STTA REPORT

Madagascar Eco-Regional Initiatives to Promote Alternatives to Slash-and-Burn Practices (ERI):

DEVELOPMENT PATHWAY TRAINING

Submitted by
Ioana Bouvier
Andrew Watson
DAI

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Acronyms

GIS	Geographic Information Systems
ESRI	Environmental Systems Research Institute
IDRISI	GIS software
GPS	Global Positioning System
ERI	Eco-Regional Initiatives
FTM	Madagascar National Geographic and Hydrographic Agency

DAILY STTA SCHEDULE

Saturday May 7
Arrive in Antananarivo

Monday May 9
Meeting with ERI National Coordinator and GIS Specialists . Inventory of equipment, software, and GIS databases.

Tuesday May 10
Development pathways presentation. Discussion with ERI partners and members of the Eco-regional Alliance.

Wednesday May 11
Development pathways practical discussion

Thursday May 12
Travel to Moramanga. Meeting with ERI staff and discussion on community mapping.

Friday May 13
Travel to Morarano-Gara. Meeting with the Morarano mayor. Travel to the Sahendrana region (Fokontany Ambohibolakely). Data collection in Sahendrana.

Saturday May 14
Data collection in Sahendrana. Mapping of community boundaries.

Monday May 16
Community mapping verification in Sahendrana.

Tuesday May 17
Restitution in Morarano-Gara. Travel to Antananarivo

Wednesday May 18
Development pathways training. Introduction to raster analysis and IDRISI software.

Thursday May 19
Development pathways training. Introduction to raster analysis and IDRISI software.

Friday May 20
Development pathways training. Introduction to raster analysis and IDRISI software.

Saturday May 21

Discussion on criteria development for Morarano priority objectives. Integration of criteria and factor weights.

Monday May 23
Final Discussion on criteria development for Morarano priority objectives.

Tuesday May 24
Map preparation.

Wednesday May 25
Meeting at Morarano-Gara.

Thursday May 26
Training evaluation and map preparation.

Friday May 27
Development pathways presentation for USAID and ERI and Alliance partners.
Travel to U.S.

I. STTA REPORT AND RECOMMENDATIONS

Introduction
The STTA was centered on training ERI staff and key partners in using GIS analysis for planning and decision support. The following discussion provides an overview of the practical applications developed during the training and recommendations for using the development pathways approach to support planning in ERI target communes. The report describes the STTA in the following sections:

Section 1 provides a brief overview of Development Pathways Training;
Section 2 discusses the field-based activities;
Section 3 discusses the practical training, analysis, and map products; and
Section 4 includes recommendations.

Concept: In order for local communities and other stakeholders to engage in better management of natural resources, they must be able to accrue tangible economic benefits from their management activities. They must have the legal right to prepare concise management plans that allow them to exclude outsiders from accessing the resources. They must be able to police the resource and impose penalties on people that do not abide by the established rules and regulations. Most importantly, they have to have the wherewithal to harvest and market the natural products in a manner that is socially equitable and financially rewarding. ERI has adapted the landscape approach to eco-regional conservation and development to address this crucial aspect of sustainable natural resource management.

Promoting development solutions as a way of augmenting rural incomes poses a significant challenge to the parallel objective of ensuring sustainable management of natural resources. It cannot be tackled in a haphazard fashion. The goal is for agricultural and natural resource-based enterprises to become economically viable and environmentally sustainable endeavors for rural communities and their private sector partners. ERI strives to solve this conundrum of how to provide livelihood opportunities while conserving the natural resource base by targeting support to enterprises using an integrated landscape approach.

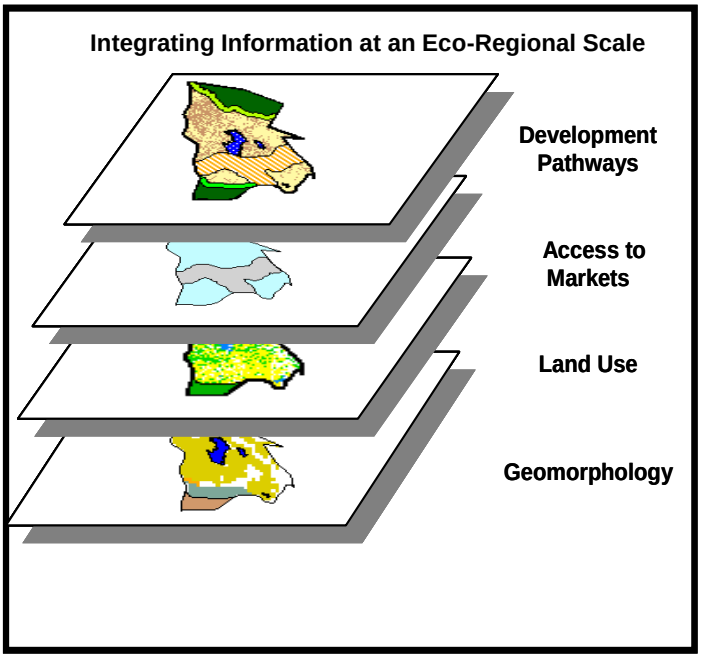
Vision: Conservation efforts in Madagascar have previously focused largely on the forest margins of protected areas as the front lines of biodiversity conservation. Similar approaches have been widely adopted and have proven ineffective because development activities tend to draw people into the area where they are taking place. The approach has failed to address the driving forces behind agricultural encroachment and depletion of natural resources throughout the larger landscapes of the humid forest zone of eastern Madagascar. In many cases, the increased population pressures have had a detrimental impact the natural resource base and biodiversity has declined. An eco-regional approach considers how broader land-use patterns influence biodiversity conservation both inside and outside protected areas. Coordinating development activities at the eco-regional scale addresses critical spatial relationships. For example, it: 1) helps reach consensus on the most promising mix of

activities and locations for achieving conservation and development goals based on resource endowments, land suitability, and access to markets; 2) addresses fragmentation of critical ecosystems, particularly important for conserving biological diversity; and 3) provides a mechanism for addressing upland-lowland linkages and related land-use conflicts within watersheds (such as reduced agricultural productivity caused by soil erosion and nutrient depletion).

Mapping: Within the complex mosaic of land use in the Toamasina and Fianarantsoa eco-regions, there are multiple opportunities for developing the rural economy in an environmentally sound manner, but many intricate variables must be understood. The eco-regional approach is a powerful tool for understanding, designing, introducing, and monitoring appropriate interventions. The methodology integrates the key variables of traditional landscape analysis: geomorphology (the structure of the landscape), prevailing land-use patterns (the current function of that landscape), conservation status and priority, and, critically, market access (the potential for increasing the landscape's value). Combining these elements yields a sharp delineation of the types of enterprise or intervention that makes the most sense and offers the greatest potential: the "development pathway."

ERI's approach employs the technical tools of GIS that allow users to visualize and analyze complex landscape scenarios. These GIS techniques facilitate the orderly and visual management of data that have a spatial character, thereby helping the ERI team, its Alliance partners and USAID plan, implement, and monitor the changes that are being promoted. We have used Geographic Information Systems (GIS) to integrate data on the locations of critical ecosystems, people, threats, resource characteristics, and markets and produce *land-use suitability maps*. In turn, the team will couple these maps with economic analysis and market studies to identify sustainable "development pathways" on a regional scale.

The ERI team has begun mapping different components of the physical and socio-economic landscape. These maps will now be used to target ecologically sound development interventions accordingly.



Identifying Viable Alternatives: ERI landscape planning efforts will be coordinated with USAID and other donors' enterprise and trade development projects to identify activities and commodities with the greatest potential for raising rural incomes and providing an alternative to slash-and-burn agriculture.

Initial discussions with key Alliance and Malagasy Government partners in Antananarivo on May 10th and 11th 2005 came to a consensus that ERI should focus on two principles "development axes": sustainable economic growth and conservation. Based on discussions with regional authorities and local partners in Toamasina (May 12th and 13th) and

Fianarantsoa (May 18th), ERI staff identified three principal development pathways. Guided by landscape planning and competitiveness principles, ERI will apply these to design and target development interventions:

- **Conservation activities** are non-extractive and minimally disruptive. They may include ecotourism, low-impact harvesting of arboreal species (for seeds, medicine, or honey), environmental services (such as water quality control), and scientific or educational functions that depend largely on preservation and conservation.

- **Natural resource-based enterprises (NRBEs)** include sustainable fishing and extraction of timber, non-timber forest products, essential oils, and grasses. NRBEs also encompass certain agroforestry activities and can include household and local processing to add value, such as making hardwood curios. Of particular importance in the ERI eco-regions is promotion of natural woodlots for fuel, timber, food and medicines. ERI also provides support for community-based forest management that provides communities with legal access to valuable timber and non-timber products.

- **Agriculture** includes cultivation of tree crops (for fuel and timber) food crops, horticulture, fruits, spices, fish, seeds, specialty tea, coffee, medicinal species, and nurseries. ERI's emphasis will be on improving on-farm land management practices related to crop selection and soil and water conservation, and promoting agricultural intensification *where appropriate*.

Activities that are likely to transform the landscape in protected and ecologically sensitive areas will only be eligible for ERI support when accompanied by rigorous mitigation measures that help avoid or minimize detrimental impact. Conservation-based activities such as revenue sharing, eco-tourism and limited harvesting of natural resources could also be supported. In other less ecologically critical zones, various natural resourced-based enterprises could be considered, but constraints such as susceptibility to soil erosion or the accessibility of local markets would further refine what activities are appropriate in specific predetermined areas. Similarly, support for agricultural-based enterprises will be limited to geographical areas where opportunities are greatest and environmental risks are lowest.

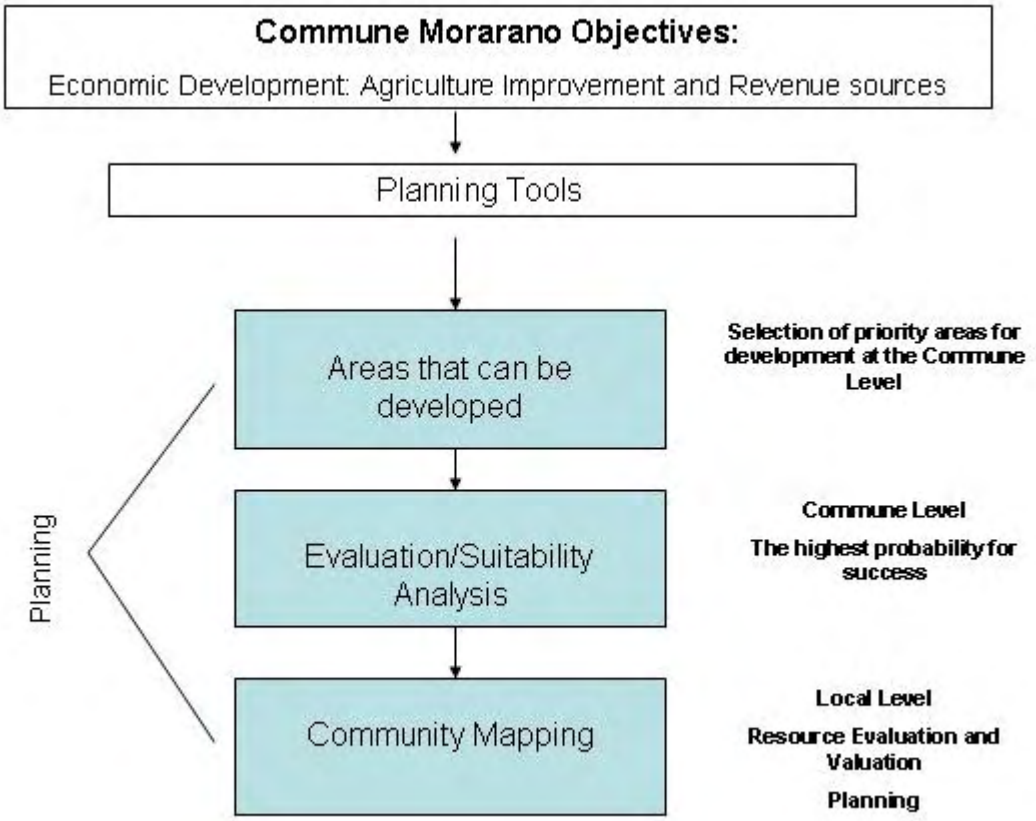
Selecting Project Interventions: ERI support for local and regional planning and implementation activities will be *demand-driven* but subject to clear selection criteria. Principal among these criteria are land suitability and conservation priority. However, rather than focusing exclusively on biodiversity "hot spots," we will identified a mix of locations and activities to demonstrate a variety of replicable models that all play an important role in reducing the depletion of natural resources and loss of biodiversity. The methodology that ERI is implementing incorporates a comprehensive monitoring system that enables us to test this innovative conservation and development hypothesis. By using remote sensing technologies, coupled with ecological and household surveys, the teams will be able to gauge with considerable accuracy and scientific rigor whether the project is having the environmental and socio-economic impact that is anticipated.

In broad terms, conservation activities will be supported within the broader protected area network; NRBEs in marginal landscapes with degraded forests and wetlands but with adequate access to markets; and agriculture on land already under cultivation in non-critical environments with ready access to land, labor and markets. The landscape approach offers a powerful tool to assist in the planning and analysis of natural resource management and

environmental issues at the regional and Commune level. As such, it meshes perfectly with the GIS support provided by ERI, using the same techniques of data acquisition and mapping. Most importantly, it enables the visual presentation of complex data, which greatly facilitates decision making at the regional and local levels. In this regard, ERI's development pathway training targted not only key ERI staff but also engaged regional and regional authorities in briefing sessions and technical discussions. We envisage these authorities using the development pathway approach to make informed spatial planning decisions in consultation with a wide array of local stakeholders. We do not anticipate that these regional and local jurisdictions will have the technical and institutional capacity to meet their own technical needs in this regard in the near term. Hence, the ERI training also target potential service provides that are currently supporting regional planning initiatives.

Section I. ERI Development Pathways Training

The Development pathways approach is a landscape-based method that can assist in land resource planning at multiple levels: national, regional, commune and local level. The approach is participatory, stakeholder-oriented and customized to accommodate the users' planning and decision making needs. The resulting map products are designed to inform the decision-making process. Figure 1, below, represents three different applications of the development pathways approach in a selected Commune. The practical training sessions focused on development pathways applications at the commune and the local level.



1.1 Training

The training was practical and structured in three parts: a field-based activity, a technical training session, and a practical application using the data and information collected during the field trip.

1.2 Participants

The participants to the training included six ERI staff from the two regional offices and five project partners (from CI, CRS, PPRR and CARE). Two participants representing the partners (CARE and PPRR) participated in all training sessions.

1.3 Location: The Morarano Commune Case-Study

The selected location for developing practical applications during training session was the Commune of Morarano-Gara, located in the Toamasina Province, north of the town of Moramanga. The Commune is a target commune for ERI interventions. With an area of over 800 km^2 and a population of about 10,000 people, the Morarano Commune disposes of important land resources and is an important rice producer. The rice agriculture is practiced using traditional farming methods. The main impediments to increasing the rice production appear to be the difficulty in obtaining fertilizers and the lack of capital to invest in water management.

Figure 2. The Commune of Morarano-Gara

Section II. Field-based activities

The main objective of the field-based activity was to identify the spatial products (maps) that can inform decision-making and planning at the local level. This stakeholder-based activity involved a practical community-mapping exercise.

COMMUNITY MAPPING

The village chosen for the community-mapping activity is located in the Sahendrana Basin, in the Fokontany of Ambohibolakely. Initial meetings revealed that the surveyed community lacks the means for estimating and representing their land resources using maps, and there is interest in using simple cartographic products to assist in planning the management of community land resources.

Community land-use mapping is a participatory activity wherein the team works with villagers to represent their knowledge of land resources in the form of a land-use map. During a four-day community-mapping activity, the ERI team conducted discussions with the purpose of identifying the approximate limits of the community territory and the land resource categories. The team also engaged in discussions regarding proposed or needed investments in the community. Figure 2, below, shows community maps drawn on the soil and paper during initial discussions in the village.

Figure 3. Participatory Community Mapping in Sahendrana

GPS equipment was used to mark the limits of the village territory and to map important landmarks and paths. The community area is large and the terrain is relatively difficult (rolling hills, dense rainforest). To address this challenge, the ERI team split into four sub-teams accompanied by local villagers. The teams drove or walked to the northern, eastern and southern boundaries of the Sahendrana community.

A recently acquired satellite image (ASTER VNIR, 15 m resolution) and a Landsat 7 ETM+ scene were used to derive general land cover information. The images are displayed on a computer screen while driving through the landscape. A GPS unit that is plugged into the computer and properly registered with the map was used to display the real-time position on the image. The images were then processed to derive general land categories and to develop vector layers. The primary land use categories include traditional rice paddy agriculture, hillside agriculture, primary forest, savannas and eucalyptus plantations (for wood harvesting). The software application used was IDRISI Kilimanjaro.

The land cover vector layers, GPS tracks and points were integrated in a community boundary map using ESRI's Arcview 3.3 and Arcview 8.1. All maps were formatted and printed in the field using a portable printer.

The printed map was provided to the community the day after collecting the field data to allow for validation of the map information. A verification/validation process is critical to ensure that the community has an opportunity to evaluate the maps and discuss the content. Figure 4, below, shows the Sahendrana villagers engaged in a discussion with the ERI team during the map validation meeting.

Figure 4. Community Mapping Verification in Sahendrana

This was the first time the Sahendrana villagers had seen the representation of their territory on a map. ERI's field agent and specialists mediated the village discussion regarding the limits and land use information. An important part of the discussion was focused on the community boundaries depicted on the map. It was impressed upon the local participants that the limits were unofficial and developed to serve as a general representation of the village territory. Several corrections were made following the verification of village limits. This is

according to the acceptance of community mapping as an iterative process where land use management plans are prepared over the course of several community meetings.

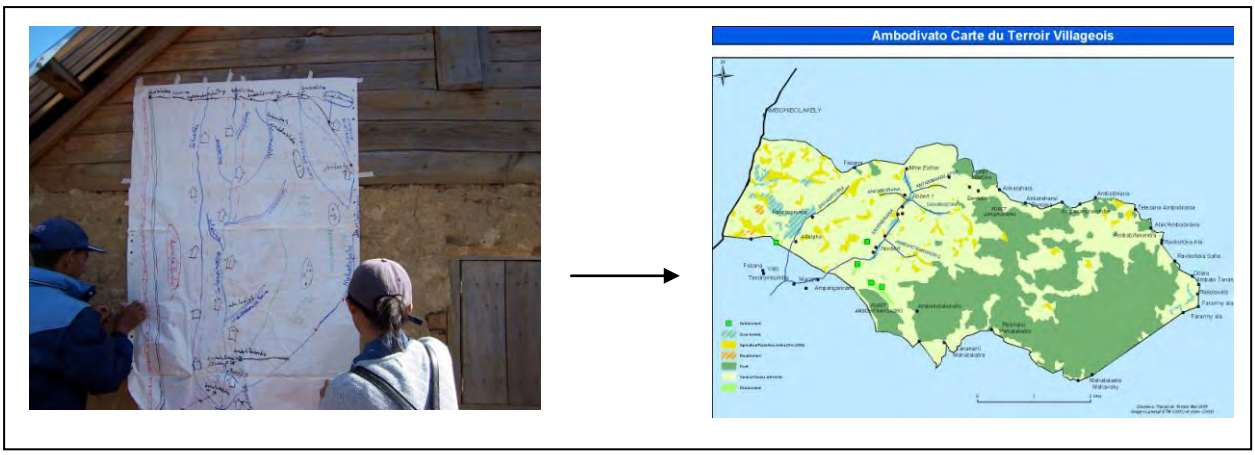


Figure 5. From Hand-Drawn Community Maps to Maps Generated using GIS technologies

The community considered the land-use map product as being useful for requesting and justifying financial support, for land use planning and for proposing investments at the community level rather than at the individual level. Community land-use maps can stimulate discussion within a community and can constitute the basis for community land-use planning and decision making. Figure 5 shows the differences between the initial village community map (left) and the final community map (right).

Section III. Multi-criteria evaluation for Development Pathways

The main objective of the multi-criteria evaluation training session was knowledge transfer for advanced GIS analysis and multi-criteria evaluation. The training was practical and included participatory discussions at the Morarano commune level to identify initial spatial products (maps) that can inform decision-making and planning at the commune level.

Figure 6. Discussing Development Options

3.1 *Commune Level PCD Objectives*

The Sahendrana community map exercise results and findings were presented to the Commune Authorities in a meeting at the Morarano-Gara. Participants included villagers from Sahendrana and Morarano-Gara, the mayor of the commune and local commune authorities. Using the community map as a basis for stimulating discussion on land-use planning, ERI team specialists asked the commune authorities to identify priority commune economic development objectives based on the PCD (Plan Communal de Developpement).

The participants engaged in a discussion about possible limitations and favorable factors to the development towards a particular objective within their commune. The discussion

included the justification for prioritizing an objective, perceived importance in the local economy, and other observations (Figure 6, above, and Figure 7, below).

Catégorie	Type	Pourquoi (raison)	Contraintes	Remarques
Amélioration de l'agriculture	• Riziculture	• Alimentation de base • Commun à la communauté • Existence de terrains vastes • Politique de l'Etat	• Hors forêt • Foncier • 25m de part et d'autre de la vois ferrée	• Zones marécageuses • Ouest du chemin de fer : zone vaste • Gestion de l'eau
	• Culture sur tanety • Arbres fruitiers et agroforesterie	• Type de sol adapté et favorable • Bas de pente	• Zones sableuses sur les pentes et bas de pentes • Rizières • Zones inclus dans les carreaux miniers	• Zone à la lisière de la forêt très favorable • Pluviométrie suffisante
Reboisement	• Eucalyptus • Espèce autochtone • Ravintsara	• Besoins et génération de revenus • Zones dénudées et érodées • Collines, à la lisière de la forêt	• Loin des rizières pour éviter l'assèchement et la dégradation du sol (humus d'Eucalyptus) • Zones encore cultivables	

Figure 7. Priority Objectives

Following the discussion with villagers and commune authorities, the ERI team organized the information related to the priority objectives in a series of Hypotheses that can affect the probability of success for each of the objectives. The Hypotheses are presented in Annex II.

3.2 *TRAINING IN ANTANANARIVO*

The training continued with a technical GIS training session in Antananarivo. This training included an introduction to a raster-based analysis software (IDRISI), fundamentals of raster analysis, Boolean analysis and operations, cartographic modeling, introduction to criteria development and fuzzy factors, multi-criteria evaluation and multi-objective land allocation. The training concluded with a two-day session dedicated to criteria development and multi-criteria evaluation for the selected objectives of the Morarano Commune.

The criteria development session engaged the trainees in a series of participatory discussions in which they used the information collected during the Commune meeting to develop hypotheses, identify criteria and supporting data and develop factors and constraints (Figure 8). The factors were aggregated using a Weighted Linear Combination method. The weights were assigned by the trainees based on knowledge of the objectives and the information communicated by Commune representatives. An explanation on criteria development is provided in Annex II.

3.3 DATA

The following data and information sources were used during the Morarano Multi-criteria evaluation training exercise:

- National land cover database (IEFN database, 1994 - FTM)
- Commune land cover database (Conservation International, 2002)

- Infrastructure (roads, tracks, railroad) developed from the BD100 database (FTM)
- Hydrography (drainages, lakes, wetlands) developed from the BD100 database (FTM)
- Villages and localities developed from the BD100 and BD 500 databases (FTM)
- Information from the PCD and monographs

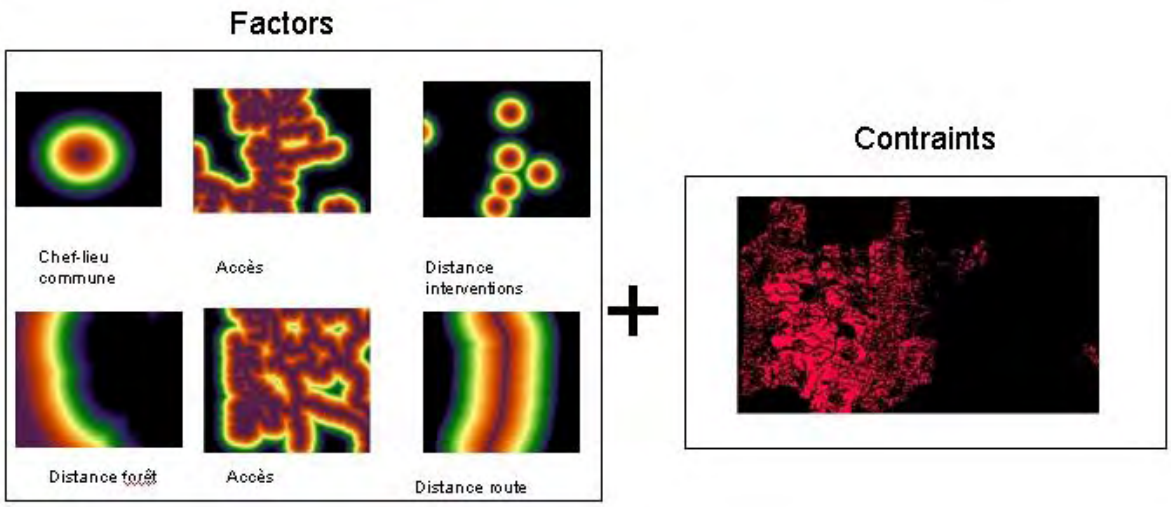


Figure 8. Examples of Factors and Constraints for the Morarano Commune Objectives

3.4 Training Evaluation

A total of six trainees completed an evaluation form. On a 5-point scale from “weak” to “excellent”, three of the trainees considered the final result of the training as “very good”; two considered it “good” and one considered it “excellent”. The training program, schedule and organization was rated as “good” by the majority (five) of the trainees and “medium” by one trainee. The training materials were rated as “”very good” by four trainees and “good” by two of the trainees.

Most of the suggestions and observations of the trainees referred to the need for continuing to practice the skills acquired during training, access to the software and follow-up support from the Bethesda Office. Some of the trainees considered the training period was too short to allow for enough exposure to the software.

3.5 RESULTS AND Map Products

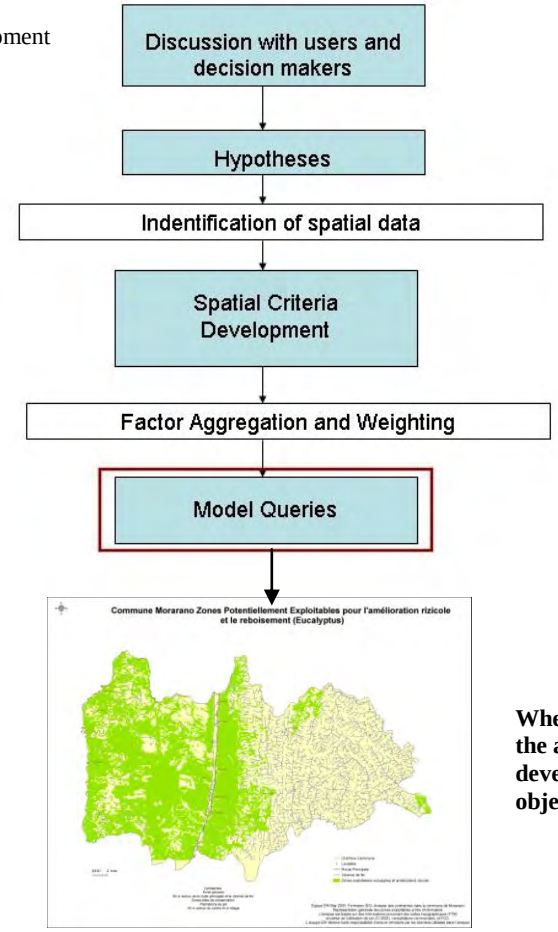
The results of the practical training exercise were presented to the Morarano Commune representatives as map products that are based on the local knowledge and that can inform the decision-making process. During the evaluation, the participants discussed the informative nature of the maps and the potential use of the map products (Figure 9, below). The Commune representatives identified a series of advantages for using these products in the planning process, including:

- The Commune planning document, the PCD, focuses on general Commune development objectives and targets. The development pathways approach offers an opportunity to complement the PCD by developing information products that support the planning and decision making toward a particular objective;

- The map products are easily understood by the Commune representatives and villagers and can be used to communicate information on proposed investments and to stimulate discussion in the Commune;
- The maps can be used in combination with the PCD to attract investors and donors in the Commune and to justify resource allocation.

Figure 9. Morarano Commune Representatives examining Development Pathways Maps

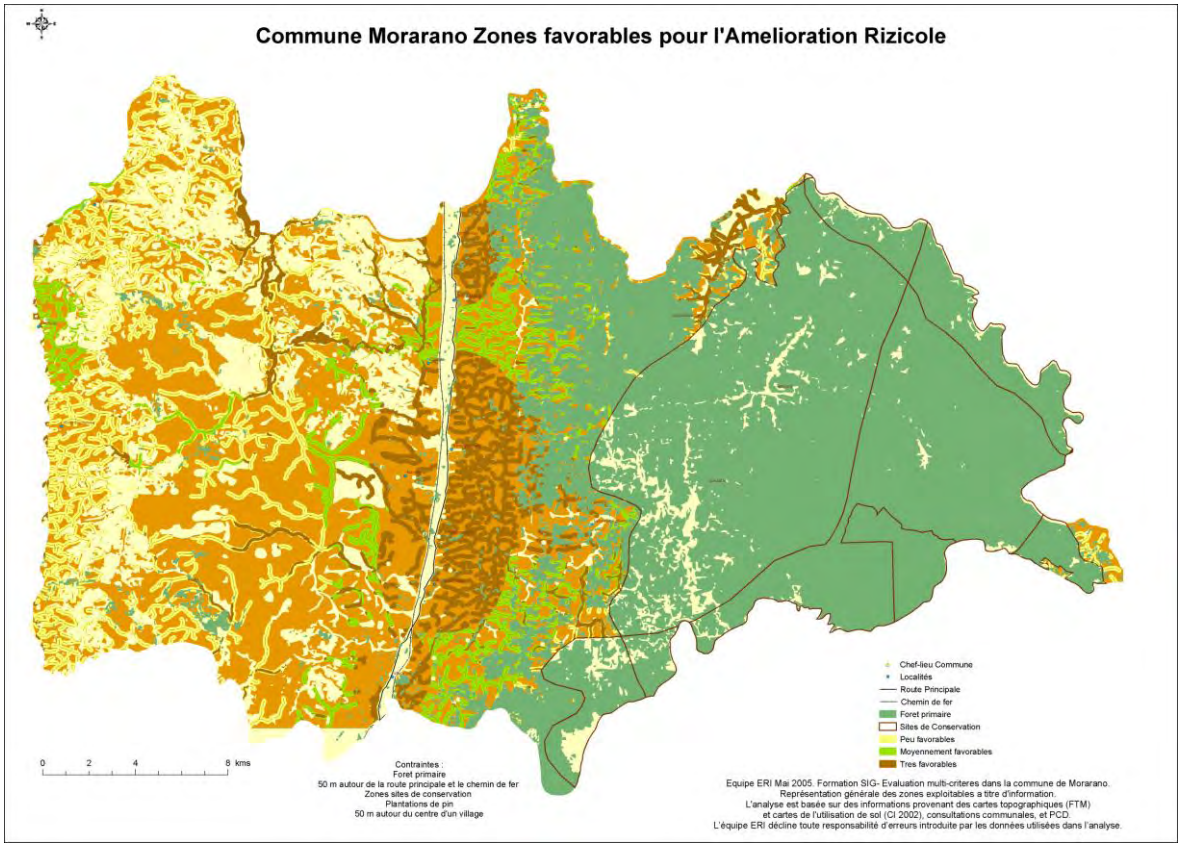
Figure 10. Model Development

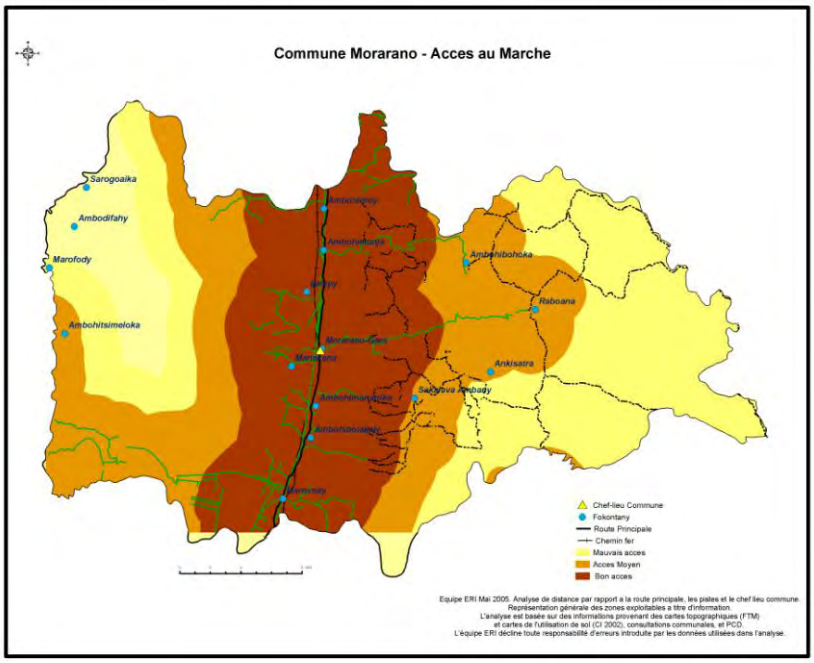


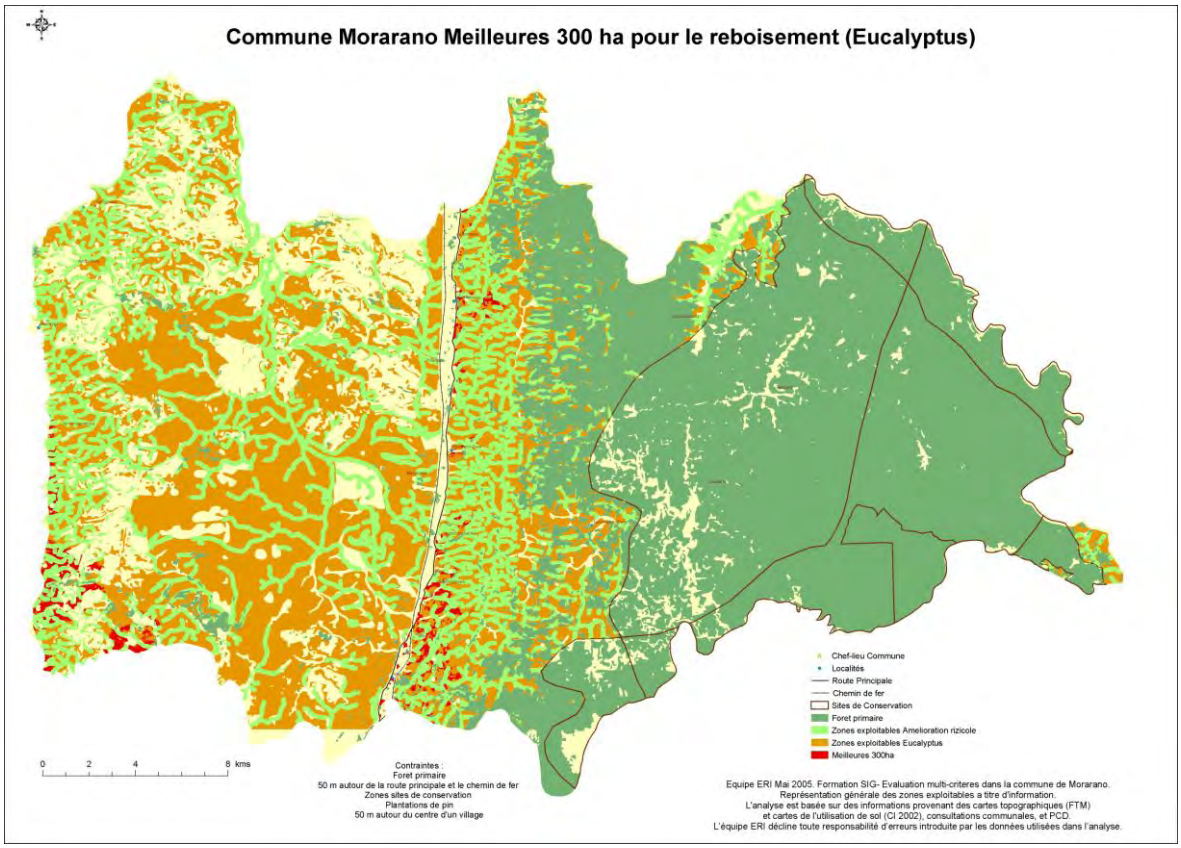
Where in the Commune are the areas favorable to the development of the two objectives located?

The results of the multi-criteria evaluation were described as dynamic products that can be refined to include additional information or to modify the criteria. The map products can be the result of a query that supports the user's need for information. Figure 10, above, shows the steps in the development of a multi-criteria model that can respond to specific planning questions. The example shown responds to a simple question: Where are the Favorable Areas for Development?

Figure 11, series of maps based on the development pathways analysis for the two objectives.







Section 4. RECOMMENDATIONS

COMMUNE LEVEL DEVELOPMENT PATHWAYS

The interest shown by the villagers and representatives of the Morarano Commune in using simple and complex map products that can inform decision making indicates that this activity can be continued in the Morarano Commune and in other target ERI Commune. The Commune representatives and villagers expressed support for continuing this activity, appreciated the value of the spatial information for the development of the Commune and volunteered to help in future data collection exercises if needed. The main concern regarding the continuation of the development pathways activities at the Commune level was related to the need for coordination between ERI and partners conducting activities in the Commune, good understanding of the map products and their potential use, and availability of reliable spatial data**.**

RECOMMENDATIONS

Replicating the Development Pathways Approach in other target Communes: ERI should consider replicating the development pathways exercise in target communes while customizing the analysis and map products to the specific needs and characteristics of each commune. This can be achieved by organizing a series of participatory discussions before and after the analysis is conducted and by underscoring the iterative nature of this process.

Coordination: Commune representatives indicated that there is a need for coordinating donor activities at the Commune level and that the Development Pathways can serve as a platform for integrating partner activities while complementing the PCD. ERI should

encourage a strong coordination between partners working in the same Commune by using map products to engage partners in a discussion and conducting a coordinated spatial data inventory. This can ensure the results of previous studies and mapping exercises conducted by partners are credited and incorporated in the Commune level analysis.

Use of Map Products at the Commune Level: Commune representatives indicated that maps are generally easily understood by a large audience. However, some of the complex map products required a series of explanations before the information was understood by the audience, and the practical use of the products was still being explored. ERI should consider organizing workshops/non-technical training sessions for Commune representatives to familiarize them with the different types of map products, use of the maps to attract and justify investments, and how to include additional queries and customization as needed. ERI should also consider starting with simple maps and supporting the practical use of these maps to complement the PCD objectives. After the initial map products are well understood and actively used at the Commune level, more complex map products (such as complex queries, multiple evaluations, and multiple objectives land allocation) can be introduced and discussed. This will ensure the maps will be used and understood at the commune level.

COMMUNICATION/INFORMATION DISSEMINATION

During the Commune meetings the Commune representatives clearly indicated the need to communicate development pathways results to a large audience in the Commune and beyond. The Commune representatives and villagers enquired about options for distributing printed maps at the Fokontany level and to other agencies - the partners, donors, regional and national authorities, potential investors.

RECOMMENDATION

ERI should consider printing and distributing Commune map products that have been validated. The printed maps should be large-format and used for display in public places throughout the Commune. Ideally, the printed maps should be laminated to resist humidity and day-to-day wear and tear. Additionally, ERI should consider using the Internet to disseminate the validated map products and findings in target communes. Map products can be distributed via the Internet using standard web pages and/or interactive Internet Mapping. An Internet Mapping system can be rapidly deployed and updated to disseminate customized map products and ERI activities, monitor progress and provide information regarding potential investments in the two Eco-Regions to a broader donor and investor base. This could contribute to the overall goal of the ERI program to help stakeholders at the commune and village level to attract investors. Interactive Internet mapping technology offers an effective option to inform prospective donors and to share “success stories” between communes and regions. An online mapping site can also be used for disseminating graphics and information developed during field visits. An example of an Internet Mapping Application can be seen at http://www.primewestuganda.com/GIS.htm

DATA MANAGEMENT AND DEVELOPMENT

One of the most time consuming aspects of GIS-based analysis is represented by data development and management. The Development Pathways exercise represented a good opportunity to conduct a data inventory at the commune level and to identify options for data development and integration.

RECOMMENDATIONS

Data inventory recommendation: ERI should consider conducting a needs assessment and data inventory in each commune to identify spatial information that can be used to develop spatial criteria for an objective. This can be done during initial consultations/discussions where project partners participate. In case spatial databases are not readily available, ERI should identify options for acquiring base map datasets already developed. For the Morarano Commune case, the FTM BD100 was identified as the most complete spatial dataset available. The BD 100 can be used by all partners to develop applications in a commune. ERI should develop a customized dataset for each target commune to include the results of previous mapping exercises.

Data development recommendation: In cases when data are not available but are needed in the analysis, ERI should consider options for data development and/or use existing data while recommending a data development activity. This is particularly true in the case of land use/land cover information which appears to be rarely developed and validated at the commune level. Involving partners in preliminary commune discussions can lead to the identification of previously unknown spatial datasets. ERI should conduct field-based GPS data collection as a means to correct and integrate different datasets. In case up-to-date reliable land-cover information is not available, the ERI team should consider options such as developing data in-house following a practical training for satellite image processing (time permitting) and/or contracting this activity.

TRAINING AND CAPACITY BUILDING

Staff in both ERI regional offices is actively engaged and interested in using GIS and spatial analysis to support planning and decision-making at the commune level. ERI has two full-time well-qualified members of staff tasked with developing and maintaining the ERI GIS databases and with developing maps and applications that support project planning and monitoring. In addition to the two specialists, technical staff in both of the regional offices participated in the Development Pathways training and demonstrated a good understanding and knowledge of GIS applications.

Some of the trainees' feedback in the training evaluation referred to the fact that the training should have been longer to include more time for practical exercises. Some trainees considered this would have given them more of an opportunity for applying the skills and becoming more familiar with the software.

RECOMMENDATIONS

Continuity: ERI technical specialists that participated in the training should continue to use practical applications and tutorial exercises provided with the IDRISI packages to become familiar with the software and raster GIS analysis. ERI should also consider purchasing two additional IDRISI licenses that can be installed in the two regional offices (in addition to the two licenses purchased for the two GIS specialists). This would allow the technical staff in the two offices to practice the applications covered during the training session.

Follow-up training: ERI should consider providing additional training for the GIS specialists in advanced raster GIS, image processing, and data modeling. Gradually adding through a training process advanced raster GIS analysis, image processing and web-based

GIS development skills to the existing ERI GIS capacity can ensure local advanced data development and modeling skills that can be sustained beyond the life-cycle of ERI.

COORDINATE SYSTEM

Currently all mapping in Madagascar is done using a custom local projection – Laborde Madagascar, which is a Oblique Mercator Projection. This requires a coordinate conversion for all data collected using a GPS. Additionally, satellite imagery (raster data) acquired for the purposes of data development or display (using a different datum) cannot be readily integrated with the local spatial datasets. The raster analysis software (IDRISI) does not support the Oblique Mercator Projection (used for the Laborde system). Several data conversion applications were tested to allow for data integration. The point coordinate conversion (COMAD) is the most commonly used to convert GPS coordinates.

RECOMMENDATION

Ideally the ERI team should use conversion tools that can allow for projection change while introducing non errors or minimal errors. The test using conversion tools showed that the conversion using the COMAD (point coordinate conversion) introduces a small error while the ESRI conversion tool using the equivalent Hotine Oblique Mercator projection (polygon and line conversion) introduces a significant error. No conversion tool was tested for re-projecting raster data into the Laborde Madagascar projection. Since the errors may easily multiplicate during the analysis, special care is needed when converting and integrating polygon and line vector features in a different projection (such as UTM) with features in Laborde Madagascar projection. It should be noted that the Laborde projection is considered appropriate for large-scale (national and regional) mapping as it minimizes distortions for regions which have a large extent in one direction but limited extent in the perpendicular direction and whose trend is oblique to the bisecting meridian which is the case of Madagascar).

A few options are available:

1. Using only the UTM coordinate system for all commune-level mapping. However, the importance of data exchange and sharing with the partners and agencies may determine the use of the Laborde projection for final map products.

2. Using a UTM grid for the raster-based analysis only (in IDRISI) and integrating the data layers in a common Laborde system using a tool such as Blue Marble's Geographic Transformer (this application will be tested in the DAI Bethesda Office).

Additionally, given the many inconsistencies discovered between the data layers from FTM, CI and other agencies for the case of the Morarano Commune, it is recommended that all data layers to be used in the analysis are first checked and corrected (co-registered) by the ERI team as needed using as reference ground control points and tracks (collected in the field using GPS).

Conclusion

Interest is expected to rise for the use of spatial information and resulting map products that can support decision making and planning at the commune and regional level.

Overall, it is anticipated that spatial analysis using a development pathways approach and the resulting map products will serve as a useful tool for supporting decision making and planning at the commune level and for promoting information exchange and communication in the two Eco-Regions.

Development pathway mapping will assist ERI target its activities and customize its interventions in order to maximize results and impact. This approach to spatial planning can be readily adopted by local jurisdictions and can help them move toward an “asset-based” approach to development that treats natural resources as economic opportunities rather than “problems” that need to be mitigated. Most importantly, the pathway maps are an important baseline for Commune planning, which enables rural communities work with local and regional authorities to identify natural resources to which they have access and develop appropriate management plans that enable wealth creation from the sustainable utilization of the resources.

This approach to spatial planning within the context of natural resource management and agriculture development will help channel scarce resources to activities and locations where they are most likely to succeed and achieve sustainable impact. The approach can be used as a springboard for applying "appreciative" techniques when working with local jurisdictions and rural communities. Community mapping then follows as a natural next step for identifying local assets in a fully inclusive and participatory manner. These approaches help build consensus for tailoring interventions that will improve natural resource management in an environmentally, economically and socially sustainable manner.

ANNEX I. SCOPE OF WORK

Eco-regional planning and monitoring tool

Background

The objective of the Eco-Regional Initiatives (ERI) program is to conserve biologically diverse forest ecosystems via agricultural intensification and diversification and improved natural resources management. The program is composed of five results modules:

- An eco-regional approach to conservation and development is adopted and implemented by multiple actors in priority eco-regions,
- Community-based management of natural resources is improved and expands to protect the forest corridor,
- Profitable and environmentally sound farming systems replace slash and burn agriculture at a landscape scale,
- Rural associations achieve financial and organizational sustainability and become effective advocates for local concerns, and
- Strategic communication, education and outreach lead to widespread behavior change.

ERI is the keystone of USAID Madagascar's rural development and environment program.

The program operates in two key eco-regions or landscapes in eastern Madagascar: the Mantadia-Zahamena landscape located in the Province of Toamasina and the Ranomafana-Andringitra landscape located in the Province of Fianarantsoa. At the heart of both of these landscapes, stretching from north to south lays a corridor of natural forest. The main threat to this biologically-rich forest is an extensive shifting cultivation system known locally as *tavy*. Local communities and farmers who practice this type of agriculture are thus the main clients of the ERI program.

Eco-regional conservation and development is an approach to resource management and planning that incorporates an understanding of the ecological, social, and economic consequences of changes in landscapes within an eco-region. Landscapes are heterogeneous mosaics of habitats and land use practices. Within these landscapes, the forest corridors, including protected areas, are the backbone of the USAID eco-regions where ERI will promote sustainable land use in collaboration with the local population. The eco-regional approach recognizes the importance of Madagascar's biological resources within and outside of the protected area network. If surrounding areas are poorly managed or neglected, protected areas will become increasingly geographically isolated, interrupting gene-flow and endangering the capacity to sustain critical biodiversity. At the same time, water quality and availability will decrease, while vulnerability to erosion, flooding, landslides and other effects of severe weather may increase. The end result will be a downward spiral of increasing vulnerability and impoverishment of both local communities and the resource base on which they rely. Success in biodiversity conservation is highly dependent upon improving the management of protected areas and forests <u>and</u> upon addressing the economic pressures on these ecosystems from neighboring communities.

The ERI program will support USAID's simultaneous strategy to safeguard Madagascar's unique biological resources, and to improve rural livelihoods at the eco-regional scale. This

will be done by encouraging local populations to transform rural production and natural resource management systems to achieve short-term and medium-term results, while laying the foundations for long-term sustainability. This program builds directly upon the efforts of several additional current and past USAID programs, and is closely integrated with other components of USAID's support to the Madagascar EP3.

There are multiple opportunities for improving the rural economy and land uses, but many intricate variables must be understood. The landscape approach is a powerful tool for understanding, designing, introducing, and monitoring appropriate interventions. The methodology integrates the key variables of traditional landscape analysis: geomorphology (the structure of the landscape), prevailing land-use patterns (the current function of that landscape), and, critically, market access (the potential for increasing the landscape's value). The spatial data product provides critical information to decisions makers regarding where to allocate project resources where the potential for success is highest. Combining these elements in a model yields delineation of the types of enterprise or intervention that makes the most sense and offers the greatest potential: the "Development Pathway."

As the ERI Program has launched its implementation phase, it is vital that these development pathways are clearly elucidated and that the spatial data are established that will help ERI and different regional development actors (Alliance members, autorités des Régions etc.) target their interventions including developing community maps that help stakeholders to inventory and valuate their land resources, a critical step in land use management planning. Linked to this effort, the baseline maps will serve the additional purpose of establishing elements of the monitoring baseline that will be used to gauge the impact of ERI activities on the natural resource base and the rural economy.

JUSTIFICATION

The development pathways maps will help to identify areas of priority based on ERI objectives on a larger scale. A landscape-based approach offers a powerful tool to assist in the planning and analysis of natural resource management and environmental issues at the Regional, Commune and local level. At the local level, community based natural resource management is a stakeholder-based activity. Community mapping empowers the stakeholder with knowledge of the shape/area of their collective land holdings, the land cover resources that are contained within this area (the community associates land use with its land cover during validation exercises). Knowing how much land is there, what is on it and where it is located is critical for land use management planning - a key activity in CBNRM activities.

Community mapping approach:

A community mapping exercise provides a unique opportunity for general training in techniques that are applicable to land cover mapping and community mapping. DAI's approach to community is a variant of the traditional PRA mapping methods, different in that it merges local knowledge of land holdings with modern spatial technologies including:

> Community sketch mapping (to gain understand of community knowledge of land holdings. This step is critical as this community sketch map is used plan logistics for a GPS survey of key community perimeter points.
>
> GPS survey will derive the key perimeter points of community land holdings from which a polygon will be drawn. Traveling to these points and mapping them is joint activity with village community members and ERI technical specialists.
>
> Satellite image interpretation (to derive community specific land cover). Training here will involve clipping the satellite image with the community area polygon. Land

cover for the community will be grouped into main categories using basic satellite image processing techniques. If there are smaller villages - the location of these might be mapped with a GPS and the villages may be grouped into a larger unit for mapping purposes.

Data Integration: Integration of satellite image derived community land cover, terrain data, GPS (perimeter points, tracks, other important mapped features such as leaders home, water taps, etc.) and other tabular data if available (project survey data, census data, education data etc...) to generate a comprehensive map that can be used for community based land use management planning aimed at boosting local economy while conserving bio-diversity. These maps can also be used to inform the client regarding strategies that ERI is deploying to satisfy project objectives. This approach has been utilized very successfully by DAI in Mozambique, Uganda, South Africa, and Madagascar.

Data validation: at the local level, existing landcover maps can be validated and new landcover maps can be generated to serve as the basis for land use management plans.

Discussion on how to help the decisions makers to use the results from these activities to make decisions.

OBJECTIVES

Main objectives for this consultancy are:

– To provide training to ERI staff and key partners on data integration and using GIS tools for planning and project decision support (i.e., using development pathways approach for allocating project resources).

– To train ERI staff and key partners in practical techniques for developing local (community) land use management plans, including spatial and tabular data integration, GPS survey, terrain modeling if deemed necessary, introductory satellite image processing. This training activity is field-based.

– To prepare a brief report that describes level of participant capacity, assessment of ERI community mapping, recommendations.

EXPECTED RESULTS

– A general understanding of the landscape and community mapping approach and potential at various levels: (a) among communal mayors and their teams, (b) among Regional decision-makers, (c) among ERI program partners (especially USAID Alliance members), and (d) among ERI staff

– A cadre of ERI technical staff and key partners capable of guiding non-technical users to adopt development pathways and community map results for commune and local communities level decision support (i.e., the data products are not intended to make decisions - they inform the discussion).

– A cadre of ERI technical staff and key partners with an exposure to spatial data integration using a landscape approach for regional and local planning.

LEVEL OF EFFORT

The level of effort is estimated at 25 days, which comprise:

5 days for preparation of training materials and data preparation in the DAI Bethesda office;

20 days in Madagascar, including travel.

WORK SCHEDULE (in Madagascar) (May 6 - May 29)

1. Travel to Madagascar (Days 1-2). **May 7-8**

2. Present series of options to the decision makers (examples of Development Pathways, Suitability Analysis and Community mapping). Ensuing discussion will determine how to approach this mapping effort and associated training, after which the SOW will be reviewed and possibly modified.

Assist in the integration and assessment of spatial data, and review the likely scope of ERI interventions in the two regions. Help develop criteria for the selection of one or two priority Commune. The data assessment will be conducted in coordination with the development of criteria for development pathways. In case existing data is deemed not appropriate for developing some of the criteria, explore options for data development, integration and validation (Days 3-5 in Antananarivo). **May 9-11**

3. Train ERI technical staff and key actors. The training will be practical:

a. Conduct a practical community mapping training exercise at the village level in a selected commune (probably one of the communities in the Morarano Commune, Toamasina Region) (Field training, Days 6-9). **May 12-16.**

b. Conduct training in ground control points collection and data validation in the selected commune (Field based, Days 10-11). **May 17-18**

c. Participate in meetings with key partners to discuss the ERI approach and the benefits to regional planning as well as the role of local institutions. Time permitting - conduct a second community mapping practical training in a community located in the second Ecoregion (probably in the Tolongoina and Alatisinany-Ialamarin area, Fianarantsoa region) (Field-based, Days 12-15). **May 19-22**

4. Review map results with ERI team members and other key partners. (Day 16-17). **May 23-24**

5. Help integrate data and draft landscape maps for priority Communes (one in each Eco-region) (Antananarivo, Days 18-19). **May 24-25**. **Note: this assumes that landcover map information specific to ERI objectives is available (as determined in the preliminary discussion)**

6. Travel from Madagascar (Day 20). **May 26**

Total number of **25** days will be necessary for this technical assistance (5 days preparatory time and 20 days in-country including travel time), but supplementary fieldwork, maintaining and updating the spatial databases, Commune-level and regional mapping, community mapping activities, and creating development pathways for the whole eco-regions (Toamasina and Fianarantsoa) will require the involvement of a permanent team, composed of ERI technicians from Alliance members and regional actors.

This assignment will be conducted in coordination with a second short-term technical assistance that will focus on establishing the "development pathway" conceptual framework and building the hierarchy of spatial data themes that will be used to construct the pathway maps.

ASSUMPTIONS

Land cover: Developing the land cover maps based on satellite image analysis is a very time intensive process, requiring detailed/on-going field work to insure that the map has an acceptable degree of accuracy for planning purposes. If the data inventory shows that up-dated land cover maps do not currently exist, we can propose a framework to create this map. Training field staff to conduct GPS surveys that are aimed at identifying the various land classes that an automated algorithm can generate will require time. The team will need to have support that allows them to travel to various land cover types identified by the automated process and label these land cover type with an appropriate land classification. As the team develops expertise in identifying key land cover categories, the pieces that comprise the classification land cover map will slowly be integrated with confidence. The resultant maps will be validated independently to determine the degree of confidence to which they can be applied for planning.

Training

- There is a budget for GPS units, field laptops and a portable printer.
- There is a budget for image processing software if any of the training activities are to be applied (capacity building versus training). We usually work with IDRISI Kilimanjaro.
- To generate positive synergy, a site must be chosen based on the probability for success. Enough time must be reserved to ensure full understanding and to generate community feedback.
- Training in Satellite image processing is introductory only. (On-going training will be required to build-capacity in this technical area)

DELIVERABLES

a) Brief training report;

b) Commune/Community land use management map;

c) Data integration to support the development pathways approach;

b) Training materials and guide for community mapping and data integration pertaining to development pathways approach.

QUALIFICATIONS

The short-term technical assistant should be thoroughly familiar with eco-regional and landscape approaches to conservation and development. He/she should be able to use satellite imagery and other data sources to develop and integrate spatial data in a GIS. He/she should be familiar with the techniques and tools required for community mapping.

ANNEX II. CRITERIA DEVELOPMENT

OBJECTIF : REBOISEMENT (EUCALYPTUS)

Raisons
Source de revenue
Pousse assez vite
Besoin de bois pour construction et énergie
Opportunités de financement pour le reboisement d'eucalyptus (favorable)
Diversité des produits dérives comme source de revenue

Hypotheses

- Pas d'eucalyptus dans la foret primaire
- Pas d'eucalyptus dans les rizières (bas-fonds et bas-pentes)
- Eucalyptus sur les hautes pentes (sommets des collines)
- Eucalyptus dans le domaine savane
- Chemin de fer – pas de reboisement près de la voie
- Aires protégées – pas d'eucalyptus
- Zones de conservation strictes– pas d'eucalyptus
- Type de sol – pauvre sol «favorable » pour l'eucalyptus
- C'est mieux de s'éloigner de foret
- Distance par rapport au village – plus près du village plus grande potentialité

- L'Expérience des villageois dans le reboisement peut s'avérer importante
- Moyens financières – limitent le potentiel pour reboisement?
- L'accès dans les villages limitent le potentiel pour reboisement
- L'utilisation du charbon comme source suplementaire de revenue – information/famille/FKT
- Le manque d'information et l'aspect complexe (au niveau local) du foncier ne permet pas son intégration dans l'analyse
- L'analyse traite seulement les zones de reboisement dans l'ensemble de la commune de Morarano (pas de différentiation entre les zones favorables au reboisement individuel ou communautaire)
- L'analyse va aider/guider les décideurs pour la prise de décision

Données

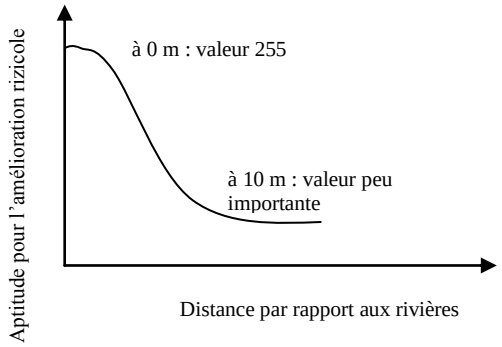
- Utilisation sol (iefn 1994, CI 2002)
- Chemin de fer
- Routes
- Pistes (avec l'état des pistes)
- Hydrographie
- Sites de conservation
- Aires protégées
- Données au niveau de FKT (monographies, études)

OBJECTIF : AMELIORATION RIZICOLE

FACTEURS

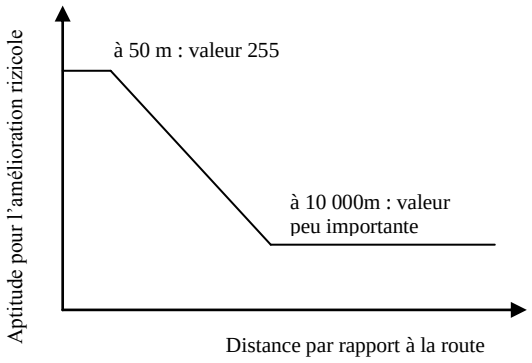
1. distance par rapport aux rivières
2. zones des marais
3. distance par rapport à la route principale
4. distance par rapport aux sentiers
5. distance par rapport au chef lieu de commune
6. présence des organismes dans les fokontany

1. Distance par rapport aux rivières

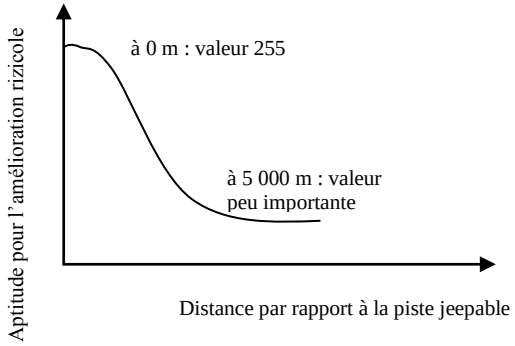


2. Zones hydro, marais et étangs, hydro zonales : valeurs 255

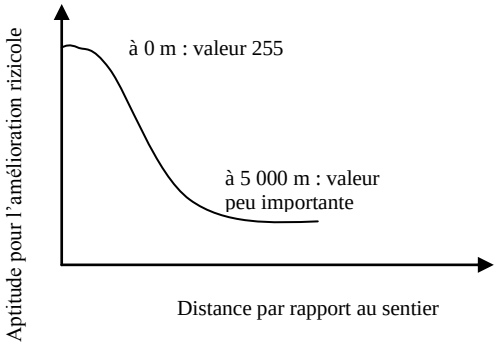
3. Route Principale :



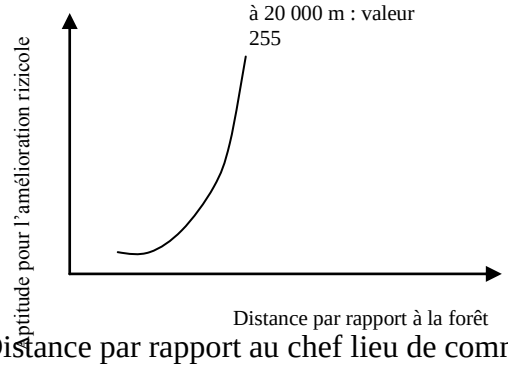
4. Piste jeepable



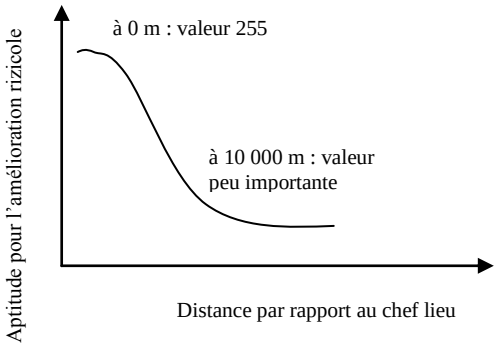
5. Sentiers



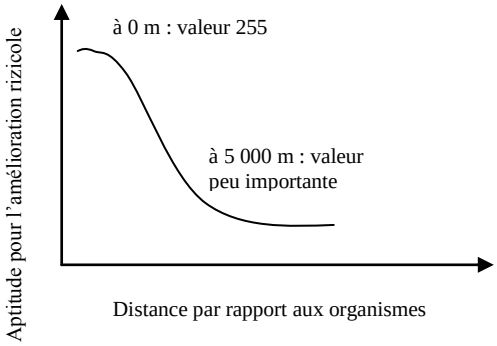
6. Forêt naturelle



7. Distance par rapport au chef lieu de commune (Morarano



8. Distance par rapport aux organismes

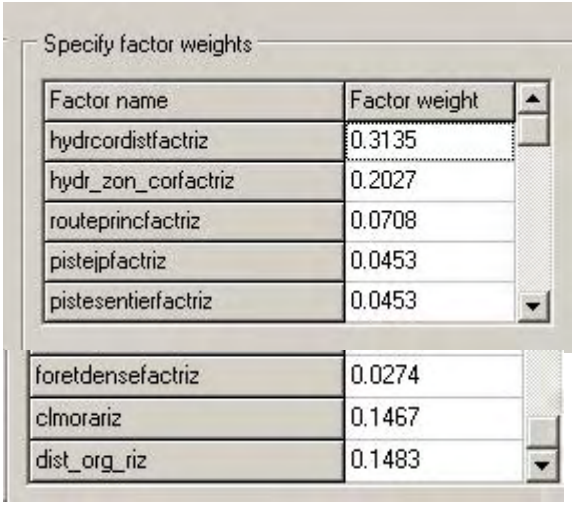


9. Contraintes pédologiques : les sols favorables le sont de moins en moins de l'Ouest vers l'Est

Pondération:

1. Hydro bas-fonds

2. Hydro zonale
3. Distance chef lieu de commune
4. Distance organismes
5. Route
6. Piste
7. Sentier
8. Forêt



Specify factor weights

Factor name	Factor weight
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hydr_zon_corfactriz	0.2027
routeprincfactriz	0.0708
pistejpfactriz	0.0453
pistesentierfactriz	0.0453
foretdensefactriz	0.0274
clmorariz	0.1467
dist_org_riz	0.1483