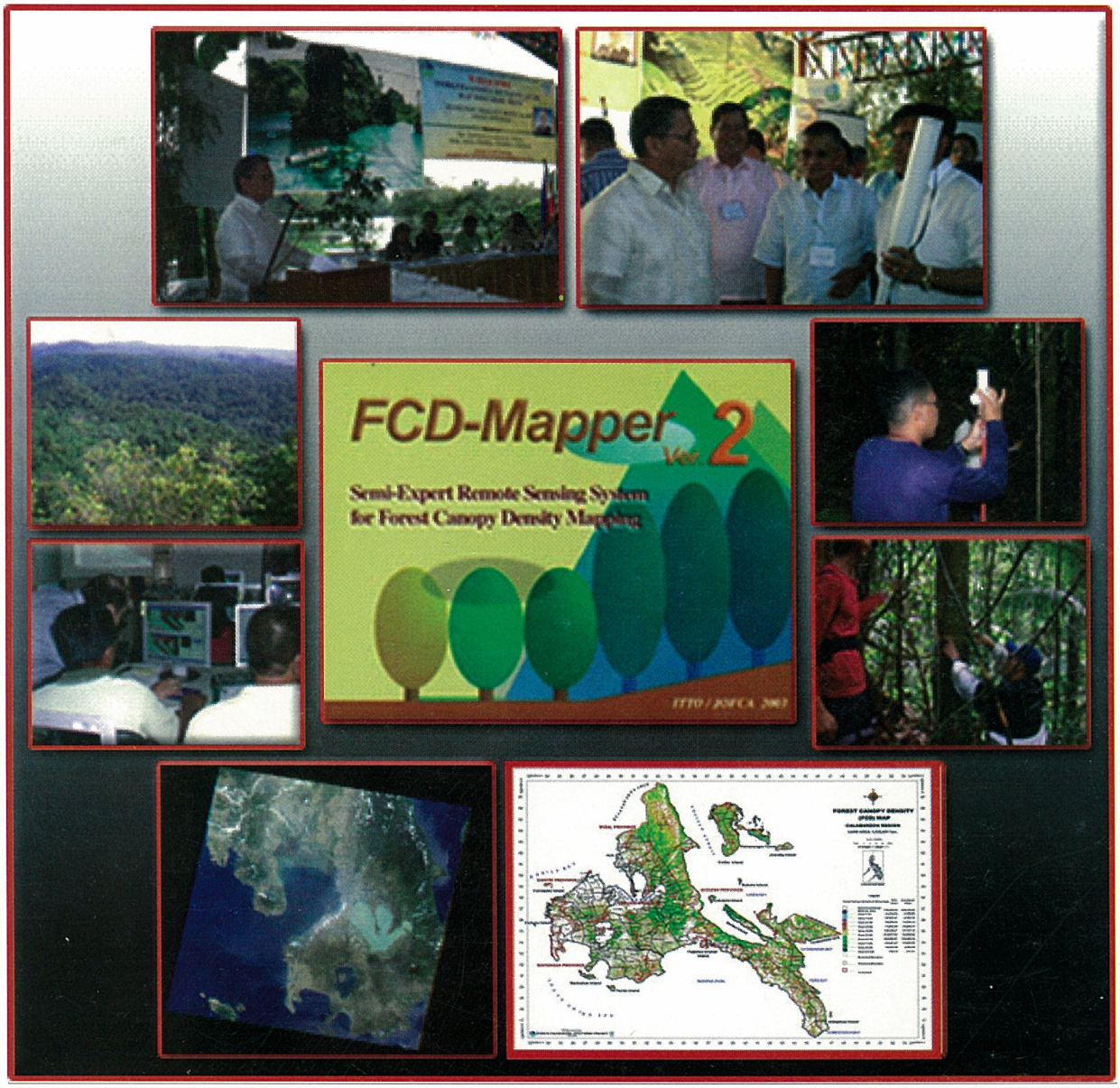
ITTO PROJECT PD 239/03 REV 1 (F)

DEVELOPMENT AND INSTALLATION OF A FOREST RESOURCES MONITORING SYSTEM (FORMS) BY UTILIZING THE FOREST CANOPY DENSITY (FCD) MODEL DEVELOPED IN ITTO PROJECT PD 60/99 REV 1 (F)

COMPLETION REPORT



JANUARY 2007

Department of Environment and Natural Resources
CALABARZON Region

International Tropical Timber Organization

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Acknowledgments

On behalf of the Department of Environment and Natural Resources (DENR), Region IV CALABARZON, we acknowledge with profound gratitude, the assistance, support and contributions of various DENR offices, i.e. Provincial Environment and Natural Resources Offices (PENROs), Community Environment and Natural Resources Offices (CENROs), Forest Management Bureau (FMB), National Mapping and Resource Information Authority (NAMRIA), Local Government Units (LGUs) as well as officials and staff of the funding institution, the executing and cooperating agencies for the successful implementation and completion of the Project, entitled "Development and Installation of a Forest Resources Monitoring System (FORMS) by Utilizing the Forest Canopy Density (FCD) Model Developed in ITTO Project PD 66/99 Rev.1(F)."

We are specifically grateful to the International Tropical Timber Organization (ITTO) represented by its Executive Director, Dr. Manoel Sobral Filho, for providing the funding support and thereby allowing the FORMS Project to become a reality.

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Finally, we are also indebted to all who shared their insights, wisdom, and expertise, in one way or another, during the implementation phase of the project.

List of Acronyms

CALABARZON	Cavite, Laguna, Batangas, Rizal and Quezon Provinces
CENRO	Community Environment and Natural Resources Office
CLUP	Comprehensive Land-use Plan
DENR	Department of Environment and Natural Resources
DILG	Department of Interior and Local Government
FCD	Forest Canopy Density
FCDM	Forest Canopy Density Mapper
FMB	Forest Management Bureau
FRDD	Forest Resources Development Division
GIS	Geographic Information System
ITTO	International Tropical Timber Organization
JOFCA	Japan Overseas Forestry Consultants Association
LGU	Local Government Unit
MIS	Management Information System
MPFD	Master Plan for Forestry Development
NAMRIA	National Mapping and Resource Information Authority
NEDA	National Economic Development Authority
NGO	Non-Government Organization
OGAs	Other Government Agencies
NTFPs	Non-timber Forest Products
OGA	Other Government Organization
PAMB	Protected Area Management Board
PENRO	Provincial Environment and Natural Resources Office
PTC	Project Technical Committee
RED	Regional Executive Director
RSRDAD	Remote Sensing Resource Development and Analysis Department
SFM	Sustainable Forest Management
UTM	Universal Transverse Mercator

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Project Completion Report

PROJECT IDENTIFICATION

Title	:	Development and Installation of a Forest Resources Monitoring System (FORMS) by Utilizing the Forest Canopy Density (FCD) Model Developed in ITTO Project PD 60/99 Rev.1(F)		
Serial Number	:	PD 239/03 Rev.1(F)		
Executing Agency:		Department of Environment and Natural Resources (DENR) Region IV CALABARZON		
Host Government	:	Republic of the Philippines		
Starting Date	:	June 8, 2004		
Duration	:	24 months		
Project Extension (at no cost)	:	3 months		
Project Costs	:	ITTO	-	US$347,118
		DENR (in kind)	-	US$ 96,380
		TOTAL	-	US$443,498

Part I: Executive Summary

1.1 Background Information about the Project

1.1.1 Key Problems

The current database for decision-making, planning and monitoring of forest resources within timberland areas in CALABARZON region is incomplete and/ or obsolete. This is due principally to reliance on conventional methods of obtaining and managing information, such as manual preparation of maps, data storage and filing. These methods require more manpower. They are costly and slow, making it impossible to keep pace with changing conditions. Moreover, decisions on fund allocation and programme/project design are often based on outdated information or dubious assumptions.

Modern information technology (IT), analysis of satellite imagery data, on-screen mapping, and data storage/filing/retrieval methodologies are viable alternatives to the outmoded systems currently in use. However, the human resource skills needed to employ these options are still underdeveloped in CALABARZON region. Additionally, budgetary limitations curtail the procurement of satellite imagery data, computer hardware, software and related peripherals that would enable the selected areas to install a new, responsive data management system, and thereby strengthen management, decision-making and monitoring. The absence of such capability to employ satellite data analysis is particularly a crucial problem since it makes it difficult to rapidly verify information on forest status submitted by provincial offices.

All of the above-mentioned factors hinder the capability of other PENROs to comply with their information-related obligations to the general public. For instance, it is not possible to respond confidently to requests from Provincial Governors, City or Municipal Mayors and their respective planning offices for reliable data on forest cover and watershed conditions. Similarly, requests from furniture shops and other wood processors/producers for data on the location, volume of timber, availability of tree farms and plantations, among others, are not easily provided. In addition to obsolete information, responses to requests are slow due mainly to an archaic data storage/retrieval system. Compounding this problem is the occasional loss of manually prepared/drawn maps and other information, and the absence of back-up copies due to lack of electronic storage/retrieval and digitization capacity.

The FORMS project is an institutional development initiative. It supports logical decision-making, policy formulation and well-planned interventions in forest conservation, development and management. Essential for successful implementation of FORMS is the ability to keep abreast of the changing demands of the people and the environment. This requires a solid platform of information, planning, methodologies, administration, research and

development. Also, the capability to carry out data analysis to guide the decision-making process, and to communicate effectively with all concerned stakeholders is crucial. Investments in information technology can contribute in a more meaningful way to development of these capabilities. Owing to its involvement in FCD-Mapped development, DENR has embarked on the potential uses of satellite imagery analysis and methods as integral component of FORMS.

Guided by decisions taken at the central level (DENR), the regional office is responsible for the project implementation. Additionally, provincial offices are the principal sources of information that provide "raw material" for decision-making at regional level. Thus, active participation and involvement by the provincial office is essential. The experiences and lessons learned in setting up the FORMS served as guide for the regional offices dealing with similar concerns, whose operations are affected by similar limitations in terms of available and reliable data on the status of forest conditions.

1.1.2 Specific Objectives and Outputs

The **Development Objective** of the project is envisioned to further provide a mechanism that supports efficient management of forest resources by, among others, enabling decision makers to access information on the actual status of the forest conditions in real time. The FORMS will collect, organize and document facts and figures on current and past forest conditions. These information will be disseminated to concerned stakeholders in user-friendly formats including color-coded maps. The project will integrate all information vertically and horizontally among the forestry administrative functions to provide the total bird's eye view of the DENR IV forestry sector.

Specific Objective No. 1 consists of establishing a remote sensing-based system for assessment and monitoring of forest resources. The outputs to be achieved under this objective are the following:

a. Skills development programmes for analysis of RS data, spatial data outputs and related forestry sector information for personnel from the regional, provincial and community offices of DENR IV who shall comprise the human resources needed to develop and implement FORMS.

b. Manual of operations for forest inventory to be used in conjunction with FCD Mapper Operations.

c. Revised and simplified User's Guide for operating FCD Mapper.

Specific Objective No. 2 consists of developing DENR personnel skilled in utilization of RS-based system. The outputs to be produced under this objective are the following:

a. Training and deployment of 40 personnel on FCD Mapper operation;

b. Training and deployment of 60 personnel on GIS;

c. Training and deployment of 88 personnel on computer systems.

1.1.3 Implementation Strategy

The project is designed to use Forest Canopy Density Mapper (FCDM) Ver. 2 software as a tool in attaining sustainable forest management. The data generated from FCDM will guide decision-makers, implementors and stakeholders on the various intervention activities to be done in order to maintain a balanced ecosystem of the existing forest areas. This scenario can be achieved by establishing remote sensing/GIS facilities, and training DENR personnel to perform the FCD/GIS processing. All data produced are to be digitally stored for easy retrieval and printing.

The general approach and methodology employed entail a general reference for data analysis indicating the status of area that require rehabilitation, protection and development. It will reveal the timetable showing the extent of areas to be developed, and identify responsible institutions that will provide support in the implementation of intervening activities, such as reforestation, afforestation, protection, harvesting and settlers' occupancy. The project will follow an interactive process on the following:

- Data inventory;
- Procurement of hardware, software and satellite imagery of data;
- Installation of hardware and software;
- Methodology and systems formulation at the regional office;
- Provisional stratification using FCD-Mapper;
- Field validation studies;
- Refinement in the regional office based on data collected;
- Training of trainers including implementation of application tests;
- Additional refinement of the operational manual as required;
- Review of each stage culminating in major technical training events, seminars and workshops; and

- Production and reproduction of thematic maps.

The Regional, Provincial and CENRO Forestry Supervisors and Provincial Focal Persons formed part of the FORMS development and installation team. The core team was responsible for collaboration with DENR main office and other related agencies, such as National Mapping and Resource Information Authority (NAMRIA). Additionally, a testing plot was identified where field validation studies and application tests were carried out. These studies and tests were implemented as follows:

- Collection and review of relevant forestry related information covering the study/test sites;
- Ground truthing in some forest types and density classes to check correlation with the provisional stratification using FCD-Mapper;
- Trial studies-cum-training tests on monitoring the change in forest status by means of multi-temporal analysis functions in FCD-Mapper; and
- Follow-up studies/training tests at the same area to verify results of previous application of the methodologies and outcomes of data analysis.

Application tests were conducted in some forest types existing in the region, e.g. mossy, montane dipterocarp, lowland dipterocarp, and coastal mangrove forest. Locations of the ground truthing were decided in consultation with PENRO and CENRO counterparts during field assessment/evaluation trips. The major aspects considered in defining the sites are as follows:

- Accessibility;
- Existence of different forest types, e.g. mossy, montane dipterocarp, lowland dipterocarp, coastal/mangrove sites, plantation forests (private lands), industrial forest plantations (public lands), and community based forest areas;
- Detailed information on the ground related to forest management are available;
- No other critical issues, such as security problem, exist in the sites.

The conduct of ground truthing activities revealed the existence of different forest types and the actual conditions of the forest stands. It also provided information on the existing and available tree species in the area, including the stand density. Moreover, the results of groundtruthing led to decision-making in

selecting appropriate management interventions. In other words, the results of ground verification provided clear direction for the immediate action to be taken through forest restoration and rehabilitation. Likewise, ground validation provided control in the monitoring of interventions conducted over time.

The establishment of RS-based system facilities at the regional and PENR offices provided updated forest density data and immediate action on the monitoring of interventions towards sustainable forest management. The acquisition of FCD technology, GIS and database management through capability building of selected foresters from various PENR and CENR offices made possible the processing and analysis of information at their respective level whereby interpretation of data generated from FCD operation were easily understood and relayed to the public.

The current project provided the DENR management, the public, and local government units with information on the extent of the forest density cover particularly within timberland areas. The degree of concern in establishing more forested areas is prioritized as the forestry scenario had been depicted accurately on the FCD map. At this juncture, it is expected that there will be corresponding and simultaneous actions over the immediate rehabilitation/ restoration of degraded areas in the province and municipalities within the region. On the other hand, timberland areas identified for potential harvesting sites not only for timber but also non-timber forest products (NTFPs) can easily be identified, planned and monitored.

Equally important, the FCD technology was envisioned to generate accurate data/information pertaining to timberland and public land for reconciliation purposes, specifically, the management interventions/actions were identified accordingly to ensure sustainable forest management.

The results of FCD generated maps were used as references for people-oriented forestry activities, e.g. slash-and-burn (*kaingin-making*) agricultural practices in the uplands shown as open areas, as well as the extent of the forest cover can be seen on the maps. Further intrusion into dense forest areas will gradually result in the reduction of forest cover and thereby create periodic catastrophic effects, such as landslide, soil erosion and diminishing tree cover, including wildlife habitat/corridors. With overlaying technique, FCD maps super-imposed with drainage/river network map also provided the appropriate strategies for improved watershed management interventions.

1.1.4 Planned Duration and Overall Costs

The Project Agreement was approved by ITTO on June 1, 2004 and was implemented by the Executing Agency for twenty-four months. However, due to some unfinished activities such as manual of operations production, map production and distribution, technical and completion report writing, the project

was extended for another three (3) months at no cost. The project implemented its activities on time, except for procurement of LANDSAT imageries. Instead, the project procured ASTER satellite data sets covering 2004-2005 period. The 2002 Landsat ETM+ imagery was provided by NAMRIA.

The project was implemented with a total budget of US $443,498.00. ITTO provided a contribution of US$347,118.00 and the amount of US$96,380 was committed by the Government of the Philippines (GOP) through equivalent contribution in kind.

All the expected outputs were completed within the prescribed project implementation period and available budget.

1.2. Project Achievements

1.2.1 Outputs/Specific Objectives Achieved

Based on the approved work plan, the main outputs projected had been achieved and completed to address the intended objectives.

Output 1.1 under Specific Objective number 1 was accomplished such as the implementation of skills development programmes for analysis of RS data, spatial data outputs, and related forestry sector information for personnel from the regional, provincial and community offices of DENR-IV who shall comprise the human resources needed to develop and implement FORMS. These activities were achieved from the Regional and PENRO level through each RS-GIS Focal Person who has been on board performing their respective data processing and systematically producing digital data from RS and GIS outputs.

Output 1.2 that consists of the production of Field Manual of operations for groundtruthing/tree inventory to be used in conjunction with FCD Mapper operations had been completed. This will serve as reference for the field personnel to undertake groundtruthing and inventory as a result of FCD generated map.

Output 1.3 that consists of the Revised Simplified User's Guide for operating FCD Mapper had been achieved. The revised guide had been refined through the results of various training for FCD Mapper.

Specific Objective number 2 is to develop personnel skilled in utilization of RS-based system. This activity was achieved with the conduct of trainings on Basic Remote Sensing (BRS), Forest Canopy Density Mapping (FCDM), Geographic Information System (GIS), Management Information System (MIS) and Computer Literacy. These trainings were participated by Foresters, Engineers and support staff from the Regional Office, Provincial Environment and Natural Resources Office (PENRO), Community Environment and Natural Resources Office (CENRO), Forest Management Bureau (FMB), Department

of Interior and Local Government (DILG) and NAMRIA. With these trainings, Regional and PENRO Foresters now have the capability to process satellite imageries and perform digital mapping. The acquired knowledge is highly relevant as the old forestry data of these offices can be updated and decision-making in managing the remaining forest resources is now doable and systematic.

1.2.2 Contribution to the Achievement of the Development Objectives

The establishment of Remote Sensing and GIS facility at the Regional office triggered great contribution towards the introduction and application of new FCD technology for satellite data processing, interpretation and digital mapping. It also contributed in the decision-making process to achieve sustainable forest management. It also provided information on the extent of the remaining forest and the degree of intervention to be done within areas that are critically degraded and marginalized. The RS-GIS facility also encouraged the various stakeholders, communities, local government units, decision- makers and other institutions on the systematic management of the forest through the provision of continuous services for the present and future generations of Filipinos.

The introduction of FCDM technology in the region provided systematic reference concerning the restoration of forest cover and easy identification of potential areas for harvesting, biodiversity conservation, wildlife habitats suitability and watershed management, among others. It also supported easy monitoring of progress of areas planted/rehabilitated through time.

The availability of FCD maps also synchronized the location where various forest renewal activities can be conducted and prioritized through a timetable, i.e when to start and complete forest afforestation and reforestation activities. With the FCD map data, activities concerning rehabilitation, restoration, watershed management, and other related activities can be easily achieved through a more cost-effective manner.

The awarding of FCD map to LGUs, NGOs, OGAs, and other stakeholders provided new challenges in the establishment of additional areas for rehabilitation, protection, development, and preparation of LGUs' comprehensive land use plans (CLUPs), among others. Moreover, the uploading of the same maps at the DENR CALABARZON website reinforced potential support for forest renewal and other similar activities geared towards sustainable forest management.

1.3 Target Beneficiaries Involvement

The DENR officials, FMB, NAMRIA, DILG, NGOs, and upland communities had been involved in the project implementation. Those directly involved were DENR technical staff, who were responsible in the interpretation of FCD generated maps. Their outputs had been distributed to all LGUs in the preparation of

Comprehensive Land-use Plans (CLUPs) in their respective areas of jurisdiction.

The FCD maps also provided reference points to properly plan, implement and monitor forest restoration, rehabilitation, resource utilization and help settle issues on upland community occupancy. It also encouraged private sectors and other institutions, through collaborative partnership by way of investing or supporting forest areas that require immediate restoration and protection.

The use of FCD maps directly benefited the DENR through a cost-effective way by regulating the degree of rehabilitation measures required in a given area. It also provided information about the projected time to harvest planted trees for wood production. It also specified the wildlife habitats and biodiversity areas that need to be protected/developed.

1.4 Lessons Learned

The main developmental and operational lessons learned from the pilot project implementation are discussed below:

1.4.1 *Developmental Lessons*

1. The introduction of FCD technology in the region made it possible to identify the forest class density areas in a stratified manner. Through this technology, the location of adequate and inadequate forest areas are easily determined and identified. Using thematic mapping, the identification of forest area is systematically done through overlaying themes on land classification whereby public and timberland areas were delineated. On the timberland theme, areas with dense and less dense forest stands were identified and delineated thereby prioritizing potential areas suited for different purposes/ activities, e.g. restoration, rehabilitation, harvesting, biodiversity conservation, wildlife habitat, pasture lease agreement, watershed management, among others.

2. The different benefits derived from FCD technology have provided confidence that sustainable forest management is indeed attainable. For instance, the extent of areas and location of remaining forests provided intervention activities to be done/shared by LGUs and other stakeholders in the rehabilitation, development and management of existing forest areas.

3. FCD technology can be learned even without formal training on remote sensing since it is user friendly with semi-expert system whereby the FCD map output can be easily interpreted as the forest density classes are represented in different shades of color.

4. Immediate decision can be drawn for interventions through more cost-effective ways since the FCD map contains information showing stratified location of the dense and less dense forest areas.

1.4.2 *Operational Lessons*

1. The production and availability of FCD maps in CALABARZON region provide road map in the attainment of sustainable forest management.

2. The RS and GIS facilities established at the regional and provincial offices provide avenue for the continuous operation of monitoring progress of forest development through satellite image analysis and interpretation over time.

3. The use of FCD in the region is sustainable through capability building carried out by staff trained by the project.

4. There is high degree of confidence that forest rehabilitation and restoration can be carried out using the FCD technology.

5. Stakeholders of forest resources now have the same level of understanding and appreciation to simultaneously carry out the areas are to be rehabilitated or not.

6. The LGUs through the FCD map can prepare their CLUPs with precision as they are guided with accurate information.

7. The ground truthing revealed accurate results from FCD as verified on the ground to identify areas for specific purpose and classification.

8. The management of forest land area is comprehensive and systematically arranged since each site identified for a certain purpose is controlled by coordinates or Universal Transverse Mercator (UTM), therefore easy to validate on the ground.

9. The certainty of forest management is secured using the FCD technology as a result of stratified forest areas in different classes had been classified, thus decision making is systematically done.

1.5 Recommendation for Future Projects

After completion of all activities, it is recommended to pursue expanded application in other timber corridor regions of the country in order to institutionalize the FCD application nationwide. The implementation of FCD technology will further strengthen planning, monitoring, enhance formulation of forestry policies and decision-making.

The FCD technology will help streamline and synchronize the gathering and management of important forestry sector data at the national level. It will provide avenue for cooperation and systematic coordination between and among regional, PENR and CENR offices, stakeholders, local government units nationwide due to its data integrity, optimum access rights to all possible users, awareness of the

system and its data content which have been ensured for quick data reference.

Furthermore, national training program should be undertaken for capability building and application of FCD-Mapper technology to develop more skilled personnel responsible for operating and maintaining developed forest monitoring system and its facilities.

There is a need to replicate the establishment of additional plots to conduct further studies concerning ground truthing methodology in relation to FCD technology and to improve existing procedures.

The availability of data bank as a result of FCD generated maps should be ensured, always ready for retrieval in every region of the country to maximize development and conservation of limited forest lands.

Hereunder are the proposed components/activities of the action plan within the framework of FCD technology:

1. Application of FCD technology in other regions of the country to improve the pacing of forest rehabilitation and restoration;

2. Incorporation of the results of FCD data in the Master Plan for Forestry Development (MPFD);

3. Utilization of FCD data by LGUs as reference in the preparation of CLUPs;

4. Provision of updated map for development and interventions;

5. Improvement of technical capability to generate updated forest cover;

6. Improvement of sustainable forest management practices in consultation with LGUs , upland and lowland settlers, NGOs, OGAs, academe and other interested institutions;

7. Formulation of relevant forest policies and institutionalize mechanism to implement SFM;

8. Establish remote sensing and GIS facility in every Regional, PENRO and CENRO offices to facilitate linkaging and centralized data processing, preparation of maps, data storage and filing to keep pace with the changing conditions;

9. Human resource development enhancement nationwide relative to FCD technology as the core FCD team in every region;

10. High level consultation with policy-makers to formulate decisions and policies concerning SFM;

11. Design of a national action plan following FCD results and identification of activities, timetable and needed resources to attain SFM;

12. Initiation of review of the status of developmental forestry projects and establish work plan in the attainment of forest rehabilitation/protection, including biodiversity conservation and wildlife habitat enhancement;

13. As a tool for SFM, determination of possible integration of the coverage and extent of all developmental projects. This will make SFM more practical and cost-effective.

14. Production of a template for all developmental and conservation activities as a result of FCD map. This will systematically identify and synchronize forest areas where to start and when to finish all identified activities in rehabilitation and restoration. Moreover, this system will also provide information where to source various forest products for harvesting and retention;

15. Availability of FCD maps in every municipality as reference in the forest development and conservation. This will provide transparency of information to LGUs, decision-makers and planners resulting in the reliable identification of activities required for forest developmental and conservation activities;

16. Conduct national training for LGUs, private sectors and other interested institutions for application of FCD;

17. Design and formulation of a national database and MIS for generated data from FCD and GIS for government and public reference;

18. Inclusion of FCD data in the National Economic and Development Authority (NEDA) as basis for national planning and budget decision-making;

19. Involvement of the Department of Science and Technology (DOST) in supporting research activities to accelerate scientific results relative to FCD technology;

20. Recommendation for adoption of FCD technology by the NAMRIA for official recording of updated forest density map; and

21. Every DENR Regional and PENRO offices are required to establish their respective groundtruthing plots to promote scientific study on the uniqueness of stand species in different elevations.

The other recommendations include the following:

1. The FCD technology is new to the country and it requires comparative analysis on the ground using other satellite imageries. The absence of scientific studies on this technology is a new challenge thereby a number of researches should be carried out to contribute in the National Code of Forest Harvesting System and Practices in Natural and Plantation Forests;

2. Existing policies should be reviewed following the results of FCD technology to enhance SFM and formulate policies on harvesting without jeopardizing the forest ecosystem;

3. Further studies should be undertaken such as simulated analysis of forest stand both in natural and plantation forest to maximize production of timberland areas in relation to socio-economic factors, e.g. poverty reduction, wealth creation, among others;

4. Marketing strategies as a result of the projected area for harvesting should be designed to maximize income for forestry sector and increase tax collection for the government;

5. Every forest land area should have appropriate uses either for protection, production or conservation to attain maximum contribution in terms of tangible and intangible benefits to the society and government. All these activities should be fully coordinated with all offices and stakeholders concerned with the initiative from the DENR as the responsible office instituting SFM;

6. All current and future programs and activities geared towards SFM should reconcile and attune with the FCD data. This system will harmonize all existing and proposed projects for rehabilitation, restoration, protection, and resource utilization.

Part II: Main Text

2.1 Project Results

2.1.1 Existing Situation at Project Completion

The pilot testing of the project utilizing the unique FCD technology strengthens the capability at the regional level of DENR operations in planning, monitoring, policy formulation and decision-making for sustainable forest management.

The established remote sensing-based system for assessment provides quick, reliable, significant and accurate information, thereby cooperation and systematic coordination among the regional, PENR and CENR offices have been institutionalized, optimum access to all possible users have been facilitated and awareness of the system and its data content have been ensured.

The trainings on Basic Remote Sensing, Forest Canopy Density Mapper, Geographic Information System (GIS), Management Information System (MIS) and Computer Literacy, further enhances capability building on operating and maintaining the developed FORMS project and its facilities.

The manuals produced such as the Refined User-Friendly Guide for FCD Mapper Ver. 2 software and Field Manual on Ground Truthing/Tree Inventory are new references that are important for FCD technology. The Revised User's Guide was a product of step-by-step procedures utilizing FCD software learned through various FCD training. On the other hand, the Field Manual for Ground Truthing/Tree Inventory was a result of the test plot established at Quezon National Park (QPL) demonstrating the step- by-step procedure in conducting field verification. This manual is the first of its kind in the country prescribing procedures on field ground verification using FCD data. The project also conducted tree inventory within the plots established to relate data recorded such as tree height and diameter class to generate data on volume per hectare. However, due to limited budget, preliminary data generated can be used only as initial step in further studies to be conducted in the expanded project.

The project has shown that FCD technology provides quick, reliable, significant and accurate information that are available for planning, monitoring, management, decision-making and policy formulation. There is a cooperation and systematic coordination among the regional, PENR and CENR offices. The project has facilitated awareness on the actual conditions of the remaining forest areas of the region.

The availability of the FCD technology at the CALABARZON region complements the work plans geared towards the systematic restoration and rehabilitation of the upland and lowland areas. It also provide controls in all tenurial instruments issued for forest rehabilitation. The FCD map showed information to all stakeholders indicating the degree of interventions to be done

within degraded land areas. Monitoring of the progress of rehabilitation becomes systematic as FCD provides accurate information on areas that contain forest plantations over time.

On the other hand, the FCD technology can be learned by the DENR personnel at the field operations with the available facility of the project. Likewise, ground verification is easily done due to the availability of trained technical personnel at the PENR and CENR offices, thereby, actual ground status is easily known and controlled. With the availability of actual ground status, map data were updated, and implementation of forestry action plan is attainable. There is also a clear understanding on how to attain serious rehabilitation measures as the DENR management realized that through FCD, sustainable forest management is doable and attainable.

2.1.2 Project Impacts

The project has significantly contributed to the attainment of development objectives which is to promote sustainable management of tropical resources in the Philippines in accordance with ITTO year 2000 objective, through the establishment of a remote sensing-based system for use in the assessment and monitoring of forest resources. Specifically, the following were the impacts of the project:

1. FCD mapping coupled with geographic information system is currently being applied regionwide and it helps provide updated information on the forest canopy density;

2. The DENR management recognized the importance of the FCD technology because it can identify and monitor forest areas for immediate rehabilitation, development and protection;

3. The public and other stakeholders realize the importance of FCD outputs as they identify and locate the areas for harvesting, plantation establishment, development and other forest business ventures without sacrificing the total ecosystem. It can be used as guide in the preparation of CLUPs for LGUs;

4. There is now a clamor for the implementation of FCD nationwide as it will reconcile national forestry data concerning the status of forest cover and its corresponding content/stocking;

5. A Regional Memorandum Order (Region IV CALABARZON) was issued requiring all provincial offices to use FCD maps in the preparation and identification of forest areas prioritized for rehabilitation and restoration.

6. The ground truthing for FCD areas can easily be done following the Field Manual produced by the project;

7. The FCD Mapper Ver. 2 software Manual was refined by the project to make it user-friendly and was tested during the conduct of FCD trainings.

2.1.3 Project Sustainability

The establishment of RS-GIS facility at the regional and PENR offices provides quick, reliable and significant spatial information for planning, monitoring, management, decision-making and policy formulation. Cooperation and systematic coordination among the Regional, PENR and CENR offices have been institutionalized, with data integrity , optimum access rights to all possible users and decision-makers. With the focal persons trained and assigned in the regional and provincial offices, the continuity of the FCD technology supported with GIS operations will be assured.

Due to reliable FCD map, the planning and monitoring of the progress of various forestry activities are systematically done thereby providing a timetable for possible harvesting regime of forest products, and instituting development schemes.

As a result of capability building, there is a continuous operation of the FCD technology. Future training through echo-seminar by the core FCD team is possible to ensure continuity of remote sensing technology for sustainable forest management.

The DENR management, Forestry Field Supervisors, LGUs and other institutions have a common understanding of the status of areas requiring rehabilitation, protection and development, especially with the availability of accurate data and/or information from FCD technology.

The FCD map serves as a yardstick for forest resources development because it utilizes satellite data that provide data/reference on the progress of plantation establishment over time. Moreover, with the identification of dense and light dense forest areas on the map, groundtruthing is easy to apply on the sites that are qualified for rehabilitation or plantation establishment and/or protection through use of GPS.

The FORMS project also strives to do fund sourcing and networking through the provision of training with appropriate service fees on Basic Remote Sensing, FCD and GIS to interested parties and institutions. Such strategy will provide continuing support and maintenance of the FCD, remote sensing and GIS training facility.

2.2. Synthesis of the Analysis

a. Specific objective(s) achievement

The two (2) specific objectives of the project were attained.

b. Outputs

All the seven (7) outputs were achieved.

c. Schedule

There was on time implementation of project activities. While the project ended on June 30, 2006, the project was extended at no cost until December 31, 2006. The additional three-month extension was confined to re-evaluation of FCD data and groundtruthing activities. This activity was time consuming as the plot establishment and tree measurements can only complete four (4) plots (20m x 50m) per day consisting two (2) sub-plots (20m x 20m size).

d. Actual expenditures

Actual expenditures were slightly below as planned.

e. Potential for replication

The current project provided relevant information on the status of existing forest, especially the identification of degraded areas that require restoration or tree enhancement in order to establish a "green" ground cover. The replication of the FCD results is highly recommended in order to prioritize restoration and rehabilitation within marginalized forest sites.

f. Potential for scaling-up

The project has a high potential for expansion into a nationwide coverage to bring about harmonized and updated forest data on areas needing immediate attention for silvicultural treatments. FCD technology is a proven methodology whereby problematic areas are easily identified for restoration and rehabilitation purposes in a more cost-effective manner.

Part III: Conclusions and Recommendations

3.1 Developmental Lessons

1. The implementation of the project provides a mechanism that supports efficient management of forest resources by enabling decision-makers to access information on the actual status of forest conditions in real time.

2. The current data base for decision-making, planning and monitoring are now updated through the establishment of Remote Sensing and GIS facility at the regional and PENR offices. The current technology that the project introduced makes it possible to quickly produce accurate data and other information to keep pace with the current forest condition.

3. The availability of the RS and GIS facility provides a methodology to analyze satellite imageries, and perform on-screen mapping. The effective storage and retrieval of various maps are easily done for forest planning, decision-making, assessment and monitoring of various intervention activities within degraded lands.

4. Requests for reliable data on forest cover are easily responded to and other similar information, such as conditions of watershed areas, status of plantations can be easily responded to; and source of wood products are systematically monitored. There is accurate and transparent information considering the availability of files that can be retrieved by computers thereby strengthening management decision-making and monitoring on the progress of rehabilitation activities.

5. The provision of training to selected Foresters, who served as the FCD core team, provided support in analyzing satellite imageries utilizing the FCD technology that improves data integrity.

6. The preparation of Field Manual for Groundtruthing/Tree Inventory provided insights into the procedures of FCD map data verification on the ground.

7. The revision of FCD Manual following the comments and observations from various FCD Mapper trainings conducted by the FORMS project further refined the FCD processing procedures and became more user-friendly technology.

3.2 Operational Lessons

1. Within the national framework, field operations at the regional and PENR offices are the principal sources of data and information that provides preliminary inputs for decision-making at the regional level, thereby the participation of the PENROs and CENROs in the forest resource monitoring is very essential.

2. The national forestry programs with components, such as watershed management, forest and wildlife conservation and forestland rehabilitation can be drawn using the FCD maps. The socio-economic factors, such as population pressure and alleviation of rural poverty are relevant in the formulation of these programs and manifested by the importance placed on community-based forest management, agro-forestry and income-generation projects. Within this national framework, the regional and PENR offices are responsible for recommending policies, plans and programs proposals, design of projects, and operating standards to promote sustainable forest management. The regional, provincial and municipal DENR offices can make use of the relevant and accurate data from the FCD maps as basis for their planning, decision-making and monitoring.

3. There is a need to expand the application of FCD technology in other regions considering that everybody's concern is to properly manage the remaining forest resources in the interest of the present and future generations of Filipinos.

4. The project focused on the generation of FCD maps and other thematic maps in order to determine the extent of areas for rehabilitation, protection and development.

5. Major players in the restoration of forest density requires the full support of LGUs and other institutions. The availability of FCD map that depict different density classes resolves the issues on where to apply rehabilitation activities in a more cost-effective way.

6. The availability of forest resources is secured because FCD technology used satellite imageries in producing data for the identification and extent of such resources in different density classes.

7. With reliable information that are readily available to monitor the progress of rehabilitation, and the time to harvest planted trees can be easily projected over a prescribed period.

8. The application of FCD technology, as planning and decision-making tool, is a must in all Forestry Field Operations geared towards the attainment of sustainable forest management.

3.3 Conclusions

The following are the conclusions:

1. The FCD technology developed in previous ITTO project is highly applicable in the field operations of Forestry Sector in the Philippines.

2. Utilizing the FCD Mapper Ver. 2 software, the generation of FCD maps can easily be learned and applied by Foresters at the Regional and Provincial offices.

3. The use of satellite imageries through FCD technology provides a reliable data for decision-making, planning, monitoring and development of forest lands.

4. To sustain FCD technology transfer, series of training should be undertaken regularly, such as the following:

   a. Basic Remote Sensing;

   b. Forest Canopy Density Mapper operation;

   c. Geographic Information System (GIS);

   d. Management Information System (MIS); and

   e. Computer Literacy (optional).

5. The FCD technology can be further developed to include ground truthing methodology by conducting further mini-research activities using different equipment and techniques.

6. It is easy to facilitate and encourage forest rehabilitation activities if management and stakeholders were provided with appropriate and reliable information.

3.4 Recommendations Based on Operational Lessons

1. The Forest Resources Monitoring System (FORMS) should form part of the regular activity at the Regional, PENR and CENR offices. Trained staff should be on board in each level and should conduct continuous satellite imagery data analysis using the FCD semi-expert system software supported with other remote sensing and mapping software. The results of the analysis should be provided to the DENR management and other stakeholders for forest planning, management and monitoring purposes.

2. The processed spatial data, including thematic maps should be available for decision-making, planning and monitoring, and policy formulation.

3. To continuously achieve efficient, cost-effective planning and monitoring of forest resources, the FCD technology should be replicated/expanded in other regions of the country.

4. The FCD maps should be used in all forest resources activities, including biodiversity conservation, wildlife habitat protection and development, illegal logging, watershed management and monitoring of forest resources over time.

5. Close coordination with LGUs and upland communities and provision of assistance in the preparation of their CLUPs should be established.

6. The FCD software should be refined and upgraded to attune to available satellite imageries that is being currently used globally.

7. Develop a model for projecting a forest canopy density through FCD map, with a corresponding projected harvestable volume of trees/logs.

8. Continuous training on FCD, Basic Remote Sensing and GIS operation for technical personnel about FCD data interpretations, processing and analysis in anticipation of movement, transfer, and promotion of personnel in the DENR structure must be conducted.

3.5 Recommendations for Future Projects

After completion of all activities, it is recommended that the pilot testing project be expanded to other regions of the country to continually achieve efficient, cost-effective planning and monitoring of forest resources. The expanded application will also help streamline and systematize the gathering and management of important forestry sector data for use in decision-making; and will improve information gathering methods by using satellite imagery analysis software developed by previous ITTO project.

The proposed expansion phase will support logical decision-making, effective policy formulation and well-planned interventions in forest conservation, development and management. Essential for successful implementation of the expanded project is to keep abreast of the changing needs and demands of the people and the environment. This will require a solid platform of information, planning, methodologies, administration, research and development. Likewise, it is crucial to carry out the updated forestry information and/or data to guide decision-making process and to communicate effectively with all concerned stakeholders. Investments in information technology can greatly contribute in a meaningful way to the development of these capabilities.

The implementation of the expanded project will strongly support the MPFD that serve as a national guide for the long-term development of the forestry sector in the Philippines. The results of FCD data can be translated into an action agenda for the country and will provide equitable access for all Filipinos the opportunities to develop and manage the forests and partake benefits derived from it. It also achieves scientific management, conservation and utilization of forest resources by the private sectors and local communities. These can be done through collaborative partnership with the national government to provide on a sustainable basis, forest-based commodities, services and amenities for the public.

Hereunder are the recommended components of the action plan to institutionalize the use of FCDM technology in the country:

1. Enhance FCD Ver. 2 software utilities and institutionalize FCD application at the national and regional offices in timber corridor areas;

2. Conduct briefings, meetings and consultations with top level DENR management, local government units, and other stakeholders concerning the application and use of FCD technology relative to sustainable forest management;

3. Operationalize the use of FCDM and GIS-IT at the national and regional offices in timber corridor areas;

4. Procure and acquire satellite data, including local thematic maps;

5. Acquire hardware and software to generate FCD and thematic map production;

6. Sustain FCDM through capacity building at the national and regional offices in timber corridor areas;

7. Implement forest resources monitoring system at the national and regional offices;

8. Formulate policies as outcomes of updated forest canopy density data;

9. Establish additional ground truthing plots to further validate the results of FCD when intended to be used in other regions of the country;

10. Produce and distribute updated forest density maps of the country;

11. Conduct national workshops to design Field Manual for ground truthing and FCD, including thematic maps; and

12. Conduct national workshops to reconcile forestry resources data through the adoption of the FCD results.

The other recommendations include the following:

1. Further studies for ground truthing activities should be conducted covering different forest types and elevations/altitudes;

2. Establish Remote Sensing facility in every DENR regional office for networking/linkaging as well as for centralized database system for DENR;

3. Similar endeavors of this kind should closely involve the LGUs and other stakeholders considering their expanded role in the management of the forest resources;

4. Remote Sensing and GIS Focal Persons should be trained and designated in every regional office;

5. Technical personnel in the LGUs, OGAs, and private sector should participate in the implementation and processing of data for FCD; and

6. Finally, there should be linkages and networking with the academe in different regions of the country to allow students and faculty members to get involved in FCD and GIS technology as a tool for sustainable forest management.

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