DYNAMIC MINERAL RESOURCES MANAGEMENT: ANOSY CASE STUDY

World Bank Oil, Gas, and Mining Policy Division

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Imagine a country or continent having an abundant mineral endowment, much of it far from ports and existing infrastructure. If the mineral endowment was properly estimated, the potential economic contributions from these resources across time could be used to strengthen policies to fight poverty. However, few of these mineral resources are likely to become viable mines without improved infrastructure. As such "mineral resource corridors" are more useful in defining prospective resource areas linked by possible multiple-use infrastructure. The use of mineral resource corridors requires a holistic consideration of the potential contribution of alternative land-use activities that could be stimulated and the corresponding impacts on ecosystems, biodiversity, socio-economic factors, and other natural processes. The proposed World Bank's Dynamic Mineral Resources Management system approach provides for holistic integration of mineral potential and infrastructure development, and the corresponding impacts of the two on the systems around them.

BACKGROUND

The World Bank's Oil, Gas, Mining and Chemicals Department provide policy advice to governments worldwide on one of the most globally recognized issues – the development of mineral resources. Dynamic Mineral Resources Management describes the conceptual foundations of an approach being tested by the World Bank staff to better estimate the potential for mineral resources to contribute to the fight against poverty. Countries have widely

Resource development decisions made today will impact a society for generations to come. Accordingly, developing nations require sound resource policies to strengthen sector governance and enable economic growth. Establishing these policies requires an understanding of the quantity and quality of the region's mineral endowment, the commercial viability of that endowment, and expectations for across-time future mineral production and its economic benefits.

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cited the need for infrastructure to link more remote regions to markets, social services, and security. With an improved understanding of the underlying mineral endowment, estimates of the potential contribution across time can better inform development policies and lead to strategic investments that may include infrastructure.

The proposed mineral resource assessment approach, being developed by World Bank staff, estimates the quantity and quality of underlying mineral resources, and the economic potential of these resources taking into account alternative regional economic development planning. The approach is holistic in employing a landscape planning approach to consider the impacts of mining and infrastructure on the natural and socio-economic systems that surround these activities:

- Alternative land-uses that include agriculture, tourism, open space, transportation corridors, industrial / commercial, sources of building materials, energy and fuel resources, hunting, and other traditional land-uses;
- Hydrogeologic resource assessments that include stream flow, water quality, precipitation and recharge;
- Ecological assessments that include vegetation, climate, conservation, habitation, and zones of unique biodiversity;
- Socioeconomic assessments that include population, transportation and migration routes, community development;
- Natural processes assessment that includes possible changes as a result of anthropogenic or natural causes;
- Stress factors affecting systems, such as water in arid landscapes

Contributions Across Time

It is often said that "… mines are made, not discovered". That is to say, prospective mineral resources undergo an economic translation to commercially viable mines under more favorable prices, improved technologies, and / or the availability of infrastructure to link remote resources to markets. Early mining development in a region typically requires large investment requirements relating to physical infrastructure (roads, rail, ports, power), which increases the overall cost of production. Generally, only a small subset of the mineral endowment would be immediately economic – perhaps the largest and richest deposit or even lesser quality deposits that are located more favorably to infrastructure. With the improvement or introduction of new infrastructure, a percentage of the mineral endowment economically translates into commercially viable mines. Thus, the contribution of mineral wealth is across time and the assessment of mineral resources is "dynamic" in a progression from:

- The underlying *mineral endowment* in a region
- The resulting *mineral resource potential* given current economic conditions
- Different estimates of *mineral resource potential* based on alternative *infrastructure development* scenarios
- Potential sector contributions to national and regional accounts from government policies that support infrastructure and regional development.

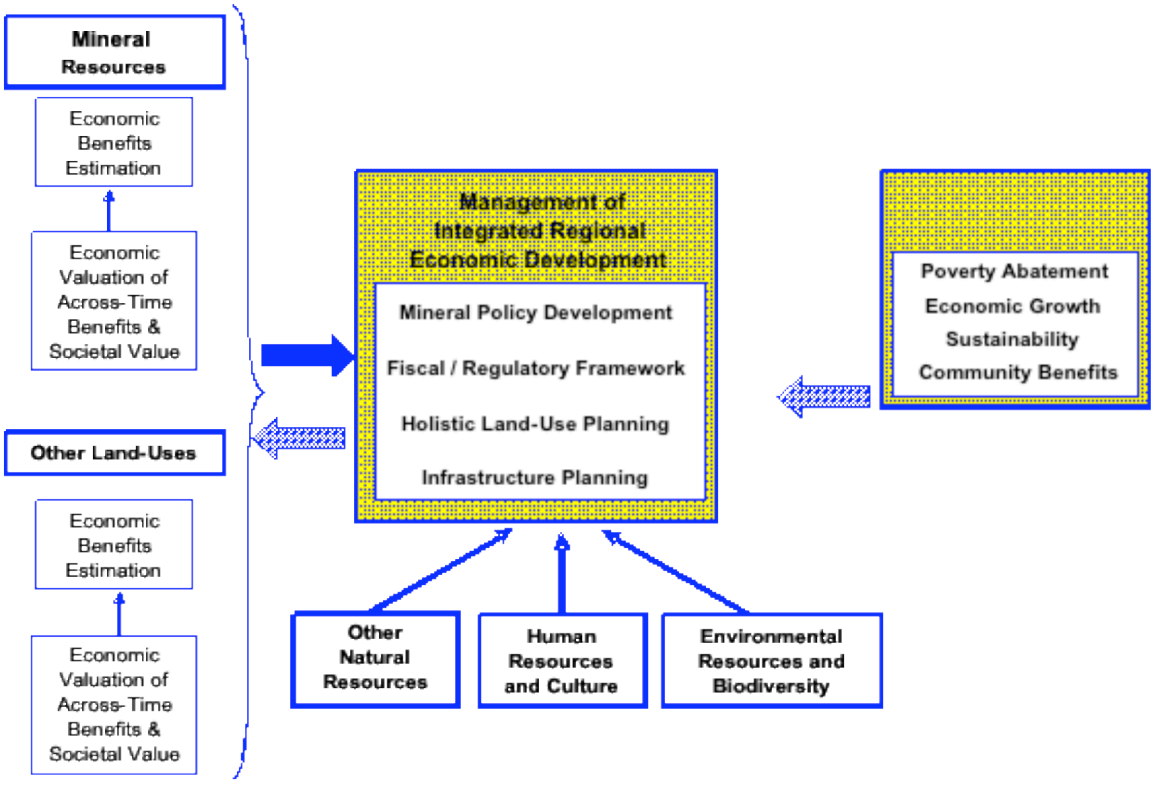

Figure 1: The interactions between the management of regional economic development and mineral resources; in consideration of higher-level development goals.

The value to a society of any of its resources can be measured by its contribution to improved quality of life. Figure 1 shows some quality of life measures as development goals to be optimized through the management of society's resources: mineral, human, and environmental. The central frame, entitled Management of Integrated Regional Economic Development, lists actions that policy planners ("managers") may initiate to achieve Society's development goals. Taking effective management actions requires managers to have access to information on the quantity and quality of society's resources. The Mineral Resource Estimation Template is designed to provide such information for mineral resources. Clearly, to be most effective, development managers should have access to similar information about all of Society's resources.

The arrow in Figure 1 from mineral resources to management actions represents the use of mineral resource estimates to identify those actions that will most effectively achieve development goals. The reverse arrow is equally important, for it represents the impact of management actions on the contribution of Society's mineral resources. Some actions by management enhance certain development goals while diminishing others. There is a delicate balance of tradeoffs between alternative land-uses. The important point to be made is that a system, replete with resource estimates, enhances the ability of management to identify and initiate those management actions that optimally attain Society's development goals in consideration of one land-use's impacts on the surrounding system.

A Dynamic Mineral Management Approach

The proposed approach being developed and tested by World Bank staff employs a dynamic system as resource policies, land-uses, ecosystems, and socioeconomic factors change through time. Geographic information system (GIS) technology can integrate data on mineral resources, hydrology, ecosystem, biodiversity, and alternative land-uses. Once constructed, a dynamic mineral resource management system requires only adjustments to economic inputs going forward. Moreover, it is a valuable tool for subsequent examination of "what if" analyses of economic development management actions, e.g. alternative routing of infrastructure development to reach various resource areas.

The economic valuation of across time benefits from mining then feed into larger processes that include:

(i) ***Mineral policy development*** based on an understanding of the potential economic contribution of mineral resources, from both discovered and undiscovered deposits, across some geographic region and future period of time.

(ii) ***Holistic land-use planning*** in which protected or sensitive areas and those incompatible with mineral development have been integrated, together with the formal integration of infrastructure improvements and additional opportunities that might arise from those improvements.

(iii) ***Regional economic development strategies*** that use resulting mineral policies and land-use plans to identify government and industry strategic investments, most likely to include development of multiple-use infrastructure.

Resource estimation answers fundamental questions of the developing nation:

- ***Geologic endowment estimation*** – what mineral endowment is indicated by the geology of the region, state, or nation; and what are the prevailing ecological, ecosystem, and climate conditions and proposed alternative land-uses?
- ***Resource stock estimation*** – what portion of this endowment, if discovered, would be commercially viable under prevailing economic conditions?
- ***Economic benefits estimation*** – what rational economic contributions might be expected given the time required for exploration and development, and the uncertainty of associated outcomes?

The proposed approach is based upon a collection of concepts and tools to define the underlying mineral resource potential of a region – the untapped potential that, if harvested, can generate economic growth. This potential includes both previously discovered deposits together with yet undiscovered deposits that might be available for

future production. This is holistic thinking, considering alternative land-uses, hydrogeology, ecological assessments, socioeconomic assessments, natural processes, and stress factors affecting systems (i.e. water resources in arid environments).

Figure 1 can be expanded to reveal within the Dynamic Mineral Resources Management approach three main components: geologic endowment, resource stock, and economic benefits estimates (Figure 2). These components in turn consist of series of integrated activities**.** Each task cascades to the next, generating unique intermediary products as shown in the figure by the text to the right of each box. As the program progresses, various expertise is required. Accordingly, resource estimation is performed by teams of qualified individuals working together to incrementally add to the overall understanding of resource potential. Uncertainty is present throughout resource estimation; consequently the outputs of mineral resource estimation are usually described by probability.

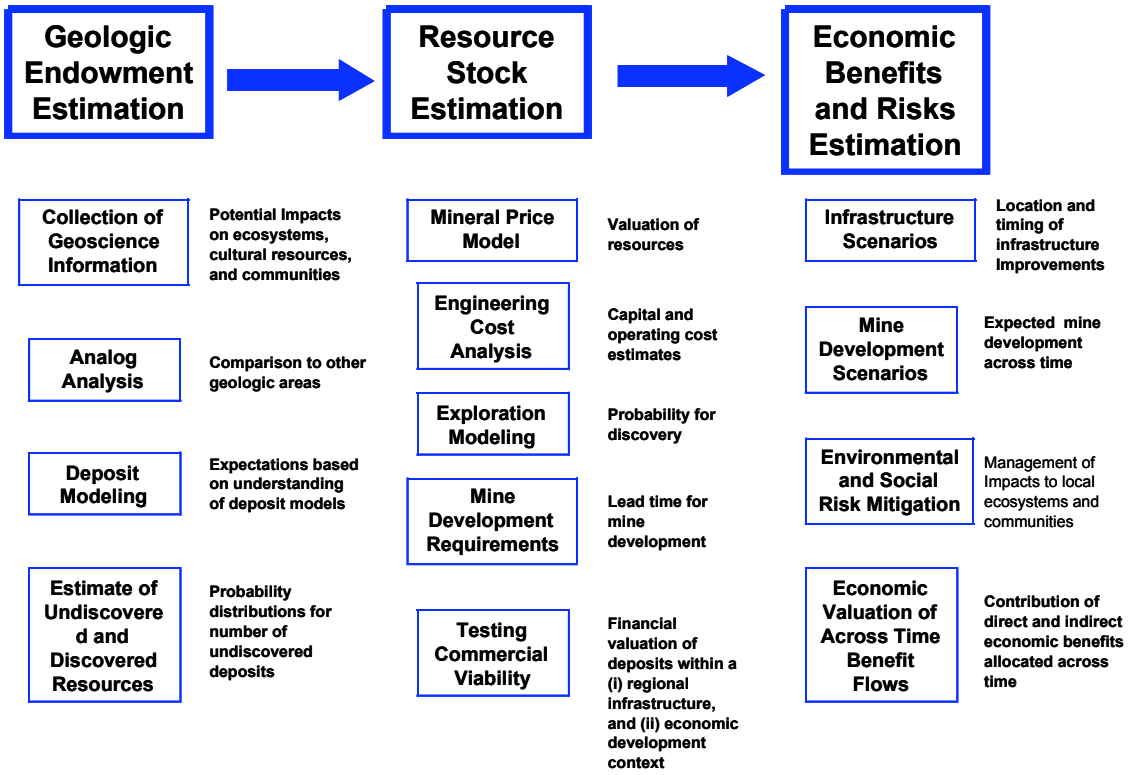

Figure 1: The overall Dynamic Mineral Resource Management System being tested progresses from consideration of the underlying mineral endowment (geologic endowment), to that subset of resources that might be economic under prevailing market conditions and technology (Resource Stock); to the across-time economic contributions to national, regional, and local accounts (Economic Benefits).

Useful Tools for Implementation

Two tools assist in the full implementation of the tasks of the resource estimation template:

- A Geographic Information System (GIS), to manage data layers

- A resource system, a computer program running within the GIS that brings together the many components of the template and performs the required simulations, calculations, and statistical analyses

Design and construction of the resource system consists of three steps:

- Design of a resource system that is compatible with the level and format of the region's basic information and computes and outputs that information useful for the management of regional economic development
- Quantification of system components, e.g. engineering cost models, exploration models, mitigation of potential environmental and social impacts etc.
- Casting the resource system as a computer simulation program within a geographic information system

Many of the tasks involved in the design and construction of the resource system can be performed concurrently; accordingly, the time required for their completion can be decreased considerably by careful planning and organization.

THE ANOSY MADAGASCAR PILOT STUDY

In late 2005 / early 2006 a pilot study of the proposed World Bank approach was undertaken for testing in Anosy, southern Madagascar. The attached CD ROM contains a description of the methodology, data collected, and analysis undertaken. Mineral resource information was intergrated with hydrogeological information, options for alternative land-uses, ecological assessments, socio-economic assessments, and community / regional development plans already in place.

To test the methodology, the World Bank, the Ministry of Energy and Mines, Madagascar and the Projet de Gouvernance des Ressources Minérales (P.G.R.M.) contracted the United States Geological Survey (USGS) to undertake a mineral resource assessment of Anosy region, Madagascar. The assessment was an initial test of concepts to identify 1) additional mineral resources that might support economic development, and 2) the potential impacts of mineral-related development on water resources, ecological resources, and communities. The final report entitled, "Une Présentation de l'Impact Future des Minéraux, l'Hydrologie, et l'Écologie sur le Développement Économique Régional Intégré de la Région de l'Anosy, du Sud-est de Madagascar" was completed in May 2006.

The Anosy Region of Madagascar is one of the lesser developed regions of sub-Saharan Africa. It contains a rich biodiversity, has a wide range of geographic and

climatic environments, and hosts an array of cultures. The region also remains one of the poorest places worldwide. The underlying mineral endowment is largely unknown. One major mineral deposit is being developed by QIT Madagascar Minerals (QMM), after nearly twenty years of planning that included a public/private partnership to develop a multiple-use port in nearby Ft, Dauphin. Other mineral resources remain largely land-locked and distant from the rudimentary infrastructure that exists. Alternative land-uses are small in scope and poverty is pervasive across the region.

The assessment team included a diversity of expertise in geology, hydrology, ecosystems, economics, geospatial analysis and community development. Emphasis was given to testing earlier tasks in the methodology relating to the compilation of highly diverse datasets and the interplay between prospect locations and roads.

The mineral, hydrogeological and ecological assessments and related studies in the 40,000 km^2 area Anosy Region contained six phases of activity:

- **Phase 1:** Compilation of data
- **Phase 2:** Initial analysis and pre-assessment
- **Phase 3:** Field data acquisition
- **Phase 4:** Selection of three prioritized areas of high mineral favorability
- **Phase 5:** Workshop in Fort Dauphin to present the results (March 23-24, 2006)
- **Phase 6:** Final reports consisting of:
    - Report of compilation material and data
    - Integrated final digital report to include environmental and community development issues as an electronic document and dynamic GIS

The system is interactive and readers are encouraged to work independently through phases using the hyperlinks provided within this document and the datasets themselves. Of particular interest is Phase 4 – the identification of three areas of mineral favorability generally coincident with favorable hydrogeological resources (water being the limiting factor to production in this arid environment) and/or unacceptable social impacts. A two-stage data analysis was undertaken:

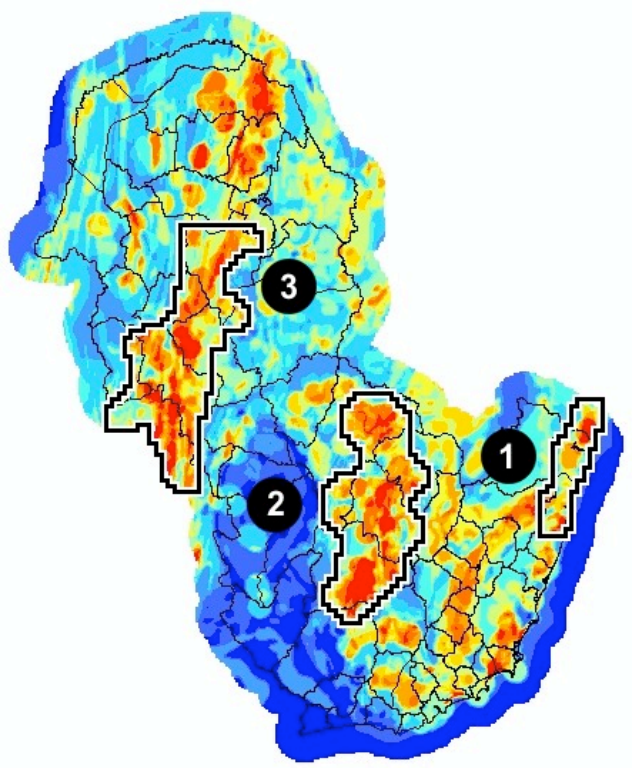

Figure 1: The Anosy case study identified prospective mineral regions (numbered above and explained in the text) in consideration of resource development on ecosystems, culture, and economy.

(a) integration of mineral resource and hydrogeological assessments; followed by (b) integration of socio-economic data; to model economic activities and/or the development of infrastructure in support of mining. The QMM ilmenite mine development was considered in the regional economic evaluation, forming a stimulus for production of water, construction materials, and energy.

Three mineral resources areas of particular interest are identified:

1. Manantenina Resource Area
2. Tranomaro-Maromby Resource Area
3. Isoanala-Inabanda Resource Area

Readers can follow interactive links to review a description of the resource potential in each priority resource area (Section 4.0, Mineral Resource Tracts), corresponding hydrogeologic evaluation (Section 5.0, Hydrogeologic Resource Tract), and ecological factors (Section 6.0, Ecological Resource Tracts). An evaluation of the economic potential (Section 7.0, Economic Context of the Hypothetical Deposits) describes the possible impacts of mining on local ecology, ecological services, and of the national and local economies. Central to the analysis are objectives within the Community Development Plans (CDP) (Section 8.0, Socio-economic Factors and Land Planning).

The Anosy Resource Assessment is presented in the form of a dynamic electronic report and GIS that is navigated like a standard web page. Hyperlinks to various sections of the document are arranged as menu items, as well as highlighted words and thumbnail images. In addition to the standard web page functionality of this document, there are several dynamic hyperlinks to Environmental Systems Research Institute (ESRI®) ArcView® Geographic Information Systems (GIS) project files. Clicking on these hyperlinks launches an ArcView project file in a separate window, which allows the user to dynamically display, overlay, and query the GIS datasets while separately navigating the report. The purpose for the dynamic hyperlinks is to allow the user direct interaction with the GIS datasets used for this study, and to facilitate planning and decision making processes. The United States Geological Survey, under contract to P.G.R.M., conducted the mineral resource assessment and contributed towards methodologies for data integration.

Anosy – Learning by Doing

The Anosy pilot study is innovative - integrating socio-economic, ecosystem, and water resource information for planning of development in the Anosy region.

- ***Mineral Resource Potential.*** The pilot study concluded that beyond exploitation of ilmenite by QMM, prospects within mineral corridors do not represent near-term, large-scale sources of growth. This finding reflects lower overall resource potential of mineral prospects near to existing roads. Outside of the resource corridors, bauxite exploitation could become more favorable for large scale mining, subject to further quality testing. The study also indicated that mineral exploitation in the Isoanala-Inabanda and Manantenina resource areas would not be negatively affected by ecological factors, restrictions of water, or the land statute. By comparison, mineral exploitation in the Tranomaro-Maromby Valley resource area appears limited by several of these factors.

  Smaller scale construction material opportunities are more favorable along the resource corridors. The Tranomaro-Maromby valley has good quality resource and the Isoanala-Inabanda mineral area could form the center of aggregate mining and distribution operation for the new upgrade of the main road going south. Taking a small-to-medium enterprise perspective, the study concluded there is good potential for local villages within the resource corridors to develop an aggregate industry employing small diesel-driven crushers using Chinese tractors already in use in the Tsivory area.

  Not surprisingly, gemstone potential remains favorable both within and outside of the mineral corridors (gemstone producers benefit from access to, but are not reliant on, roads). Near-term economic potential for placer and hard rock gemstone mining, particularly sapphires and to a lesser degree tourmaline and other gemstones was identified. This potential is detailed in the monograph, in the three areas of mineral potential in the Dynamic GIS, as well as in the results of the Workshop tables in the Dynamic GIS.

- ***Mineral Resource Corridors.*** To better understand the impact of infrastructure on mineral resource potential, a 5–km-buffer around known roads was overlain on the mineral favorability maps. Resulting "mineral resource corridors" define proximity of favorable mineralization to transportation routes. This allows regional planners to consider what, if any, mineral resources might benefit directly through new or improved infrastructure in Anosy. Areas outside of the corridors may contain equally good or even better mineral potential – but they are more remote and less likely to reap positive benefits directly from improved or new infrastructure. Planners in Anosy will want to consider what additional mineral development may be stimulated in rebuilding the road network, and along what route.

  The Isoanola-Inabanda Resource Area is the most enhanced mineral resource corridor. Indeed, resource corridor analysis created 13 more precise growth poles

–Manantenina, Littoral, Ranomafana Valley, Andohahela, Amboasary, Amboasry West, Tranomaro, Tranomaro West, Tranomaro North, Isoanala, Isoanala-Betroka, Ivahona, and Betroka North. Growth poles not represented in this new analysis are Tolagnaro (Fort-Dauphin), Manambaro-Fort-Dauphin Corridor, and Tsivory.[3]

- ***Potential Mining Impacts on Communities.*** The system addresses the potential impact of mining activities on neighboring communities for the three resource areas selected; and compares these impacts to those in existing planning documents.

- ***A Revised Socio-Economic Model.*** An Integrated Socio-Economic Model based on favorability maps for mineral resources, hydrogeology, ecology, and transportation routes is available. While the regional development plan originally identified several growth poles in the Anosy Region, the findings of the pilot application indicate that three resource areas (Manantenina, Tranomaro-Maromby, and Isoanala-Inabanda) contain thirteen more defined and restricted growth poles.

- ***Water Supply for Resource Development.*** The hydrogeologic favorability analysis considers the interplay of mining and necessary water resources. The analysis indicates that (a) areas along the eastern coast and in the coastal mountains of the Anosy Region, particularly the Manantenina Resource Area, are most favorable for mineral development, whereas (b) water supply favorability in the Tranomaro-Maromby resource area is lower.

- ***Proposed Land Withdrawal Areas.*** The analysis identifies key areas deemed favorable for prospecting within proposed land withdrawal areas. Not wanting to lose potential economic development while also needing to protect critical biodiversity -- this issue is discussed in further detail under follow-up actions by Commissions below.

- ***Ecosystem Recovery Post Mining.*** Potential for woody re-growth is an important factor in the environment's ability to sustain and recover from mining. Favorable resource areas integrated with woody re-growth zones show a notable overlap in the southeast coast, particularly within the Manantenina Resource Area and in the mountains west of the Ranamofana Valley. In addition, the highlands west and northwest of the Isoanala-Inabanda Resource Area also show moderate, favorable overlap.

[3] *Seven original economic development poles (Tolagnaro, Coastal Zone, the Tolagnaro-Manambaro Corridor, the Ranamofana Valley, the Andohahela National Park and Environs, and the Amboasary and Tsivory poles) and four subsequent growth poles (South-Betroka, North-Betroka, Kalambatritra, and Mangoky poles) were modeled.*

Regional Planning Actions

The system supports economic development at many different scales and focus points. In a regional planning workshop in Anosy the system was used to plan mineral resource development in consideration of hydrology, ecology, economics, and land planning with experts. Regional planners created "Commissions" to discuss the results in light of different development objectives:

- Regional geology, minerals, geomorphology, and soils attended by QMM, PGRM, other mining specialists
- Regional hydrogeology attended by Eau et Foret and NGO specialists
- Regional ecology attended by ANGAP, WWF, CI, QMM, and environmental specialists
- Regional socioeconomic and planning attended by local Mayors, Planners, and planning specialists

Each Commission developed strategic actions for follow-up. For example, the Commission on Regional Geology, Minerals, Geomorphology, and Soils discussed the implication of developing various mineral resources in consideration of land status. For the Tranomaro-Maromby area, where prospective lands are currently restricted for mineral exploration and development, the group proposed to carry out mapping projects to refine understanding of the resource potential and then organize a meeting of stakeholders to discuss revision of land classifications to insure that favorable mineral potential areas are not unreasonably restricted. This dialogue would be balanced by consideration of impacts on ecosystems, habitats, water resources, and community. Specific committee recommendations are to rehabilitate and develop roads to increase access to mineralized areas, develop a framework for consultation with land-owners, and provide technical assistance to fledgling construction material producers.

Next Steps

The Anosy system continues to evolve, drilling down into more specific issues that may include modeling ecosystem health, assessing adequacy of water supply, evaluating the potential for hydro resources, and assessing sites for producing construction materials (sand, gravel, and crushed stone) for both Ft. Dauphin and the QMM mine. Broader testing of the system will shift to downstream tasks relating to modeling of resource development across time and corresponding benefit streams at the national and local level.

Mineral resource development is one of the most consequential activities of any nation. Decisions taken today will impact a nation for generations to come. The decision to undertake resource development must be informed with a sound understanding of the underlying resource and potential impacts and contributions of those resources across time. The proposed Dynamic Mineral Resource Management System is demonstrating that such an approach can be implemented successfully in Sub-Saharan Africa.

APPENDIX A – USE OF THE SYSTEM AT THE REGIONAL / COMMUNITY LEVEL

The Results of this project were presented at a workshop in Fort Dauphin on March 22 and 23, 2006. The purpose of the Fort Dauphin workshop was to deliver and discuss the results of the project and to develop planning strategies regarding mineral resource development in terms of hydrology, ecology, economics, and land planning with experts. Several "Commissions" were created to discuss the results in light of different platforms. They were:

- Regional geology, minerals, geomorphology, and soils attended by QMM, PGRM, other mining specialists
- Regional hydrogeology attended by Eau et Foret and NGO specialists
- Regional ecology attended by ANGAP, WWF, CI, QMM, and environmental specialists
- Regional socioeconomic and planning attended by local Mayors, Planners, and planning specialists

Commission on Regional Geology, Minerals, Geomorphology, and Soils: The Commission discussed the implication of developing various mineral resources including: bauxite, clay, mica, uranium-thorium-apatite, tin and tungsten, gem stones (sapphire, tourmaline), cordierite, sillimanite, graphite, and building materials (sand/gravel and other aggregates, limestone, cement, and ornamental stone). They also discussed land status, particularly for the Tranomaro-Maromby area, where much of the land in the identified mineral potential area is currently restricted for mineral exploration and development. The group proposed to compile a database for specific deposit types; conducting geochemical surveys; inventory known mineral occurrences; carry out exploration and mapping projects; and document and update the metallurgical knowledge and find the extent of known deposits. They also recommended that:

- Perform a market study and evaluation
- Rehabilitate and develop roads to increase access to mineralized areas
- Contact property owners to determine what they plan to do with their land, and how the government can assist with their plans
- Provide guidance and assistance with developing local sand and gravel or crushed stone enterprises (building materials)
- Organize a meeting of Ministries of Mines and Environment, Water and Forests to discuss revisions to present land classifications to allow for access by mining interests and to insure that favorable mineral potential areas are not restricted

Suggested players included: Anosy Region, MEM, DMG, MINENVEF, MTPT, Malagasy Government, PGRM, investors, and mining companies.

The Commission on Regional Hydrogeology: The Commission discussed the availability of ground water and surface water and the infrastructure for water supply, health and sanitation. Other issues included:

- Insufficient infrastructure to obtain potable ground water
- Ground and surface water contamination from human activities and lack of sanitary systems
- Insufficient infrastructure for irrigation
- Erosion of watershed slopes due to deforestation
- Insufficient surface water resources – potential conflicts with exploitation
- Severe lack of water resources in the southwest Anosy region

Their suggestions included:

- Environmental impact studies
- Increased information-education-communication on matters of sanitation
- Development of an adequate infrastructure to exploit water resources
- Building of hydro-agricultural dams
- Reforestation and agro-forestry programs
- Ecosystem restoration
- River embankment protection/revegetation
- Determination of buffer zones surrounding sensitive areas

The suggested players include: FID, PSDR, IPPTE, MINENVEF, NGOs, and private local companies.

The Commission on Regional Ecology: The Commission discussed the implications of environmental and ecological issues to the Anosy PRD, including: the ongoing ZICO study; consideration of habitation density for the Anosy Region conservation project; identifying and establishing potential protected areas (especially Tsikoroky, Ivahona, and other lakes); and the resolution of overlapping interests. The group also discussed the impact of brush fires, protection of endemic species and watersheds (especially in the Betroka watershed), favorable zones for reforestation, and management of wood supply. Some implications for the Anosy Region include: extension of the Amboassary pole; a linkage between the mining and halieutic potential in Manantenina; and the estimation of value and sustainable management of renewable (biological, environmental, and ecological) and non-renewable (mineral) resources. Proposed follow-up activities included:

- Strategic impact studies
- Data acquisition on fires (particularly brush fires)
- Biodiversity and ecological inventory
- Field verification of existing land use / land cover and other key environmental datasets
- Identification and prioritization of areas to protect based on taxonomic group
- Initiation of the SAPM processes

The management of forests and watersheds would include creating buffer zones, reforestation, and habitat conservation. The management of mineral potential areas would include the development of a sustainable development framework to maintain,

regulate, and govern mining activities. To improve implementation of the Anosy PDR, the following priorities are suggested:

- Concentrate activities in the three priority mineral potential areas
- Develop a mechanism of collection and management of data and information at the regional level
- Include all participants and stakeholders in ratifying the final report

The suggested players included Birdlife International, USGS, ANGAP, CIREEF, WWF, ACORDS, and other conservation agencies and local and regional stakeholders.

The Commission on Regional Socioeconomic Development and Planning: The Commission discussed the mining potential of each the resource areas and the hydroelectric potential in Manantenina. Some of the development concerns, issues, and opportunities are:

- The isolated nature of the Manantenina resource area
- Deforestation
- Water supply and food security
- Demographic growth
- Energy resources
- Ecotourism
- Animal husbandry of interest to local customs
- Assistance in the economic development of local players

In order to further evaluate these concerns, issues, and opportunities, the group suggested:

- Additional data collection on mining and hydroelectric potential
- A compilation of research permits and studies in the Region
- Construction of an agriculture potential map created by integrating hydrogeologic favorability, lithologic (parent materials), soils, topographic/elevation, and climate data; a feasibility study to address the rehabilitation of roads along the coast to promote inland access and alleviate isolation

The growth and development of various businesses and industries in the Region could be promoted by:

- Improvements to energy generating capacity
- Including small local and(or) alternative energy generation sites
- Availability and access to the mineral resources identified in the three mineral potential areas
- Organization, formalization, legalization and professionalization of small artisan miners
- Establishing financial services and councils
- Development of adventure/eco-tourism

- Commercialization and promotion of Anosy product "brands"

Improvement to the physical and social infrastructure should include:

- Rehabilitation of roads for tourism and agriculture
- Development of local sand and gravel and crushed stone (aggregate) enterprises, reforestation and revegetation/protection of river embankments
- Construction of micro-dams
- Diversification of dietary patterns
- Increased variety of agricultural products produced; construction of wells, water sources and processing centers
- Enforcement of PRGF
- Development of a strategy for regional population growth (family planning and management of population migration).

The suggested players included Anosy Region authorities, MEM, CRD, Ministry of Public Works, Institution of Microfinance, the Tourism Office, NGOs, CCD, Ministry of Health and Planning, Ministry of Population, PHBM, SAPM, MAEP, MinEnv, WWF, ANGAP, PNUD, and local stakeholders and communities.

Overall Recommendations Identified By All The Commissions:

- Road rehabilitation and the development of an expanded road network, as well as related development of local sand and gravel and crushed stone (aggregate) enterprises
- Electrical power supply, stability, and increased generation capacity,
- Water quality and availability for domestic (health and sanitation), animal husbandry, agricultural, and mining purposes
- Reforestation and revegetation, particularly related to protection and management of surface water resources (stream and river embankments) and to management of fuel-wood resources in upland areas
- Multi-jurisdictional governance, cooperation, and revisions to land status classification and property issues
- Full access to data and participation in the planning process for the various National, Regional, Communal stakeholders
- Additional collection, verification, and geospatial analysis of data pertinent to geological/mineral, hydrogeological, environmental/ecological, and socio-economic factors that influence development and planning in the Anosy Region