MEETING REPORT

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

18-19 September, 2013; AWF Conservation Centre, Nairobi, Kenya

Project overview

Facing limited conservation resources, conservation managers and planners often need to make trade-offs in decisions regarding 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 be short-sighted, leading to sub-optimal outcomes for all stakeholders. Climate change impacts such as shifting species ranges complicate the picture further 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 cited.

The African Wildlife Foundation (AWF) with technical support from the Wildlife Conservation Society (WCS) is holding a two day workshop at the AWF's Conservation Centre in Nairobi on September 18-19 2013 to expose conservation managers, planners, members of the development community and government to MARXAN and how it can be used to improve decision-making. We aim to do this through analyzing a case study of the trade-offs between biodiversity conservation, carbon conservation, and development under climate change in the Kilimanjaro Ecosystem straddling the border of Kenya and Tanzania.

Forests and miombo 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, but also compromise our ability to mitigate climate change in the region. 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 for REDD+ into one overall goal that maximizes 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. This workshop will review the tools, modeling approach, data inputs, and preliminary results to set the stage for another round of analysis and presentation of final results at a second workshop in early 2014. Both workshops will inform the process of developing an integrated general management plan for the Kilimanjaro Ecosystem.

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

Workshop Goals

1) Introduce scenario planning using Marxan to explore trade-offs in landscape prioritization
2) Review and refine modeling input data; identify gaps, and shortcomings in the methods
3) Review modeling results and understanding of landscape climate change impacts to draft recommendations for further research/modeling effort
4) Begin development of planning scenarios

Welcome

Dave Loubser of AWF welcomed workshop attendees and provided an overview of the series of workshops planned under this project fits within AWF wider objectives for the landscape. He stressed that the results presented in the workshop were preliminary in nature, and that the primary objectives

of the workshop were to introduce attendees to the methodology and solicit advice on additional information to support the analysis. He stressed AWFs hope that the analysis would be a collaboration between all partners, and that through that collaboration the results of the analysis would be much improved. David Williams then gave an overview of the USAID BATS program through which ABCG and the workshop were funded. David explained how the workplan is part of a collaborative effort between three NGOs (AWF, JGI, WCS) and that similar workshops were being held in two other African landscapes.

Kilimanjaro landscape overview

Noah Sitati set the stage for the workshop by covering the conservation challenges the landscape is currently facing. He talked about the how the conservation targets of the landscape were selected and 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.

Introduction to systematic conservation planning and the Marxan optimization tool

Dan Segan then explained the theoretical underpinnings and origins of systematic conservation planning. The talk covered the fundamentals principles of systematic conservation planning, including stating of quantifiable objectives, complementarily, efficiency and an emphasis on an engaged and participatory planning process. The Marxan decision support tool was introduced to attendees with an overview of how the tool has been used to explore trade-offs in other landscapes. The presentation led to an interesting discussion about the role of cost in the identification of conservation priorities.

Review of the data

David Williams gave a presentation on the data that had been gathered to support the planning processes to date. He covered both the biodiversity data used in the analysis as well as the socio economic layers that could be included. The talk walked participants through how datasets were identified and collected, and how they would be used within the Marxan planning framework. David also provided attendees within an overview of theory behind species distribution modeling (SDMs) and

how SDMs would be used in the analysis to define contemporary and future scenarios for key conservation target distributions in the landscape (Fig 1).

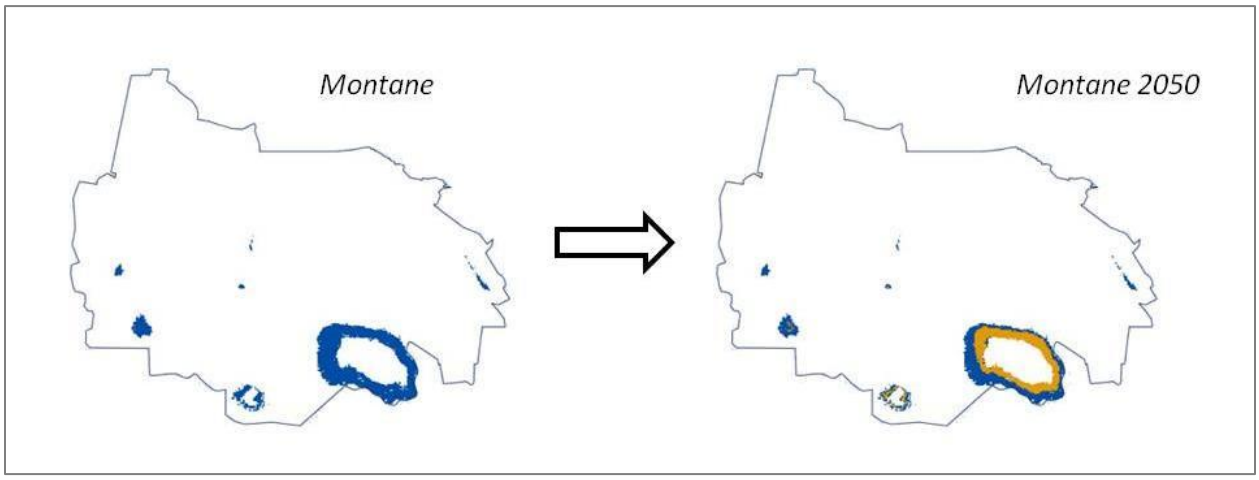

Figure 1. Example species distribution model of the extent of Montane ecosystem in the Kilimanjaro Landscape today (blue areas) and the forecasted extent of the ecosystem in 2050 (orange areas) Change in priority conservation areas when integrating potential future development.

After David's talk participants were divided into three working groups based by their individual areas of expertise and interest. The three working groups were 1) Water resources, 2) Land use and 3) Species. Each working group was provided with a specific set of instructions and detailed maps characterizing available data for the region (Fig 2).

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

The working groups were tasked with reviewing the data in their subject area and asked to identify gaps in the current data and provide recommendations for addressing those gaps before the second workshop. Each group was asked to focus on the identification of pre-compiled datasets that could be leveraged to support the analysis, rather than the design of new lines of scientific inquiry. Specific instructions provided to each group are included in appendix 3. After the session each group provided a review of what they had discussed to the full workshop.

Marxan Demonstration

Dan Segan demonstrated the Marxan decision tool for the workshop and walked users through how the data compiled for the preliminary analysis had been integrated into the decision support tool. The session afforded participants the opportunity to iteratively explore the impact of decisions through an interactive target setting exercise during which targets were removed/added or adjusted at the suggestion of participants. David and Dan then demonstrated for participants how the information collected during the interactive mapping and data review session in the first day of the workshop could be integrated into the analysis. The regions identified by participants in the land-use working group as likely to be developed in the future were digitized in ArcGIS and then used as a cost surface within Marxan. Using areas where future development was likely to occur as a cost in Marxan meant that they were avoided when selecting priority areas for conservation action (Fig 3). At the request of workshop participants the session also included a detailed overview of how information is processed for Marxan.

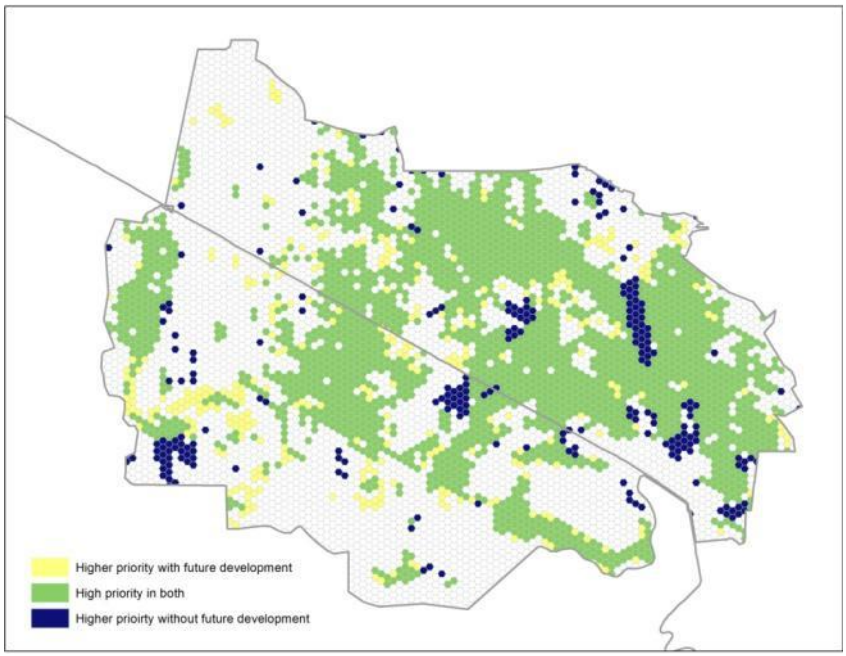

Figure 3. Change in priority conservation areas when integrating potential future development. Areas in Blue were more important when likely future develop was ignored, Yellow areas were more important when future development was considered, green areas were important in both, and white areas were less important. The conservation features and targets used in this analysis were preliminary in nature, and the map presented is meant to be indicative of how future develop could be considered, rather than a prescriptive set of conservation priority areas.

Climate change impacts and responses

Dave Loubser gave a presentation that detailed the current and potential impacts of climate change on the landscape. The linkage between climate change and other landscape stressors was stressed during the talk, and the need to consider climate change in conjunction with these other stressors, because climate change alone may not be responsible for ecological demise, but it could be the figurative "straw that breaks the camel's back". Impacts highlighted in the presentation included many of the climatic changes that have already been observed in the landscape, including increased frequency of extreme climatic events, such as the extreme drought in 2009 and floods earlier this year. The talk prompted a larger discussion of the role of climate change in the work of the represented institutions.

Following the general discussion of participants reformed in their working groups from the day before, and each group was asked to discuss two themes:

1) Have they observed any differences in the region's climate during their time on the landscape?

2) What has been the response of human communities and wildlife in the landscape to the changes in climate or extreme climatic events?

Observed climate changes

Participants cited a number of ways in which they felt the climate of the region had changed. Two examples are included below.

- Droughts have become more frequent and pronounced in the region, with the suggestion that frequency has increased from 7-10 to 3-5 years.
- Increased storm intensity coupled with land clearing and livestock grazing patterns has led to washouts and increased gully formation in much of the landscape.

Observed response to climate change and climatic extremes

Below is a subset of the examples of how extreme climatic events and changes in climate have shaped the response of communities and wildlife in the Kilimanjaro landscape. Examples of some of the responses are included below:

- The 2009 drought resulted in a massive loss of livestock (up to 60%), the die-off of livestock has lead to a redistribution of livestock among region's inhabitants with some tending larger herd sizes and others having given up livestock altogether. It has also caused many pastoralists to shift from livestock to goats whose browsing ability makes them less susceptible to droughts.
- In response to the drought many communities have moved closer to water sources or have constructed pipelines to capture and transport water from water towers.
- The loss of livestock during the drought has meant that more people are surviving off of forest products and has resulted in increased charcoal burning.
- Droughts have led to increased human wildlife conflict, especially conflict with elephants and communities for water.
- Droughts have been linked to the spread of wildlife disease, including increased prevalence of bovine tuberculosis, and it has been suggested that recent hippopotamus deaths of anthrax may be linked to spores that were buried in the soil that were uncovered as hippos were forced to dig deeper for food, uncovered the spores.

Workshop conclusion and next steps

The workshop concluded with a discussion of what would happen next in the analysis. Participants were advised that the next workshop would likely take place in early 2014, and participants should be prepared to comment on data and scenarios as they continued to be developed in the months leading up to the next workshop. All participants expressed interest in taking part in that process. Participants also expressed great interest in the steps that would follow after the next workshop and how the plan and outcomes of the workshops would be communicated to other government ministries and to stakeholders in the landscape. Specific action items outlined below:

1) Follow up with the experts and additional data sources identified in during the workshop. Participants identified over 15 additional datasets, and 13 regional experts that they recommended to be consulting during the planning process.
2) Develop resource allocation strategies and future scenarios and storylines for the landscape.
3) Refine data sets (including SDMs) used in the analysis, and re-run the Marxan analysis to identify trade-offs in the landscape.
4) Develop a communication strategy for workplan. Several participants expressed interest in widening the audience for the work, then to develop targeted communication materials for the individual audiences. It was also noted that while the internal discussion about the future of the landscape was dominated by the threats to the landscape, it is critically important that was we expand our audience for the work we are able to use a positive narrative to communicate with people in the landscape.
5) Set-up a dropbox account for the project to facilitate data sharing and collaboration

Appendix 1. Workshop agenda

Day 1 – Wednesday, September 18			
Time	**Topic**	**Description**	**Speaker**
8:30 – 9:00	Arrival	Registration	
9:00 – 9:15	Welcome	Why are we here?	Dave Loubser
9:15 – 9:30		What is BATS/ABCG	David Williams
9:30 – 9:45	Introductions		All
9:45 – 10:30	Conservation planning	Overview of conservation targets/threats and conservation planning process in the Kilimanjaro landscape.	Noah Sitati
10:45 – 11:15	Coffee/Tea break		
11:15 – 12:45	Introduction to Marxan	What is Marxan? How does it support systematic conservation planning? Example applications: case studies of how people went through the process.	Dan Segan
12:45 – 1:45	Lunch		
1:45 – 2: 45	Data	Review of data used to inform decision making in this workshop	David Williams
2:45 – 4:00	Participatory mapping and data review	Break into small groups to map expert knowledge: • Critical water resource areas • Land use: agriculture, mining, pastoralism, plantations, REDD+ • Species targets: elephants, declining ungulates, large predators, avifauna. Wildlife migration routes	Working groups (all groups comment on data used, targets and alternative sources of information)
4:00 - 4:15	Coffee/Tea break		
4:15 – 5:00	Group report back	Reconvene - review of conservation and cost mapping in working groups	1 representative from each group
5:00 – 5:15	Day 1 wrap up	Day 1 review, what to expect from day 2	Dave Loubser
Day 2 – Thursday, September 19			
Time	**Topic**	**Description**	**Speaker**
8:30 – 9:00	Arrival		
9:00 – 9:15	Welcome		Dave Loubser
9:15 – 10:15	Marxan demo	Discussion and feedback on of how the information refined/collected in day 1 can be used to inform decision making.	Dan Segan
10:15 – 10:45	Coffee/Tea break		
10:45 – 11:45	Climate Change	Overview of climate change in the Kilimanjaro landscape: trends, projections, impacts.	Dave Loubser
11:45 – 12:15	Climate Change	Livelihood diversifying potential of livestock	Mohammed Said

		based carbon sequestration options in pastoral and agro pastoral systems in Africa	
12:15 –1:15	Marxan Scenarios	Presentation of Marxan scenarios under climate change in the Kilimanjaro landscape.	Dan Segan
1:15 – 2:15	Lunch		
2:15 – 3:15	Climate adaptation strategies	Discussion of potential climate adaptation strategies/opportunities to build resilience. - water resources/catchments - land use/community adaptation - species ranges shifts/movement corridors - adaptive capacity of landscape actors	Dave Loubser
3:15 – 4:15	Participatory adaptation review	Utilize the diverse experience of the group to consolidate information, identify knowledge gaps, and draft recommendations on how to fill them using data/modeling or other means. Focus on: • Critical water resources • Land use: agriculture, mining, pastoralism, plantations, REDD+ • Species targets: distribution, abundance, seasonality, movement corridors.	David Williams
4:15 – 5:00	Group report back	Reconvene - review of conservation and cost mapping in working groups	1 representative from each group
5:00 – 5:30	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
Dan Segan	WCS	Conservation Planner, Climate Adaptation Team
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
Nuru Shabani	Tanzania Ministry of Energy and Minerals	Licensing and Mineral Rights Section
Dr Benard Kissui	SFS	Center Director
Dr Moses Makonjio Okello	SFS	Senior Director, East Africa / Center Director, Kenya
Dr Evans Mwangi	LTSI-PREPARED	Principal Consultant-LTS
Lekishon Kenana	KWS	Senior Scientist
Julius Cheptei	KWS	Senior Warden, Amboseli NP
Wycliffe Mutero	KWS	Senior GIS Analyst
Matthias Mwavita	KWS	Senior Warden, Chyulu NP
Dr Mohammed Said	ILRI	Senior Scientist-Pastoralism/Adaptation
Ademola Ajagbe	Birdlife	Regional Science and IBA Programme Manager
Philip Lenaiyasa	AWF	Senior Community Development Officer
Andrea Athenas	AWF	Program Design Manager – Agriculture and Energy
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
Fiesta Warwina	AWF	Country Director-Kenya
Michael Maina	AWF	Sr. GIS Officer
Irene Muthuka	AWF	GIS Officer
Moses Ogada Oyoo	42geomatics.com	Mining survey company
Pauline Kuruga	Geologic Society of Kenya	Chief Operating Officer

Appendix 3a. Instructions provided to direct discussion in the water resources breakout group.

Objective: review available information water resources. Identify gaps, and potential solutions.

Water resources data:

1. Wetlands – our wetlands data is derived from a combination of satellite image interpretation and classification.
    a. Are any major wetland areas missing? Please add and label on map.
    b. Which of these wetland areas are permanent water sources? Please add and label on map.
    c. Who uses these permanent wetlands—people, wildlife, livestock, all above? Please label.

2. Water features – rivers, springs, water holes, etc. Our rivers data comes from FAO-africover. AWF and partners collected other features using satellite image interpretation or GPS.
    a. Which are permanent water sources?
    b. Are there other permanent sources not on the map? Please add and label.
    c. For each permanent source, label users: people, livestock, wildlife, all above. Please label accordingly.

3. Are there other sources of such information available for this landscape? Please complete table below.

Dataset/Description	Source Organization	Source Contact

Appendix 3b. Instructions provided to direct discussion in the Land-use breakout group.

Objective: Review available information on land uses, identify gaps, and potential solutions.

Land use data:

1. Mining: Our mining data comes from the respective Ministries in Kenya and Tanzania working with a consulting firm.
    a. Please add any operational mining areas to the hardcopy map provided—label accordingly.
    b. Are any planned or highly likely mining sites missing from the landscape? Please add and label.
    c. Which of the licensed mining areas are likely to be developed in the next 5 years. Which in the next 40?

2. Agriculture: our estimation of landscape agricultural areas is currently represented by the "Agriculture-Settlement" class in the 2010 LULC product. We would like to refine this layer for the modeling.
    a. Are there areas currently marked as "Agriculture-Settlement" that contain little to no agriculture? Please mark and label on the map.
    b. What areas is agriculture likely to expand into? Please mark and label on the map
    c. What are the primary crops in the landscape? Please mark where each is grown
    d. Do you know of any regional agricultural experts that we should be in contact with? Please list name and organization
    e. What are known ecological constraints for those species:

Ecological Constraint	**Species:**	**Species:**
Elevation:		
Temperature:		
Rainfall:		
Slope:		
Other:		
Other:		

3. Plantations: Current extent of plantations was interpreted from satellite imagery.
    a. What planned or highly likely plantation expansion areas are known? Please mark and label on the map.
    b. What are the major plantation tree species in this landscape?

c. Do you know of any regional experts in plantation forestry that we should be in contact with? Please list name and organization
d. What are known ecological constraints for those species:

Ecological Constrain	**Species:**	**Species:**
Elevation:		
Temperature:		
Rainfall:		
Slope:		
Other:		
Other:		

4. REDD+/Carbon: we have above ground carbon data from Woods Hole Research Center.
    a. What planned or highly likely REDD+ sites are known? Please mark and label on the map.
    b. Which areas are experiencing high rates of deforestation? Please mark and label on the map.

5. Other land uses: did we miss any major land uses of today or the future?
    a. Are there any major road works planned in the region? Please mark and label on the map.
    b. Are there any other major development projects planned for the region (eg. Dams, Urban expansion)? Please mark and label on the map.
    c. What major land uses should we consider today? Please add footprint to map and label.
    d. What future land uses should we include in our analysis? Please add footprint to map and label.

Appendix 3c. Instructions provided to direct discussion in the species breakout group.

Objective: Review available information species targets. Identify gaps, and potential solutions.

<u>Species observation data:</u>

1. Most of our current species information comes from the 2010 aerial total count taken under drought conditions. Recognizing that many of these species are wide-ranging mammals, and that this data offers a limited snapshot, what other sources—datasets, potential organizations/individuals--are available? Please add any tips below.

Dataset/Description	Source Organization	Source Contact
2013 aerial total count	KWS/TAWIRI/ATE	Wycliffe Mutero muterow@kws.go.ke

2. Who are the primary species experts that we should be reaching out to gather more information on species?

Species or Group	Expert name | Organization | Contact information
Ex. Birds/ Carnivores / Lions	

3. We have identified information on the distribution of predators as the largest gap in data on species. Can we add any known hyena locations to the hardcopy map?
4. Are we missing any critical wildlife corridors to include in the analysis? Please draw on map.

5. What concerns or caveats would you offer about using the aerial survey data to model species distributions?

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