



Using Marxan as a tool to make scientifically sound decisions considering trade-offs involving conservation actions and development under climate change

A Case Study from the Kilimanjaro Ecosystem, Kenya/Tanzania

19–20 June, 2014; AWF Conservation Centre, Nairobi, Kenya



AFRICA BIODIVERSITY COLLABORATIVE GROUP



This report is made possible by the generous support of the American people through the United States Agency for International Development (USAID) under the terms of Cooperative Agreement No. RLA-A-00-07-00043-00. The contents are the responsibility of the Africa Biodiversity Collaborative Group (ABCG). Any opinions, findings, conclusions, or recommendations expressed in this publication are those of the authors and do not necessarily reflect the views of USAID or the United States Government. This publication was produced by **African Wildlife Foundation and Wildlife Conservation Society** on behalf of ABCG.

Project overview

Facing limited conservation resources, conservation managers and planners often need to make trade-offs in what they want to conserve and where. Such decisions may involve multiple stakeholders with dramatically different priorities, further complicating the decision making process. These decisions are also being made against a backdrop of all prior land-use decisions, which have often proved to be short-sighted, leading to sub-optimal outcomes for all stakeholders. Climate change impacts such as shifting species ranges and changes in agricultural productivity further complicate the outlook. To address these often difficult resource allocation problems a suite of decision support tools have been developed to assist managers. One such tool, MARXAN, has been used around the globe to identify critical areas for species and ecosystem conservation that minimize the impact of conservation decisions on other stakeholders. MARXAN can also be used to assess trade-offs between competing objectives, or to identify where offsets for development impacts (e.g. forestry, farming etc) would be best sited.

The African Wildlife Foundation (AWF) with technical support from the Wildlife Conservation Society (WCS) held a two day workshop at the AWF's Conservation Centre in Nairobi in September 2013 to expose conservation managers, planners, members of the development community and government to MARXAN and how it can improve decision-making for all concerned. We initiated a case study using the Kilimanjaro Ecosystem straddling the border of Kenya and Tanzania to develop scenarios that enabled exploration of the trade-offs between biodiversity conservation, carbon mitigation/REDD+ projects, in land use planning, and provided a platform to consider the impacts of climate change and other development projects.

Woodlands are important ecosystems in East Africa sustaining important plant and animal biodiversity and delivery of ecosystem services. Currently, these woodlands are being cleared or degraded at an unprecedented rate. This loss will compromise biodiversity, ecosystem services, and contribute significantly to ongoing carbon emissions. It is therefore important to identify and prioritize forest and woodland areas that will achieve large conservation and mitigation gains considering their conservation value in the contemporary context and that under climate change, so as to achieve the greatest return on limited conservation and REDD+ investment. Such interventions should also attempt to minimize social cost, and increase ecological connectivity to enhance resilience to climate change and human pressures. This USAID funded project aims to provide case studies of how to integrate the objectives of climate change mitigation, climate change adaptation, and biodiversity conservation into a single planning framework that achieves the three objectives while minimizing impacts on competing land

uses. The spatially explicit planning framework and scenario planning approach is designed to allow stakeholders to identify clear trade-offs and prioritize robust investments at the landscape scale.

The September 2013 workshop outlined that challenges and how systematic conservation planning could be used to address them. This report details the proceedings of second workshop held in June 2014 that followed up on the process started in September 2013. The objective of the second workshop was to help inform planning in the Kilimanjaro Ecosystem, by providing examples for how climate change and development could be integrated into a spatially explicit planning process, and to develop a communication strategy to convey findings to various target audiences. Based on the recommendations of participants in the first workshop, we revised data inputs and analyses between September 2013 and June 2014. The preliminary findings based on the outcomes of those analyses were presented for comment at this workshop.

The aim of this report is to provide a summary of the two-day workshop. The agenda for this workshop can be found in Appendix 1. The meeting was well attended with members of USAID, Kenya Wildlife Service (KWS), Tanzania Wildlife Research Institute (TAWIRI), African Conservation Centre, the Geologic Society of Kenya, School of Field Studies, and the Ministry of Agriculture. The full list of attendees is included in Appendix 2.

Workshop Goals

1. Review new data and Marxan-generated scenarios to explore tradeoffs, highlight major related challenges, and identify analysis areas for refinement.
2. Develop landscape storylines constructed around desired outcomes across specific themes (e.g., water resources, wildlife species, land uses).
3. Develop a communication strategy involving communication materials and storylines tailored to individual audiences such as policy makers and land use sector leaders.

Welcome

David Williams of AWF welcomed the attendees and began by offering the conservation context of the workshop emphasizing how the Kilimanjaro Landscape is the focus of expanding development pressures including human population growth, external investment, and subdivision. The rate of development is accelerating a trend that is likely to continue in the future. While the development will bring many benefits to the region, it could also pose challenges that undermine those gains. The major conservation planning questions include: what land sectors will expand, where? How will these changes influence conservation priorities? What will happen to the intersection of land use and conservation interests under climate change? What will be the impact of all these changes on conservation in the region and the tourism that it supports?

Given the speed and complexity of change today, the historically reactive conservation approaches are insufficient. With this project, we strived to develop a methodology that enables stakeholders to make informed decisions based on what is likely to happen given prevailing trends in the landscape. Because about half the participants did not attend the first workshop, we devoted a portion of the second workshop to reviewing background information and providing an overview of the planning process.

Kamweti Muto of ABCG provided a brief introduction to ABCG and discussed how the Kilimanjaro effort is one of three parallel landscape conservation planning exercises sharing the same tools and Marxan-based methodology.

Kilimanjaro landscape overview

Noah Sitati, the Kilimanjaro Landscape Director, led the workshop through profiles of salient conservation features in Kilimanjaro as well as the conservation threats the landscape is experiencing. Noah discussed the rationale for conservation targets selection in addition to the AWF framework for

identification and prioritization of threats within the Kilimanjaro landscape. The talk highlighted many of the conservation interventions AWF and partners are currently employing in the region.



Figure 1. Clockwise from top left: David Williams, Dan Segan, Dave Loubser, Noah Sitati, and Lucy Warungi. Photos courtesy of Kamweti.

Climate change work in the Kilimanjaro region

Lucy Warunigi, Executive Director at the African Conservation Centre (ACC), briefed the workshop on ACC's climate change work in the region. ACC's research history in the Amboseli area extends back to 1967 and they have documented land use and vegetation dynamics for the last 50 years. ACC partnered with the Missouri Botanical Garden and others to conduct a vulnerability assessment of the Kenyan borderlands—a region spanning Serengeti-Maasai Mara area in the west to Tsavo and Mkomazi in the east. The assessment considered the cumulative impacts of climate change and landscape fragmentation and their impact on biodiversity and local livelihoods. The project compiled an extensive plant occurrence database and used it to model predict habitat suitability for a host of plant species. Other components investigated climate change impacts on local water flows and availability and land

conversion patterns. The work helped to inform ACC future research agenda and interventions to improve resilience by promoting adaptation in pastoral systems. ACC and AWF are building on this by developing a vulnerability and adaptation framework for dry land /savanna ecosystem processes and services.

Review of the data

David Williams, AWF Director of Conservation Geography, presented the input data that the project had sourced and generated principally as inputs to the spatially explicit scenario modelling. Data assembly efforts emphasized conservation targets—both species and ecological systems targets, land uses that dominate the landscape, and core datasets (e.g., land use/land cover) that enable sound predictions of feature distributions under current and future climates. David provided a brief overview of species distribution modeling (SDM) theory and model generation in this project using the SDM software, MaxEnt. The talk highlighted significant data acquisitions and processing that had occurred since the first workshop, including:

- Two contemporary aerial survey data from wet/dry seasons and spatial input from breakout groups in the first workshop
- Changes in the geographic scope—the analysis areas increased 35%,
- Development of seasonal distribution maps that captured the impact of climate phenomena like droughts.
- Improvements in the individual SDMs. The SDM Toolbox, a software designed to improve SDM predictive performance using MaxEnt by facilitating application of best practices, was used to filter out redundant environmental (independent) variables and counter spatial autocorrelation in the species observations.

His talk concluded with examples and discussions of SDM outputs and outstanding data gaps. He also discussed the between species differences in observed responses to past climatic variability.

Figure 2. Photos of the species and land use working groups captured as the reviewed the data collected on day one of the workshop.

Marxan Demonstration

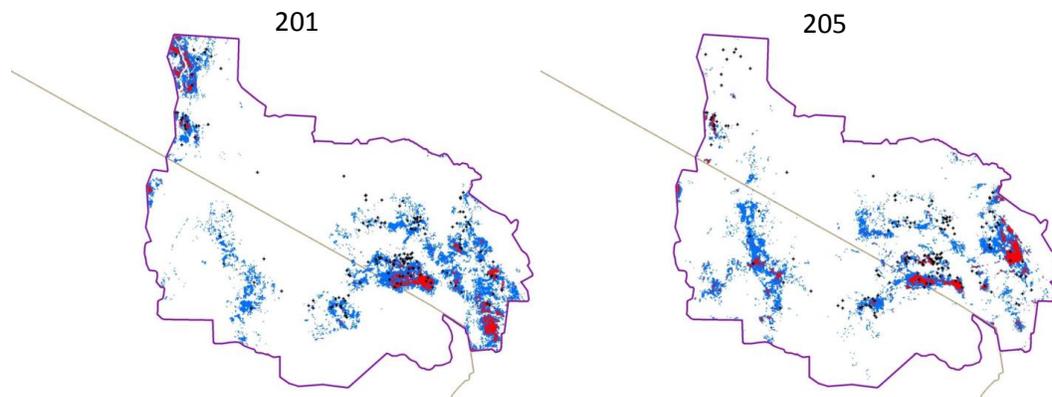


Figure 1. Forecasted extent of suitable ecological conditions for elephants in the Kilimanjaro Landscape today (left) and the forecasted extent of the similar habitat in 2050 (right). Blue areas indicate lower probability of occurrence and red areas indicate higher probability of occurrence. The suitable habitat in 2050 is based only on where elephants were observed during a dry "wet season" count (April 2013). The April 2013 count was one of three contemporary aerial total counts used to identify areas in the landscape where elephants aggregated.

Systematic Conservation Planning

Dan Segan, a WCS Conservation Planner, introduced the group to the origins, principles and sample applications of systematic conservation planning. That set the stage for an overview of decision support tools and how they fit into conservation planning and finally, the principle decision support tool used in this project, Marxan. Dan articulated reasons why projects around the world use Marxan, emphasizing its ability to consider multiple factors (costs, biodiversity, spatial constraints) and systematically generate transparent, repeatable data-driven solutions that facilitate understanding and decision-making. To orient the group to the mechanics of Marxan, Dan then led a 'Reserve design game' that challenged participants to solve a simple spatial optimization problem manually. Participants attempted to manually identify areas two work that would achieve conservation objectives for three species while minimizing overall cost. As a group we then looked at the Marxan identified solution, compared it to the solutions identified by individual participants, and discussed the challenge of making multi objective decisions.

Dan then presented an overview of the major steps involved in a Marxan project before highlighting examples of Marxan in practice from across the globe. He closed his talk by offering a perspective on

systematic conservation planning under climate change noting that planning for climate change requires consideration of the suite of changes, and not just incorporation SDMs that use mean climate conditions to predict change in suitable range. The full suite of climate impacts that should be considered includes consideration of how changes in the intensity and frequency of extreme events and incorporation of how people are likely to respond to climate changes.

Climate change observations and responses

Dave Loubser, the AWF Climate Change Director profiled current and likely climate changes and the impacts they are likely to have. He then summarized input from the first workshop on observed impacts and responses to climate change in order to stimulate a discussion that elucidated observations of new impacts or related responses in the Kilimanjaro region. Participants cited a number of ways in which they felt the climate of the region had already changed.

Kilimanjaro landscape analysis region considering development and climate change.

Dan Segan presented the results of the Marxan analysis highlighting key findings and trade-offs. He started by explaining the steps involved in creating the Marxan database (covering parameterization, conservation targets and costs), and the priority conservation areas identified based on contemporary climate conditions. From there, he demonstrated how emphasizing the influence of land uses such as human settlement areas and the anticipated growth of the agricultural or mining sectors altered conservation target spatial solutions generated by Marxan (Figure 2).

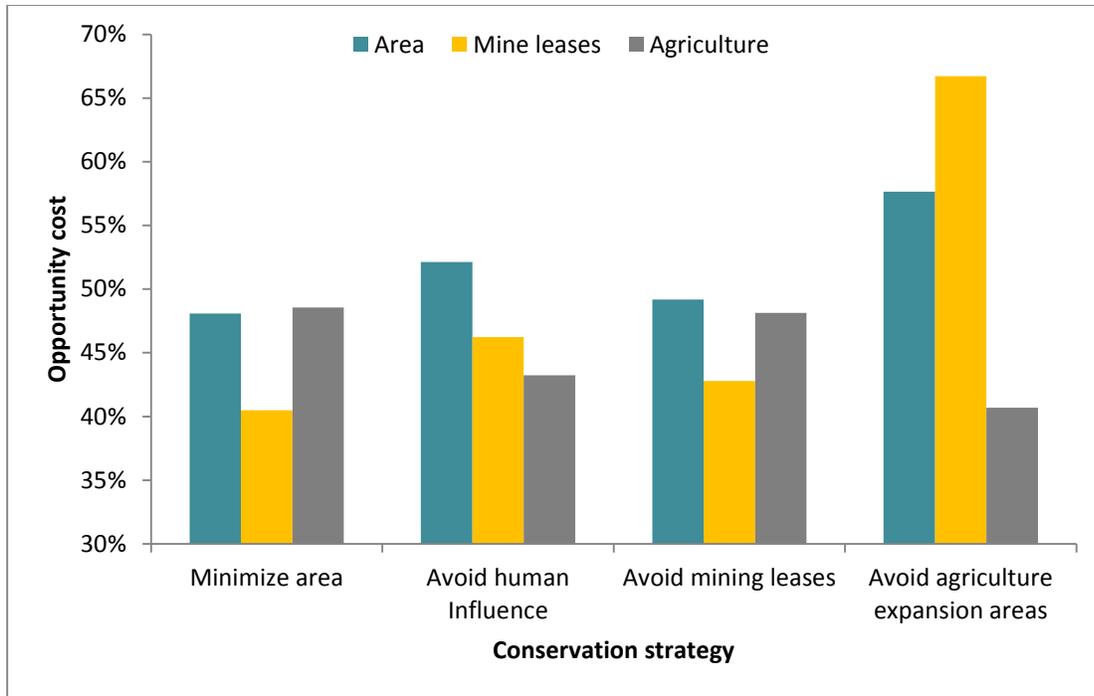


Figure 2. The distribution of opportunity cost of conservation under four different conservation strategies. Opportunity cost measure as the proportion of mapped area of interest for each use included in conservation zones.

The discussion of results then shifted to how the potential impacts of climate change were integrated into the analysis to develop climate-adjusted scenarios and identify priority areas under those scenarios. Figure 3 compares a drought model generated using species observations recorded under severe drought versus that that generated with observations under more average precipitation.

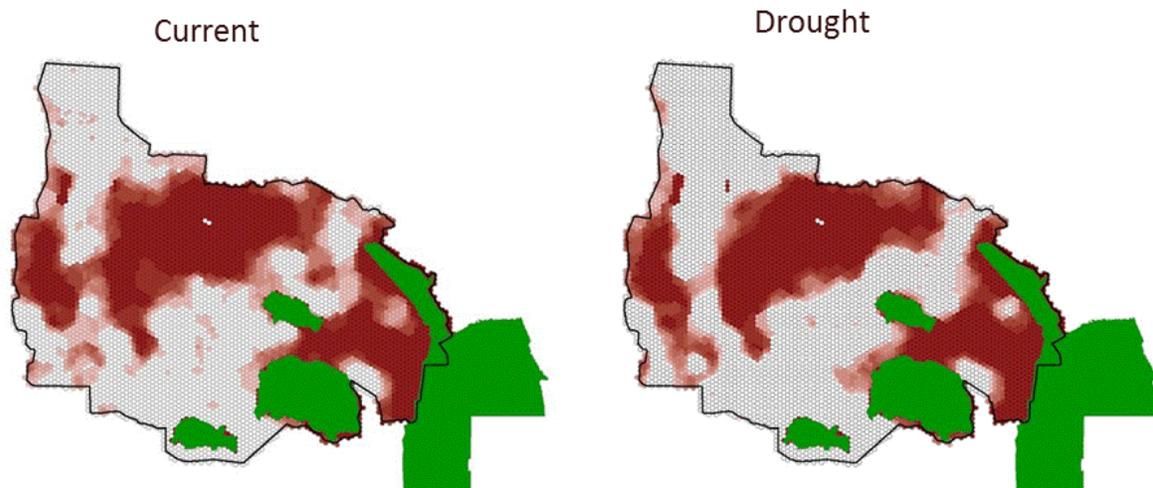


Figure 3. Change in priority conservation areas under contemporary average climate as compared with that for severe drought conditions. Darker red areas represent sites identified more commonly as being part of the Marxan solution set; grey areas are excluded from solution sets; green areas are national parks.

Breakout Group Discussion

Participants were then divided into smaller groups for a breakout session to review the results in greater detail. Each group was asked to frame their discussion around the four questions listed below and then report back to the full group on each discussion points.

- Do the results make sense?
- Develop recommendations for improving the analysis.
- What scenarios are missing? (E.g. should greater emphasis be placed on climate change or integration of future development projects?)
- Are the conservation targets appropriate?

Participants felt that the results were generally sound and consistent with observations on the ground and appreciated how conservation blocks and potential corridor links were clearly identified.

Suggestions to improve the analysis included:

- More data collection through collaboration with partners to improve conservation target representation and expand the study areas to include more of the ecosystem.
- Expert review and ground-truthing for verification and perhaps calibration of results.

- Further exploration of scenarios, especially with respect to future land use change, and impact on critical habitat areas. Scenarios could factor in natural disturbances such as wildfires and floods that can influence ecosystem processes.
- Add or emphasize climate sensitive species and better represent species guilds such as carnivores and non-mammalian taxa.

From Analysis to Action: What does this analysis mean for conservation?

After the full group discussion of the results, David Williams initiated another breakout session by posing a series of questions surrounding potential implications of the analysis for the groups to consider, including:

- What new opportunities arise from the analysis?
- Should conservationists reposition efforts geographically?
- How might engagement with different sectors or actors be influenced?
- What barriers to positive change/action are presented?

Some of the salient group recommendations follow:

- Engage other sectors and industries such as mining, water, agriculture, government agencies more directly and at different levels (e.g., national and county/district level). Capitalize and inform existing planning processes such as Kenya's Vision 2030.
- When designing interventions, consider the political elements of the landscape.
- Gather more information from the Chyulu region, especially on water resources
- Conduct a summary analysis of a suite of scenarios to determine priority conservation areas.
- Barriers to change include government inertia, rigidity, and political interference.
- In order to engage a wide range of audiences, results need to be interpreted or made more accessible.

Communication of results

In order for our findings to make a difference, they need to influence decision-makers in conservation, government, and the private sector. Dan Segan led a discussion addressing the question: How do we convey our results effectively to various audiences and how do we expect these audiences to use them?

There was strong consensus among participants that in Kenya, the group should engage Kenya's 2030 process to create a long-term development blue-print that aims to transform Kenya into a middle-income country. In particular our findings could influence 2030 planning related to land reforms and infrastructure development. In Tanzania, the project could inform regional environmental impact evaluations for several proposed infrastructure projects including the proposed electric transmission line from Namanga to Singida. In both countries, the project should design communication materials to engage respective government ministries of environmental management, lands, agriculture, and water resources.

Workshop conclusion and next steps

The workshop concluded with a discussion of next steps. The project leadership will consider implementation of recommendations from the two workshops including additional data input and scenarios to revise findings and refine the communication strategy as steps towards final communication materials. The project will continue to shape AWF's adaptation program. Most immediately, AWF will work with ACC and other partners to assimilate components of the project findings and approach into its dryland/savanna vulnerability and adaptation framework.

Appendix 1. Workshop agenda

Day 1 – Thursday, June 19			
Time	Topic	Description	Speaker
8:30 – 9:00	Arrival	Registration	
9:00 – 9:15	Welcome	Why are we here?	David Williams
9:15 – 9:30	Intro to ABCG	What is ABCG?	Kamweti Mutu
9:30 – 10:00	Introductions	Participant introduction and workshop objectives	All
10:00– 10:30	Landscape review	Overview of conservation values and major processes impacting conservation work in the Kilimanjaro region.	Noah Sitati
10:30 - 11:00	Climate change in the region	African Conservation Centre climate change work in the Kilimanjaro region.	Lucy Waruingi
11:00 – 11:20	Coffee/Tea break		
11:20 – 12:15	Data review	Review of information available to support planning. How has new information been incorporated since the last workshop?	David Williams
12:15 – 12:45	Discussion	Discussion of the data available	All
12:45 – 1:45	Lunch		
1:45 – 2:15	Systematic conservation planning	Using the information to inform decision making. What is Marxan? How does it support systematic conservation planning?	Dan Segan
2:15 – 2:45	Reserve Design exercise		Working groups
2:45 – 3:00	Coffee Break		
3:00 - 3:30	Systematic conservation planning (cont.)	How has Marxan been applied in practice?	Dan Segan
3:30 - 4:00	Observed Impacts	Observed impacts and responses to climate change identified at the first workshop	Dave Loubser
4:00 – 4:15	Discussion		All
4:15 – 4:30	Day 1 wrap-up	Review of day one and overview of what to expect tomorrow.	David Williams
END OF DAY 1			

Day 2 – Friday, June 20			
Time	Topic	Description	Speaker
8:30 – 9:00	Arrival		
9:00 – 9:15	Welcome	Review of what we covered yesterday	Dave Loubser

9:15 – 10:15	Analysis	Presentation of Kilimanjaro landscape analysis region considering development and climate change. Highlight key findings and trade-offs.	Dan Segan
10:15 – 11:00	Small group discussion	Break into small groups to review/comment on analysis methodology and findings.	Working groups
11:00 – 11:15	Coffee/Tea break		
11:15 – 12:00	Group report back	Reconvene - One representative of each group summarizes the discussion within the break out groups.	All
12:00 – 12:15	From analysis to actions	What does this analysis mean for conservation?	David Williams
12:15 – 1:00	Small group discussion	From analysis to actions - new opportunities - reposition efforts geographically - engagement with different sectors or actors - barriers to change	Working groups
1:00 – 2:00	Lunch		
2:00 – 2:30	Group report back	Reconvene - Group discussion of identified opportunities and barriers to change	1 representative from each group
2:30 – 2:45	Communication of results	Identification of target audiences - How do we expect these audiences to use the findings/methods? Recommendations for landscapes that would benefit from similar processes	Dan Segan
2:45 – 3:15	Small group session	Groups develop recommendations for effectively communicating with identified audiences. Critical leverage points?	All
3:15 – 4:00	Group report back	Reconvene - Group discussion of identified communication strategies	1 representative from each group
4:00 – 4:30	Day 2 wrap-up	What have we covered? How will this information be used? What happens next?	Dave Loubser
END OF WORKSHOP			

Appendix 2. Workshop attendee list

Name	Organization	Position
Sammy Weru	USAID-East Africa, Env. And Global CC	Program Development Specialist - Biodiversity and WASH
Samuel Bakari Wana	TAWIRI	Researcher
Dr Maurus Msuha	TAWIRI	Principal Research Scientist
Dr Benard Kissui	SFS	Center Director
Dr Moses Makonjio Okello	SFS	Senior Director, East Africa / Center Director, Kenya
Dan Segan	WCS	Conservation planner
Beatrice Nyamwamu	Ministry of Agriculture Representative	Agricultural Officer
Wycliffe Mutero	KWS	Senior GIS Analyst
Matthias Mwavita	KWS	Senior Warden, Chyulu NP
Zainabu Salim	KWS	Amboseli NP Warden
Richard Parsitau	Kajado County Govt	
Moses Masibo	Geologic Society of Kenya	Chairman
Nathan Gichohi	AWF	Kilimanjaro Ecologist
Dave Loubser	AWF	Director-Climate Change
Dr Noah Sitati	AWF	Kilimanjaro Landscape Program Manager
David Williams	AWF	Director-Conservation Geography
Michael Maina	AWF	Sr. GIS Officer
Irene Muthuka	AWF	GIS Officer
Edwin Tambara	AWF	Conservation Planner
Enos Omondi	AWF	Monitoring and Evaluation Officer
Per Karlsson	AWF	Program Design Officer
Lucy Warungi	ACC	Executive Director at African Conservation Centre
Kamweti Mutu	ABCG	ABCG Officer