HOW IS FIA HELPING OTHER COUNTRIES MONITOR THEIR FORESTS?

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ABSTRACT

The demand for forest monitoring is growing rapidly with emphasis on carbon dynamics, due in part by incentives being negotiated under the United Nation's Reducing Emissions from Deforestation and Forest Degradation (REDD+) process. While much of the temperate and boreal forest in developed countries is being monitored as part of national forest inventories, tropical forests are the least monitored and most at risk of deforestation. The Forest Inventory and Analysis (FIA) program of the U.S. Forest Service is working through its National Inventory and Monitoring Applications Center (NIMAC) to coordinate technical assistance in forest monitoring for other countries. NIMAC has developed a 15-step approach and an inventory planning and design tool. Examples from Honduras, Peru, Guyana, and the Democratic Republic of the Congo are given. Challenges remain in the areas of efficient plot configurations and sampling designs for remote areas with high biodiversity and in maximizing the use of remote sensing to enhance ground-based estimation.

INTRODUCTION

The demand for forest monitoring is growing rapidly around the globe with an emphasis on carbon dynamics. This is driven in large part by incentives being negotiated under the United Nation's Reducing Emissions from Deforestation and Forest Degradation (REDD+) process. Others reasons include sustainable forest management for timber products, biodiversity conservation, wildlife habitat, and other ecosystem services. The United States government is interested because REDD+ is a cost-effective opportunity for reducing carbon emissions while providing for sustainable use of forests to help keep them as forests. While much of the temperate and boreal forests in developed countries are being monitored as part of national forest inventories (NFI), tropical forests are the least well monitored and most at risk of deforestation.

WHAT IS FIA DOING ABOUT IT?

The Forest Inventory and Analysis (FIA) program of the U.S. Forest Service is working through its National Inventory and Monitoring Applications Center (NIMAC) to coordinate technical assistance in forest monitoring to other countries. Requests for assistance come through the U.S. Department of State's Agency for International Development and International Programs of the U.S. Forest Service. NIMAC identifies individuals from within and outside NIMAC with the skills needed for each project, thus improving efficiency and providing more consistent assistance. NIMAC staff has also developed documentation and software tools to enhance the quality of the advice and delivery of technical assistance in a collaborative manner.

WHAT IS NIMAC DOING?

NIMAC takes a 15-step approach (Scott 2009) that starts by determining each country's objectives and monitoring needs. This focuses the effort on the goals and ensures that each step supports achievement of the goals. To facilitate the first seven steps, NIMAC developed an inventory planning and design tool called the Design Tool for Inventory and Monitoring (DTIM). NIMAC also offers advice on the use of other FIA tools, such as data recorder software, databases, and data analysis. While some in-country assistance is critical, FIA has adopted a capacity-building approach by providing training that can be offered in the United States, the host country, as multi-country workshops, as webinars, or as online training tools.

The 15 monitoring steps are grouped into four categories:

A. Design phase
B. Data collection
C. Database and data processing
D. Analysis, reporting, and decisionmaking

DESIGN PHASE

The first seven steps focus on planning and designing the inventory. DTIM was developed to lead users through these steps. DTIM is continually being updated; a Spanish language version is now available.

1. *Identify stakeholders and their objectives.* Typically there are national and international stakeholders. Objectives often include measuring (or assessing) carbon sequestration, sustainable timber production, and biodiversity

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conservation. DTIM provides a list of common objectives from which to choose.

2. *Identify key monitoring questions for each objective.* Develop questions that will determine whether the chosen objectives are being met. This is often challenging, so DTIM provides a list of standard questions that are linked to the list of common objectives from which to choose.

3. *Identify attributes needed to answer each question.* This is often best done by identifying the table of estimates needed to answer the question, such as estimating area by forest type and stage of development class when the objective is to restore forest composition and structure. DTIM presents a list of FIA attributes (or metrics) that could be used to answer each of the standard questions.

4. *Evaluate existing data to determine if they are sufficient for answering the questions.* Identify available data sources for the area of interest. Determine whether data cover the entire area of interest, include all the required attributes, and have sufficient precision to answer the questions. If so, skip to the analysis phase. If not, then determine what is needed to fill the data gap. Typically, there are only data for parts of tropical countries and are rarely from remeasured plots.

5. *Determine the precision required and funds available for the inventory.* For each of the key variables (e.g., forest area, area change, totals for each of the forest carbon pools, and total commercial volume), determine the confidence level (e.g., 90 percent) and confidence intervals (e.g., ±15 percent). The decisionmaker must assess the risk of making an incorrect decision based on imprecise estimates. REDD+ payments are to be linked to the reliability of the estimates. Precision requirements are difficult to establish; cost limits are usually easier to determine, so the inventory planner can focus on optimizing precision for inventorying a suite of variables for a predetermined funding level. By specifying both in advance, the final requirements can be established iteratively. In many cases, external matching funds are being provided to begin the monitoring project.

6. *Determine the optimal plot design based on the requirements and information needs, then determine the sampling design, including sample sizes.* For long-term monitoring (remeasurements), we recommend using proportional allocation to strata. Since strata boundaries tend to change over time, the selection probabilities can become very complicated to determine. The subject of plot design is ripe for further research in the tropics, but solutions usually involve large plots (e.g., 0.5 ha) due to high biodiversity and remoteness, and plots are rectangular (e.g., 20 x 250 m) due to difficulty of determining border trees.

7. *Identify the plot locations.* For new inventories, we recommend a spatially balanced design such as FIA's hexagonal grid (Reams 2009) or NIMAC's space-filling curve approach (Lister and Scott 2009). This method was utilized by NIMAC in the broadleaf inventory of the Rio Plátano region in Honduras.

DATA COLLECTION

8. *Develop a field guide.* We encourage the use of existing guides (or some of the attributes they contain) from within the country, nearby countries, or developed for international use, such as by FAO (United Nations Food and Agriculture Organization). Collect the targeted attributes in as consistent a way as possible for upward reporting purposes. An important part of this process is developing definitions for each variable, such as land use and land cover classes, and forest land. FIA's field guides are available at: http://www.fia.fs.fed.us/library/field-guides-methods-proc/

9. *Plan the field logistics and provide training.* Field logistics is an issue that is usually best left to local expertise and to international organizations, such as FAO's National Forest Monitoring and Assessment group, who routinely do this kind of work. The tropics present many logistical challenges so the solutions are different. For example, FIA uses one to two person field crews. But crews in the tropics typically range from 5 to14 people, often including one or two trained foresters, someone skilled at identifying tree species, one or two crew members who wield machetes to clear the way, and sometimes a cook and someone to care for the crew's health. FIA has cooperated in conducting field training, including field safety.

10. *Conduct data collection.* With planning, preparation, and training completed, the field work begins. We encourage the use of portable data recorders (PDRs) to collect the data in the field. Since FIA's MIDAS (Mobile Integrated Data Acquisition System) program is very specific to FIA, NIMAC is working with Honduras on the development of a general data entry program called SIBP2. We also recommend performing Quality Control and Quality Assurance checks. While revisiting plots to check on data quality is expensive, not checking can be even more expensive, because forest management decisions could be based on inaccurate data.

DATABASE AND DATA PROCESSING

11. *Store data in a database.* Upload the data from the PDRs or enter the data from tally sheets, and store in a relational database. Run edit checks on the data – data validation and

crosschecks. If using a PDR, the edits should have been done during data entry in the field where the corrections are most easily and accurately made.

12. *Use models and formulas to estimate computed fields.* Once the data are clean, then computed variables, such as basal area, volume, biomass and carbon, are calculated and added to the database along with the field data. For countries in the REDD readiness phase, this can be a challenge since the carbon pool models often do not exist and no credit will be given when models from outside the region are used. Any stratification used (either prior to plot selection or afterwards must be assigned to individual plots and the stratum weights stored in the database. These stratifications are typically obtained from classification of satellite imagery.

ANALYSIS, REPORTING AND DECISIONMAKING

13. *Perform the analysis.* Produce one-, two- or three-way tables to answer the questions asked in the second step. FIA has developed an MS Access program called EVALIDator. The program is stored with the data and can be downloaded at http://www.fia.fs.fed.us/tools-data/default.asp then click on FIA DataMart. It produces tables with associated sampling errors. Produce report(s) based on the tables. This step is often never reached, leaving the data greatly underutilized. Easy-to-use analytical tools help to overcome this problem. The program has proved flexible enough for recent use in a project in Honduras.

14. *Check that monitoring system met the need.* Did the data collected meet the information needs? Were the questions answered? Were the precision and cost limits met? Adjust the monitoring system as needed for application elsewhere and/or for remeasurement.

15. *Make management decisions.* For REDD+ countries, the results will be used to make decisions on payments and as feedback on the efficacy of policies, regulations, and programs.

EXAMPLES

FIA has provided assistance in the Democratic Republic of Congo, Peru, Guyana, and several other countries. The recent focus has been on REDD+, national forest inventories, inventories for sustainable forest management planning, and on estimating populations of endangered species, such as mahogany.

As the largest of the 10 countries in the Congo River basin, the Democratic Republic of Congo (DRC) has received significant attention to improve a forest monitoring in preparation for an eventual operational REDD+ mechanism. The country is seventh in forest area (321 million ha) and has the second largest tropical forest. Much like Alaska, it is remote with few roads. Inventories of some of the regions have been completed in the accessible areas, but a national forest inventory has never been completed. Aerial photography is outdated. Securing quality satellite imagery for the DRC is difficult due to persistent cloud coverage and other challenges. Historically, the deforestation rates are low. In addition to REDD+, DRC is interested in a full NFI and in intensifying the sample further to inform management of production forests (forest management concessions) and otherwise better inform land-use decisions. The expectation is that additional well managed forests would provide sorely needed economic development opportunities from national to the local levels, resulting in many benefits including providing a viable alternative to slash-and-burn agriculture. Peru has initiated three large inventory projects. In the first project, FAO and Peru are co-funding the first complete national forest inventory. NIMAC is providing some technical assistance with the planning and design. In the second project, Peru is preparing for a second round of offering forest concessions for roughly a third of the country's forest area (the remaining two-thirds is under various forms of protection). NIMAC is providing assistance on how to do a low-cost pre-concession inventory that provides improved spatial resolution for the bidders of individual concessions. Third, NIMAC is exploring options in Peru for enhancing the estimates of the mahogany and Spanish cedar populations, such as by increasing the NFI plot size for these species and/or intensifying the sample in areas with high probability of occurrence.

In Guyana, FIA has provided technical assistance that led to two requests for proposals, one for estimating carbon for REDD+ and the other on remote sensing to estimate land use change. NIMAC will continue to provide technical expertise on a national forest inventory in addition to Measuring, Reporting and Verification (MRV) for REDD+, but will focus on providing various kinds of training.

U.S. Forest Service International Programs and FIA plan to expand the training to provide more consistent and effective technical assistance to the many countries seeking such aid. By providing regional training sessions to multiple countries, web-based training, and hosting training sessions in the United States, the demand on FIA staff time should be reduced.

FUTURE DIRECTION

Although FIA has long provided technical assistance to other countries, the current demand is unprecedented. To meet this demand, FIA is collaborating with FAO, other international aid agencies, universities, and other partners on several topics. Research is needed on efficient plot configurations and sampling designs for remote areas with high biodiversity. The current methods are efficient for one-time inventories, but may not be cost-effective for long-term monitoring. Research is needed on maximizing the use of remote sensing to enhance ground-based estimation. Fortunately, considerable funding and efforts are being expended to address this important issue. Other topics include how to quantify forest degradation and how to determine the baseline. To assist with planning, design, electronic data collection, data management, analysis and reporting, NIMAC, FAO and others are developing software tools that are flexible for meeting individual countries needs. Finally, training materials and modules are needed in various forms, such as in-country, regional and U.S.-based training sessions, webinars, web-based tutorials, and documentation. Together, these efforts will help address the growing need for forest carbon monitoring.

LITERATURE CITED

Lister, A.J.; Scott, C.T. 2009. Use of space-filling curves to select sample locations in natural resource monitoring studies. Environmental Monitoring and Assessment. 149:71-80.

Reams, G.A.; Smith, W.D.; Hansen, M.H.; Bechtold, W.A.; Roesch, F.A.; Moisen, G.G. 2005. The forest inventory and analysis sampling frame. In: Bechtold, W.A.; Patterson, P.L., eds. The enhanced Forest Inventory and Analysis program - national sampling design and estimation procedures. Gen. Tech. Rep. SRS-80. Asheville, NC: U.S. Department of Agriculture Forest Service, Southern Research Station: 11-26.

Scott, C.T. 2009. Overview of the National Inventory and Monitoring Applications Center (NIMAC). In: McWilliams, W.; Moisen, G.; Czaplewski, R., eds. Forest Inventory and Analysis (FIA) Symposium 2008. RMRS-P-56CD. Ft. Collins, CO: U.S. Department of Agriculture Forest Service, Rocky Mountain Research Station: 223-229.