegal loggers and traders were able to avoid enforcement operations with information provided by mobile phone. Making information on forest resources widely available also carries the risk of making illegal logging and encroachment easier and more profitable. While these are legitimate concerns, those with an intent to break the law almost always stay ahead of the curve with new technologies, making it essential that law enforcement is equally equipped with modern technology.

Building forest governance structures and using ICT to support them requires investments in both physical and human capacities. Heeks (2001) identifies six key questions that must be answered to assess readiness for e-governance:

1. Is the data system infrastructure ready?
2. Is the legal infrastructure ready?
3. Is the institutional infrastructure ready?
4. Is the human infrastructure ready?
5. Is the technological infrastructure ready?
6. Are the leadership and strategic thinking ready?

The last question is the most critical: if the leadership is strong, it should be possible to address the other challenges more effectively.

INFORMATION MANAGEMENT AND THE ROLE OF ICT IN THE FOREST SECTOR

Forestry has been using information on resources and timber yield ever since the concept of scientific forest management was developed in the 19th century. Hetemäki quotes Recknagel from 1913, who said that the information required to prepare forest management plans included soil type, topography, wildlife, growth and yield, and marketing (Hetemäki, Nyrud, and Boston 2005). The same information forms the basis for management plans today, 100 years later; however, new technologies have dramatically changed the way this information is collected and applied. And new elements have changed the need for information in forestry. The most fundamental change has been in the way local communities and other local stakeholders are included in decision making.

The World Bank Forests Sourcebook (2008) discusses the importance of information in forest management and sustainable forest development. Much of the discussion is on inventories and resource assessment. The sourcebook also emphasize the importance of REDD+ as a driver of information needs in forestry. REDD+ implementation and monitoring, reporting, and verification (MRV) require robust information systems.

Forest information technology has not always been recognized as a key component of reform processes. The World Bank was actively involved in the transition of Eastern European forest administration in the 1990s. Participants in these processes learned that forest administrations need to transform themselves to service delivery institutions. Even if forest administration (responsibility for policy, legislation, regulation, and some public good functions; budget funded) and forest management (timber sales and forest management; funded by sales) are separated, the institutional structure does not matter. A World Bank report states that "... the evidence strongly suggests that the functional form of a forest organization simply does not matter. Very different models can succeed and very different models can fail" (World Bank 2005).

The findings from Eastern Europe stress the importance of appropriate management and generation of information. The World Bank report emphasizes the importance of information to the performance of the service provider and the fact that it needs to be made available to both clients and policy makers. The information should cover both financial and operational issues as well as performance assessment of agencies. Public access to this information is a prerequisite for public accountability. However, the report on the Eastern European experience does not cover how technology was applied to implement the reforms. Information management and technology were not seen as essential ingredients in developing the organizations; the primary concern was the institutional setup. Public access to information services during the reforms was much lower than it is now, but that does not explain the lack of attention to ICT development in public agencies.

The lessons were gradually learned, and forest management information systems (FMISs) became an essential element in programs where institutional reforms were part of the project design. FMISs were essential elements in forestry projects in countries as diverse as Argentina, Bosnia and Herzegovina, India, Kazakhstan, Romania, and Russia (World Bank 2008). The systems focused on the forest sector and forest administration in the narrow sense, and cross-sectoral links have not been built.[10] Information system development has also been integrated in wider forest sector reform programs (see **box 6** and **box 7**).

Several factors have created a demand for a more integrated approach to FMISs; working only within the forest sector or—even worse—only within the forest administration is not feasible. The following are the three main interlinked drivers of change:

1. **Technological change and convergence.** Technological change allows people to explore data from anywhere in the world and collaborate with others. They can integrate data from many sources, establish baselines, generate alerts through change detection and red flags, and

BOX 6. WORLD BANK SUPPORT FOR FOREST MANAGEMENT INFORMATION SYSTEMS

Implementation completion reports (ICRs) for a sample of recent World Bank forestry projects show that while the objective was to introduce computerized information management systems to facilitate institutional reform, the approach was not always successful.

ICRs for three forestry projects in India note that the project objectives for forest management information systems (FMISs) were not achieved or were limited in their success owing to delays in assigning consultancy contracts or lack of technical capacity.[11] More positive outcomes have been noted in projects in Romania and Bosnia and Herzegovina.[12] In Romania, the ICR found that "the full system has been installed and tested in headquarters and field office. Regional Forest Inspectorates and Ministry staff have been trained in its use…. For future FMIS development, off-the-shelf systems are now available at reasonable costs." The project in Bosnia has had a much more positive outcome, apparently because of a phased approach. In the initial phase, the focus was on developing overall IT capacity where it was needed, followed by introduction of specialized capabilities such as GIS mapping tools. In addition, the project took an incremental approach: modernization of an existing centralized business management information system (BMIS) and then a move toward incorporating forest management functionality into that system to make it a more fully functional FMIS (i.e., with business as well as silvicultural functionality).

In these projects, forestry administrations seem to have welcomed the computers, but the links among technology, information management, and institutional reform are not always strong. This issue has not been rigorously analyzed, but the ICRs suggest reasons for the poor performance. The biggest problem seems to have been a lack of clarity regarding how to get the best from the technology, as well as inadequate analysis on how technology could be used to improve information management and thus core business processes. In some cases, technology was seen as a way to spruce up the front office, while back office processes remained largely unaltered. On the basis of these findings, one might assume that forestry departments did not need information technology to improve their functioning. However, it would be more appropriate to conclude that information management needs were insufficiently assessed before executing large-scale introductions of new technologies. The following are other important reasons for the lack of effectiveness in some of these projects:

- The FMIS components were too big and complex.
- Government staff were unfamiliar with the technical side of information management, which made it difficult to draw up specifications for consultants to develop the systems.
- Delays in the awarding of contracts meant that the systems could not be tested by the client until the end of the project period.
- Insufficient attention was paid to change management and generating buy-in from staff at all levels.

Source: Authors.

provide this information anywhere in the world in real time. One example is the increased use of Google Earth Engine–based applications to present geospatial information.[13] Collecting information from a variety of sources requires active collaboration with other agencies and stakeholders.

2. **Increased openness, transparency, and participation.** The forest sector can no longer work in a vacuum, not sharing information with all stakeholders. As can be seen in the various examples (especially in the country report from Finland), information transactions with subsistence, recreational, commercial, and other forest users is increasingly part of management systems for public forests. Private forest owners also need to communicate with stakeholders. Having an open and flexible information system is an efficient way to collect and share information. If access to networks and telecommunication services is inadequate, several communication methods need to be used to ensure that participation is widespread and some social groups are not excluded.

3. **National e-strategies and e-development programs.** Many developing countries have set up ambitious programs to develop e-government and information management across the public sector and the national economy. Forestry influences other sectors and vice versa; therefore, information system development must take a whole-of-government approach to ensure that the appropriate links are built in. For example, if state forest authorities have commercial or other revenue-collection functions, links are needed with relevant authorities (e.g., treasury, ministry of finance). Law enforcement, environmental, and land management authorities all need access to forest information, and REDD+ increases the need for cross-sectoral information management. Developing national systems is more time-consuming than working within a sector. But even if fully integrated systems cannot be established at the outset, the systems should be flexible enough to allow for information sharing, and emerging interconnectivity demands should be part of the concept design.

Logyard in Malaysia
Photo: Helveta, Ltd.

BOX 7. VIETNAM: MANAGEMENT INFORMATION SYSTEM FOR FORESTRY SECTOR (FORMIS)

The Management Information System for Forestry Sector (FORMIS) introduces modern approaches to information management in the Vietnamese forest sector, including technological solutions for information integration, remote sensing technologies, and mobile technologies. FORMIS contains a number of subsystems and modules to provide information for steering the sector toward sustainable forest management. FORMIS will also help the Ministry of Agriculture and Rural Development (MARD) align its IT investments with those in other development projects, to create a harmonized, cost-effective system.

FORMIS is expected to reduce the fragmentation of information by harmonizing standards within MARD. The project will provide consistent data structures, standardized and consistent data collection methodologies, and centralized coding systems. The fragmented nature of existing forestry information is partially caused by a system-by-system approach—planning and building information systems without a strategic overview. This project pays particular attention to initial planning of the strategy and the system architecture. The time and resources spent in planning will be amply repaid in improved cost-effectiveness, lower maintenance costs, and higher value added from reliable and transferable information.

FORMIS is expected to create the following benefits:

- Computerized planning and reporting will replace manual operations, increasing the reliability and timeliness of information. FORMIS is expected to produce on-time, updated plans and reports.
- Centralizing forestry data in provinces and at the national level will improve the availability, consistency, and reliability of information for end users.
- Computerized information systems will reduce the need to travel and many of the costs of planning, reporting, and monitoring forestry activities.
- Standardized information will enable data aggregation and comparison of information from different locations, time periods, and organizations.
- The FORMIS portal can be used to publish and distribute information and services for national, provincial, and local stakeholders.
- Information systems will contribute to transparency and equality of access to information and government services (e-services).
- Easy access to information will increase general awareness among stakeholders, enabling faster and easier adoption of new approaches.
- Verifiable information on forest resources and activities is required for market mechanisms, particularly financing related to climate change and certification of forests and forest products.

The various information and monitoring systems in Vietnam have been developed separately. MARD's goal is to integrate these systems into a single source. Financial reporting systems in Vietnam are fragmented, and consolidated budget and expenditure information is not available. Improving data management could help with public finances in the sector.

Sources: Development of Management Information System for Forestry Sector (FORMIS): Overall Work Plan March 3, 2010 (unpublished); Fowler et al. 2011; and Vietnam Development Report 2011.

4 INNOVATIONS AND LESSONS FROM THE FIELD

In this section, we describe ICT applications in the field, including their strengths and weaknesses. The examples are grouped according to the World Bank's five pillars of forest governance. The section ends with lessons learned and common elements from the examples.

ICT experiences in the forest sector have not been systematically studied, but many new applications have been piloted in different countries. Experience with ICTs in other sectors—such as banking, agriculture, fisheries, and public sector governance—has also generated lessons on how technology can be used to improve governance and service delivery. In this section, we explore some of the ICT applications that are especially relevant for forest governance. While most of the cases come from the forest sector, we include some nonforestry cases because of their relevance and potential for the forest sector. The discussion is focused on understanding what works under real-world conditions, the potential for replication and scaling up, and what can be learned from other sectors.

ICTs are essentially tools or enablers that are useful in situations in which information needs to be broadcast (1) to a large number of people, (2) quickly, (3) over long distances, (4) in real time, and (5) at low cost. Information is a key cross-cutting requirement for all the pillars of forest governance. Information that is timely, accurate, relevant, easily accessible, and regularly updated is essential to ensure that the objectives of good governance are achieved. ICTs can help improve information management under each of the five pillars. For example, Web-based social networks and e-government portals have potential for increasing transparency and public participation (Pillar I) (**table 3**), and mobile phones have a role in mapping and data sharing as a means of improving the quality of forest administration (Pillar III). Some ICT tools can be used to address multiple governance problems. For instance, the Poi Mapper (see **box 17**) can be used to map and update data on boundaries and logging (Pillar III) and to monitor illegal logging (Pillars I and IV). CyberTracker software has been used effectively to track wildlife in parks, to track criminals in South Africa, and for forest inventories in Mexico. The only pillar in the World Bank framework that we do not specifically address is Pillar II, stability of institutions and conflict management. However, if issues of transparency, quality of administration, and economic efficiency are resolved, conflicts can be avoided.

The field examples are discussed from several perspectives: the audience or users, feasibility, user-friendliness, and, to the extent possible, cost. The objective is to assess the replicability of the model: the nature of the business model, whether the application would work in other locations, and whether it is sustainable.

We prepared three detailed country reports to analyze the lessons from the experiences of countries with different forest governance challenges and different stages of advancement in application of ICTs. The country

TABLE 3. PILLARS OF FOREST GOVERNANCE AND ICT

PILLAR OF GOVERNANCE	WHAT IS THE INFORMATION MANAGEMENT PROBLEM?	WHAT ARE THE ICT APPLICATIONS THAT CAN HELP?
I. Transparency, accountability, and public participation	Insufficient access to key information on forest management, land tenure, concessions, etc. No forums for the public to share ideas, alert forest managers, or register complaints. Lack of information or public consultations on planned development projects and major land use changes.	■ E-government and open government applications ■ Advocacy and awareness campaigns through text messaging and Internet social networking sites ■ Community radio ■ Crowd sourcing to increase public participation ■ Collaborative and participatory mapping
II. Stability of forest institutions and conflict management	(Applications presented under other pillars.)	
III. Quality of forest administration	Costly and difficult to gather detailed information for forest inventories and carbon estimation. Extensive damage from forest fires and insufficient advance information for forest managers to take action. Conflicts between humans and wildlife; wildlife poaching.	■ Forest cover and carbon stock assessment with CLASlite and Airborne LiDAR ■ Real-time fire alerts ■ Wildlife tracking and conflict management
IV. Coherence of forest legislation and rule of law	Difficult to monitor movement of logs from forest areas. Information for legality verification is easily tampered with. Lack of awareness of forest laws. Surveillance of critical areas for illegal activities is expensive.	■ Technologies for surveillance and deterrence; computerized checkpoints and GPS ■ Technologies for tracking timber, chain of custody systems ■ Legal information management systems: Global Legal Information Network ■ Mobile and online crime reporting services
V. Economic efficiency, equity, and incentives	Lack of transparency in auctions, sales, and allocations of licenses for planting. Accurate information on distance and time needed to optimize timber transportation and increase cost efficiency.	■ Online timber sales, licenses, and auctions ■ Logistics ■ Mobile phones or PDAs for carbon estimation and receipt of payments

Sources: World Bank 2009a, and country reports.

reports are from Finland, which has almost universal access to information technology, has specialized ICT applications in the forest sector, and is ranked very high in good governance; Ghana, which has international timber exports and problems of illegal logging; and Uganda, which has little overall ICT development in the natural resource sector.[14]

The three main lessons from these cases are (1) we can learn a lot about policy and general governance, as well as specific applications in the forest sector, from the experiences of developed countries such as Finland; (2) external funding, such as development assistance, is usually necessary to offset the initial risk of failure; and (3) complex systems, such as the Ghana National Wood Tracking System, require upfront capacity building and institutional change management before they can be fully effective (**box 8**).

BOX 8. ICTS IN FOREST GOVERNANCE: EXPERIENCE IN THREE COUNTRIES

Finland is one of the world's leading countries in applying ICT across all levels of society and in different economic sectors. The forest sector has played a remarkable role in Finnish society for over a century. Alongside the rapid overall development of ICT, forest sector actors have actively developed and applied ICT solutions to improve efficiency. Conventional ICT applications have been developed to support decision making and improve the efficiency of the wood supply. In the past few decades, the importance of communication between forest actors and the general public has become an emerging requirement, and new solutions have been introduced to respond to the needs in this area. Finland is currently in a transition period to second-generation solutions—many e-services are being revised and improved. Major drivers are changes in the operating environment and the rapid development of hardware and communication possibilities.

In general, ICT readiness in the Finnish forest sector is very high, which reduces the need for capacity building and technical support when new solutions are introduced. The key success factors for ICT solution development and application processes are the involvement of stakeholders, adequate capacity, and a high level of trust between the government and private forest owners. For developing countries, the Finnish model presents two important lessons: (1) good outcomes from ICT solutions depend on a good communication strategy and upfront involvement of stakeholders, and (2) piloting with a smaller user group is beneficial to ensure the quality of the final product.

The Uganda report shows that the country has put in place the legal and policy architecture for expanding the role of ICTs in all spheres of development. However, in general, the forest sector has lagged behind in adopting these technologies. The high cost and specialized technical skills needed for traditional remote sensing and GIS applications have been limiting factors, and corruption, illegal logging, and other forest crimes are notable governance problems in the country. The lack of avenues for citizens to hold public officials accountable has been cited as a governance challenge in the sector, and the growth of mobile phone connectivity in the country is being exploited by illegal loggers and poachers.

The experience from Uganda also demonstrates how linking ICT and e-readiness assessment to extensive governance diagnostics provides a good basis for reform.

The important lesson from Uganda is the spontaneous development of ICT applications in response to governance challenges–the ACODE campaign (see **box 13**) is a good example. In addition, private sector initiatives are using technologies to optimize plantation management and processing. In Uganda, the government has created the space for ICT applications to be widely used but has not provided direct support. In this environment, innovative, low-cost applications would thrive, and radio is still the most influential technology to reach the rural population.

In Ghana, while the country has made progress with Internet and mobile connectivity in general, applications in the forest sector are lacking, with the exception of the National Wood Tracking System, which aims to establish a system for tracing the chain of custody. The system is still being piloted; completely implemented, it would enable the forest department to track timber slated for export all the way down to the stump and certify legal timber to meet requirements under the voluntary partnership agreement (VPA) with the European Union. However, it is a donor-driven system, which raises questions about its sustainability after external funding ends.

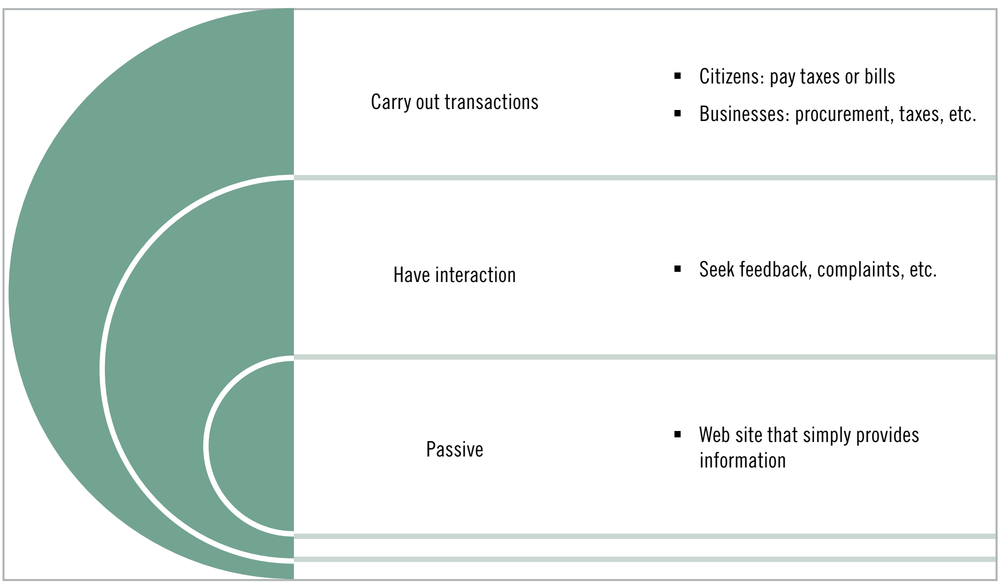
Sources: Country reports for Finland, Ghana, and Uganda.

TRANSPARENCY, ACCOUNTABILITY, AND PUBLIC PARTICIPATION

The availability of information is a precondition for transparency, accountability, and efficient public participation. Increasing the accountability of the government and its institutions is a key issue in all countries. Decisions made about the conversion of forest land, allotment of concessions, and building of large infrastructure are often not systematically shared with the public. Transparency and access to information are essential if public sector forest institutions are to be held accountable for their performance. Making the public aware of forest sector policies, laws, and the rights and responsibilities of citizens and the state is the first step in increasing transparency and accountability. Public participation and support for forestry activities can be increased by actively seeking public opinion and suggestions on government actions through easily accessible avenues. The following are some of the approaches to increasing transparency, accountability, and public participation through ICTs:

- E-government services and open government applications
- Advocacy campaigns via text messaging and Internet social networking sites
- Community radio
- Crowd sourcing—mapping for the people, by the people
- Collaborative and participatory mapping

FIGURE 2. TYPES OF WEB-BASED SERVICES



Source: Authors based on Hanna 2010.

Open Data Applications for E-government and Open Government

Open government, open data, and e-government initiatives are meant to increase access to government-owned information and increase transparency and accountability in general. Open government and open data initiatives provide access to information that would otherwise be out of bounds, while e-government solutions are designed to increase efficiency, reduce corruption, and improve service delivery. All these approaches use ICTs to make government more transparent and efficient. ICTs can be used to increase transparency of government processes in a passive way, such as through Web sites that notify the public of new policies and laws without seeking any feedback. A more advanced option is to actively seek feedback through interactive e-government applications in which citizens' opinions are considered in decision making. Different levels of interaction between the government and citizens are possible with different kinds of Web sites and portals (**figure 2**).

Web sites are the first and simplest point of communication with the public in the digital world. Many ministries of the forest and the environment have Web sites with information on key policies, programs, and organizational responsibilities; however, only a few of these have interactive features that allow them to receive information from users. A very advanced example is the Forestry Commission for the United Kingdom Web site, which provides users with information, access to relevant policies and procedures, and links to wider e-government applications in the country (**box 9**).

BOX 9. UNITED KINGDOM FORESTRY COMMISSION WEB SITE

The Forestry Commission of the United Kingdom is one of the best examples of e-government in action in the forest sector. The commission's Web site not only disseminates information on the forests under its jurisdiction but also serves as a platform for interaction with citizens, including e-commerce services. The site is user-friendly and, from a governance perspective, includes a number of beneficial features:

- Information on all aspects of forestry (educational, recreational, scientific, and industrial).
- Up-to-date statistics on timber production, sales, and inventory.
- An information search feature through the Land Information Search, a map-based tool that provides information about land designations.
- Information on grants and licenses for planting and felling, with a feature for online comments on individual applications.
- An environmental impact assessment register that shows details of the commission's decisions about the potential environmental impact of work to carry out afforestation or deforestation, or to build forest roads or quarries.
- Online auctions through the e-timber sales portal.

In addition to these interactive features, the site details the government's policies on freedom of information and the rights of citizens to information held by state agencies, the commission's policies and standards for sustainable forest management, and the process of consultation the commission follows before planting or felling in any woodland. The commission also conducts an annual survey to gather and post public opinions on forestry.

Source: http://www.forestry.gov.uk.

The U.S. government has its own open government initiative at the federal level and open data initiatives in several states, through which it shares information on state Web sites.[15] Australia, New Zealand, and the United Kingdom have similar open government or open data policies. At least eight cities and one province (British Columbia) in Canada have open data policies and share information with the public. There are numerous benefits of having access to large volumes of data. For example, budget information for the forest sector could be used to monitor performance of state agency projects, and data on harvesting volumes and areas could be used by interested civil society organizations to monitor whether harvest levels are sustainable and critical ecosystems are protected.

While open data policies are primarily initiated by government agencies, it is possible for civil society organizations to generate the demand for open data policies. The International Budget Partnership (IBP) is an NGO and the initiator of the Open Budget Initiative (OBI), a research and advocacy program to promote public access to budget information and the adoption of accountable budget systems. The flagship activity of the OBI is the Open Budget Survey, which evaluates whether governments give the public access to budget information and opportunities to participate in budget processes. IBP has also created the Open Budget Index to measure the commitment of countries to transparency and to allow for cross-country comparisons. This global initiative could also be applied in the forest sector, and NGOs could initiate an OBI for the forest sector in a specific country. The role of ICTs in this case could be to increase access to information through Web sites or mobile phones.[16]

The Central Vigilance Commission (CVC) of India is a good example of a partial open government initiative (**box 10**). The CVC takes in complaints against officers of the central government and its affiliates, and encourages citizens to take action to reduce corruption and fraud. In the Republic of Korea, the multilingual Web site www.epeople.go.kr allows citizens to present grievances on service delivery and poor governance.

E-government services are high on the agendas of many countries, and studies document success stories in developed and developing countries as well as detailed analyses of failures. From the government's perspective, the primary motive for launching e-government services is to improve the efficiency and cost-effectiveness of operations. Reducing corruption is usually not stated as an objective, but studies have shown that e-government programs have a positive impact on user perception of corruption and transparency. For example, a World Bank study (2009b) found that in India, users' perception of corruption in the electronic land registration and records services (the Bhoomi, CARD, and Kaveri projects) was lower than their perception of corruption in the older manual systems (**figure 3**). This finding might be the result of the reduction in the discretionary power of employees to delay or deny service, which is often the starting point for corruption.

Computerization of agricultural land records and simplifying their availability through village-level computer kiosks has demonstrated that it is possible to reengineer old systems of land registration and record maintenance. In spite of frequent changes in ownership of agricultural land, the new systems have been widely accepted by farmers. In India, costs savings from the system paid for the investment cost of the first phase in four years. It is conceivable that a similar system would work for forest lands, especially as boundary changes related to forestry are generally less frequent. And, as with farmland, the change would have a

BOX 10. INDIA – CENTRAL VIGILANCE COMMISSION WEB SITE

India's Central Vigilance Commission (CVC) was conceived to be the apex vigilance institution, free of control from executive authority, monitoring all vigilance activity under the central government, and advising various authorities in government organizations as they plan, execute, review, and reform their vigilance work. The CVC is a statutory body; its Web site contains the following sections and features:

- Information on its role, responsibilities, and strategies to combat corruption.
- Direct communication with the public through messages and transcripts of speeches to bolster confidence in the institution.
- Instructions for how any citizen can lodge a complaint against corruption without fear of disclosure or reprisal.
- List of central vigilance officers—each organization is expected to nominate a senior officer to whom an employee can take a complaint on corruption.
- Statistical reporting of the achievements of the commission and its annual report.
- Details of convictions of public servants by the courts, as well as information on public officials against whom an inquiry has been initiated or a penalty imposed. This section also reviews the performance of various departments responsible for conducting investigations.

A decade ago, publishing the names of officials undergoing inquiries on charges of corruption on the CVC Web site created a stir in the media, but the pubic favored the practice. Despite the low level of access to computers and the Internet in India, the information has been widely disseminated throughout the country on the radio and through print media. Thus, the site has had a broader impact than would be expected on the basis of India's computer density.

With the explosion in mobile ownership and more widespread use of the Internet, the CVC has stepped up its use of ICTs. The Blow Your Whistle feature is a technology-supported anticorruption initiative that allows citizens to report through mobile phones and the Internet by uploading text, audio, and video files. Known as Project Vigeye, the system requires registration; once a complaint is filed, the complainant can log in and check the status of the complaint. Blow Your Whistle also has discussion forums and podcasts on corruption in the country, as well as videos and links to other resources.

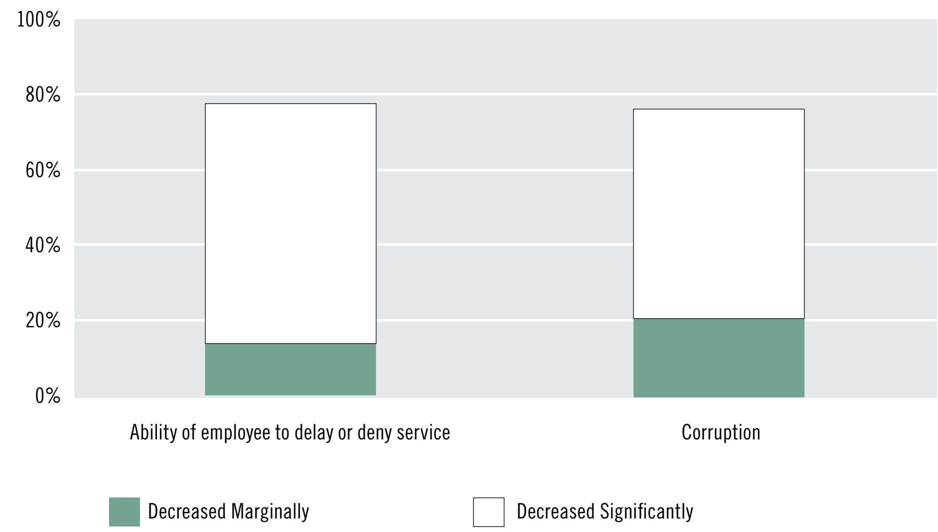
Source: http://blowyourwhistle.in/pages/about-us.

number of nonmonetary benefits: reduced ambiguity regarding boundaries, more transparency of ownership and responsibility, better relations between the forest authorities and communities, and monetizable benefits such as lower levels of corruption. With the increasing focus on carbon benefits of forests and the associated monetary compensation, questions of boundaries and ownership will have to be addressed sooner rather than later, and ICTs offer an efficient way to do it.

Advocacy and Awareness Campaigns via Text Messaging and Social Networking Sites

The large number of mobile phone subscribers in developing and developed countries, and the relatively simple technology for setting up mass text messaging systems (see **box 12**) are helping NGOs and advocacy

FIGURE 3. IMPACT OF E-GOVERNANCE



Source: Based on World Bank 2009b.

BOX 11. E-GOVERNMENT SERVICES IN INDIA: LAND RECORDS

The Bhoomi project in the state of Karnataka in India delivers two online services: (1) issuing records of rights, tenancy, and crop inspection; and (2) filing requests for changes in land records. Bhoomi was launched in 2001 as the first successful computerization of land records and land title registration in India. The government of Karnataka undertook the massive task of computerizing 20 million land records of 6.7 million farmers, then offered online services.

Bhoomi transformed the traditional system in which a village accountant maintained paper records—it used to take between 10 days and a month for a farmer to get a copy, depending on the whims of the accountant and almost always involving a bribe. The new computer-based system provides the same records in a few minutes. To keep the process transparent, the software uses a bio-logon system in which authorized users' fingerprints are used to log in. The system maintains a record of every transaction, which enables senior management to identify and investigate discrepancies. The latest modifications allow farmers to check the status of their requests and lodge a complaint if a service has not been delivered quickly and competently.

Source: Bhatnagar 2009.

BOX 12. ADVOCACY AND AWARENESS TOOLS

FrontlineSMS is a free, open source software that turns a laptop and a mobile phone into a central communications hub. Once installed, the program enables users to send and receive text messages with groups of people through mobile phones. The following are some of the program's features:

- No Internet connection is required.
- A phone and SIM card can be attached and the local mobile phone service operator paid per SMS as usual.
- All phone numbers and records of incoming and outgoing messages are stored.
- Data are stored on the user's computer, not on external servers.
- Messages can be sent to individuals or large groups and replied to individually, which is useful for fieldwork or during surveys.
- The program is easy to install and requires little or no training to use.
- Developers are free to use the source code and add their own features.
- The program can be used anywhere in the world simply by switching the SIM card.

Source: http://www.frontlinesms.com.

groups reach out to more people than is possible through traditional mass media. NGOs have used text messages effectively in their campaign for a new forest law in Argentina and to generate public pressure on a food company to stop it from sourcing palm oil from companies that replace primary rainforests with oil palm plantations. Sites such as www.mobileactive.org connect NGOs and advocacy groups using mobile technologies for social change and help them with information on the latest trends, do-it-yourself guides, and reviews of mobile applications.

The growth of SMS (short messaging service) or text messaging in advocacy campaigns can be attributed to the following factors:

- Mobile phones are personal accessories; they are carried everywhere and kept switched on almost 24 hours a day. So the target audience is almost always accessible.
- Messages targeted at individuals are more likely to generate a response than those broadcast to a mass audience.
- Responding to a text message is easier and quicker than making a phone call or sending a letter, especially when the responder does not have to pay to send the message.
- Mobile phones allow two-way interaction, so feedback is received almost instantaneously.

The value of text messaging has been proved in a number of situations, especially with respect to accountability and transparency in public service delivery. For example, the Blue Link Information Network in Bulgaria set up a Web-based platform through which NGOs and volunteers can send text messages about illegal logging. The information is verified against a checklist of criteria before being submitted to the executive forest authority for action.

NGO campaigns use Internet social networks such as Facebook and Twitter to target young people, who are the primary users of these networks. For example, in 2010, an international NGO carried out a two-month campaign through Twitter, Reddit, Facebook, and online video against an international food company for its use of palm oil from suppliers linked to rainforest destruction. As a result of the campaign, the food company announced in May 2010 that it would partner with the Forest Trust, an international nonprofit organization, to rid its supply chain of any sources involved in the destruction of rainforests.[17] This approach may be more feasible in medium- and high-income countries, where there is more access to the Internet, than in low-income countries. In many developing countries, text messaging is still the primary means of data collection and dissemination. A combination of media can be used successfully, as the example from Uganda demonstrates (see **box 13**).

Community Radio

The use of radio to broadcast development issues is not new; however, *community* radio is relatively new. Over the past decade, several community radio stations have been established around the world to help women and marginalized groups build networks and gain access to information on health, livelihoods, farming, weather, and markets, and to educate communities on democracy, citizen rights, and gender issues.

BOX 13. UGANDA: CIVIL SOCIETY ORGANIZATIONS USE ICTS IN ADVOCACY CAMPAIGNS

In 2007, the government of Uganda was ready to remove the legal protections on a third of the Mabira Central Forest Reserves and give the land to a sugar company. However, sensitivity to environmental issues had been heightened in Uganda by campaigns about the links between forests and floods, unpredictable weather, and rising food prices.

Civil society organizations (CSOs) used ICTs to mobilize activists, disseminate information, and alert the public about official actions that would affect them adversely. Environmentalists took their fight to FM radio stations and discussion groups, and used SMS to lead a boycott against the company's sugar until the plan to grab part of Mabira Forest was dropped. The use of SMS was particularly effective. The company's sales declined, and some retail businesses took its products off their shelves.

Environmentalists argued that giving away part of Mabira Forest would have more adverse effects than a sugar shortage, and some politicians criticized the government for its lack of concern about the forest. SMSs alerted people and encouraged them to join the movement to stop the forest giveaway. The CSO campaign was complemented by other actions in the country and a strong negative reaction from international development partners. Eventually the plan was withdrawn.

Source: Uganda country study.

Radio sets are relatively cheap, widely available, and easily repaired, even in the poorest regions. In several African countries, radio broadcasts are the primary medium for communicating political and religious messages. According to Myers (2010), "There are now high numbers of small- scale FM stations almost everywhere, thanks to more liberal regulatory environments and to the falling cost of technology. It is now possible to set up a small 40 watt FM station for under US$4,000."[18] The same report quotes a finding by the BBC World Service Trust that local commercial radio grew in Sub Saharan Africa by an average of 360 percent between 2000 and 2006, while community radio grew almost 14-fold over the same period. In the poorest areas of the globe, radio is the medium of choice, far outstripping other mass media in terms of audience numbers. For instance, in West Africa, radio ownership dwarfs all other communication equipment, including TV and mobile phones. In Africa overall, 80–90 percent of households have access to a radio.[19]

According to the United Nations Education, Scientific and Cultural Organization (UNESCO), "Community radio provides an ideal medium for the communication of development information directly to those who need it without commercial or other pressures on the use of air time."[20] Community radio is often defined by scale of operation: a small station that can broadcast on FM for a radius of 15 to 20 km. The station is often operated and maintained by local community members, who chip in for its maintenance costs. Other, more advanced, radio transmission technologies have emerged, but the role of, for example, high-frequency and satellite radio in forest-related communications has not been established.

In general, a local FM station run by the community can be set up with about US$5,000–$15,000 in initial costs. In places where electricity is a problem, such as Niger and Mali, solar-powered stations have been set up. Generally, technical capacity is not a constraint, and community radio stations are being successfully operated by local youth in several countries. However, licensing and content development are critical for successful operation. Community stations do not have commercials and often depend on public funds to operate. In some cases, governments waive the license fees for community radio meant for development purposes. Networking among stations is another way to build community information networks and exchange information.

In many cases, national legislation determines whether radio broadcasting is possible. Internet radio and cassette-based diffusion can be used in countries where laws have not yet been introduced to free the airwaves.

Radio can be combined with other media. Radio programs can use Internet browsing to bring the latest news to their listeners, answer questions about specific issues, and conduct discussions with local teachers and other experts. Radio browsing combines the power of the Internet with the reach of radio. In response to listeners' queries, the presenter gathers information from reliable Web sites. During the program, the presenter surfs the Internet with a local expert, such as a forestry or agriculture extension official, or a community development expert. Together, they explain and discuss the information they find in the language used by the community. This process has been successfully demonstrated at community media centers piloted by UNESCO in Sri Lanka, Bhutan, and Nepal, among others. Mobile phone technology can also be combined with radio programming, so listeners can call or text directly to the program.

BOX 14. HOW CAN COMMUNITY RADIO BENEFIT FOREST GOVERNANCE?

Fight corruption and increase awareness of citizens' rights

In Malawi, the Development Communications Trust (DCT) broadcasts "village voice" recordings from a network of radio clubs around the country. These clubs report on (among other things) delays, corruption, malpractice, and mismanagement by forest service providers, including international NGOs, and local authorities and politicians. The problems are broadcast on national radio, and the ministry, individual, or organization is invited to reply on the air in a mediated dialogue with community members. The DCT says that 70 percent of radio club problems are resolved satisfactorily after they have been aired nationally. The broadcasts are supported by UNDP, Oxfam, and the Malawi national AIDS body.

In Sierra Leone, KISS-FM in Bo and SKY-FM in Freetown have been reporting on corruption and governance. The stations started a series called "Mr. Owl" that reports on corruption among local police. The series has resulted in increased pay for the police and the establishment of a community affairs department. The voter education program "Democracy Now" resulted in a higher voter turnout in the station's listening area compared with other parts of the country.

Increase women's empowerment

USAID's Women in Governance pilot program in Mali distributed more than 500 Freeplay radios to women's listening groups in April 2004. The radios were designed for rural African conditions—batteries can be charged manually by winding or through solar power.

Increase awareness of environmental issues and public participation in policy development

In September 2009, Developing Radio Partners (DRP, an American NGO) launched a yearlong pilot project called "Our Environment, Our Future" that brought residents information they need in the way they can best use it: by radio. DRP worked with Breeze-FM—a community-oriented private station in Chipata, Zambia—and with six other radio stations in rural Zambia and Malawi. The project helped the stations create and broadcast local environmental programming. It also encouraged the innovative use of mobile phones to expand the stations' interaction with listeners, using the text messaging software FrontlineSMS (see **box 12**). The project helped build skills in environmental reporting and developing relevant content; for example, reports on the impact of deforestation on local agriculture and on sustainable farming methods.

Sources: Myers 2010; USAID 2005; and http://developingradio.org.

With the aid of WorldSpace, RANET, or a satellite radio subscription through First Voice International, community radio stations in remote locations can access news and entertainment. However, the main benefit of community radio is the programming it provides in local languages, in formats communities relate to, and on issues of local importance. For example, in Papua New Guinea, a mix of community radio and digital audio programming has been used to convey messages about forest management and sustainable land management.[21] The programs were presented in the form of a drama in several local dialects and were listened to at community gatherings, where the questions raised by the key characters

Listening to Community Radio (Tanzania)
Photo: Farm Radio International

could then be discussed. This technology could serve forest communities in other countries as well, to keep them aware of policy changes and developments that might have an impact on their resources and their lives, especially with regard to climate change, forestry, and carbon payments. Direct access to information in local languages through radio Internet browsing would help bridge the information gap for communities that do not have access to international forums.

Crowd Sourcing to Increase Public Participation

Combining a Web-based platform with inputs from text messages increases the versatility of the information gathered. Information can be instantly geo-referenced and can provide an overview for decision makers to help them prioritize activities. In addition to increasing transparency and public participation, crowd sourcing can serve as a means to track accountability of civil servants. This application gained popularity after Ushahidi became a success story in the aftermath of the Kenyan riots in 2008 as a means to keep citizens informed about safety and security, using information reports from individuals. The success of Ushahidi has led to its replication in other countries for other purposes, such as an emergency response mechanism or a data collection tool (**box 15**). It is being applied in Kenya as a wildlife sighting and tracking tool. A similar application by the Blue Link Information Network in Bulgaria was initiated to gather information on illegal logging; the information was simultaneously posted on the Web site to show authorities where illegal activities were concentrated. The project was established in 2008 as a broad network of citizens and NGOs; it linked a Web-based platform for information alerts about illegal logging with the protection and control work of the state forestry administration.

BOX 15. PUBLIC PARTICIPATION AND CROWD SOURCING OF DATA

Ushahidi (Swahili for "testimony") is designed to take input sent by mobile phone or e-mail. It uses free software called FrontlineSMS (see **box 12**) that turns a laptop and a mobile phone into a text-broadcasting hub. When a text message is sent from a hot zone, it syncs with the Ushahidi software and shows up in a Web administrator's in-box. The administrator can decide to send a message back to the sender to verify the information, send out a blast alert to a large number of people, post the information on a Web page with location information from Google Maps, or all three. Although Ushahidi was primarily developed as a quick information gathering and broadcast tool during the riots in Kenya in 2008, it has been adapted for other, non-crisis-response uses as well. The following programs use the Ushahidi platform to gather information from people and map it, to show where events are happening and how large an area is affected:

- Wildlife Trackers is a citizen science project to track wildlife in Kenya.
- Stop Stockouts is an initiative to track near-real-time stockouts of medical supplies at pharmacies (in a medical store or health facility) in Kenya, Uganda, Malawi, and Zambia.
- Kenya: the initial mashup, used to track reports of incidents of violence around Kenya.
- South Africa: used to map xenophobic attacks perpetrated against non-South Africans.

The Ushahidi platform combines the benefits of the Internet and mobile phones, and could be used to generate near-real-time information on forest crimes, fires, wildlife sightings, and so on. The advantage of mobile SMS-based data inputs is immense in remote and rural areas.

Source: http://www.ushahidi.com.

Alerta Miraflores in the municipality of Miraflores, Peru, is an extensive system to track and report incidences of crime in the town. Callers report crimes to a control room, and the information is transmitted to law enforcement officers, who check the veracity of the reports. Crowd sourcing can be used for many different purposes. But while it is a cost-efficient way of collecting information, systems must be in place to ensure that the data entered are valid and have not been fabricated. The managers of the San Francisco Urban Forest Map have built in specific algorithms to raise red flags regarding dubious data inputs, and they carry out random field verifications (**box 16**).

Crowd sourcing can be used not only to increase public participation in law enforcement and reporting of crimes but also to generate new ideas and innovative approaches to solving problems or improving processes and procedures. For example, the e-government portal of the Republic of Korea solicits ideas from citizens and recognizes those whose ideas are adopted by the government.

How useful are these Internet-based applications in improving forest governance? The simple technology and relatively low cost of installation and operation make mobile text messaging one of the most easily adaptable ICT applications. Services such as FrontlineSMS and MobileActive provide guidance and links to open source tools to help set up these services. Setting up a Web-based service such as Ushahidi is also relatively easy with a reliable Internet connection.

> **BOX 16. CITIZEN-POWERED URBAN FOREST MAP OF SAN FRANCISCO**
>
> The Urban Forest Map is an example of crowd sourcing—a collaboration of the government, nonprofits, businesses, and citizens of San Francisco to map every tree in the city. Citizens can create an account and upload the location, diameter at breast height, and a photo of the tree, following instructions on the Web site. The site includes a link to an online guide, "Urban Tree Key," with photos to help identify trees.
>
> The project is the first of its kind, and there has been some concern regarding the quality and authenticity of the data entered by the members of the public. The collaborators intend to carry out field verification of random samples of data.
>
> *Sources:* http://www.urbantreekey.org; http://www.urbanforestmap.org; and Friends of the Urban Forest (http://www.fuf.net).

Internet-based social media are relevant in urban situations where youth, who use these sites extensively, are the target audience. The sites are a good option to increase public participation in forest stewardship and generate global public pressure for better forest governance. However, they might not be much use in rural settings where Internet connectivity is unreliable. Mobile text messaging systems, on the other hand, have great potential for rural and forest-based situations.

Crowd sourcing can be a powerful tool to reach out to and enlist community members, volunteers, and NGOs in forest protection and management activities. Such a network could reduce the cost of forest protection by eliminating the need for the physical presence of state forest personnel in all locations while simultaneously enhancing the level of protection by allowing community members to keep an eye out for unusual activity. Text messages can inform forest authorities of the presence of vehicles or signs of logging in unauthorized locations and report forest fires or wildlife sightings. Crowd sourcing is fast and cheap, and can be used for a wide variety of purposes. Forest-based communities can report fires or signs of poaching and let authorities know about progress on work and the presence or absence of staff from duty stations.

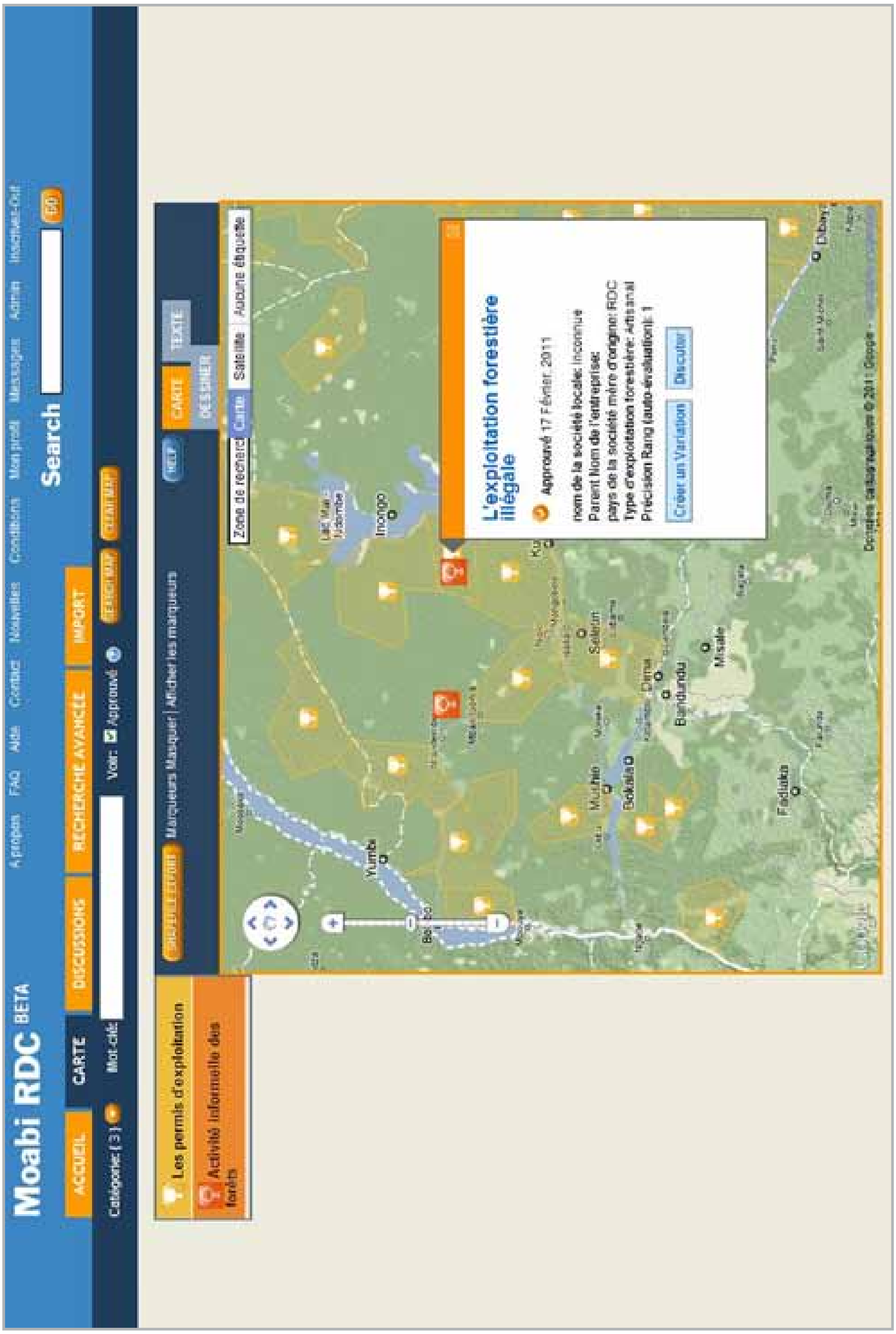
Two challenges in the use of text messaging are connectivity to cellular networks and the cost of sending text messages. These costs can be reduced to some extent in agreements with service providers. Another challenge is to ensure that the incentives for people to participate are sufficiently high to keep the system operating in a timely and accurate manner. In forest-based communities, the text messaging service could be linked to delivery of other basic services, such as health services. So, while the community provides information to the forest authority on the state of the forest, the state forest authority could commit to responding to community needs in the same speedy manner.

Collaborative and Participatory Mapping

Maps are vital for decision making in forestry. Public sector forestry institutions prepare maps to record changes in cover, using data from remote sensing satellites; but day-to-day changes at a smaller scale are often not recorded or not available in easily accessible formats to a wider audience. Until recently,

Collecting data in Poi Mapper (Kenya)
Photo: Plan Kenya

Visualizing data in Poi Mapper (Kenya)
Photo: Plan Kenya



Screenshot of WWF's Moabi Web site
Photo: WWF-US

mapping devices and software have been out of reach for nonspecialists. However, new software makes it possible to put the power of creating and updating spatial information in the hands of field staff and local communities. Open source programs (see **box 34**) make this undertaking more affordable for application developers. In partnership with forest agencies, communities can help create and update information on forest maps. Information on boundaries, use rights, planned developments, small-scale logging, or clearing for agriculture has implications for land use management and governance. Information presented on maps is a powerful visual tool for decision making. It also increases transparency, which is essential when the interests of several stakeholders are involved.

Collaborative mapping is another tool to facilitate spatial data collection and analysis. Although it might seem similar to crowd sourcing, this approach is more appropriate for the forest sector, as it allows mapping of points of interest and other geo-referenced information, such as specific routes and areas. Collaborative mapping can be useful for staff of forest departments, NGOs, and national planning and policy-making bodies.

With the availability of open source and simple software for desktop computers, even nonspecialists can view and upload data to maps. Increased efficiency in information sharing across countries and continents enables greater scrutiny of forestry projects, especially where stakeholder involvement is concerned. High-speed Internet services facilitate the accessibility of data; information on forest cover, deforestation rates, density, and so on can be accessed by a wide range of audiences. Collaborative mapping has the potential to increase and widen the scope of stakeholder participation in project design and management, and to facilitate viewing and updating of project data. We describe three applications relevant for the forestry sector:

- Poi Mapper
- WWF's Moabi
- Control Intelligence Earth (CI Earth) Participatory Mapping

Plan International in Kenya is piloting the Poi Mapper (point of interest mapper) to develop a geospatial database for project planning and management. Field staff upload answers to questionnaires that are preloaded on mobile phones and take photos to record the status and use of development infrastructure such as schools, drinking water sources, and clinics. The information includes the number of school-age children and the proportion of the population without access to sanitation facilities. Each point of interest, such as a school, is tagged with GPS referencing. This information is uploaded to the Poi Mapper portal, where it is overlaid on a digital map to provide the agency with a spatial overview of its projects. This database provides the management of Plan International Kenya with a comprehensive overview of its projects in the field and facilitates better planning for available resources. One feature of the application is that it allows organizations to share data, especially when they are working in the same region. For example, route and area information that has been collected by one organization can be shared with another. This application would be very relevant for forestry, as it facilitates mapping of route and area data as well as point locations.

Moabi is a collaborative mapping system that enables groups and individuals to build a large database for sharing, viewing, editing, and discussing spatial information relevant to REDD+. The system is currently under development by the World Wildlife Fund (WWF) Macroeconomics Program Office and Conservation Science Program. Moabi allows policy makers, research institutions, and potential carbon project developers to view, download, and edit relevant spatial data. It will facilitate on-the-ground monitoring of activities such as illegal logging, mining, and the bush meat trade. With mobile mapping devices, data can be collected and directly uploaded to the system, either over the Internet or by mobile phone. To compensate for slow Internet connectivity, data can be sent to proxies who upload it and make it available to global users. The site is built on widely used open source software—such as Google Maps API and Drupal, a Web content management system—to help ensure that the design is flexible, easily customizable, and functional on a wide variety of computers and Web browsers.

BOX 17. POI MAPPER

The Poi Mapper is a mobile geomapping, data management, visualization, and sharing solution that can be integrated with open source portal tools such as Drupal or Vaadin and map engines such as Google Maps or Geoserver. It runs on standard low-end GPS-enabled phones as well as smart phones. It enables mapping of:

- places, such as the location of schools and water points
- routes, such as roads and water pipes
- areas, such as community boundaries, forests, fields
- structured survey data, such as numbers, text, and multiple choice
- multimedia, such as images

The Poi Mapper can be used in online/offline modes for work in inaccessible locations and allows viewing of data on digital maps on a Web browser. It eliminates the need for expensive hardware/license investments or the need for software licenses. It allows open access of the stored data and the possibility to integrate open source analytics tools such as Pentaho for data mining purposes.

Multiple users can browse and update the same information, and previous versions of data are maintained for tracking purposes. Data are globally accessible over the Internet via a Web browser, with appropriate authorization. Once an organization registers on the Poi Mapper Web site and creates its account, the software can be downloaded to a mobile phone. Questionnaires relevant to the organization's work also can be created and downloaded to mobile phones. Existing data from a particular location on the portal can be downloaded and only new fields updated, which makes the system fast and efficient.

The application is available for a monthly subscription fee per user, which allows the organization to store its data and edit it on the Poi Mapper portal. At this stage, Poi Mapper does not have options for data input through icons; this capability can be developed if needed, but it would restrict the type of data that could be collected or monitored.

Source: http://www.pajatman.com.

Any registered user in Moabi can post data to the Web site, but the data must be approved by a peer review member. Users will be able to view both approved and unapproved data in the system and provide ratings or comments on any material posted. The system offers an incentive to contribute information by recognizing regular contributors through elevated status or promotion to the peer review panel. For mobile phone contributors, incentives may include phone credit awards. Moabi is being developed with funding from a donor; however, once the first application is successfully tested in the Democratic Republic of Congo (launched in March 2011), subsequent replications can be developed with a smaller budget of US$30,000–$50,000.[22]

Moabi has a high level of utility in forest governance to increase transparency, public interest, and participation in development activities that could lead to deforestation and illegal logging, and to promote law enforcement. The application will be more useful when it allows data collection and uploads via mobile phone to offset the lack of Internet connectivity in rural areas. However, the peer review process for information displayed on the portal could become a point of contention among stakeholder groups with different interests, so it would be important to ensure the integrity of the process.

Participatory mapping is already extensively used by development agencies and NGOs around the world, but customizing a handheld PDA with icons and images, and training members of local and indigenous communities in its use are important advances. Helveta Ltd.— an international corporation that develops and deploys supply chain and asset management software for timber and agrocommodities—has pioneered the use of its Control Intelligence (CI) Earth software to create maps of forest inventories in an online environment accessible by all registered users (**see box 18**).

This innovative project is not without its problems. An interim review cited a number of concerns, mainly with regard to project management and coordination among project partners, but also related to the software; for example, a need for ways to recharge the GPS batteries without having to travel long distances and improvement of the icon designs.

The Poi Mapper seems highly relevant for project-level application and is tested for use in the forest sector through a pilot in Vietnam. Having both offline and online capabilities is an advantage for use in the forest sector, where access to the Internet or to a cellular network is often erratic. The Poi Mapper requires a subscription fee and registration for users to download the software and upload their data to the portal, as well as a monthly fee. The price depends on volume, whether it is part of a project, and the country in which it is used. The current default price is US$15 a month for NGOs and local users in developing countries and $30 for commercial organizations and users in developed countries. The developer requires a minimum monthly engagement of $750 (25 users) to set up a new database and a support agreement. The price of the mobile phones on which the system works starts at $50 if GPS is not required or $150 with embedded GPS, making them affordable for certain project-specific applications. Field staff already use mobile phones, and the application, if it proves useful for project management, is no more complicated than text messaging.

The successful use of handheld computers by local communities shows that technology can be customized and need not be a barrier for nonliterate people. However, the devices currently used in the project cost

BOX 18. PARTICIPATORY MAPPING IN CAMEROON

This project has been implemented in partnership with local and indigenous forest communities across the southern forest zone of Cameroon and with the Forest Peoples Programme, University College London, Centre pour l'environnement et le développement, and Helveta Ltd. People in forest-dependent communities were trained to use GPS-enabled handheld computers to create forest inventory maps. The computers run a specially developed, icon-driven software, Control Intelligence (CI) Earth, that requires no literacy skills. Data are captured using CI Mobile and GPS reader technology. CI Mobile combines handheld data entry with data from GPS, radio frequency identification, and bar code readers to gather accurate records of how assets are being managed and processed in the forest or factory. CI Earth uses a CI Mobile interface configured to record data types that are relevant to the particular user or region. CI Earth data are synchronized with CI World through any locally available means of Internet connection, from satellite through dial-up modem. GPS-referenced data are then made available in CI World in chart form and through GIS applications such as Google Earth and ArcView.

The users are supposed to carry the devices on their daily expeditions into the forest, recording their use of resources and their observations of any illegal logging activities they encounter. The data are transferred via satellite link to a data center in the United Kingdom, where they are translated into maps that users can access. Accurate manipulation of these devices will create reliable data and maps to define resource use, document customary areas, and expose illegal logging practices. So far, data have been collected south of Dimako in eastern Cameroon. Logging activities were monitored both in and outside communal forest areas where Baka pygmies live or hunt. Members of forest communities in the Mbalmayo region recorded bulldozer tracks that indicated industrial logging activities near illegally felled trees located outside the legal commercial logging boundaries. Data gathered by local communities helped a logging company operating in the area determine which communities it should consult about management plans for local forest areas as part of its Forest Stewardship Council certification process.


Collecting data (Cameroon)
Photo: Helveta Ltd.

The CI Earth software with handheld computers has also been used in Nigeria to monitor biodiversity in the Afi Mountain Wildlife Sanctuary, which is home to a subpopulation of the critically endangered Cross River gorilla.

Source: http://corporate.helveta.com/uploads/news/20100107015150-Helveta%20Cameroon%20CaseStudy_2009.pdf.

anywhere from $800–$1,200, putting them out of reach for most forestry departments. The need for such expensive, rugged devices might be justified by the nature of the task—extensive data collection in remote locations—but appropriate technology has to be selected on case-by-case basis.

QUALITY OF FOREST ADMINISTRATION

High-quality professionals and good information management are key requirements for effective forest management. While the training provided by forestry schools is important, access to continuing education programs and information on the latest developments in the field are equally important. Distance learning programs are available on the Internet from a wide range of universities around the world, and some forest service Web sites host customized training packages online. For example the U.S. Forest Service has several online training programs on a number of technical tasks, ranging from basic statistics to cruising and scaling. One application on this site is the Timber Theft Program, which uses regression analysis to estimate standing tree volumes from stumps. Demonstrations include how to input data, how to perform regression analysis, and how to generate reports in the program.[23]

Not all online training courses have been sustainable. The Catholic University of Chile developed UC Virtual, an extensive array of online professional development courses and modules for forestry professionals. The courses were discontinued owing to lack of user demand.[24]

Information management—specifically, *spatial* information management—is the second key requirement for forest administration. Good management plans need reliable data. In Finland, MESTA is a free, Internet-based software used to prepare and discuss forest management plans with communities, mainly in Lapland, where the state forest enterprise manages forests (**box 19**). The software makes writing and reviewing alternative management options easier and facilitates better dialogue with communities that do not have a detailed knowledge of forestry. Similarly, in the UK, the Forestry Commission found that community discussions about forest management plans were more productive when the commission presented digital plans—3-D maps and images to make presentations more appealing and make it easier for nonspecialists to comprehend the long-term outcomes of the actions being proposed.

Around the world, government agencies routinely use satellite imagery and GIS to map changes in forest cover; they often overlay the maps with other features and developments to obtain a comprehensive picture of the causes and rates of deforestation. While forestry departments in many parts of the world are familiar with the use of remote sensing (RS) images and GIS to prepare maps showing density and changes in forest cover, the need for highly specialized technicians to interpret satellite images in a meaningful way has kept the technology out of reach for many. Software is now being developed that makes it possible for people with limited training to use RS and GIS more easily. This development can be compared with developments in word processing software: just as the latter has become more accessible over the past few decades, eliminating the need for users to learn and remember function commands, RS and GIS are becoming more accessible to governments, indigenous peoples, and NGOs.

BOX 19. MESTA: PARTICIPATORY FOREST MANAGEMENT APPLICATION

MESTA is open access Internet software developed and funded by the Finnish forest research institute Metla. It was first developed to serve as a tool for Metsähallitus (the state enterprise that manages state forests and most protected areas) for participative forest management, but it has become available to help private forest owners evaluate various growing strategies. The software was developed to enable holistic evaluation of decision alternatives based on acceptance borders for decision criteria (e.g., the minimum acceptable income from the forest cuttings).

The software's strength is that it can illustrate the effects of different strategies at a stakeholders meeting. Understanding various alternatives and their corresponding results helps stakeholders accept and consider each other's needs. The software also provides information on potential costs and benefits.

Metsähallitus has used MESTA in participatory forest management in eastern and western Lapland, where decision making often requires difficult compromises on seemingly opposing objectives and needs, such as combining logging with nature-based tourism.

Compared with other methodologies for evaluating management alternatives, MESTA enables users with less knowledge about the subject to study the alternatives. It is considered to be especially efficient for communicating with stakeholder groups that have less direct contact with and knowledge of forestry.

Sources: Finland country report and http://mesta.metla.fi/index_eng.cfm.

While the methodology of interpreting satellite images and estimating forest cover is fairly well understood and accepted around the world, obtaining estimates of carbon in different kinds of forests, for different age classes and species, is not that simple or cost-effective. Yet, this is likely to be a priority task in the coming decade, as negotiations advance for a REDD+ regime that rewards countries with higher carbon stocks in forests. Recent advances in technology are making it possible to estimate carbon stored in trees in different types of forests, as well as differences in carbon density in well-stocked forests compared with degraded forests.

The quality of forest administration depends on good policy and administration, financial and human resource management, law enforcement, and management of land tenure, timber sales, and revenue. All of these require unhindered information flows within the forestry department, with other parts of the government, with the private sector, and with citizens. Comprehensive forest management information systems (FMISs) are considered to be the ideal solution to enhance the capacity of public sector forestry institutions to manage these information flows. FMISs require a significant investment of resources, as they are designed and implemented on a large scale and need a reliable support infrastructure and personnel to function. FMISs have their pros and cons (**box 6** and **box 7**), and success has been variable. However, it is possible to deploy smaller scale ICT solutions to manage information requirements in key areas—such as tracking fires, inventories, and wildlife—without investing thousands of dollars in hardware and software. Some of these solutions can introduce new technology to government personnel in unintimidating ways, paving the way for more technology-intensive solutions in the future. Three such applications are discussed below:

- Real-time fire alerts
- Forest cover and carbon stock assessment with CLASlite and Airborne LiDAR
- Wildlife tracking

Real-Time Fire Alerts

The near-real-time fire alert system was developed by combining NASA's Moderate Resolution Imaging Spectro-radiometer (MODIS) data with GIS. The Fire Information for Resource Management System (FIRMS) developed at the University of Maryland (**box 20**) is a service that analyzes data from MODIS and presents them in a form that is easy for field personnel to use. The system can deliver e-mail alerts to subscribers with information on possible fires in their area of interest.

Conservation International (CI) is developing a more focused alert system for use in specific biodiversity hotspots around the world; it is currently being piloted in Madagascar, Bolivia, Peru, and Indonesia. This system delivers alerts on fires within a few hours after the NASA satellites sweep the earth. The Center for Applied Biodiversity Science at CI's International Resources Group; Madagascar's Ministère de l'Environnement, des Forêts et du Tourisme; and USAID have teamed up with the MODIS Rapid Response System and FIRMS to develop an e-mail-based alert system to warn of fires in or around protected areas and areas of high biological importance.

The Fire Alert System is a fully automated analysis and alert system that delivers a range of products tailored to a user's specific needs. These include simple text-based e-mails containing the coordinates of active fires in protected areas, areas of high biodiversity, different vegetation and land cover types, administrative units, and user-defined regions. Each e-mail alert also provides information on the time and date of satellite observations and a confidence value for each fire detected. In addition to fire response and management, the system is being extensively used to monitor and inform enforcement officials of suspected illegal logging and encroachment in protected areas. These services are an excellent example of how technologies can converge to deliver information across the globe in nearly real time.

Other highly advanced fire management systems include the one used by the New South Wales Rural Fire Service in Australia, which combats extensive bushfires. HeliFIRE turns MapInfo Professional into a purpose-built application for the airborne mapping of fires. Using a GPS connection, HeliFIRE becomes a moving map application that shows the user's current position. A purpose-built toolbar allows the user to click and record from a defined set of features. Fire features such as Active/NonActive Fire Edge, Fire Trails, Threatened Properties, Water Sources, and Fire Fighter Locations can be recorded accurately as the aircraft tracks over the features. This information is transmitted immediately via the Internet to the users on the ground who are making the response decisions.

BOX 20. FIRE ALERTS: RAPID RESPONSE SYSTEMS INTEGRATE REMOTE SENSING AND GIS

Remote sensing and GIS are being integrated to provide timely information on large-scale fires in the tropics. Data are provided by the moderate resolution imaging spectro-radiometer (MODIS) onboard NASA's Aqua and Terra satellites, which are part of the international Earth Observing System. The satellites orbit the earth from pole to pole, covering most of the globe every day—Terra in the morning and Aqua in the afternoon.

Fire Information for Resource Management System

MODIS uses thermal and mid-infrared data to spot fires and provide near-real-time images in the public domain on the Internet, but forest managers in the field need to receive and analyze the data quickly. The University of Maryland developed the Fire Information for Resource Management system (FIRMS) to serve this community. FIRMS processes and displays information on the Web about active fires within four to six hours after the satellite overpass. Subscribers can also sign up for e-mail alerts on fires in their area of interest. The alert system is a powerful tool that allows for a rapid response. The Web Fire Mapper is an open source Internet-based mapping tool that pinpoints the locations of hotspots and fires, and allows them to be viewed on an interactive map of the world, combined with a selection of GIS layers and satellite imagery. Each location represents the center of a 1 km area containing one or more actively burning hotspots or fires. FIRMS is currently being transitioned to an operational system at the United Nations Food and Agriculture Organization.

CI's Fire Alert System

Conservation International's (CI's) Center for Applied Biodiversity Science, Madagascar's Ministère de l'Environnement, des Forêts et du Tourisme, and the U.S. Agency for International Development have teamed up with MODIS and FIRMS to develop an e-mail alert system for fires in or around protected areas and areas of high biological importance. The system currently focuses on certain biodiversity hotspots: Madagascar, Bolivia, Peru, and Indonesia. It is a fully automated analysis and alert system that delivers a range of products tailored to a user's specific needs, such as simple text-based e-mails containing the coordinates of active fires in user-defined regions, or file attachments to be used in other applications. Subscribers can select from a range of background images and maps. The next phase of the system will include multivariate/multicriteria analysis, more flexible user customization, and an advanced report generator.

In addition to fire response and management, the Fire Alert System is being extensively used to monitor and inform enforcement officials of suspected illegal activity, such as illegal logging and encroachment in protected areas.

Sources: Davies et al. 2009 and https://firealerts.conservation.org/fas/home.do.

Another application, MapDesk, turns this information into updated fire maps. This custom application from MapInfo Professional includes several features that have been standardized to allow quick generation of maps with minimal training. The utility of these applications is evident when you realize that the New South

Wales Rural Fire Service comprises some 70,000 personnel, most of them volunteers. Information derived from these applications is delivered to all 70,000, to other combat and support agencies, and to the broader community.[25] Custom-designed systems are expensive to build and maintain, but e-mail and text message updates such those sent by FIRMS are free and can be used to keep field staff updated on fire situations in almost real time.

Forest Cover and Carbon Stock Assessment With CLASlite and Airborne LiDAR

The Carnegie Institution's CLASlite (Carnegie Landsat Analysis System-lite) is simple enough for desktop application by users who are not specialists in remote sensing and GIS but have some training on the software (see **table 4**). The software package is designed for highly automated identification of deforestation and forest degradation from remotely sensed satellite imagery. CLASlite runs on a standard Windows-based computer and can map more than 10,000 square km at 30 meters spatial resolution of forest area per hour of processing time. Outputs from CLASlite include maps of the percentage of live and dead vegetation cover, bare soils, and other substrates, along with quantitative measures of uncertainty in each image pixel (Asner et al. 2009).

Free licensing of CLASlite is granted to noncommercial nonprofit organizations in Latin America following the completion of technical training. The CLASlite Web site reports that as of June 2010, more than 150 government institutions, noncommercial NGOs, and academic or research institutions had been trained in the use of CLASlite.[26]

The developers of CLASlite have also tested airborne light detection and ranging (LiDAR) in conjunction with remote sensing and ground mapping in an effort to establish it as an efficient, low-cost method to assess carbon in various kinds of tropical forests. While airborne LiDAR itself is not new, its use in forestry has been limited. However, combined with the free and user-friendly CLASlite software, LiDAR could be within easy reach of most governments that will need these tools for carbon assessment under a future REDD+ regime. The system provides estimates of aboveground carbon density at a spatial resolution of 30 meters, making it one of the largest high-resolution biomass mapping studies in the world. Pilot assessment with this method has been carried out in Peru, Hawaii, and Amazon regional forests. The methodology combines information from satellite images and airborne LiDAR with measurements from field plots (see **box 21**).

LiDAR as well as other examples in this chapter are built on platforms that are widely available to the public. Both satellite and mapping data have become increasingly available online. This has led to an increase in accessible geospatial applications. Linking different applications allows presenting locally collected

TABLE 4. CLASLITE – LEVEL OF TRAINING VARIES ACCORDING TO THE COMPLEXITY OF THE FOREST

TYPE OF DISTURBANCE	TRAINING REQUIRED
Deforestation without subsequent secondary forest regrowth	Requires little training. Areas are easily identifiable.
Areas of selective logging and heavy forest disturbance	Requires some training.
Areas of very little disturbance and even small tree-fall gaps	Requires in-depth training and additional time.

Source: CLASlite Users' Guide (available at http://www.claslite.ciw.edu/).

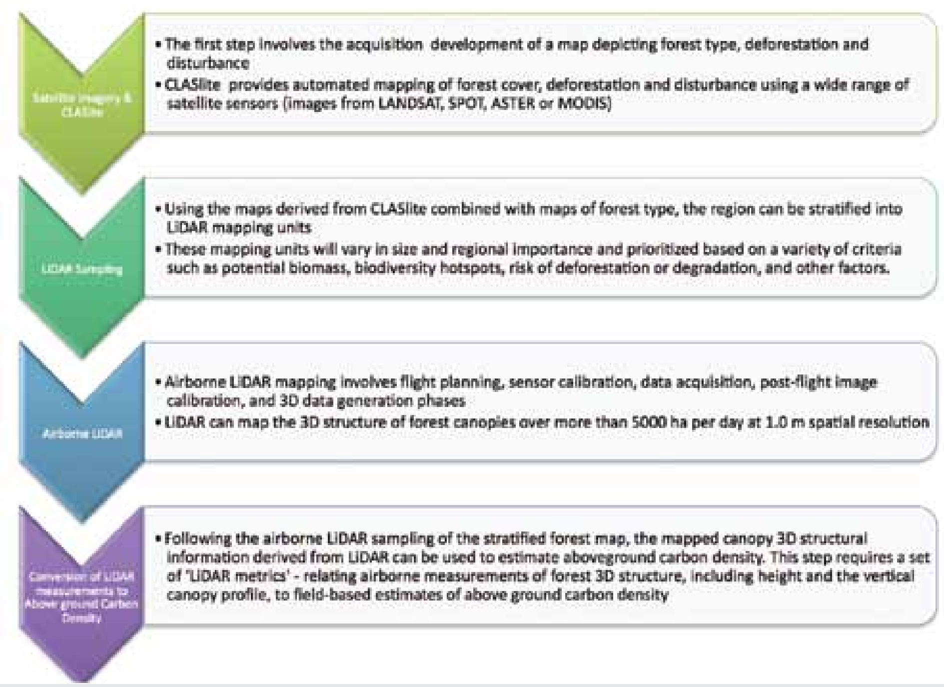
BOX 21. CLASLITE AND LIDAR

CLASlite (Carnegie Landsat Analysis System-Lite) is a key component of a cost-effective method developed at the Carnegie Institution that integrates satellite and airborne light detection and ranging (LiDAR) mapping to support high-resolution forest carbon mapping. It converts satellite imagery from its original (raw) format through calibration, preprocessing, atmospheric correction, and cloud-masking, then performs a Monte Carlo spectral mixture analysis to derive high-resolution images. It identifies areas where clearing, logging, and other forest disturbances have recently occurred. CLASlite does not provide a final map but a set of ecologically meaningful images identifying forest cover, deforestation, and forest degradation that can be readily analyzed, processed, and presented. While CLASlite is highly automated, its use requires a level of training that matches the complexity of the forest area (see **table 3**).

This approach involves four steps undertaken in concert to produce a rapid high-resolution forest carbon assessment:

1. Mapping of vegetation type and forest condition using freely available satellite data and CLASlite.
2. Large-area mapping of three-dimensional forest canopy structure using airborne LiDAR.
3. Conversion of LiDAR structural data to aboveground carbon density estimates using LiDAR-carbon metrics and field calibration plots.
4. Integration of the satellite map with the airborne LiDAR data to set a high-resolution regional baseline carbon estimate.

According to the developers of the system, the cost—using a combination of commercial and free data sources—is approximately US$ 0.10 per hectare and likely to decrease.



Sources: Asner 2009 and http://claslite.ciw.edu/en/index.html; http://claslite.ciw.edu/documents/CLASlite_PeruREDD.pdf.

information and observations in high quality map-based platforms. Google Earth Engine is perhaps the most widely used platform (**box 22**).

Wildlife Tracking and Management

Conflicts between humans and wildlife are common where communities live in or near wildlife sanctuaries and parks. The following applications prove that rural communities can use ICTs for wildlife tracking and management in cooperation with park management. Even simple text messages sent on a regular basis to communities to keep them updated on the movement of wild animals can go a long way to help people stay safe and, in turn, not harm the wildlife. "Push to talk" is an infrequently used feature of mobile phone networks in developing countries. However, it has been used to reduce human-elephant conflicts in the Laikipia district of Kenya (see **box 23**). This pilot demonstrated that park employees, communities, and the private sector can come together to find a viable solution to manage wild elephants and save crops, assisted by the innovative use of mobile phones.

The CyberTracker is a free software that was developed to enable indigenous communities with little or no literacy to track wildlife in game parks (CyberTracker Conservation 2007). The software uses icons and pictures to guide data input and works on handheld computers enabled with GPS capability. One of the longest ongoing uses of CyberTracker is at the Kruger National Park in South Africa, where park rangers collect vast amounts of data on, for example, the movements and behaviors of key species, fires, availability of water, illegal presence and activities of humans, and presence of new or invasive species of plants. The GPS records the ranger's path and provides a record of the patrol. The daily observations made with the CyberTracker are used to estimate the spatial distribution of populations of different species, mortality, and possible disease outbreaks; to monitor park boundaries; and to prevent poaching and other illegal activities. CyberTracker has been piloted in several other locations, including the Botswana, Cameroon, Chad, Gabon, Republic of Congo, South Africa, Tanzania, and Zambia. These pilots primarily involve recording and monitoring wildlife and biodiversity data to aid research and management.

Coherence of Forest Legislation and the Rule of Law

In the forest sector, different types of resource use, both commercial and noncommercial, are governed by various laws. The laws are often complex or obscure, interpretations can be inefficient, and resolving disputes or prosecuting crimes can take unreasonably long times, even for seemingly petty issues. In addition, forests have several characteristics that make them prone to timber theft and other illegal activities, such as these[27]:

- Owner absent
- Owner/manager unaware of inventory and value
- Potential witnesses indifferent or hostile to owner
- Police untrained, under equipped, uninterested
- Easy to bribe one's way out of trouble
- Staff untrained and underpaid

- Asset unsupervised/unguarded
- Lax business practices/procedures
- Loot easy to sell

BOX 22. MAPPING IN THE CLOUD: GOOGLE EARTH ENGINE

Google Earth Engine is a technology platform that puts an unprecedented amount of satellite imagery and data, both current and historical, online for the first time. It enables global monitoring and measurement of changes in the earth's environment. The platform will enable scientists to use Google's extensive computing infrastructure—the Google "cloud"—to analyze this imagery. The images of the earth from space contain a wealth of information. Scientific analysis can transform these images into useful information: showing the locations and sizes of forests, detecting how they are changing over time, and directing resources for disaster response or water resource mapping. The challenge has been the massive scale of satellite imagery archives and the computational resources required for their analysis. Many of these images have never been seen or analyzed. Scientists will be able to build applications on Google Earth Engine to use these data. The possibilities include the following:

- Landsat satellite data archives over the past 25 years for most of the developing world are available online, ready to be used with other datasets including MODIS. A complete global archive of Landsat is expected to be available soon.
- The time required to analyze data will be greatly reduced on Google's computing infrastructure. By running analyses across thousands of computers, unthinkable tasks are now possible for the first time.
- New features will make analysis easier, such as tools that preprocess images to remove clouds and haze.
- Earth Engine will support collaboration and standardization by creating a common platform for global data analysis.

Google Earth Engine can be used for a wide range of applications—from mapping water resources to providing ecosystem services to preventing deforestation. The initial use of Google Earth Engine is most likely to include supporting the development of systems to monitor, report, and verify efforts to stop global deforestation. During UNFFFC CoP-16 in Cancun in December 2010, it was announced that 10 million central processing unit hours a year over the next two years would be donated on the Google Earth Engine platform to strengthen the capacity of developing world nations to track the status of their forests in preparation for REDD+.

The Earth Engine was developed in collaboration with the Gordon and Betty Moore Foundation, the U.S. Geological Survey, Mexico's state forest agency, scientists at the Carnegie Institution, the Geographic Information Science Center at South Dakota State University, and Imazon.

Sources: Google Blog (http://googleblog.blogspot.com/2010/12/introducing-google-earth-engine.html) and Google Initiatives for SFM/REDD+ open platform—data and tools for earth monitoring and measurement, Rebecca Moore (http://www.unep.org/stap/Portals/61/docs/SFM/20.Moore.pdf).

BOX 23. KENYA: RESOLVING HUMAN-ELEPHANT CONFLICTS WITH MOBILE TECHNOLOGY

The Laikipia district in Kenya is home to the country's second largest population of wild elephants. Competition for land exists in the district among wealthy farmers who own large ranches, private conservancies, small agriculturists, and the elephant herds whose natural habitat and migratory corridors have been made inaccessible by human activity. The frequent encounters between people and elephants have been known to cause human and elephant deaths.

To find a viable solution to this situation, the GSMA Development Fund—in collaboration with the University of Cambridge Laikipia Elephant Project, Laikipia Nature Conservancy, Laikipia Wildlife Forum, Safaricom, Wireless ZT, Nokia, and Nokia Siemens Networks—devised a closed group communication network among park staff, ranch owners, and farmers in the district, with special "push to talk on cellular" handsets. This technology combines the functionality of a walkie-talkie or two-way radio with a mobile phone and enables communication between two people or among a group with the push of a button. The pilot project used stakeholder consultations and training to initiate communication among the Kenya Wildlife Service staff, ranch owners, farmers, and NGOs—communication that normally would not take place in a systematic way. The project's goal was to reduce human-elephant conflict through early communication among stakeholders regarding elephant movement and access to help from wildlife rangers when needed.

In the pilot, improved communication among the various stakeholders significantly reduced human-elephant conflict: 73 percent of the participants said that the technology provided early warning of elephant raids and allowed farmers to take preventive actions. Sixty-five percent reported that the system also helped prevent the theft of livestock and aided in the recovery of stolen livestock. Twenty-one percent reported that management response, especially from Wildlife Service staff, improved. One user noted that group communication increased pressure on the government staff, as numerous people could hear a request for intervention; thus, accountability among Wildlife Service staff seems to have increased. The Wildlife Service reported that receiving reliable information over a larger area helped them be more effective on the job.

While the results of this pilot were very encouraging, the service was not rolled out on a larger scale, because cellular operators did not find this technology commercially attractive in Kenya. Nevertheless, the pilot proved that it has benefits in specific situations and could be used in other locations where similar challenges exist in wildlife management.

Source: Graham et al. 2009.

Many of these vulnerabilities can be addressed through the use of ICT, although some–such as absent owner or inadequate inventory–are related more to the overall capacity of forest administration than to law enforcement in a strict sense. If forest managers have better knowledge of their resources and of the activities in the forest, that knowledge can help prevent and detect forest crimes. For example, chain of custody systems help prevent illegal logging and can also be used to improve the overall efficiency of supply chains.

Effective law enforcement systems in the forest sector usually follow three steps: (1) prevention, (2) detection, and (3) suppression. Technology has an important part to play in each of these steps in efforts to curb illegal logging, transportation, and processing of timber, and trade in wildlife. A variety of ICT applications can be used to improve deterrence and response measures. Some have been discussed in detail in previous World Bank reports (see Asia-Pacific Forestry Commission 2010, Dykstra et al. 2003, and Magrath et al. 2007). A few innovative applications are reviewed here:

- Prevention: crime mapping, corruption hotlines
- Detection: timber tracking, chain of custody systems, checkpoints, satellite images, GPS surveillance
- Suppression: crime databases, case management systems.

CyberTracker handheld device (South Africa)
Photo: Eric Vandeville / Rolex

Mobile and Online Crime Reporting Services

Governments around the world are increasingly involving citizens in crime reporting through e-government services that allow them to report incidences of corruption and crime. Citizens can send text messages, leave voice messages, or send e-mails to authorities. Involving citizens is a cost-effective and reliable way to prevent crime. The Web site of India's Central Vigilance Commission (see **box 10**) has a similar system through which anonymous callers can report corrupt officials of state agencies.

A crime prevention project in Peru shows how citizens can effectively contribute to law enforcement and crime reduction in a municipality. The municipality of Miraflores has developed an Internet-and-phone-based system called Alerta Miraflores that:

- gives citizens a way to report incidents to local security officials;
- captures data electronically and displays it on reports and maps so public safety officials can pinpoint the location of the call and dispatch the closest officers; and
- helps municipal officials manage citizen security proactively, respond more rapidly, and analyze their results.

By improving its ability to rapidly respond to incidents, providing timely feedback to citizens, and capturing detailed crime information, the municipality was better able to prevent crime and increase citizen security. Alerta Miraflores has reported a 68 percent drop in robberies since 2003, a 30 percent reduction in assaults, and a significant reduction in overall crime. An assessment showed that the system enjoys high-level political support from the mayor, who regularly monitors its implementation; this support ensures that staff morale and discipline are maintained. Providing citizens and the municipality with access to every report in the database fosters accountability. The transparency of the system enables the mayor and his staff to call citizens to acknowledge their valuable reports or apologize in case of mistakes.

A similar application has been used by the Blue Link Information Network project in Bulgaria to combat illegal logging. The project enlists both NGOs and citizens to report suspicious activities that can trigger additional investigation by the forest agency. Individuals participate by registering alerts (30 alerts have been logged into the system since its launch in July 2009) and by supporting NGO experts in the preliminary checks on these alerts. An alert is checked against a list of indicators of probable criminality before the case is submitted to authorities. Established environmental NGOs in Bulgaria have demonstrated their support for the project by providing expert advice on forestry issues, participating in preliminary checks, and lobbying for the integration of the online platform into the work of the state forestry administration. While this project was developed and executed by an NGO, it can easily be undertaken by forest law enforcement agencies that have a direct stake in preventing theft. The ability to send and receive information via text messages or voice messages (as in Alerta Miraflores) allows the system to be used by almost anyone.[28]

Incentives are a big issue in forest crime reporting: will people in rural areas take the initiative to report, especially if they have to pay for the call? Unlike urban crime, which directly affects residents and motivates them to act, illegal activities in forests have a more indirect effect, and forests are typically common or state property. To involve citizens in forest governance, incentives must be significant enough to make them risk reporting. Another key issue to be resolved is the confidentiality of information and the safety of the informants. Information must be carefully handled to ensure the safety of persons who report crimes and to ensure that the reporting system itself is not used to spread unfounded allegations.

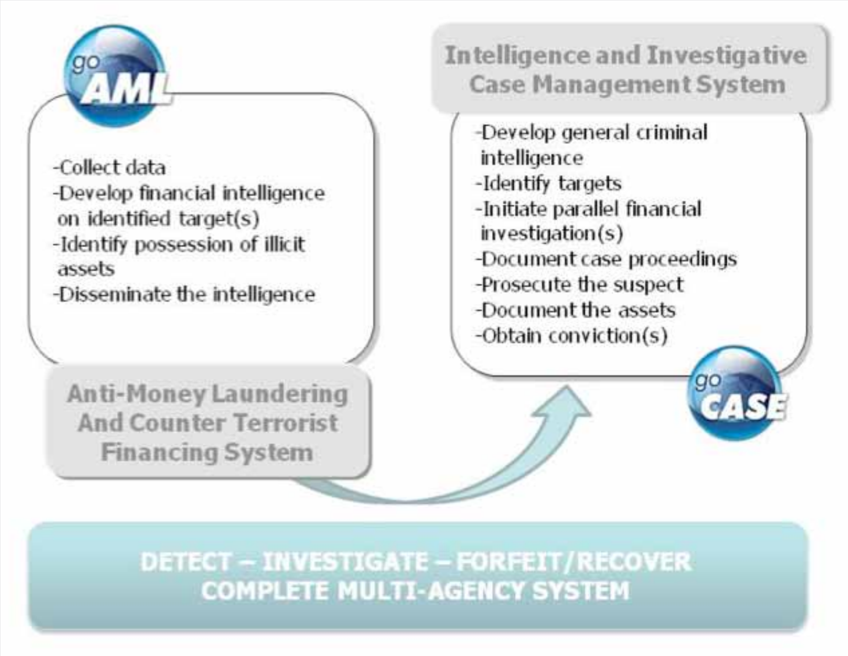
Tracking and suppressing illegal logging and trade in endangered wildlife usually requires cross-border information gathering. The United Nations Office on Drugs and Crime (UNODC) helps nations track international criminal activities; it has developed a number of software applications to help countries collect, analyze, and share intelligence and information on international crime (see **box 24**). These systems can also be used in anti-money-laundering investigations, which depend on gathering and analyzing large amounts of data on financial transactions. The products depend on interagency deployment and could be an effective tool in countries in which illegal logging places a serious economic burden on state revenue and could be a source of financing for other serious criminal activities. UNODC provides technical support for installation of the software. So far, no specific information exists on the use of these systems to curtail forest crime.

Technologies for Surveillance and Deterrence

Several sophisticated technologies are available for crime detection; a few are specific to the forest sector. The computerization of checkpoints in Gujarat, India (**box 25**) is an example of how technology can enable better law enforcement and increased revenues for the state. This project also shows how misuse of

BOX 24. UN OFFICE ON DRUGS AND CRIME: "GO" FAMILY OF PRODUCTS

The Information Technology Service of the United Nations Office on Drugs and Crime (UNODC) specializes in the development, deployment, and support of software applications for use by Member States in various program areas. The products of the Government Office (GO) family are part of UNODC's strategic response to crime, particularly serious and organized crime. The GO family includes integrated investigative case management and intelligence analysis tools for financial intelligence units; law enforcement; investigative, intelligence, regulatory, prosecution, and asset recovery agencies; and courts and other government agencies involved in the criminal justice system. All the software products include multifaceted integration and can function as stand-alone applications or together to form one global system, depending on the needs of the country. The use of systems that can interface with each other encourages interagency and cross-border cooperation and information sharing at the regional, national, and international levels.



Source: http://goidm.unodc.org/goidm/en/products.html.

technology, especially when it was designed for law enforcement, must be anticipated and prevented. An assessment of the project found that partial deployment of the system and lack of effective monitoring meant that transparency, efficiency, and corruption were not satisfactorily addressed. For example, the display panels showing the weight and penalty details of the vehicles to the drivers were always switched off, so the drivers could not see the measured value. Further, the system did not include a mechanism for locking the transaction after the vehicle was weighed, which enabled inspectors to randomly bypass the system and collect a smaller "unofficial" amount in lieu of the large official penalty charges. Because the system did not include an electronic payment option, it did not record payments for excess loads.

BOX 25. COMPUTERIZED CHECKPOINTS IN GUJARAT, INDIA

In late 1999, the state of Gujarat in India computerized the processes of inspecting trucks carrying goods and estimating the duty owed by deploying electronic weighbridges, video cameras, and computers at the border checkpoints. The manual system was corrupt and inefficient, and resulted in a significant loss of revenue for the state. Computerization was expected to improve the processes of identifying vehicles and estimating duties, and to plug the leaks and increase revenues. The deployment of the technology enabled checking of all vehicles and remarkably enhanced revenue collections: a cost-benefit analysis of the system showed that government revenues increased four-fold from Rs.5.6 million to Rs.23.7 million in three years, although the number of vehicles seems to have increased by only 7 percent. However, it was still possible for corrupt checkpoint officials to take bribes from truck drivers who did not understand the technology or the actual duties they owed. So, while the system improved efficiency, it did not improve user satisfaction or the perception of corruption among government officials manning the checkpoints.

Source: Indian Institute of Management 2002.

A slightly different approach for surveillance with the help of GPS has been successful in fisheries in West Africa, under the Sustainable Fisheries Livelihoods Program of the UN Food and Agriculture Organization (FAO) and the UK's Department for International Development (DFID). Community surveillance of inshore fishing grounds in Guinea has reduced illegal incursions by industrial trawlers by 59 percent. Members of the fishing community on Guinea's northern coast use GPS technology to track poachers. The fishermen can calculate the exact location of a poaching trawler using a handheld GPS receiver and can radio the information to the nearest coast guard station. The GPS coordinates generate a red flag alert if the trawler is in a prohibited zone. The coast guard then dispatches a patrol boat to intercept the intruder. A two-year experiment using GPS- and radio-assisted community patrols has proven so successful in Guinea that the approach is being adopted by other West African fishing nations. The key to the program's effectiveness lies in the partnership between the coast guard and small-scale fishermen using their own motorized canoes.[29]

While small communities may not be in a position to monitor all vehicle movement inside forests, authorities could use a similar approach for surveillance of vehicle movements in unauthorized areas. This could deter timber poachers.

Technologies for Timber Tracking and Chain of Custody Systems

Ghana National Wood Tracking System

The Ghana National Wood Tracking System (WTS) developed by Helveta Ltd. is a timber legality assurance system that helps reduce illegal logging; it is a key initiative under the EU-Ghana voluntary partnership agreement (VPA). For other technologies for timber tracking, see **box 26**.

Currently, the system traces only wood from on-reserve areas destined for export, but the national rollout plan includes coverage of wood from off-reserve areas, imports, underwater extraction, and plantations. A chain of custody system should cover all wood and wood products in circulation in a given market; otherwise,

BOX 26. TECHNOLOGIES FOR TIMBER TRACKING

Radio frequency identification (RFID) labels represent an advanced technology that holds considerable promise for use in wood chain of custody systems. RFID uses communication via radio waves to exchange data between a reader and an electronic tag attached to an object, for the purpose of identification and tracking. Some tags can be read from several meters away and beyond the line of sight of the reader.

On average, an RFID chip costs from US$0.07–$0.15. An important advantage of RFID systems for log tracking is that signals can be read rapidly, remotely, and under difficult conditions. RFID labels can potentially store a large amount of data, are difficult to counterfeit or tamper with, and can provide a high level of covert security. These devices can significantly facilitate data capture, data processing, and security audits. It is possible to encode RFID labels at all stages of the wood supply chain, from the field to the end user. RFID labels can enhance logistics and inventory functions.

Microtaggant tracers can be used with other labels to provide additional security and to aid investigations of log theft or log laundering. They are not a stand-alone labeling technology.

Chemical and genetic fingerprinting offers some promise for the future but are currently too expensive and have not been sufficiently developed for routine use in wood chain of custody systems. They are likely to prove most useful for proving the origin of wood in investigations of log theft or log laundering.

The global positioning system (GPS) is a satellite-based navigational system in which a group of 27 satellites help identify the exact location of a GPS receiver anywhere on earth. GPS tracking devices can be used to track the movement of vehicles in concession areas and can quickly identify vehicles in unauthorized locations. The GPS vehicle tracking unit can have a wireless modem that communicates with global tracking systems. GPS data are sent directly from the vehicle to servers, where the information is processed for the user. All of this happens in real time. Driver interaction can be avoiding by using a hardwired tracking system that is installed discreetly in the vehicle. The units are always on and users can always tell where a vehicle is in real time over the Web.

Sources: http://gpstrackit.com/faq and Dykstra et al. 2002.

it is easy to mix illegal wood with wood from legitimate sources. The system uses handheld computers to scan plastic bar codes and tags on trees and logs in remote forest areas, capturing measurements such as species, diameter, length, and geospatial location, as well as the date, time, and name of the person who enters the data. Field data are uploaded over the Internet to a secure mainframe computer, which interprets and organizes the data into tailor-made reports and maps of forest areas.

The WTS is based on an existing Helveta system called CI World. It has four main components:

- Identification and tagging of individual products or consignments using bar-coded labels.
- Incorporation of these tag numbers into the statutory forms used for declarations, inspections, and other relevant records and reports.

- Use of electronic technology for data collection and transmission.
- Development of a database to receive, analyze, and report all wood production and wood movement.

Various modules of the WTS have been configured, but it has taken longer than expected for the Forestry Commission to conduct the pilot. Logistical issues and internal information gathering issues also have delayed the project (see **box 27**).

Liberfor Chain of Custody System

Liberia is the only country that has ever had UN sanctions banning all timber exports. The sanctions were issued in 2003 to prevent the use of timber exports to finance civil war in the country. After the sanctions were lifted in 2006, it was decided that a robust chain of custody (COC) was needed to ensure the integrity of logging and revenue collection. The Liberfor chain of custody system ensures transparency of payments,

BOX 27. GHANA NATIONAL WOOD TRACKING SYSTEM

The Ghana National Wood Tracking System (WTS) follows the chain of custody of wood across the country, allowing Ghana to demonstrate compliance and control of its timber supply chains and to secure access to premium markets in the European Union and the United States.

Stock enumeration involves numbering and tagging yet-to-be harvested timber—standing trees in the lots or compartments in the forest reserves. A number is engraved on each tree, and a white bar code tag is attached that has the same number. Each enumerator receives a PDA equipped with GPS, GSM, scanner, camera, and data input; the enumerators venture into the reserve with field rangers and supervisors. When the timber is harvested, the engraved numbers and bar code allow it to be tracked through the process to export. Enumerators collect the following information:

- Allocation of reserves, compartments, and lots.
- Consortium holding.
- Consortium harvesting schedule and by whom.
- Plant species and how harvest is done.
- Where to mill.
- Due diligence on taxes.
- GPS position of trees.

Timber flows are monitored and verified through logging, processing, and local sales or export by means of product labeling, physical inspections, and electronic checks. The WTS enables the tracking of individual logs and consignments of processed products, even with changes in status (e.g., ownership or location) or properties (e.g., species, remeasurement, new grading, length trimmed, new logs cross-cut from an existing log, new bundles replacing old bundles following sorting). The use of ICT in this system case allows a more comprehensive overview of wood movement than the previous paper-based system could possibly provide.

Source: Ghana country report.

independent monitoring of approvals for payment and shipping permits, and monitoring of all log movements. The internationally approved concession review in 2005 identified irregularities in payments and shipping permits as a major contributor to the US$64 million of arrears. In addition to satisfying domestic integrity and compliance needs, a COC system is required under the VPA that has been negotiated between Liberia and the European Union.

Liberfor is a public-private build-operate-transfer (BOT) partnership developed in 2007 to implement a COC system to trace forest products. The chain extends from the stump to the point of export to prevent illegal timber from entering the supply chain and being exported. The system is currently managed by a private international company, but management will be gradually transferred to the Forest Development Authority of Liberia (see **box 28**).

The system will monitor all timber flows in Liberia and ensure the integrity of regulatory documents and sampled field checks. It will also prepare all timber sales and taxation invoices, and monitor logging company payments to the government. After checking that all requirements have been meet and payments made, Liberfor issues an export permit for the timber.

Implementation of the system and the use of handheld scanning devices in the field have not happened at the pace expected during the design phase. The system is still being run manually, which was not the original intention. There are some difficulties in the field regarding specification details and concerns about the durability of the COC tags.

Liberia is restarting its commercial forestry industry after a long period of uncontrolled logging during the previous regimes and the civil strife, and this process is taking much longer than expected. The tradition of long-term planning in forest operations was lost, and the level of operational planning, cost management,

BOX 28. LIBERIA: LIBERFOR CHAIN OF CUSTODY SYSTEM

Forests cover 45 percent of the total land area in Liberia and are an essential source of revenue and economic development for the country. Emerging from a 14-year civil war, the country needed to build a system to manage its forest resources professionally and sustainably. In the past, illegal logging had been a key driver of corruption and financial, social, and legal problems. For example, in 2006, approximately $64 million of logging revenues were in arrears and only 14 percent of revenues were accounted for.

Liberfor, the new timber chain of custody system, has been designed to prevent a return to the uncontrolled logging of the past. The system is being operated on a build-operate-transfer basis by SGS Liberia. Like the Wood Tracking System in Ghana, Liberfor is based on the Helveta platform. Its main components are as follows:

- CI Earth – Mapping
  - block maps
  - stock surveys
  - plantation compartment maps

- TracElite – Chain of Custody
  - tree felling
  - cross-cutting, dressing, and log registration
  - transport of logs and wood products
- Performance Management
  - data reconciliation
  - data verification
  - random sampling and inspection
- Document Management
  - concession registration
  - invoicing and regulatory documents
  - management tag control

The following are some of the Liberfor's achievements by mid-2010:

- Approximately 440,000 trees have been tagged and located.
- Approximately 180,000 trees have been verified in the system.
- More than US$11 million in revenue has been invoiced, mainly in area fees in fiscal year 2009/10.

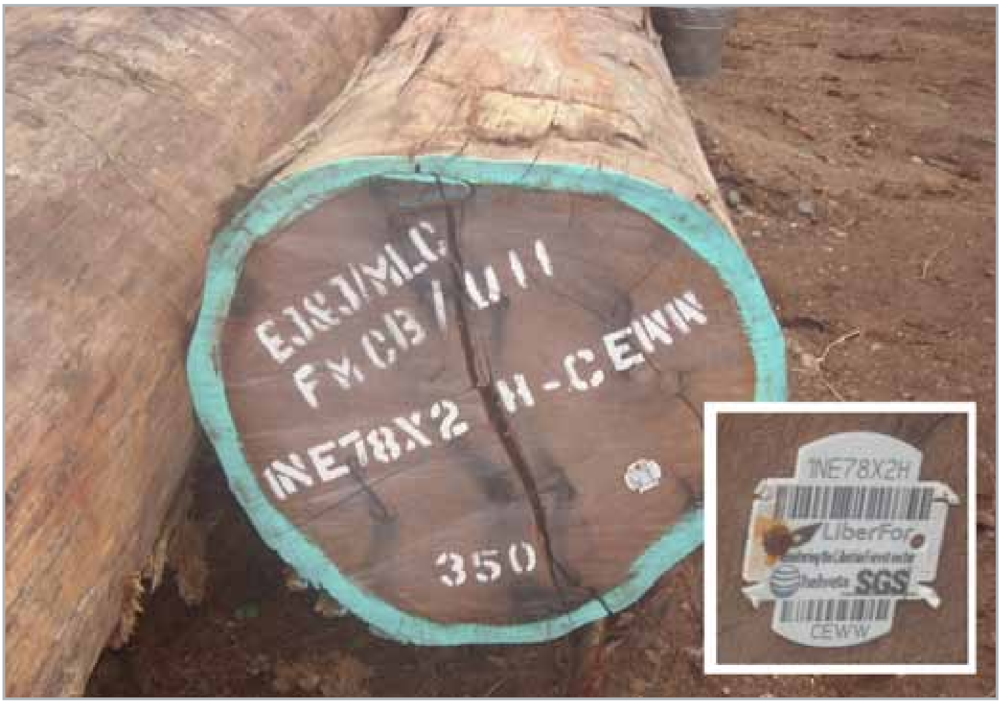
With the new system, the Liberian Forest Development Authority will be able to

- manage the chain of custody for all wood products from the forest point of origin to the export gate or domestic market;
- manage the conditions for release of timber export permits;
- ensure that taxes and fees related to timber production and trade are collected; and
- invoice and monitor payments by logging companies to the government through an information system involving the forest administration, the ministry of forestry, and the central bank.

The system strengthens the capacity of the Liberian forest administration. Also, both the authority and the private concession holder have a more accurate picture of the resource base in the forest: this is a precondition for sustainable forest management.

While the system is technically functioning and able to meet the requirements of law enforcement and revenue collection, there are major concerns regarding its sustainability and feasibility. Some stakeholders in both the public and private sectors think the system is too complicated, has increased transaction costs unnecessarily, and is inappropriate for the Liberian context. These concerns were based on the need to have a 100 percent inventory (above a threshold size) of the logging sites, as opposed to only collecting information on commercial species; inappropriate design of the chain of custody tags; and dependence on Liberfor inspectors. Another area of concern is that the system is housed on Helveta servers in the United Kingdom rather than in-country. Long distances and limited international bandwidth could lead to reliability issues.

Sources: The authors and the Liberfor team. PROFOR has provided financial support to Liberfor.



Liberfor tags and traditional logging company markings (Buchanan port, Liberia)
Photo: Tuukka Castrén / World Bank

and professionalism in the logging industry must be built up again. Some of the concern over the requirements set forth in the COC system are related to the fact that companies have not yet fully identified the value of the system in their operational planning.

The Liberfor services were expected to be self-financing, with costs recovered by stumpage and export fees collected by the government. But low log export volumes have created severe financing gaps, and unanticipated donor contributions have been required to maintain the system. This situation and uncertainty over the long-term potential for commercial forestry in the country have raised concerns about the sustainability of the Liberfor system.

Legal Information Management: Global Legal Information Network

The Global Legal Information Network (GLIN) is an electronic online tool that enables access to up-to-date legal information at a low cost.[30] The system was developed by the U.S. Library of Congress to improve access to original legal texts. In Gabon, the government has used GLIN to publish the primary sources of the law—specifically, environmental law—to aid in successful implementation of forest law enforcement and governance (FLEG) processes. Membership in GLIN, a modern legal archiving system, helps the government strengthen the rule of law and encourages discussion among stakeholders (e.g., forest administrations, the private sector, donors, civil society, NGOs). In Gabon, the government provides sustainable access to GLIN for the general public in both urban and rural areas. GLIN was established in Gabon to deal with cross-border problems, organize investments and tax policies, serve as a monitoring and evaluation system, and harmonize the legal system of COMIFAC (Central African Forest Commission) countries.

After a yearlong implementation period, the system was functional and all environmental laws were available online. Currently, GLIN provides access to almost 2,000 laws and continues to update the system by adding new laws as they are published. Compared with many other attempts to develop such a system, GLIN is extremely cost-efficient.[31] With little in the way of publicity or information campaigns, the site has seen a steadily increasing number of visits—from 8000 in 2009 to more than 44,000 in 2010 (**figure 4**).

For many decentralized courts and government institutions, the Internet is the sole source of access to reliable, up-to-date legal information. In Gabon, GLIN has supported decentralization and the development of e-government in a country in which the preservation and archiving of documents is not a well-established tradition. Recent improvements to Internet access in Africa have made it easier to use GLIN, even via mobile phones. Cyber cafés in many villages and the expansion of mobile networks mean Internet access at a lower cost, even in remote areas.

ECONOMIC EFFICIENCY, EQUITY, AND INCENTIVES

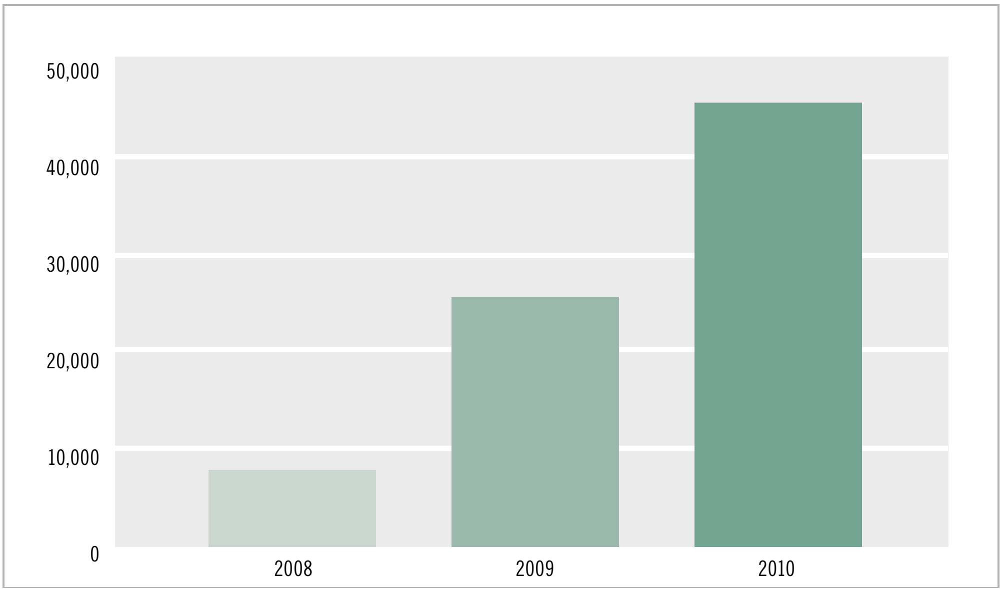
In commercial forestry, concession allocation processes and timber sales and auctions are prone to unfair practices, collusion, and nontransparent decision making, which affect state revenues and private sector competitiveness. In general, participatory design of systems and processes, and proper enforcement of the law should promote equity and economic efficiency. Thus, technologies that aid law enforcement can be considered tools that enhance equity and efficiency. For example, the computerized checkpoints discussed earlier (see **box 25**) have had a direct impact on state revenues, although their primary purpose was law enforcement. Some of the new systems for timber tracking are being linked to concession award processes, although information is scarce on how well they work in practice.

Online Timber Sales and Licensing

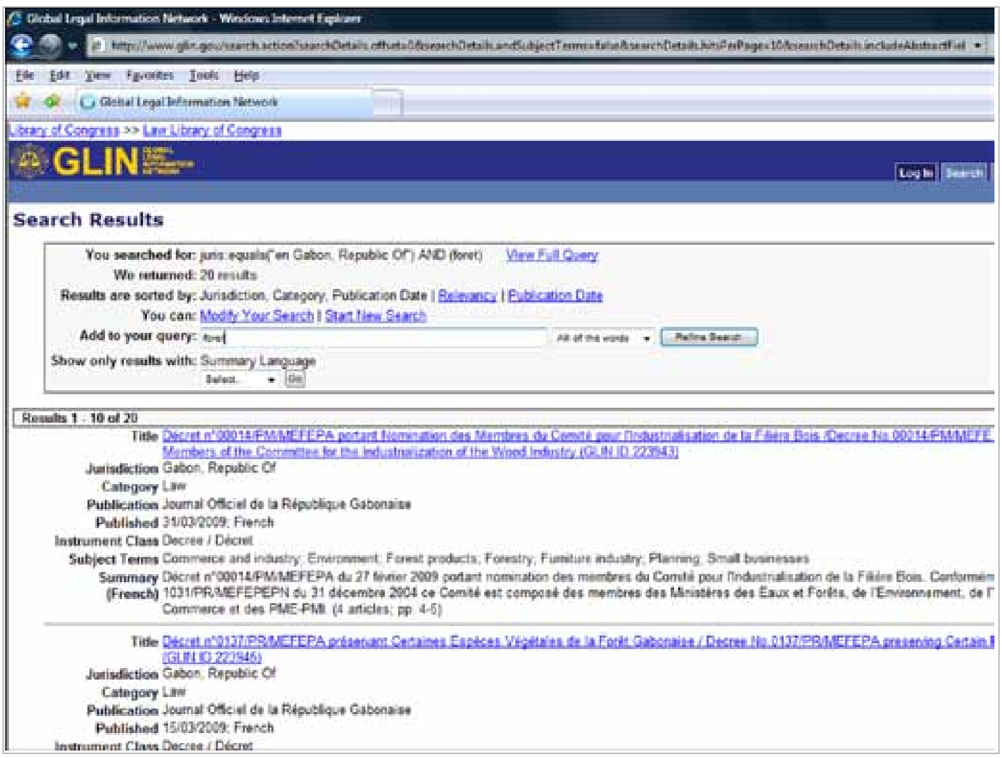
Various ICT applications are designed to promote business transactions between the public and private sectors; one area that can potentially benefit from ICT is online auction of public timber. Most forest agencies in developing countries do not have integrated and well-functioning forest management and information systems that would enable e-auctions. Even among developed countries, only a few have fully online systems. The UK's Forestry Commission has an advanced system: the auction process is fully online and integrated into the e-government services of the UK government.

The auction site is simple to use and includes a Help feature that covers most common problems. The site explains the different types of auctions and allows bidders and nonbidders to view sales events, which increases transparency. All terms and conditions are posted, so that bidders are fully informed. The site also has links and phone numbers through which users can seek assistance. Bidders cannot see each other's bids, and losing bidders are given the name of the winner only on request. The sales event closes automatically when the bidding closes, and the winner is informed with no need for paperwork.

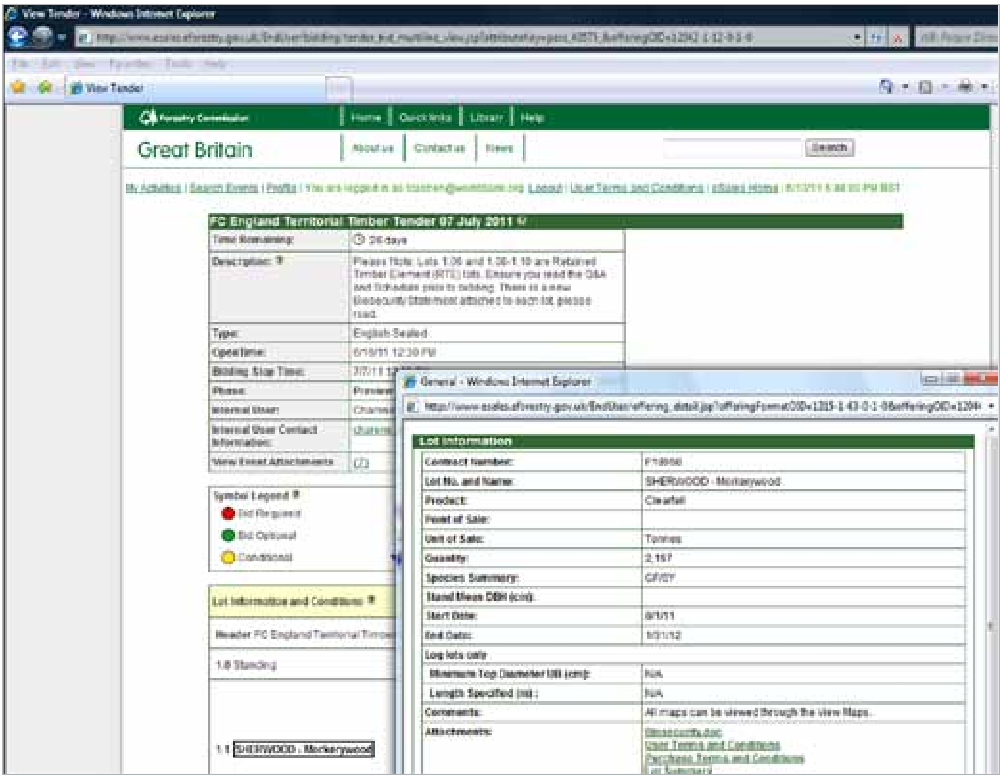
FIGURE 4. GLIN GABON: VISITORS TO WEB SITE, 2008–2010



Source: PROFOR 2010.



Screenshot of GLIN website



Screenshot of UK Forest Commission online timber sales

How effective are electronic timber sales? The UK system has been operating since 2004, and about a third of the Forestry Commission's annual production of about 6 million m^3 is sold on the open market. Cost-benefit analyses carried out by the commission reveal that approximately £100,000 is saved annually as a result of electronic sales.[32]

The electronic timber sales and auctions system was developed over a decade, using an incremental approach that allowed the commission to measure the enthusiasm for a fully electronic system among its own staff and among businesses that purchase timber. The system relies on extensive data from various sources; for example, accurate land ownership, inventory, and harvesting forecasts are required for the system to function effectively. A high level of technical support on the information technology side and regular interaction with and feedback from the user community are important to keep the system functional and user-friendly.

In a related online system, the UK Forestry Commission enables private forest and farmland owners to apply for a grant to plant trees on their land or a license to fell trees. The system enhances transparency by displaying all applications on the Web site, linking each application by its case number to a map that shows the location of the proposed activity. Each grant proposal includes a description of the activity and the amount due to the farmer or land owner. In the case of felling, the site has a link to the commission's procedures on consultation, which include the performance standards and turnaround times at different stages of the license approval process. Members of the public have a certain amount of time to comment on a case.

Both portals enhance the transparency and accountability of the UK Forestry Commission, while ensuring fair and economically efficient business transactions.

Logistics

Tracing or tracking technologies can also be used to improve logistics and thus economic efficiency. RFID and other tracking technologies follow wood from point of origin to point of sale, ensuring compliance with the law, but these technologies can also improve economic efficiency. As discussed earlier, chain of custody systems were originally developed for law enforcement and verification purposes; however, improved knowledge about raw material flows and structures can enable the forestry sector to improve logistics and manage those flows.

Two examples from Finland demonstrate the use of tracking devices to improve efficiency and productivity **(box 29)**. Indisputable Key used RFID chips to reduce waste and increase the usable volume of wood from the harvest, while the METKA project was aimed at reducing transportation costs to increase productivity. Costs are optimized when only the piles of bioenergy wood that have dried to the right moisture content are transported. Both Indisputable Key and METKA could be adapted for use with any wood-processing unit around the world.

Revenue Management in REDD+ Schemes

The forest sector is at the center of global attention, as the international community increasingly focuses on climate change mitigation through reducing emissions from deforestation and forest degradation. The parties to the United Nations Framework Convention on Climate Change (UNFCCC) are discussing a regulatory instrument to compensate countries for emissions reduction through payments for carbon that is stored and sequestered. To receive these payments, tropical forest countries are expected to take three key steps: (1) establish a reference scenario or baseline for deforestation, reforestation, and greenhouse gasses (GHGs); (2) scale up implementation of activities to monitor and reduce deforestation and degradation; and (3) report on emissions reduction, independent verification, and receipt of payments. The success of REDD+ will depend on tropical countries' efforts to halt deforestation and degradation, and to collect, analyze, and report national-level forestry and carbon data as evidence of these actions. Forest inventories are time-consuming and costly, and estimation of forest carbon is an evolving science. Most tropical forest countries have little forest data and inadequate capacities to meet these requirements. They will have to use new technologies that make collection, analysis, and updating of forest data simpler, quicker, and cost-effective. In addition, carbon stock estimates must be accurate and must identify different types, species, and age classes, and different degrees of degradation. **Box 30** and **table 5** describe some possible uses of technology in each phase of REDD+ to meet these data requirements.

BOX 29. RADIO FREQUENCY ID CHIPS FOR EFFICIENT WOOD PROCESSING

Indisputable Key, EU-funded project for development of RFID-based tracking systems

Indisputable Key was a three-year, multinational, EU-funded project to develop RFID-based timber tracking systems. It was launched in 2006 with a total budget of EUR 12 million and held its final seminar in March 2010. The primary objective of the project was to decrease the proportion of timber that is wasted or used for lower value end products than the initial timber quality would have warranted. Data management was based on individual associated data methodology in which each felled tree has a unique code embedded in a microchip that is connected to a database. The chip or tag can also include information about the log parameters, felling location, and time of felling. This information is used in subsequent stages of the production chain to optimize process exploitation.

As part of the project, a new type of RFID tag was developed that used pulping-compatible raw material, so the tag does not affect any of the processing options. The project also developed transponders suitable for reading and modifying data in harvesters and in such tools as large metallic saws, the latter of which had earlier experienced problems. The products and system used to read and process the data written into the tag are designed to function well in all weather conditions in the EU area, from the cold and ice of the north to the warm and dry conditions in the south.

Increased efficiency is achieved in the timber supply through the ability to source the raw material from the harvesting point all the way to the most profitable producing unit. Currently, the forest industry consumes timber in a bulk manner, without taking full advantage of the characteristics of timber from different origins. If we can identify different sources, we can take differences in timber quality into account in processing and increase the market premium for better timber quality. The methodology and technology behind the developed system are fully transferable to any geographic area.

METKA

METKA is an RFID technology-based tracking system. The objective of the project was to develop an operational tracking system for local bioenergy supplier Vattenfall, which benefits from increased profitability of wood-based bioenergy production. The software developer, Protacon, built the information database behind the system on existing Oracle-based stock management software. The tracking system uses RFID tags attached to the bioenergy wood piles when they are harvested. The system uses cheap, low-capacity bulk tags, which allows Vattenfall to also track low-value items. The tag allows the company to follow the chain of custody and optimize processes to reduce transport costs. Another benefit is the ability to optimize the drying time for harvesting residuals to minimize transport costs and maximize the caloric value per transported unit. This has a remarkable effect on profitability. Currently, the system is in use by two forest management associations and two operators. About 10 vehicles and forest tractors use the system.

Sources: Finland country study and http://www.indisputablekey.com.

BOX 30. ICTS IN REDD+

REDD+ activities need to be carried out with the participation of indigenous and local communities that have long-standing cultural and socioeconomic ties to forests. Issues relating to their tenure and rights to forest resources are often unclear and are disputed in many countries, and there is little understanding of how future payments from a carbon market would be distributed. In these situations, technologies can help demystify forest information and make it more transparent and accessible to increase the participation of communities in the decision-making processes.

Pilot projects in different parts of the world are currently testing various approaches to REDD+. Projects are focusing particularly on information collection and analysis for forest carbon estimation at the national and subnational levels, and approaches for involvement of and benefit sharing with indigenous and local communities, especially with regard to mapping and measuring forest boundaries, degradation, and carbon levels. Two of the more advanced projects are the Community Carbon project in Mexico[33] and the Surui Indigenous Peoples project in the Brazilian Amazon.[34] Both use smart phones/PDAs with preloaded software for data collection on biomass from sample plots and boundary demarcation using GPS functions. These projects are training local communities to update the data and use simple interfaces on the devices to convert the data into carbon estimates.

Another pilot project, in Ethiopia,[35] had individual farmers access the international carbon offsets market and receive payments directly through a mobile phone. Small farmers near Bahir Dar were asked to measure the diameters of trees on their land twice a year and put the information into a text message that, along with each farmer's unique identification code, was sent to the regional watershed users association office. Standard software computed the amount of carbon stored on each farm as well as the change from the previous measurement; any increase in stored carbon dioxide was converted into cash using the going rate for CO2 on international markets, and farmers were paid by their local association.

In Kenya, Tanzania and Uganda, The International Small Groups and Tree Planting Programme (TIST) has since 1999 been empowering small groups of subsistence farmers to invest in fast growing trees. To date about 50,000 farmers in Tanzania, Kenya Uganda and India are participating in the program and about 7 million trees have been planted. TIST Small Farmer Groups develop nurseries and decide which species to plant and where to plant them; on their own farms or around villages. The benefits include production of tree fruits, nuts, firewood, timber and protection of agricultural crops. The farmers receive a payment for each live tree . The eventual goal is to mobilize about 70% of net revenues from carbon sales.

In the interim, based on experiences from similar on farm tree planting programs being supported by the Kenya Department of Forest and Wildlife, by private agribusiness companies and by the Bio Carbon Fund, farmers and private companies investing in trees could potentially be earning a 13–20% financial rate of return on investments. USAID has provided support to the TIST program mainly towards capacity building.

Transparency and accountability are key elements and TIST has developed technology to monitor progress and results. Using handheld computers and GPS, highly trained local quantifiers visit each tree grove and record the location, number, size and species of live trees. They take pictures of group members, their nurseries and trees and upload this information into a central TIST database using cell phones and Internet. Investment needs for this program during the next 10 years could be in the order of $30 million.

Sources: Authors and http://www.tist.org/.

TABLE 5. ROLE FOR ICTS IN THE DIFFERENT PHASES OF REDD+

PHASES OF REDD+	HOW ICTS CAN BE USED	RELATIONSHIP TO FOREST GOVERNANCE
1. Establish a reference scenario and strategy. Map boundaries of forests and ownership, forest cover, and extent of degradation. Carbon estimates – stock and emissions.	Remote sensing ▪ LandSat, ALOS, MODIS, SPOT, etc. ▪ Airborne LiDAR mapping and analysis using Earth Engine, CLASlite/ILWIS/Arc View ▪ Permanent plots for field measurement ▪ PDAs enabled with GPS ▪ Smart phones connected to the Internet with preloaded data collection formats	Pillar I: transparency, accountability, and public participation Pillar III: quality of forest administration Pillar IV: coherence of forest legislation and rule of law (Pillar II: stability of forest institutions and conflict management)
2. Scale up investments, implement REDD+ strategy, and monitor carbon. Develop monitoring system and estimate costs for implementation, maintenance, and training.	National information management systems for reporting from different sectors	Pillar I: transparency, accountability, and public participation Pillar III: quality of forest administration Pillar IV: coherence of forest legislation and rule of law (Pillar II: stability of forest institutions and conflict management)
3. Receive payments for carbon based on reporting and independent verification (e.g., communities, subnational entities, private sector).	Indigenous peoples and community members register and report through mobile phones and receive payments directly through mobile accounts for forest carbon sequestration.	Pillar V: economic efficiency, equity, and incentives (Pillar II: stability of forest institutions and conflict management)

COMMON ELEMENTS

We have described several examples of how ICTs are being used to promote better governance in forestry and related sectors. These cases demonstrate a wide diversity of approaches and technologies, but they do not cover all the applications in use to address the challenges of forest development.

The selected cases (the individual cases as well as the country studies from Finland, Ghana, and Uganda) reflect a fragmented landscape, with a number of innovative models but little scaling up. But even the small pilot programs provide insights regarding the opportunities and challenges inherent in using ICTs in forestry. Some common elements can be identified to summarize the experiences—common factors that define the successes and limitations in the models presented above.

- **Information and communication technologies can improve forest governance, but operation, maintenance, and project design issues must be addressed.**

All our examples show that, if they are properly planned, mobile and Internet applications can improve various aspects of governance. Moreover, these systems can be combined with others to provide a full array of services to forest professionals and the general public. Real-time alert systems such as HeliFIRE in

South Africa and Conservation International's FIRMS are high-tech systems targeted primarily at forest and firefighting professionals. CLASlite and Airborne LiDAR, as well as the chain of custody systems, are mainly used by trained professionals. At the other end of the scale, the carbon measurement system in Ethiopia, crowd-sourcing systems in Bulgaria and Kenya, and the various participatory mapping systems are simple and inexpensive to use. This diversity shows that existing technologies have much potential and are already being used in innovative ways to meet complex challenges.

But having or developing appropriate technology alone is not adequate. Two issues are crucial for long-term sustainability: first, project design must be appropriate and focused on meeting an existing or emerging demand; and second, developers must consider operational and maintenance issues.

The community-mapping program in Cameroon was well received but soon faced difficulties and has not been sustainable. The PDA-based technology met the technical objectives, and communities were able to collect and upload data. However, the project design failed to address incentives to the communities and their members, and thus was not able to achieve long-term sustainability.[36] This example also shows that "conventional" criteria for successful project design apply in ICT projects: interventions must be rooted in a local context, relevant for participants, and sustainable.

From the Poi Mapper model, we learn that the most time-consuming part of application development is the time spent designing the survey questionnaire to ensure that the application will meet actual information needs. Modern application development platforms make it easy to develop and replicate the user interface and the technical application itself. But this could actually be a problem, as ICT projects often introduce transformational rather than incremental change in target communities. Gradual change builds on existing processes and structures, and corrects identified shortcomings. ICT innovations, on the other hand, often introduce entirely new ways of working and thus may be difficult to incorporate into existing structures.

Examples from the Ghana country study show that ICT systems must be securely rooted in their host organizations. Introduction of e-governance applications might change the overall functions, but these applications must still support the ultimate service delivery functions of the host organization.

Many of the examples in this report are built on specific technology platforms and were justified by testing the applicability of a particular technology rather than considering various options for solving a specific problem. Thus, most of them can be defined as solution driven rather than problem driven. Many aspects of design and implementation did not receive enough attention. Only the UK Forestry Commission carried out a cost-benefit analysis of its online services; most technology users had not done any financial analysis of their models, nor did they have explicit plans for scaling up.

The case studies show that—with appropriate training—forest personnel, stakeholders, and communities can learn to use new technology and applications. Communities with minimal or even no literacy were trained for data input using mobile handsets and PDAs. The key factor was developing appropriate user interfaces.

Operational and maintenance issues are crucial. Recurrent issues include power supply (e.g., to recharge laptops, mobile phones, and PDAs); spare parts (e.g., replacement batteries); and service. These issues are very common to ICT applications in all sectors; innovations are especially needed to enable easy charging of mobile phones in rural locations.

- **ICTs work well for some aspects of governance, but their use must be linked to institutional demand and systematic assessment of governance needs.**

In the examples, we see that ICTs can enable reform in forest governance, but not all dimensions of reform are receiving equal attention. Most applications are focusing on increasing transparency and public participation (Pillar I), improving the quality of forest administration (Pillar III), or improving the coherence of forest legislation and the rule of law (Pillar IV). We found fewer examples of using ICT to promote conflict management and the stability of forest institutions (Pillar II) and–surprisingly–of applications to enhance economic efficiency, equity, and incentives (Pillar V). The development of applications has not been systematic or based on a framework of forest governance; rather, applications have emerged over a long period and from various sources. ICTs have not been a visible element in sector reform; thus, their use has not been mapped against any systematic definition of forest governance. Also, forest administrations are often structured to implement their legally mandated functions rather than to focus on information or knowledge management.

The current distribution of applications reflects the interests of the organizations that developed them (often environmental or ICT4D NGOs) rather than their assessed potential to address the most important problems. As demands and opportunities for improved economic efficiency emerge, the supply of ICT applications will increase; for an example, we need look no further than the vast expansion of mobile banking applications.

Changes outside the immediate ICT4D realm may increase the demand for a more systematic approach to ICTs in forest governance. First—although ICTs will be essential to meet the need for extensive data generation under REDD+; storage and analysis for monitoring, reporting, and verification (MRV); and transfer of carbon payments—the field experience in these areas is limited. If REDD+ is integrated into global climate change mitigation agreements, there will be a demand for robust, reliable, and cost-efficient MRV systems and other ICT applications.

Second, it is expected that REDD+ readiness and investments will increase the amount of funding available for improving forest governance. Readiness preparation proposals (RPPs) prepared by many governments with support from the Forest Carbon Partnership Facility (FCPF) and the United Nations Collaborative Programme on Reducing Emissions from Deforestation and Forest Degradation in Developing Countries (UN-REDD) focus on forest governance. In addition, the Forest Investment Program (FIP) provides funding to selected pilot countries for investments leading to transformational change and climate change mitigation. Part of this funding is probably used to improve information and communication systems and management.

Both FCPF and UN-REDD use guidelines and templates for how proposals should be prepared at the country level. The programs do not specifically address information management and technology; however, mapping known ICT applications in the context of preparing an RPP will clearly demonstrate that most phases could benefit from ICT applications. So far, many of the ICT applications have not been fine-tuned to meet RPP needs. International organizations active in REDD+ processes should consider developing tools that are tailored to meet the needs of readiness processes.

Third, a number of ongoing initiatives are analyzing the status of forest governance and preparing indicators; these initiatives are supported by NGOs (e.g., the World Resources Institute, Transparency International, and Chatham House) as well as international organizations (e.g., the World Bank and FAO). These international organizations are working on a joint approach to identify key elements for analyzing governance. The outcomes of this work on frameworks and indicators will help identify the exact parameters of "forest governance" and areas where ICT applications can be used (see the Uganda country report).

- **Users are able and willing to use new technologies, but they need to be aware of the service and motivated to use it.**

Connecting with the right audience for ICT applications can be a challenge. Finland has more than 440 000 privately owned forest properties and approximately 272 000 forest owners, but only a tiny fraction of them (about 150) commented on the new forest law during public e-consultations. In Chile, online professional development for forest officials was discontinued owing to lack of demand. However, the U.S. Forest Service online training program for its staff and other interested parties is very successful.

Even models that are fully functional from a technical perspective may fail to deliver or perform below expectations. Clients must be able to provide feedback and must have clear incentives to use the system. The community-mapping project in Cameroon showed that, without the right incentives, people will not respond. Particularly in public services, participation is essential to legitimize the service: although the Finnish legislation was opened for online comments, maybe the process did not fully meet the original objectives of public consultations. Is the option of giving an opinion enough, or does the small number of respondents suggest that the process was not inclusive? The U.K. Forestry Commission's experience shows that e-auctions with motivated commercial buyers are feasible, but the general public requires a more personal form of interaction. Therefore, when the commission is seeking public comment, it uses town hall meetings rather than online consultations.

When forest and other authorities make information available, they facilitate the decision-making process. Ultimately, the information will be the basis for public consultations and inclusive decision making; if key information is not made widely available, many affected communities and other stakeholders may not fully participate. Even limited dissemination is beneficial. For example, if authorities disseminate information through Web sites, it is available to media and NGOs, even if the general public does not access the information for technical or language reasons. At least it is out there, subject to public scrutiny. In Ghana, forest authorities have set up Web sites that can be accessed by the civil society, which increases transparency in the sector. Some challenges in information dissemination are the production of raw data and the need to constantly update the information. Web sites set up during donor-funded projects especially tend to become outdated once donor support ends.[37]

- **Technology can make existing systems more efficient and previously unfeasible activities possible.**

The U.K. Forestry Commission estimates that its Web site has provided cost savings well in excess of the initial, relatively high cost of the service. The LiDAR applications have enabled large areas to be mapped at a relatively low cost. Timber tracking and other law enforcement systems have greatly improved the effectiveness of law enforcement. Achieving the same impact through conventional methods would have been much more expensive for both law enforcement bodies and the logging industry. For example, the Liberfor model collects information that concessionaires and logging companies could use to improve the efficiency of their operations and marketing; however, that would require capacity building in the private sector.

Some gradual improvements to efficiency are the result of the increased use of ICT applications; they are the answers to questions about how to do things better and how to reengineer existing processes. ICTs can also be enablers of entirely new activities. Crowd sourcing of data is a primary example—this would have been impossible through manual means. And even though it is not perfect, the model in Ethiopia of collecting carbon measurements through mobile phones would not have been possible with conventional means; transaction costs would have been prohibitive. Mobile technologies also enable individuals to participate in sensitive activities such as reporting corruption and other crimes, because their identities can be better protected.

These transformational models are more difficult to develop than the incremental models described above. Transformational models require more innovation than incremental models. In the latter, the problem is often identified through practice; in the former, developers must first identify the problem and then find the solution. We must take a venture capital approach and accept a higher failure rate in transformational pilots, but the potential returns are much higher.

- **Some services are consumer driven and can become financially self-sustaining, while others are public goods and must be financed from public sources.**

Most of our case studies and examples are from donor- and NGO-financed programs or public sector activities, but ICT applications are also being developed for mobile banking, market services, and other commercial uses. Developers and users are interested in the financial sustainability of these services, and how the costs of setting them up and running them can be recovered from clients.

In most public goods and services, including forest governance, the situation is different. For example, law enforcement is a public good and should be financed from public resources, not by user fees. Assessing the financial sustainability of public goods and services must include public funding and cover broader efficiency gains than just cash revenue. For private services, the situation is different: conventional business calculus can be applied, although targeted subsidies may be included; for example, to the rural poor to enable them to use mobile banking services.

- **Applications that use mobile phones, radio, and the Internet can be deployed quickly, with minimal technological support.**

In many cases, the technology exists and only the application needs to be invented. Many of the forest governance applications in this report were developed on existing platforms as demand-driven innovations. They are used in a number of ways to increase public participation and surveillance of forest areas, to monitor fires, and to reduce human-wildlife conflicts around parks and protected areas. Not all the applications are new: radio is one of the earliest ICTs to be deployed in development communication and continues to be one of the most ubiquitous.

We can see this trend in the ICT sector as well, particularly in Internet development, where even relatively advanced applications can be developed outside corporate structures. Both the public and private sectors, as well as NGOs, have established innovative networks and structures to promote decentralized development of applications. One example is the Grameen AppLab in Uganda (**box 31**).

- **Costs can be a limiting factor.**

The initial cost of a Java-enabled mobile phone that allows data input over the Internet and has a camera is around US$50. Phones without Java are cheaper, but they have no capability for maps or Internet connectivity, making them useful primarily for short messaging services (SMS) or text messages. **Table 2** shows that, despite

BOX 31. GRAMEEN APPLAB: INCUBATOR AND NGO–PRIVATE SECTOR PARTNERSHIP

AppLab (Application Laboratory) is an initiative of the Grameen Foundation. By leveraging the power of information and communications technologies, AppLab seeks to overcome the barriers to accessing information that contribute to the poverty cycle.

AppLab uses mobile technologies to both disseminate and gather relevant and actionable information. It develops mobile phone applications and services that allow people to access information on important topics such as health and agriculture. For example, through a simple text message, a farmer can receive tips on treating crop diseases, learn local market prices, or get advice on preventing malaria.

Grameen Foundation developed the AppLab concept in 2006 and brought Google and mobile phone carrier MTN Uganda together as its partners. Grameen leads the efforts on the ground in Uganda, including research to understand needs, identification of appropriate applications, engagement with local partners to develop and customize content, and piloting and testing applications to bring them to launch and scaling.

Google's role is to provide human and technology resources to advance the development of the application solutions. MTN Uganda provides the communications infrastructure, general on-the-ground support, and marketing support, and leverages its unparalleled distribution network to ensure that rural users are aware of and able to benefit from the services.

Google.org contributes to the focus on rural community development and assessment of the impact of the project.

http://www.grameenfoundation.applab.org/

the recent decrease in ICT costs and price wars in some markets (e.g., Kenya[38]), the cost of a mobile phone and Internet services can still be high relative to income levels.

The Push to Talk on Cellular system requires special handsets; users pay regular mobile phone use charges as well as extra charges for talk time. Cost is definitely an issue for applications that use high-end devices such as PDAs and handheld GPS. For instance, in the Cameroon pilot supported by Helveta, the handheld PDA costs between US$800 and $1,200. In addition, charging the handsets and replacing batteries can be difficult in remote locations.

Another factor is the nature of costs: high upfront investment costs can be an impediment even if the costs of using and maintaining the system are low once it is established. This problem can be overcome by using innovative business models or partnering with the private sector. For example, the Poi Mapper comes in two models. The client can chose a software-as-service (SAS) contract with a monthly fee per user—the client purchases the handsets and the technology is provided under a service contract. Or the client can purchase the whole application and run the system on its own servers. This choice allows flexibility for different clients that may have different ICT infrastructures and capacities.

For a summary of ICT applications and their relevance for the various pillars of forest governance, see **table 6**.

TABLE 6. SUMMARY OF FIELD EXAMPLES

PILLAR OF GOVERNANCE	SUITABLE ICT APPLICATIONS	ISSUES
Transparency, accountability, and public participation	■ E-government and open data initiatives ■ Advocacy and awareness campaigns through text messaging and social networking sites ■ Community radio ■ Crowd sourcing to increase public participation ■ Collaborative and participatory mapping	■ Most applications are based on the Internet and mobile phones, so they are technologically less challenging and cheaper to deploy. Cell phone applications are more useful in forested areas. ■ E-government and open data initiatives require legal and political support and are best led by government agencies. ■ NGOs and civil society can establish and manage mobile phone applications, community radio, and participatory mapping. ■ Costs to users/communities need to be offset through funding from donors or the private sector. Community radio stations can be set up for US$5,000–$15,000 and managed by community members. Short messaging services can be purchased at bulk rates from cell phone companies. ■ GPS capability is required for mapping applications. PDAs (US$800–$1,200) or smartphones ($150–$200) can be used, depending on how rugged the device has to be.
Quality of forest administration	■ Forest cover and carbon stock assessment with CLASlite and airborne LiDAR ■ Real-time fire alerts through MODIS ■ Wildlife tracking and conflict management through mobile phone applications	■ These applications are for government agencies. ■ Satellite imagery is now available at low or no cost, and recent developments have simplified software for interpretation. However, technical training is essential to interpret images and generate maps. ■ The LiDAR approach for carbon assessment is still in the early stages, and costs are estimated at US$0.10 per hectare. The Carnegie Institution for Science, Department of Global Ecology is the main provider of the LiDAR technology for forest cover and carbon assessment. ■ Cybertracker software is free to download onto PDAs and can be tailored for various uses, such as tracking wildlife, following the movement of logs, and locating specific tree species. This is a good technology for working in collaboration with communities. ■ MODIS and the Fire Alert system offer free text and e-mail services for fire alerts.
Coherence of forest legislation and the rule of law	■ Technologies for surveillance and deterrence: computerized checkpoints and GPS tracing of vehicles ■ Technologies for tracking timber: chain of custody systems ■ Legal information management systems: Global Legal Information Network ■ Mobile and online crime reporting services	■ Comprehensive chain of custody systems are expensive operations, primarily useful where the benefits of legality assurance outweigh the costs, as in timber-exporting countries. The costs of these systems could be shared between industry and government, as benefits accrue to both. ■ Less expensive crime-reporting hotlines could be set up to work through voice and text messages. All crime-reporting systems must ensure citizens' anonymity and safety.
Economic efficiency, equity, and incentives	■ Online timber sales and auctions, licenses ■ Logistics	■ These applications work well in situations in which the forest sector is fairly advanced in the use of information technology. While the government agency may have to pay to set up and maintain the applications in their initial phases, some services used by the industry—such as online auctions and inventory data—might include user fees to offset the costs to the public sector.

5 THE WAY FORWARD: MAKING FOREST GOVERNANCE 2.0 A REALITY

Building on the framework of ICT and e-governance development, and on the country case studies and the examples presented above, we list 10 key factors to consider in developing ICT interventions for forest governance. Some are based on the generic ICT4D principles and their application in the forestry sector, while others relate to the special characteristics of forestry.

The examples presented in this report show the potential for using ICT to improve forest governance, but they also show that there are no easy solutions. ICTs can improve development outcomes only if they serve a genuine purpose. In this section, we look at the "how" issue: the operational questions that confront national forest agencies and project managers, who are the key decision makers in the field. What factors are necessary for ICT-enabled good governance?

The first seven factors apply to all ICT4D and e-government initiatives:

1. Ensure that the ICT policy environment and state of e-readiness are conducive to reform.
2. Define the problem and the information need.
3. Determine the best entry points and the appropriate technology.
4. Design culturally appropriate and relevant applications.
5. Ensure the involvement of end users and publicize the service widely.
6. Estimate costs, sustainability, and scalability.
7. Address data security and privacy issues.

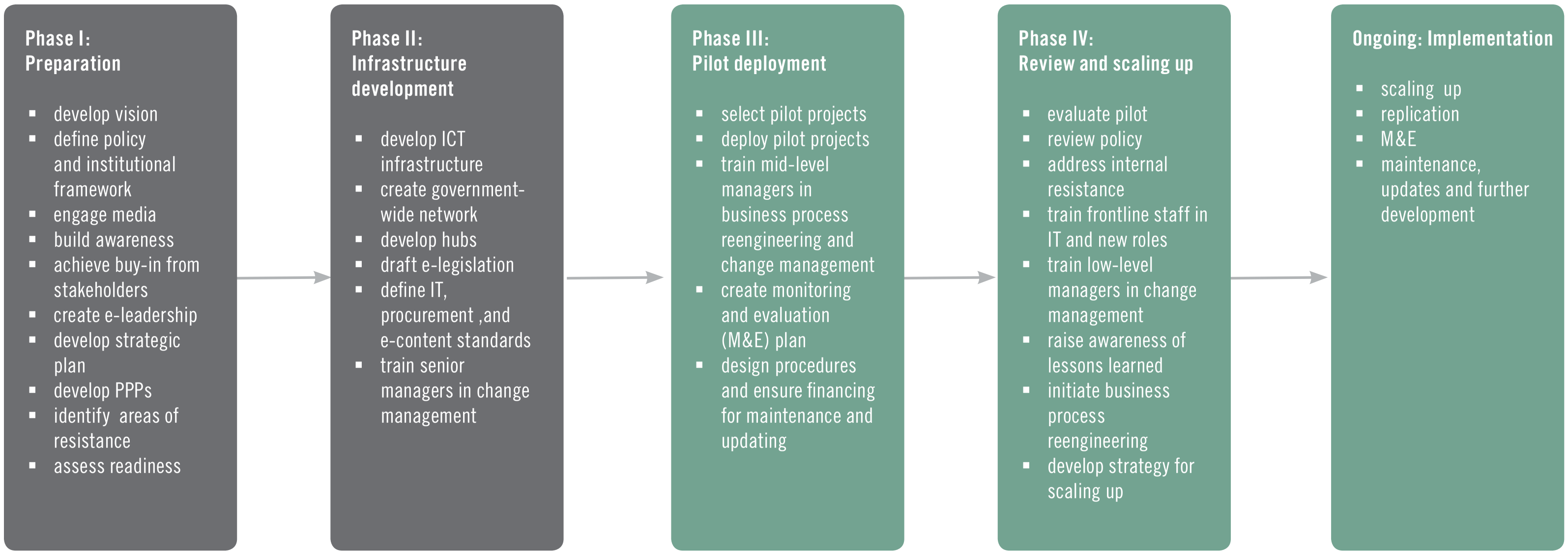
The last three factors are specific to the forest sector:

8. Ensure the existence of adequate information on the resource (e.g., inventories).
9. Identify the stakeholders (e.g., indigenous peoples, women, and the rural poor) and try to ensure their participation.
10. Ensure buy-in from forest authorities and other stakeholders.

1. Be familiar with national ICT policies and e-readiness. Projects can be developed in countries with low readiness, but they must be designed accordingly.

In designing forest sector ICT applications, it is essential to understand national and sectoral e-readiness, as well as the country's position in the governance development trajectory (see **figure 5**). Forest issues are

FIGURE 5. PHASES OF E-GOVERNMENT DEVELOPMENT



The last three columns refer to sector-specific applications.
Source: Based on Hanna 2010.

BOX 32. HOW IS E-READINESS ASSESSED?

The UN global e-government survey measures and compares countries for e-government readiness through its e-government index, which is a composite index that includes the Web measure index, the telecommunication infrastructure index, and the human capital index. The 2008 Web measure index is based on a five-stage model that builds on the previous levels of sophistication of a Member State's online presence. As a country migrates upward through the various stages, it is ranked higher in the Web measure index. The 2008 telecommunication infrastructure index is a composite index of five primary indexes of a country's infrastructure capacity as they relate to the delivery of e-government services:

1. Internet users/100 persons
2. PCs/100 persons
3. Main telephones lines/100 persons
4. Mobile telephones/100 persons
5. Broad banding/100 persons

The human capital index is a composite of the adult literacy rate and the combined primary, secondary, and tertiary gross enrollment ratio, with two-thirds weight given to the adult literacy rate and one-third to the gross enrollment ratio.

Another e-readiness assessment tool is the Connectivity Scorecard, which emphasizes the practical dimension of ICT use. It measures the extent to which governments, businesses, and consumers make use of connectivity technologies to enhance social and economic prosperity. The scorecard attempts to measure "useful connectivity," which is a combined measure of hard measures like number of computers or broadband width on the one hand and user skills on the other. The scorecard measures government and the private sector separately.

Sources: http://unpan1.un.org/intradoc/groups/public/documents/un/unpan028607.pdf and http://www.connectivityscorecard.org.

by their nature rural issues, so access often plays a predominant role; however, rural access to mobile and Internet networks has increased tremendously over the past few years. Poor e-readiness is not an impediment to increased use of ICT in the forest sector if the interventions are designed appropriately.

Particularly in environments with weak capacity, the risk is that developers will create systems that are independent of each other and do not adhere to national e-strategies. Some innovations, such as like cloud computing, require interventions at a broader government level rather than at the level of a single agency or sector.

A country's policies governing ICTs are important, as well as freedom of information policies and the extent to which government agencies are willing to share information with citizens. E-readiness is not only about technology: the country needs to have a legal framework and institutional capacity that ensure access to information, privacy, and public disclosure. Information societies are based on both technology and legal rights.[39]

The UN's global e-government survey measures and compares countries for e-government readiness on a composite index comprising a Web measure index, a telecommunication infrastructure index, and a human capital index. According to the 2008 survey, all countries in Africa, except South Africa, were ranked below the top 100 in terms of e-readiness. However, several African countries have a high level of mobile phone ownership.[40] Thus, although they may not be e-ready in the strict sense, the high level of mobile phone use offers an opportunity to deliver the benefits of ICT-enabled good governance.

As long as researchers, civil society, government watchdogs, and the political opposition have access to essential forest information—even if the general public remains unconnected—a certain amount of transparency exists. There is a cost factor in dissemination; for example, inventory information on forest resources or the forest agency's financial statements would be prohibitively expensive and difficult to disseminate through nonelectronic media, so even limited public access through electronic media is better than no access at all.

2. Define the problem clearly, assess the information needs, and compare possible solutions.

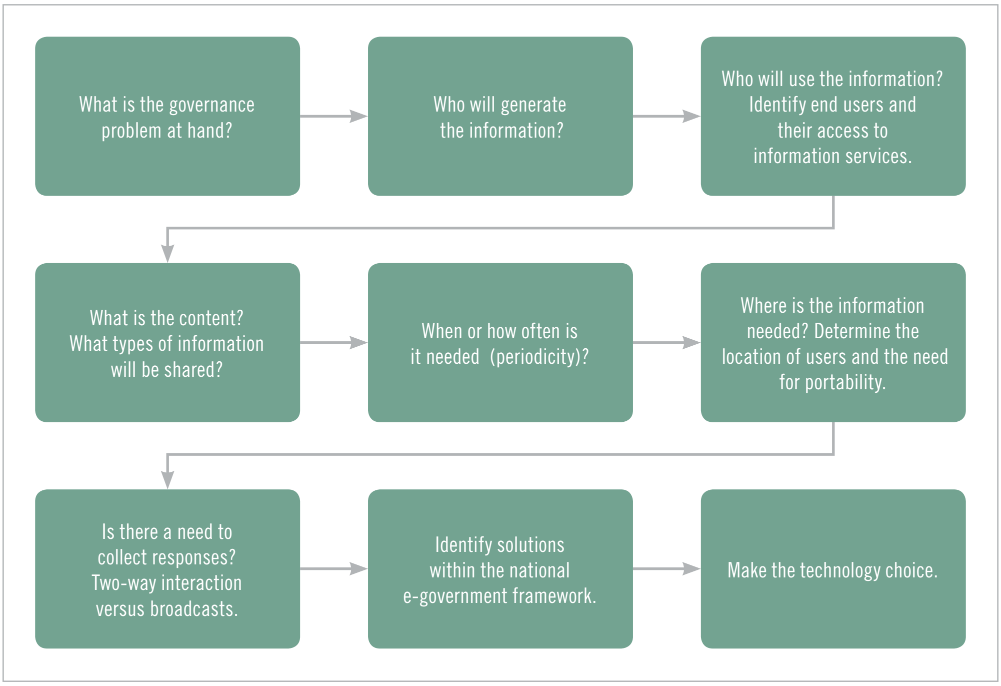
Defining the problem is a fundamental requirement for any kind of project. ICTs are tools or enablers, and having good tools is no assurance that a problem can be addressed. A systematic process like the one mapped out in **figure 6** is required to identify the most appropriate technology. The objective is to find the most cost-efficient and feasible solution. Mobile and Internet applications provide many benefits, but traditional low-tech communication channels can also be appropriate, especially where access to information networks and electricity are limited. If no systematic feedback systems are required and the information is not time-sensitive, posters, community meetings, and radio can be effective.

Decision makers must recognize all potential trade-offs; for example, ICT solutions are usually expensive to set up, but recurrent costs per client may be low. Also, access to information will not be universal—some segments of the society will not be able to access it. This exclusion should be studied carefully and its gravity assessed. Services to the general public should be accessible by as many people as possible, but the situation may be different for some special value-added services. For example, information on community rights in forestry should be universally accessible and disseminated through diverse media, while information on international trade or timber sales to commercial wood processing companies can be limited to online clients, who can be expected to have access to relevant ICT applications. The possibilities for recovering costs from users vary.

In the following situations, an ICT application may be appropriate:

- Information needs to be distributed fast and updated frequently.
- There are several users.
- Information must be sent across large distances.
- information needs to be mobile

FIGURE 6. DECISION-MAKING FLOW IN TECHNOLOGY CHOICE



- Feedback or two-way interaction is required.
- Cost or quality benefits will be achieved.
- Exclusion of some groups owing to lack of accessibility will not notably affect their rights as citizens.

3. Determine the best entry points and the appropriate technology.

In ICT development, gradual and incremental introduction of new services based on existing services can be beneficial. Systems aimed at the general public and for which extensive end-user training cannot be provided should be based on familiar user interfaces. Existing programs and applications are the best bets to ensure success. For example, in India, experience with telecenters shows that adding new services to existing centers is an effective way to improve public access to information. Piggybacking public services to existing commercial services is another way to improve access.[41]

Another decision that must be made in selecting entry points is the type of technology that will be used. The country reports from Uganda and Ghana focus on Internet applications; however, at the same time, a vibrant market is emerging for mobile applications to serve rural populations, especially in Africa.[42] Mobile phones and even smart phones are much more common than Internet-connected computers in developing countries. The multiuse nature of phones means that they can be used to access information services as well as for conventional telephone use. And they are much more widely available than computer-based Internet services.

BOX 33. DEVELOPING FOREST SECTOR AND RURAL ICT4D

Mobile Active—an online community of practice—lists 10 pitfalls in mobile ICT4D projects. This is a useful list of *not-to-do* actions:

- Don't clearly state project objectives.
- Don't plan ahead.
- Go it alone.
- Don't adjust and don't compromise.
- Ignore the community.
- Don't scale your rollout.
- Ignore critics.
- Burn your budget.
- Burn bridges.
- Don't plan for the end.

FailFaires is an informal forum organized by Mobile Active in which ICT4D project developers analyze the reasons for failed ICT projects in order to learn from them.

Inveneo's ICT Sustainability Primer offers the following key principles for what to consider in designing ICT projects for low-resource environments.

ICT infrastructure

In low-resource settings, the following factors can be critical to project success:

- Use hardware with the lowest possible power draw.
- Select equipment with as few moving parts as possible.
- Select field-serviceable and locally available parts.
- Ensure computer virus protection.
- Ensure that software is designed and tested for local reality (e.g., no broadband connectivity or high-power computers required).
- Select user-appropriate software and hardware interfaces.
- Ensure local connectivity. Even where Internet bandwidth is slow and expensive, local connectivity between sites, such as the district forest office and ranger stations, can be fast and cheap.

Power infrastructure

An ICT system is only as reliable as the power system that supports it.

- Good electrical design and low maintenance are basic requirements.
- If possible, use hybrid systems (e.g., batteries can be charged by more than one power source, such as solar panels and a generator).
- Build around locally available inputs.

Sources: http://mobileactive.org/how-fail-mobileactives-definitive-guide-failure; http://failfaire.org/; and Inveneo 2010.

Building ICT access around devices and interfaces that the target audiences use increases the likelihood of successful uptake. As shown in figure 6, identification of the target audience and its e-readiness helps direct both the technology choice and the interface design toward appropriate entry points.

4. Design culturally appropriate and relevant applications.

Services must be locally adapted and relevant, and must meet the needs of the target audience. Applications should not require language skills that are not widely available. Particularly in areas with low literacy rates, e-applications should form part of an extensive service package through which nonliterate users can access the information in various ways besides reading. Public agencies and voluntary NGOs can help with this effort. One approach is to use local community radio to disseminate information originally found on the Internet.

Local innovation hubs are important to ensure that design is culturally appropriate. Working at the local level and involving end users in the design of the system will ensures that applications are responsive to local needs and that they will be used. Even if the information seems to be relevant and the technology works as planned, a system may fail to deliver expected outcomes if potential users perceive the whole service package as irrelevant and not providing value added. Users should receive feedback, and crowd-sourcing and community mapping applications need to include clear incentives for participants to provide information. This is a precondition for long-term sustainability of the models.

Culturally appropriate and relevant content requires that the target audience and the added value to be provided are adequately defined. A common element of many less-than-successful applications is that they were based on the technology rather than a clear idea of the service to be delivered. People do not always recognize the potential of new technologies; moving the technology frontier sometimes requires that innovations be based on both existing and emerging technology. However, wide-scale application cannot be based on technology alone; it requires the existence of a demand and readiness for the service.

5. Involve end users and publicize the service.

It is not enough just to set up a system—the target audience must be aware of it and its benefits. New applications and systems require marketing and active dissemination of the opportunities they offer. This aspect may be of particular concern to public sector agencies, which are typically not marketing-oriented. The target

Rainforest landscape in Uganda. Photo: Douglas Sheil / CIFOR.

audience can be reached through both traditional rural dissemination approaches and more sophisticated marketing and advertising techniques.

E-readiness is an essential factor to ensure that services will be used and investments in new systems will provide the desired outcomes. However, readiness alone is not always enough. The country report from Finland shows that even in a developed country, e-services can be underused. Despite the fact that Finland has some 440 000 privately owned forest properties and approximately 272 000 forest owners, only 150 e-comments were received on pending forest legislation. It is not clear whether the low participation rate was due to a lack of information of the process or a lack of interest, or if other, more conventional, consultation platforms were available.[43]

This is a cost management issue if the transition to e-services requires that old systems are maintained in parallel with the new options; but once uptake of the new application is adequate, the parallel system can be discontinued, leading to cost savings.

6. In designing projects, consider costs, long-term financial sustainability, and scalability.

Many pilot studies and applications are funded and subsidized by international donors, NGOs, or national governments, and private foundations have done extensive work introducing new technologies in low-income countries. However, especially for commercial services, an application's long-term sustainability depends on end-user participation and out-of-pocket expenditures, typically through the purchase of various information technology services.

Most pilot projects focus on building technological knowledge and expertise. Very few pilots have focused on the financial sustainability of the models. Little comprehensive information exists on the investment costs of developing systems, and few analyses are available of overall lifecycle costs. More research is needed in this area. However, from other areas of ICT application, it is clear that after high initial investment costs, recurrent costs can be relatively low. Thus, the issue of scaling up is paramount: if a model can be adequately scaled up or replicated, the initial investment can be recovered and the application will become sustainable.

In the forestry context, replication is more appropriate than scaling up. Going to scale would be relevant for national forest authorities posting information for the general public and seeking feedback on specific issues.

Costs can be a major impediment to sustainability. The Liberian example on chain of custody shows that higher than expected costs or lower than expected revenue flow can endanger the long-term viability of technologically appropriate models. ICT investments must include a robust process to ensure both technical and financial feasibility of the technology chosen and to ensure that procurement is managed appropriately. One option often mentioned to reduce costs is the use of open source software; however, OSS is not without its limitations (see **box 34**).

BOX 34. OPEN SOURCE SOFTWARE

Open source software (OSS) is a computer software or application that is available free of charge under certain conditions (see definition below). OSS can originate from public sector activities (e.g., research projects, donor-funded development projects) or from the private sector. In the private sector, fee-based services (e.g., training, installation, and customization) may be linked to the software.

Using OSS is often proposed as a way to reduce costs in ICT applications. The assumption is that not using proprietary software and paying related license fees will lower costs. However, software license fees are only part of the costs of an ICT application. Costs related to customization, installation, training, and hardware can be much higher than the license fees themselves.

However, OSS can provide notable benefits as a development platform. It allows for constant adaptation and upgrading of applications by local experts, replication in other sectors, production of different language versions to cater to local minorities, and replication of successful models in other countries. OSS is potentially a useful approach for increasing the use of ICT in a cost-efficient way, although it has limitations.

Definition
As defined by the Open Source Initiative, the distribution terms of open source software must comply with the following criteria:

Free Redistribution

- The license shall not restrict any party from selling or giving away the software as a component of an aggregate software distribution containing programs from several different sources. The license shall not require a royalty or other fee for such sale.

Source Code

- The program must include source code and must allow distribution in source code as well as compiled form.

Derived Works

- The license must allow modifications and derived works, and must allow them to be distributed under the same terms as the license of the original software.

Integrity of the Author's Source Code

- The license must explicitly permit distribution of software built from modified source code.

No Discrimination Against Persons or Groups

No Discrimination Against Fields of Endeavor

- The license must not restrict anyone from making use of the program in a specific field of endeavor (e.g., business use).

Distribution of License

- The license must not be specific to a product.
- The license must not restrict other software.

License Must Be Technology-Neutral

Source: Open Source Initiative (http://www.opensource.org/docs/osd).

Some information relevant to forest governance is a public good and needs to be made available as a public service. Basic information about forest resources, concessions, and trade statistics, as well as information related to disclosure of government actions, should be made available free or for a nominal fee based on actual costs. Information needed by the rural poor should be made as accessible as possible, financially and otherwise. However, value-added information services do not need to be free, particularly if they have business value. One could argue that while information or data alone should be made available as widely as possible, summary or aggregated data with notable processed content could justifiably come at a price. In many industries, information is a valuable resource.

Another way of increasing efficiency and reducing costs–at least in the initial phases–is to focus e-services on areas and clients where the benefits will be immediate. For example, applications that deal with human-wildlife conflicts need not be rolled out in all parts of a country; likewise, systems designed to address illegal logging should be directed at problem areas. It is important to launch systems to address specific problems rather than provide random solutions.

ICT developers need to ensure adequate funding for both initial investments and recurrent costs. Governance is sometimes perceived as based on political will rather than investment; however, information system development requires investments in both physical and human infrastructure. In business-based models, costs are covered by user fees; in public services, public funding is required. Whatever the financing model, developers must rigorously analyze the basic parameters and ensure a sustainable financial base for the application.

7. Address data security and privacy issues, and develop risk mitigation to prevent misuse of technology and inaccurate data.

Cybercrime is a risk in a technology-dependent world. While access to ICTs to track illegal activities facilitates law enforcement, the converse can also be true: illegal loggers and wildlife poachers might intercept communications between forest authorities and informers, or text messages could be used to deliberately mislead law enforcement agencies. Law enforcement bodies should have sufficient resources and expertise to counter disinformation and investigate criminal activities. The potential for misuse of technology requires that authorities and other stakeholders employ appropriate risk mitigation measures, including a full understanding of the risks. Measures must be in place to identify discrepancies in data—inaccurate information might signal deliberate attempts to mislead authorities or simply unintentional mistakes and misunderstandings.

Privacy is another area of concern, especially the security of whistleblowers' identities. If ICT applications aim to encourage public participation in forest law enforcement (e.g., by establishing hotlines to report illegal logging, poaching, or corruption in the forest sector), they must not jeopardize the personal safety of informants.

The next three issues are specific to the forest sector.

8. Ensure the existence of adequate information on the resource (e.g., forest inventories and resource assessments) or the ability to improve data collection.

In the section on information management, we discussed the key types of information needed for forest governance. The examples presented in this volume list various kinds of information that can be collected and disseminated through the use of ICT. But these applications are of limited value if the information does not exist; if, for example, countries have not inventoried their forests or collected data on the social conditions of forest-dependent communities. A good example is Liberia, where the last forest inventory was carried out in the 1970s. So, even with the advanced Liberfor chain of custody system, we do not have a clear view of sustainability; that is, whether logging should be decreased or increased.

Having adequate data is a precondition for transparent information sharing. Lack of data cannot be overcome by an investment in technology alone, but these investments do not have to be sequential: a country can collect inventory information at the same time ICT applications are developed in a parallel process.

9. Identify all the stakeholders (e.g., indigenous peoples, women, and the rural poor) and try to ensure their participation; avoid local elite capture.

The forest sector has diverse stakeholders with various levels of knowledge and competence. Large enterprise representatives, as well as senior managers and technical specialists in forest administrations and international NGOs usually have a high level of knowledge of the sector and good access to and understanding information systems. At the other end of the spectrum are people in rural (especially indigenous) communities, who may have very limited formal knowledge of the sector and poor or no access to information networks. Access may be unequal within the community, too, with women or poor people excluded while local elites have some access and knowledge.

To avoid elite capture and the unintended exclusion of key stakeholders, any information system development plan must include comprehensive stakeholder/client mapping. This process will help developers assess the information needs and choose the best way to provide the required information services.

10. Ensure buy-in from forest authorities and other stakeholders.

Adoption of an e-governance agenda in forest agencies may occur in various ways. It may require strong normative guidance from national e-government programs and agencies housed in higher level coordinating bodies (e.g., the president's or prime minister's office) or in a ministry that is clearly mandated to oversee national e-strategies (e.g., the ministry of finance or planning). Or adoption of such an agenda may be the result of financial incentives. Increased use of new technology is often driven by efficiency gains and cost savings. If these can be clearly analyzed and demonstrated, agencies will be motivated to stay engaged and expand their use of ICT. For this to happen, the agency must be able to retain some of the savings in its investment or recurrent budget, to compensate for possible incremental costs, at least during the transition phase. These approaches are not mutually exclusive but can be applied simultaneously

Our examples of applications have shown that the technology almost always works, but genuine buy-in from authorities and other stakeholders may be lacking. And in none of our examples did ICT lead to a transformational change in forest administration or governance. The involvement of authorities and stakeholders in the development of information systems serves two purposes: (1) these people are likely to be in key positions for making decisions about resource use; and (2) with few exceptions, forest authorities have most of the relevant data on forests and their uses. This information is a precondition for various open data systems and applications.

Many NGOs and international organizations have developed innovative models, but if key authorities and senior management are not involved, the new systems will have limited value. This may be a key issue in donor-funded projects, where the problem is often an imbalance between the resources available for project teams and implementation units on the one hand and the resources available to the "regular" civil service on the other. Projects are often able to equip the implementation units with modern hardware and software, while other departments remain poorly equipped. If we want to see wide-scale ICT reforms, relevant agencies must be upgraded in a way that allows them to participate. This requires adequate investment funding for hardware upgrades, system development, and human capacity building.

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NOTES

1. Examples for pillar II are included in other governance pillars.
2. For example, it was not until 1996 that James Wolfensohn, then president of the World Bank, gave a major speech on the adverse impacts of corruption that led to major policy initiatives in the Bank.
3. The World Bank is developing an online sourcebook on ICTs in agriculture, to be published in 2011.
4. This has become an issue in, for example, Indonesia. For a case study of decentralization and local corruption, see Holloway (undated) and World Bank (2003). See also Smith (2010).
5. For a comprehensive presentation on recent initiatives to curtail illegal logging, see Brown et al. (undated).
6. For example in Liberia, land was recognized for many decades as the property of indigenous communities. However, from the 1950s on, it was increasingly considered state property. If communities wanted to own it, they had to buy it back (Wily 2007).
7. Compare this figure with the combined circulation of the world's 100 largest newspapers: 127 million (http://www.easypr.com/).
8. This has led to various sector-specific terms such as e-health and e-education to describe applications of technology in these sectors. Another modification is m-government and m-governance, which refer to the use of mobile applications and appliances.
9. For an in-depth analysis of the growing impact of ICTs in development, see World Bank (2009b).
10. See the Bosnia and Herzegovina case study in World Bank (2008).
11. The implementation completion report (ICR) for the Andhra Pradesh Forestry Project notes, "The project has, in the latter stages, obtained up-to-date GIS hardware and software and established a new Geomatics Centre… .However, the system has only been fully operational in the latter stages of the project." The ICR for the Uttar Pradesh Forestry Project notes, "The main weaknesses at (project) entry were…an expectation that the implementing agency would manage large consultancies, such as the forest management information system (FMIS), when its capacity in this area was limited. Other shortcomings were in the development of the FMIS, which was rudimentary and not a full-fledged planning tool at project closure." From the Madhya Pradesh Forestry Project ICR: "Another shortcoming in sector management was the failure to deliver an improved macro-level planning process supported by an FMIS and associated capacity building."
12. Romania Forest Development Project (P067367) and Bosnia-Herzegovina Forest Development and Conservation Project (P079161).
13. See, for example, Forest Monitoring for Action (FORMA), which uses freely available satellite data to generate rapidly updated online maps of tropical forest clearing (http://www.cgdev.org/section/initiatives/_active/forestmonitoringforactionforma).
14. The reports are available for download at http://www.profor.info.
15. http://www.whitehouse.gov/open/about and http://www.data.gov.
16. http://www.internationalbudget.org/what-we-do/open-budget-initiative.
17. http://www.mongabay.com and http://www.greenpeace.org.
18. http://www.developingradiopartners.org/index.html.
19. Statistics for 11 countries for which consistent data were available: Botswana, Cameroon, Democratic Republic of Congo, Kenya, Nigeria, Senegal, Sierra Leone, South Africa, Tanzania, Uganda, and Zambia, quoted in Myers (2010).
20. http://www.unesco.org/webworld/cmc.

21. http://ictupdate.cta.int/en/Feature-Articles/Digital-audio-in-Papua-New-Guinea.
22. Leo Botrell (WWF-US) personal communication.
23. http://www.fs.fed.us/fmsc/measure/index.shtml.
24. Gurovich (2006) and Gurovich (pers. comm.)
25. http://www.meridianawards.com/past-winners/view/combating-bushfire-wild-land-fires-in-the-state-of-nsw-australia.
26. http://claslite.ciw.edu/en/index.html.
27. Magrath, William (2009): Presentation at World Bank–FAO workshop on forest law enforcement and governance in Asia–Pacific, Kuala Lumpur, November 2009 (unpublished).
28. http://www.spasigorata.net/ and http://www.bluelink.net/en.
29. ICT Update No.16, February 2004; http://ictupdate.cta.int and http://www.fao.org/english/newsroom/focus/2003/sflp4.htm.
30. http://www.glin.gov.
31. Investment cost less than US $200,000. PROFOR has provided financial support to GLIN.
32. UK Forest Commission (personal communication)
33. Peters-Guarin and McCall (2010). CyberTracker was used to carry out community forest carbon mapping in San Juan Bautista in the municipality of Uruapan and another ejido in the Taretan municipality
34. The Amazon Conservation Team, Google Earth Outreach, and the Moore Foundation: http://www.amazonteam.org/index.php/233/The_Sete_de_Setembro_Indigenous_Reserve and http://www.google.org/earthengine.
35. Personal communication from project team.
36. The communities did not receive feedback or summaries of the data they collected. In addition, participants originally understood that they would be compensated for their work. When payments did not materialize, the communities lost interest in participating. In an interim evaluation report, "Enabling Independent Monitoring of Forest Resources by Local and Indigenous Forest Communities" (unpublished, November 2009).
37. Also, large entities may stop updating Web sites. The Liberia Forest Initiative (LFI) Web site has been updated only through 2007, although the LFI is still in existence.
38. A local service provider lowered the price of SMS to 0.2 Kenya schillings (approximately US$ 0.0025) per message. However, clients must commit to use a minimum amount of services, so the overall cost remains high (http://www.businessdailyafrica.com/ September 14, 2010).
39. For example, the WSIS Declaration of Principles (WSIS-03/GENEVA/DOC/4-E (12 December 2003) states:

    (21) Connectivity is a central enabling agent in building the Information Society. Universal, ubiquitous, equitable and affordable access to ICT infrastructure and services constitutes one of the challenges of the Information Society and should be an objective of all stakeholders involved in building it. Connectivity also involves access to energy and postal services, which should be assured in conformity with the domestic legislation of each country.

    (22) A well-developed information and communication network infrastructure and applications, adapted to regional, national and local conditions, easily accessible and affordable, and making greater use of broadband and other innovative technologies where possible, can accelerate the social and economic progress of countries, and the well-being of all individuals, communities and peoples.

    (24) The ability for all to access and contribute information, ideas and knowledge is essential in an inclusive Information Society.

    (25) The sharing and strengthening of global knowledge for development can be enhanced by removing barriers to equitable access to information for economic, social, political, health, cultural, educational, and scientific activities and by facilitating access to public domain information, including by universal design and the use of assistive technologies.

40. http://www.researchictafrica.net/new/images/uploads/ria-policy-paper_ict-access-and-usage-2008.pdf.

41. A good example is the Finnish experience in electronic identification for public services. After 10 years, only 220,000 e-ID cards had been issued for a population of 5.3 million, so the system was discontinued. The problem was that commercial banks had developed better ID systems, and these systems were also used by the state for identification for public services.

42. See, for example, http://ictupdate.cta.int/ (Issue 57: December 2010).

43. In 2009, Finland ranked 10th in the world in e-readiness, according to the Economist Intelligence Unit: http://graphics.eiu.com/pdf/E-readiness%20rankings.pdf. Number of forest owners: http://www.stat.fi/til/mmtal/2008/mmtal_2008_2010-03-25_kat_004_fi.html.

FOREST GOVERNANCE 2.0: A PRIMER ON ICTS AND GOVERNANCE, EXPLORES A WHOLE RANGE OF USES OF INFORMATION AND COMMUNICATION TECHNOLOGY THAT CAN INCREASE PUBLIC PARTICIPATION AND IMPROVE LAW ENFORCEMENT AND ECONOMIC EFFICIENCY TO STRENGTHEN GOVERNANCE IN THE FOREST SECTOR.

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