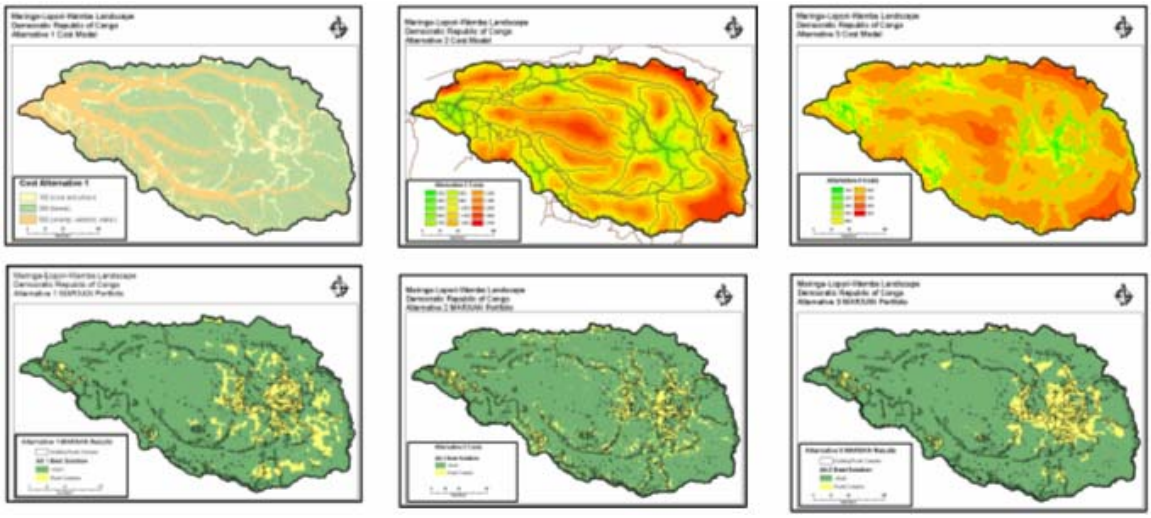
Technical Assistance to the African Wildlife Foundation on Planning and Zoning in the Maringa-Lopori-Wamba Landscape, Congo



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With Contributions from
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Acronyms

AWF	African Wildlife Foundation
CAPS	Conservation Assessment and Prioritization Software
CARPE	Central African Regional Program for the Environment
DRC	Democratic Republic of Congo
DSS	Decision Support Systems
MARXAN	Marine Reserve Design using Spatially Explicit Annealing
MLW	Maringa-Lopori-Wamba
UCL	l'Université catholique de Louvain, Belgium
UMD	University of Maryland
USAID	US Agency for International Development
USFS	United States Forest Service

Background on USFS Role in CARPE

The USDA Forest Service (USFS), through the Office of International Programs, is an implementing partner in the US Agency for International Development's (USAID) Central African Regional Program for the Environment (CARPE). The USFS provides technical and capacity building assistance in improving forest management in the Congo Basin, specifically land management planning processes in CARPE landscapes. These landscapes were chosen for their biodiversity and conservation importance and established as foundations of regional conservation and sustainable natural resource use. These areas contain protected areas, current or future timber and mining concessions, villages and settlements, and extensive forests that people depend upon for their day-to-day resources.

The multiple-use mandate of the USFS in managing National Forests and Grasslands in the United States requires planning which integrates conservation strategies to achieve ecological sustainability and resource use to contribute to economic and social sustainability. Capitalizing on this experience, the USFS has been asked by USAID/CARPE to develop planning processes and guides for comprehensive landscape level planning and for the three use zones within landscapes: protected areas (PA), community based natural resource management zones (CBNRM) or community use zones, and extractive resource zones (ERZ). The USFS has created planning guides and is continually developing processes and models in collaboration with the NGO landscape leads (African Wildlife Foundation, World Wide Fund for Nature, Wildlife Conservation Society, Conservation International) and central African governments.

Introduction: Scope of Technical Assistance

The USFS had planned to provide a technical assistance team to the African Wildlife Foundation (AWF) to develop collaboratively a pilot landscape zoning methodology, based on the Maringa-Lopori-Wamba (MLW) landscape in the Democratic Republic of Congo (DRC). The mission was to develop landscape level management plans utilizing a multiple use approach and focusing

on issues impacting the landscape as a whole, harmonizing the best available data for the creation of an initial landscape zoning map. In addition, the USFS and AWF were to identify weaknesses in existing data and zoning approaches and examine alternative approaches to be addressed over time. The USFS and AWF were particularly interested in planning software that could be applied to landscape data to produce a zoning map. This USFS team consisted of John Sidle and Julie Luetzelschwab. Just prior to departure to DRC John had a family emergency and could not travel. While in DRC I also had a family emergency and departed early. The work, however, was carried on from the States by email and telephone.

Section 1: Background and Context

Before the trip, conference calls among USFS, AWF, and University of Maryland (UMD) addressed data needs for the mission. Some data were provided beforehand and more data were examined in Kinshasa. Working with Jef Dupain, AWF's director in Kinshasa, and other stakeholders from the Ministry of Environment, Ministry of Rural Development, and the WorldFish Center we discussed conservation goals and human activities and needs in the 70,000 km^2 MLW landscape.

Conservation planning is being facilitated in many parts of the world through the use of software that can optimize an area or landscape for protected areas or reserves. Such algorithms can also be applied to other planning needs. MARXAN, developed by Ball and Possingham (2000), is the reserve design software that was tested to model the landscape zones (see web site listed at the end for a complete description of MARXAN). Because little explicit or surrogate spatial data or species and habitat models exist for key conservation features such as bonobo habitat, applying MARXAN to guide the placement of protected areas is currently problematic. However, as biodiversity information becomes available, literature is thoroughly reviewed, and as species expert panels convene, it will be possible to use MARXAN to guide the establishment of additional protected areas in the MLW landscape.

In the meantime, a certain amount of human social data was available to allow the use of MARXAN to model areas, "human reserves", needed by people now and in the future. Population densities, trails, roads, villages, agricultural fields, plantations, and other human induced features allow MARXAN to model Community Use Zones in MLW. A population for the landscape from 2005 LandScan data was derived and projected to 2014 using a 3% annual population increase. The conservation target for Community Use Zones became the hectares of land needed for agriculture and living space in 2014. MARXAN was run on three alternatives: land cover only, no conservation, and conservation emphasis. The results of the trial runs were provided in a PowerPoint presentation, attached in Annex 3. Other trial runs using different MARXAN parameters will produce varying results to guide planners now and in the future as data are refined.

Section 2: Issues, Findings, and Recommendations

- Data gaps and available data vary in a scale and projection and often lack metadata or any lineage information. Furthermore, planning is a continuing endeavor. The application of MARXAN and other tools is not static at one point in time.
    - Develop a plan for data collection in MLW setting priorities, timelines, methodologies, and detailing equipment and training needs. A table titled "data needs" follows in Annex 4.
    - Develop data standards (preferably those used by other CARPE partners) including theme and field naming conventions, coding standards, and a standard projection.
    - Ensure datasets have metadata and a defined projection
    - Continue to work with and identify new partners and stakeholders and share data. Establish a close relationship with other NGOs that are planning to use MARXAN to plan protected areas throughout the Congo Basin in DRC.

- MARXAN and MLW MARXAN results limitations
    - Setting up MARXAN input files and viewing results are cumbersome. Natureserve's Vista software warrants further exploration because Vista sets up input files for MARXAN and outputs can be easily viewed in ArcMap. Natureserve also offers training and user support. Vista also delivers a decision support system that integrates conservation information with land use patterns and policies, providing planners, resource managers, and communities with tools to help manage their natural resources. It enables users to create, evaluate, implement, and monitor land use and resource management plans that operate within the existing economic, social, and political context to achieve conservation goals.
    - MARXAN is most productive with multiple conservation targets (dozens to hundreds). Further runs to model community use zones could be done by using multiple targets such as areas to grow crops (this could be broken down by crop type), hunt, fish, and gather forest products. However more data is needed on soils and where subsistence activities occur.
    - This trial run of MARXAN was intended to explore the usefulness of the tool for landscape zoning in MLW. As additional data becomes available tools like MARXAN will be more effective. Any model output considered for incorporating into management zoning must be subject to expert review and ground verification.

Section 3: Recommendations and Implementation Steps

- Filling Data Gaps
    - A spreadsheet (attached in Annex 4) has been provided listing data needs. AWF can fill out the status/availability of each theme. The USFS could assist with helping to set priorities and provide input on data gathering techniques and data standards.

- The USFS could assist by offering expertise in GPS field unit selection and training in how to use the units.
- The USFS will work with SPOT and ESRI on a grant for high resolution imagery
- Species information from the literature, reports and other sources needs to be reviewed to guide MARXAN in the optimization of a system of biodiversity reserves in MLW.
- Expert species panels should be carried out for MLW.

- Utilizing MARXAN and other Decision Support Tools (DSS) tools such as Vista
  - Because of the complexity of MARXAN a tool such as Natureserve's Vista should be used to facilitate the modeling process. One license costs $1500 with one year of support. Vista also allows other aspects of planning not addressed by MARXAN.
  - For MARXAN to better delineate the Community Use Zone, more data are needed on current and potential areas for hunting, fishing, farming, and collecting forest products. The amount of area (hectares) needed per person for each activity is also needed. MARXAN is more effectively used on multiple "species" and each of these activities could be a "conservation feature" with a target of hectares needed for each activity.
  - Groupement and secteur boundaries have a strong influence on where people live. These datasets should be updated for the entire landscape and can then be used in MARXAN as a barrier to population spread.
  - The population for the landscape was derived from 2005 LandScan data and an annual population increase of 3% was estimated. Current population and growth figures are used as targets for MARXAN and will dictate the amount of land needed for the Community Use Zone. These figures should be verified.

Annex 1: References

- Trip report by John Sidle and Jena Hickey: http://carpe.umd.edu/resources/Documents/MLWTripReportFinal.pdf)
- MARXAN: http://www.ecology.uq.edu.au/index.html?page=27710
- DSS Tool Reference: http://www.natureserve.org/prodServices/ebm/pdf/NatureServe_EBM_Tools_Survey.pdf
- Natureserve Vista: http://www.natureserve.org/prodServices/vista/key_features.jsp
- LandScan: http://www.ornl.gov/sci/landscan/
- Land Cover from Janet Nackoney of UMD
- Wildlife Habitat Connectivity Corridors from David Williams, AWF
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- Barnes, R. F. W., and S. A. Lahm. (1997) An ecological perspective on human densities in the central African forests. Journal of Applied Ecology 34: 245-260.
- Zhang Q., Justice C.O., and Desanker P.V., 2002. Impacts of simulated shifting cultivation on deforestation and the carbon stocks in the forests of central Africa, Agriculture, Ecosystems and Environment, 90, 203-209.

Annex 2: Some of the People Contacted

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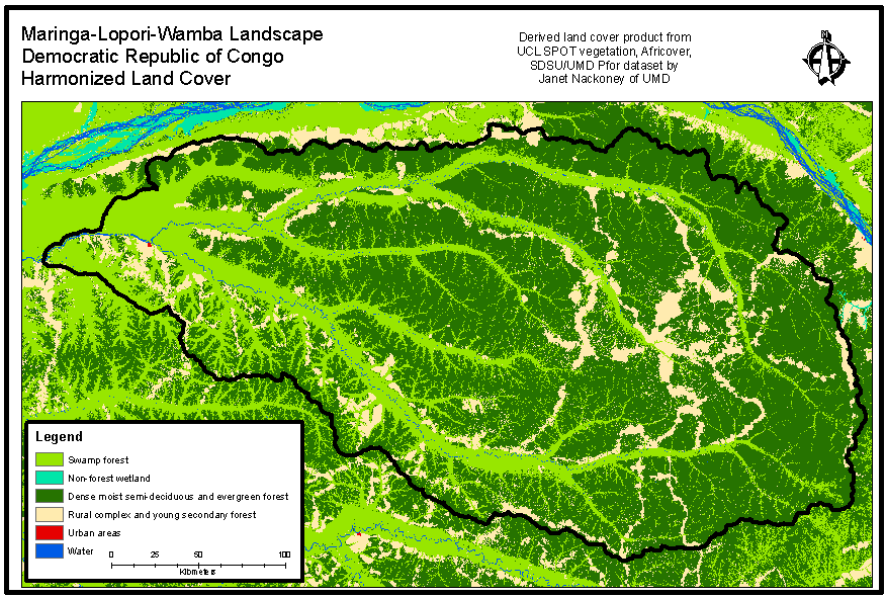
Patrick Crist, Natureserve

Annex 4: Data Needs

Resource Area	Database
Elevation	Aspect, slope, hillshade
Elevation	Elevation data
Geology	Caves inventory
Geology	Geology
Geology	Mineral resources
Geology	Soils
Heritage	Clan boundaries, current & historic
Heritage	Heritage resource sites (sacred areas, cemeteries, etc.)
Land Status	Protected areas (parks,reserves)
Land Status	Protected area buffer zones
Land Status	Land uses (agriculture, urban, forest, etc.)
Planning	Management Zones
Socio-Economic	Attitudes, values, beliefs (including towards protected areas)
Socio-Economic	Fires, agricultural burning
Socio-Economic	Forestry concessions
Socio-Economic	Human waste disposal sites
Socio-Economic	Illegal activities monitoring (poaching, trawling, …)
Socio-Economic	Infrastructure, lines (pipelines, utility lines…)
Socio-Economic	Infrastructure, points (cell towers, wells, airstrips, boat docks…)
Socio-Economic	Markets (size, bushmeat)
Socio-Economic	Mineral and Oil concessions
Socio-Economic	Mineral and Oil reclamation areas
Socio-Economic	Plantations
Socio-Economic	Populated places (villages, cities, logging camps, fishing camps, etc. with population & other census info)
Socio-Economic	Roads, trails and use level
Socio-Economic	Subsistence activities/zones (hunting, fishing, firewood gathering)
Vegetation	Rare plant populations
Vegetation	Vegetation classification
Water	Precipitation/Weather data
Water	Rivers (with navigability)
Water	Water quality monitoring
Water	Waterbodies
Water	Watersheds
Wildlife/Veg	Invasive species populations
Wildlife	Wildlife critical areas (mineral deposits, bais, mangroves,…)
Wildlife	Wildlife known areas of concentration, feeding areas, etc.
Wildlife	Wildlife observations
Wildlife	Wildlife surveys
Other	Satellite Imagery
Other	200k and 250k base maps

Annex 5: Final Program Presentation

Landscape Planning



Landscape Planning
Maringa–Lopori–Wamba (MLW)

Technical Assistance Provided by the US Forest Service in Collaboration with African Wildlife Foundation and Other Partners
Fall 2007

SDSU

UNIVERSITY OF MARYLAND

UCL Université catholique de Louvain

CARPE

USAID FROM THE AMERICAN PEOPLE

AFRICAN WILDLIFE FOUNDATION

CARPE Landscape Zones

- **3 CARPE Macro-Zones for MLW**
  - **Protected Areas** are zones where the predominant purpose is the conservation of the natural state of flora, fauna, and other natural resources
  - **Community Based Natural Resource Management Zones**, also called **Community Use Zones** are areas where communities have property rights over natural resources and utilize them for community benefit; activities may include subsistence agriculture, hunting, fishing, and collection of forest products
  - **Extractive Resource Zones** include activities such as forest concessions, large-scale private plantations, mining and safari hunting
- Macro-Zones can then be divided into micro-zones which are at a finer, more site-specific scale

People and Conservation

Mission Goals

- Work with AWF, stakeholders and partners to identify key conservation targets and biodiversity elements
- Review existing approaches and spatial tools available for landscape-level zoning
- Assemble and review available spatial data and identify data gaps
- Conduct trial runs of recommended spatial modeling approaches and tools using best available data
- Collaboratively review results and methodologies and assess strengths and weaknesses and data needs
- Summarize findings and assist AWF and partners with incorporating them into a first detailed outline of a manual for DRC landscape zoning guidelines

Identifying Conservation Features

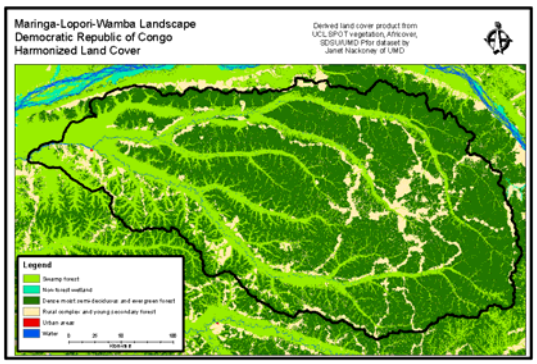
- Wildlife habitat for key species including bonobos, Congo peacock, and forest elephant
- Large blocks of primary forest
- Aquatic areas
- Habitat connectivity corridors

Identifying Human Needs

- Space to grow crops
- Space for growing villages
- Places to fish
- Places to hunt
- Places to gather forest products
- Markets to trade goods

MLW is large (73,000 km^2) and Poorly Known

- Available Spatial Data
  - Population Density
  - Plantations
  - Agricultural and fishing villages
  - Elevation
  - Land Cover (*terra firma* forest and swamp forest)
  - Roads and trails
  - Rivers
  - Limited bonobo nest inventories



Lack of Direct and Surrogate Biodiversity Information for Conservation Planning

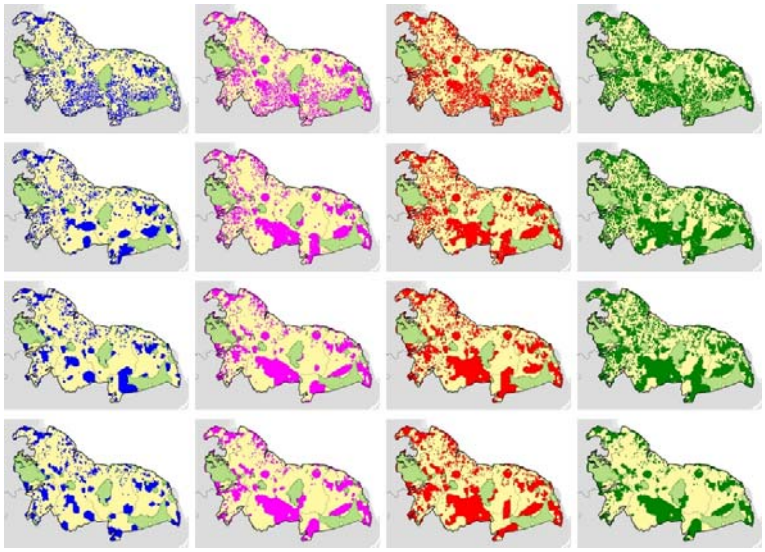
- Species distribution
- Species habitat models
- Forest types
- Forest structure
- Soil types
- Geology

The Approach

- Assess the current and future needs of people
- Assess the human threats to biodiversity
- Estimate areas for people and later areas for conservation and conservation practices in the remaining landscape

The Approach

- Use analytical spatial tools to develop maps of conservation scenarios, each employing slightly different conservation target levels and other parameters.



MARXAN

- Reserve Design Software
  - Selects efficient sets of areas (or planning units) to meet user-defined biodiversity targets, while minimizing "conservation cost" across the planning region (MLW)
  - Input data typically include species distributions, habitat or vegetation types, and other biological features of interest.
  - Spatial constraints, such as compactness of the resulting reserve system and minimum areas for focal species, may also be incorporated.

MARXAN

- Reserve Design Software:
  - Offers a variety of heuristics including greedy, rarity, and irreplaceability
  - Parameters can be set to control clump size (minimum size of a reserve) and distance between clumps to prevent fragmentation
  - Portfolios can be ranked and thus compared

How Does MARXAN Work? Bonobo Example

- Attempts to design an optimal reserve network based upon conservation targets (e.g., minimum ha of bonobo habitat desired for MLW)
- Establishes planning units ($1km^2$; 73,000 planning units)
- Examines each planning unit's value (hectares of bonobo habitat) and cost (cost of adding the planning unit to the portfolio including the cost of its boundary)
- Attempts to create the lowest cost portfolio while fulfilling targets

Lack of Biodiversity Information

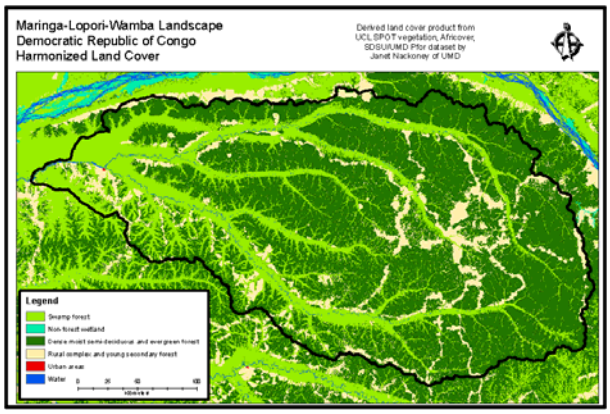
- Therefore, initial focus of MARXAN application is to develop a system of "human reserves" rather than protected areas.

Modeling Human Habitat Needs by 2014
3 Alternatives

1. Land cover only
   - Least biased
   - Existing Protected Areas included
2. No conservation
   - Assumptions made on where people would like to live and grow crops
   - Protected Areas were not included
3. Conservation emphasis
   - Assumptions made on influence of humans on wildlife
   - Existing Protected Areas included

Assumptions

- Population in MLW buffered 2 km was 704,927 using 2005 LandScan data
- Rural complex is where most people live and grow crops
- Acres of rural complex from UMD Land Cover is 686,000 ha (686,000 ÷ 704,927 = 0.97 ha/person)
- Population growth is 3% /yr (population will be 919,769 in 2014)
- **893,000 ha** will be needed for rural complex by 2014 (25% increase)
- Once existing rural complex becomes too crowded and agricultural land less productive people will move into the dense forest and will avoid swamp and wetlands
- People will continue to live in existing rural complex

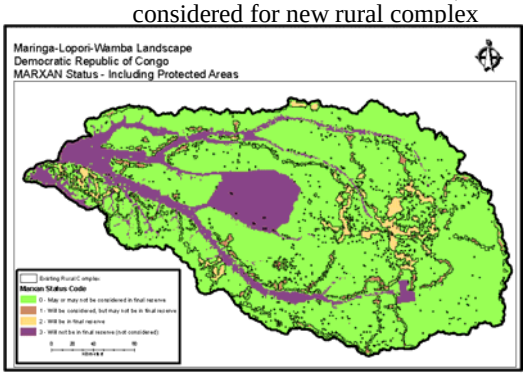


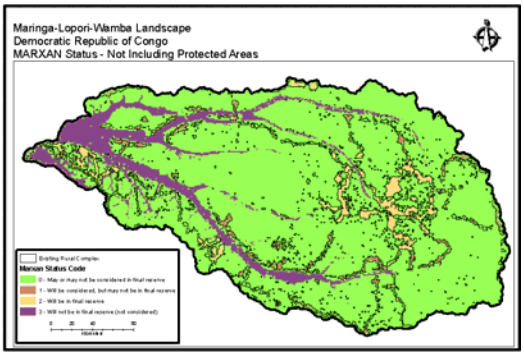
MARXAN Setup

- UMD Land Cover was used as a base layer
- Targets were hectares of existing rural complex and hectares of forest
- The alternatives use different cost models
- The alternatives use different status inputs (planning units that are fixed in the reserve or cannot be included in the reserve)
- Simulated annealing with normal iterative improvement was used for all 3 alternatives

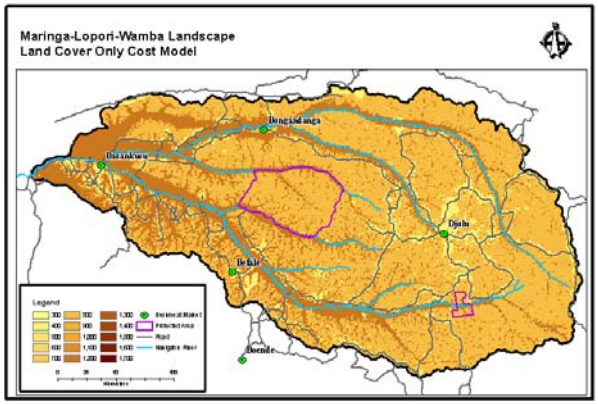
MARXAN Status

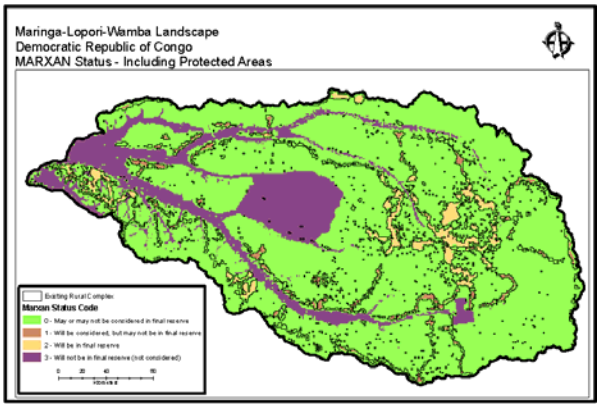
- There are 4 status values that can be optionally assigned to a planning unit
  - 0 - May or may not be considered in final reserve
  - 1 - Will be considered, but may not be in final reserve
  - 2 - Will be in final reserve (fixed in reserve); some areas of existing rural complex with existing higher population densities were fixed in the reserve
  - 3 - Will not be in final reserve (not considered); swamp, water, and wetland will not be considered for new rural complex



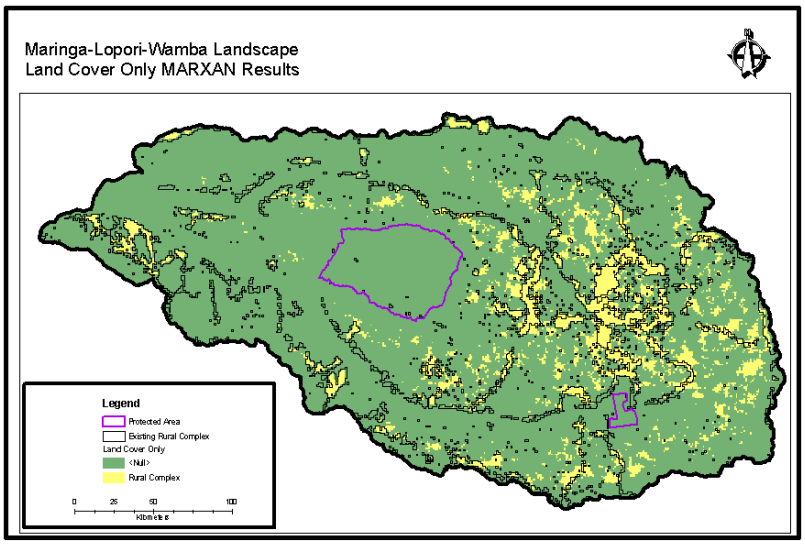


Alternative 1 – Land Cover Only with Protected Areas

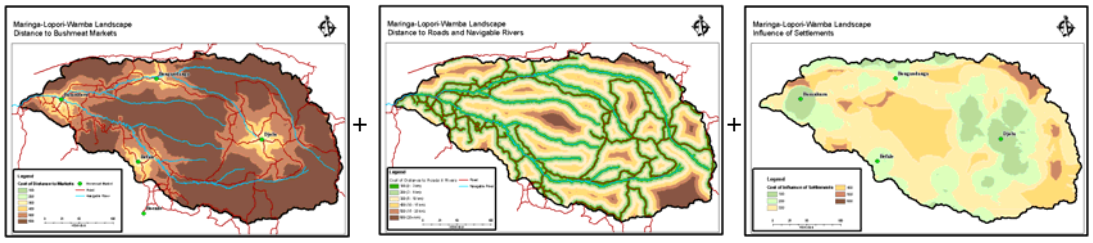




Alternative 1 – Land Cover Only MARXAN Results



Alternative 2 - No Conservation (Human Habitat Cost Model with No Protected Areas)



Assumptions:
- Protected areas do not exist
- Humans prefer to live near existing settlements
- Humans prefer to live near roads or navigable rivers
- Humans prefer to live near a large market
- Humans prefer not to live in swamps or wetlands

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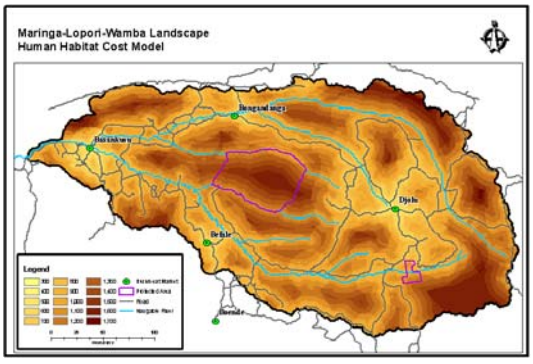
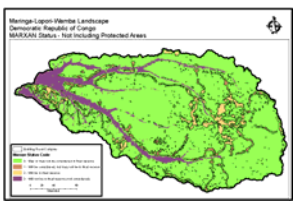
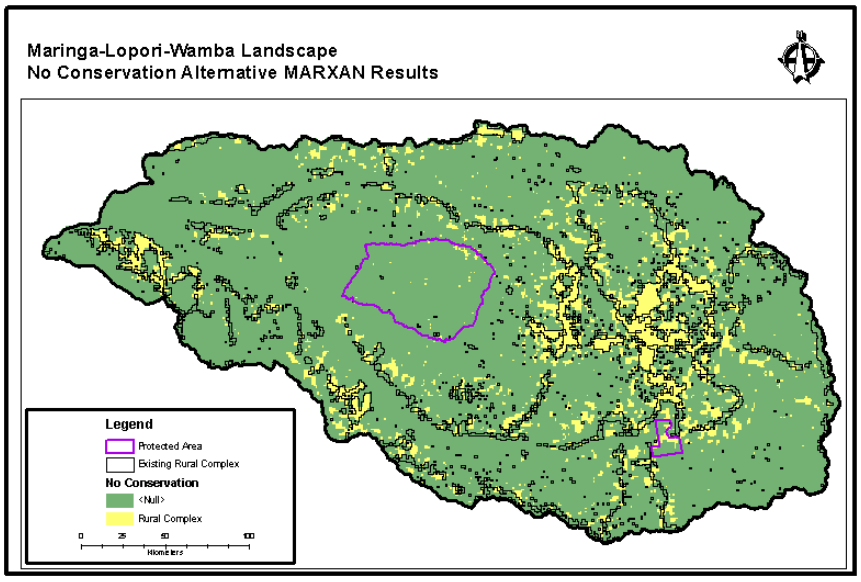
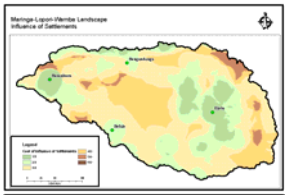


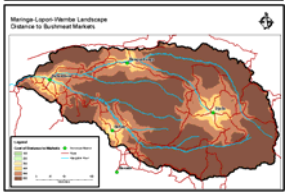


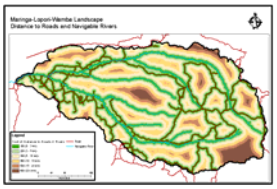
Alternative 2 – No Conservation MARXAN Results

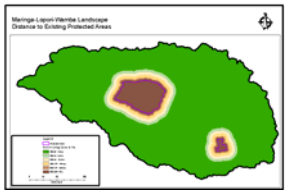


Alternative 3 -Conservation Emphasis Cost Model



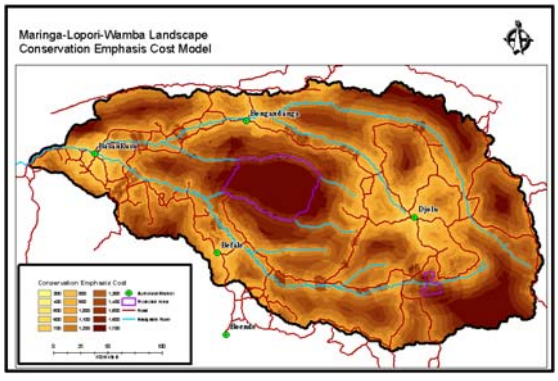




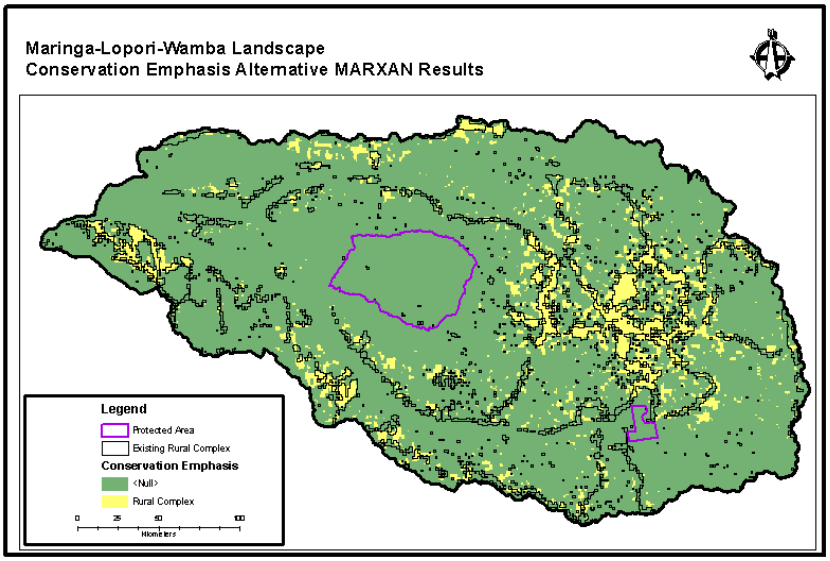


Assumptions:

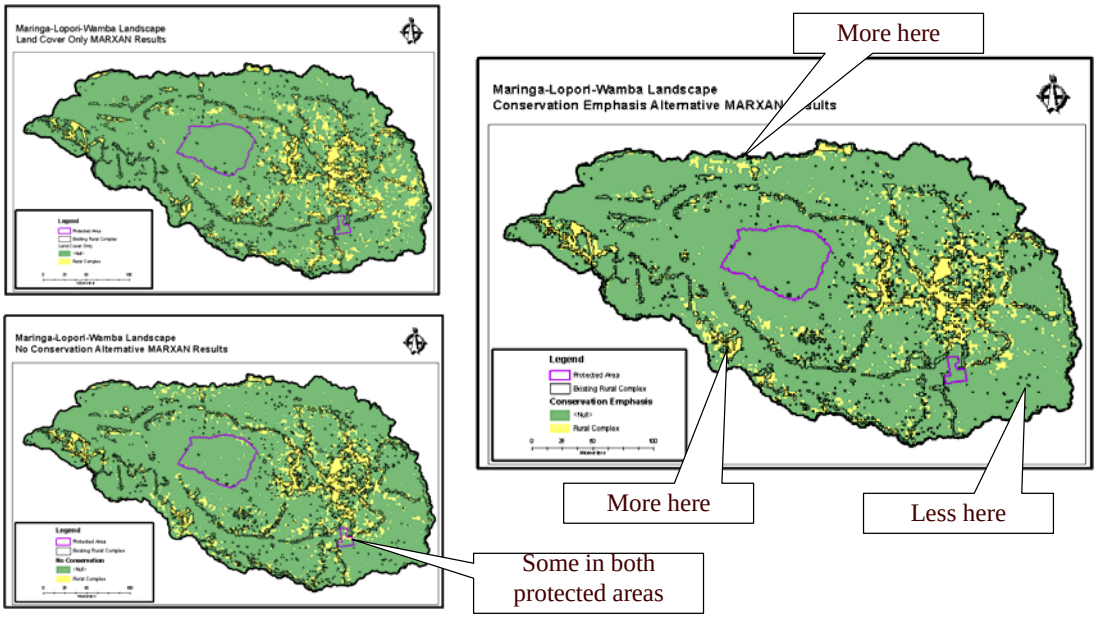
- Protected areas exist
- Wildlife prefer to avoid humans and human activities
- Wildlife habitat connectivity corridors created by David Williams, AWF
- Cost model based on Threats to Biodiversity model created by Janet Nackoney, UMD



Alternative 3 – Conservation Emphasis MARXAN Results



MARXAN Alternatives Differences in the Results



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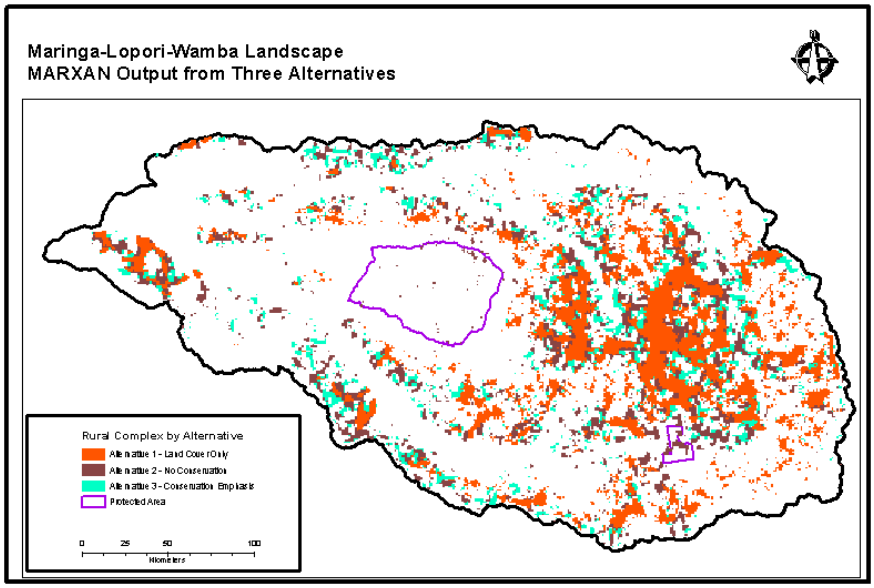

Issues and Recommendations

- Data gaps and data that is available comes in a variety of scales and projections and often lacks metadata or any lineage information
  - Develop plan for data collection setting priorities, timelines, methodologies, and equipment and training needs. A slide titled "data needs" follows.
  - Develop data standards (preferably those used by other CARPE partners) including theme and field naming conventions, coding standards, and a standard projection
  - Ensure datasets have metadata and a defined projection; without knowing lineage a dataset looses its value
  - Continue to work with and identify new partners and stakeholders and share data

Issues and Recommendations

- MLW results and MARXAN limitations
  - This trial run of MARXAN was intended to explore its usefulness as a tool for landscape zoning in MLW and other CARPE landscapes. This MLW example can serve as an early prototype. Inputs to the cost models and decisions on assigning status codes should be further reviewed and tested as the prototype evolves.
  - MARXAN is not very user friendly and setting up MARXAN and viewing results can be cumbersome. Natureserve's Vista software warrants further exploration. Vista sets up input files for MARXAN and outputs can be easily viewed in ArcMap. Natureserve also offers training and user support.
  - MARXAN works best with multiple species/conservation targets (dozens to hundreds) and using it to model one species limits its usefulness. Further runs to model a community use zone could be done by using multiple targets such as areas to grow crops (this could be broken down by crop type), hunt, fish, and gather forest products. However more data is needed on soils and areas of human activities.
  - People tend not to move out of their groupement. MARXAN's parameter to separate reserves would not work well for this scenario because the groupements vary greatly in size. Planning units along the boundaries could be given a STATUS = 3 which would prevent them from being included in the "reserve" system and could act as a barrier.
  - Any model output considered for incorporating into management zoning must be subject to expert review and ground verification.

Use of Marxan for Protected Areas

- Species data from literature needs to be collated with to develop wildlife models
- Expert panels should be convened to advise on species and key biodiversity conservation features for MLW
- Run Marxan for an optimal systems of protected areas in MLW

Data Needs

Resource Area	Database
Elevation	Aspect, slope, hillshade
Elevation	Elevation data
Geology	Caves inventory
Geology	Geology
Geology	Mineral resources
Geology	Soils
Heritage	Clan boundaries, current & historic
Heritage	Heritage resource sites (sacred areas, cemetaries, etc.)
Land Status	Protected areas (parks,reserves)
Land Status	Protected area buffer zones
Land Status	Land uses (agriculture, urban, forest, etc.)
Planning	Management Zones
Socio-Economic	Attitudes, values, beliefs (including towards protected areas)
Socio-Economic	Fires, agricultural burning
Socio-Economic	Forestry concessions
Socio-Economic	Human waste disposal sites
Socio-Economic	Illegal activities monitoring (poaching, trawling, ...)
Socio-Economic	Infrastructure, lines (pipelines, utility lines...)
Socio-Economic	Infrastructure, points (cell towers, wells, airstrips, boat docks...)
Socio-Economic	Markets (size, bushmeat)
Socio-Economic	Mineral and Oil concessions
Socio-Economic	Mineral and Oil reclamation areas
Socio-Economic	Plantations
Socio-Economic	Populated places (villages, cities, logging camps, fishing camps, etc. with population & other census info)
Socio-Economic	Roads, trails and use level
Socio-Economic	Subsistence activities/zones (hunting, fishing, firewood gathering)
Vegetation	Rare plant populations
Vegetation	Vegetation classification
Water	Precipitation/Weather data
Water	Rivers (with navigability)
Water	Water quality monitoring
Water	Waterbodies
Water	Watersheds
Wildlife/Veg	Invasive species populations
Wildlife	Wildlife critical areas (mineral deposits, bais, mangroves,...)
Wildlife	Wildlife known areas of concentration, feeding areas, etc.
Wildlife	Wildlife observations
Wildlife	Wildlife surveys

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Acronyms

AWF	African Wildlife Foundation
CARPE	Central African Regional Program for the Environment
DRC	Democratic Republic of Congo
DSS	Decision Support Systems
MARXAN	Marine Reserve Design using Spatially Explicit Annealing
MLW	Maringa-Lopori-Wamba
UCL	l'Université catholique de Louvain, Belgium
UMD	University of Maryland
USAID	US Agency for International Development
USFS	United States Forest Service