The WCS Albertine Rift Climate Assessment Project
conceptual approach and key outputs

Anton Seimon, WCS-New York
ABCG workshop, Washington DC
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WCS Albertine Rift Climate Assessment – conceptual approach

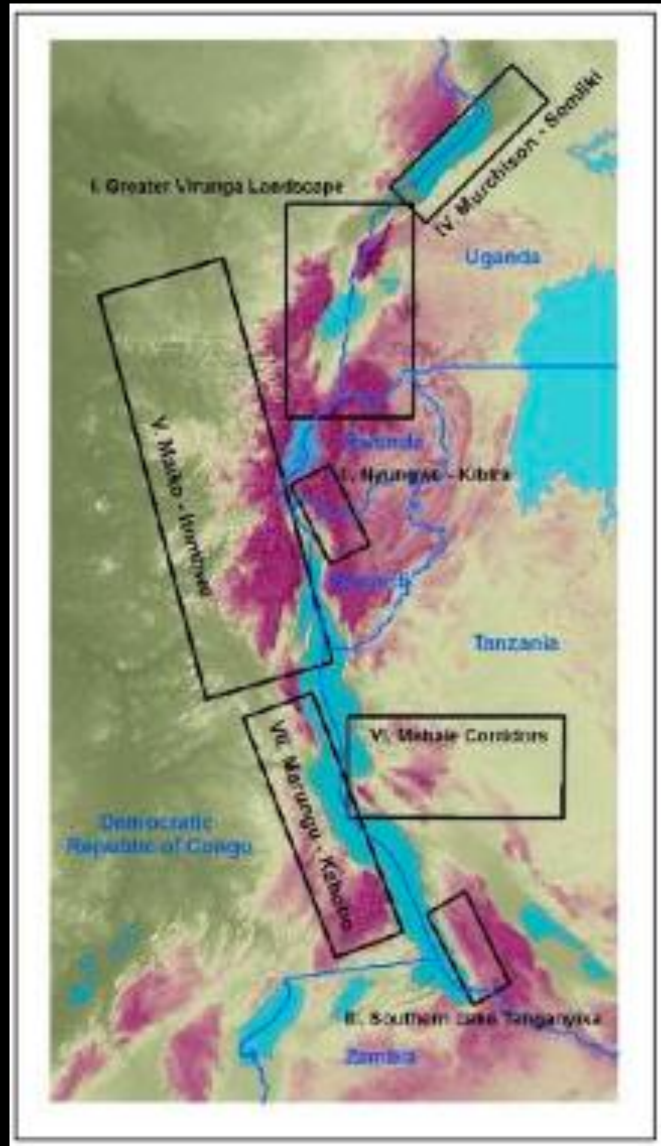
1. Climatological baseline studies
2. Ecological modeling using climate model inputs
3. Monitoring for climate change
4. Stakeholder consultation and outreach
5. Implement adaptation activities
6. Repeat process every 5-10 years

Developed *ad hoc* without a guiding framework

Complex topography characterizes the Albertine Rift

High variability in climatic conditions across space:
- Temperature is largely a function of elevation, proximity to great lakes
- Rainfall is much more complex, influenced by landform configurations

Topography: primary climatic control



Core biodiversity conservation landscapes examined in WCS Climate Assessment

Controls over regional climate

Spatial variability largely governed by topography and land surface type
= local forcing

Seasonal to annual variability influenced by factors far outside region, especially sea surface temperature patterns
= external forcing

Phase I: Albertine Rift Climate Assessment

Review all the necessary parameters to assess future impacts of climate change on biodiversity in the Albertine Rift.

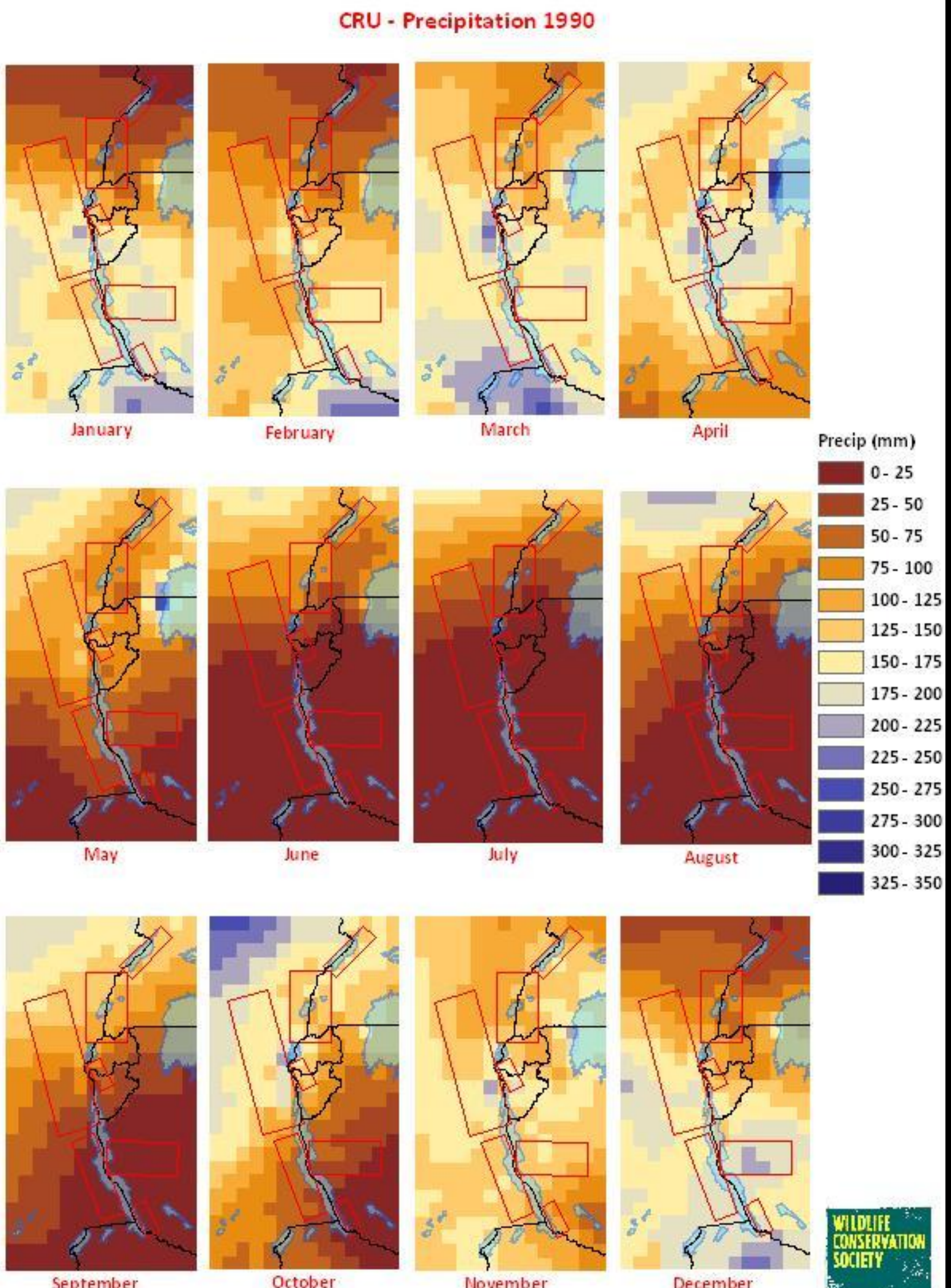
Quantify conservative-to-extreme predictions of regional climate change during the present century across the Albertine Rift.

Estimate the effect of climate change on the future distribution of biodiversity, in light of the results of review process and based on preliminary research.

Examine national and regional policy frameworks and institutional capacity for monitoring and developing adaptation to climate change in the Albertine Rift.

Precipitation climatology

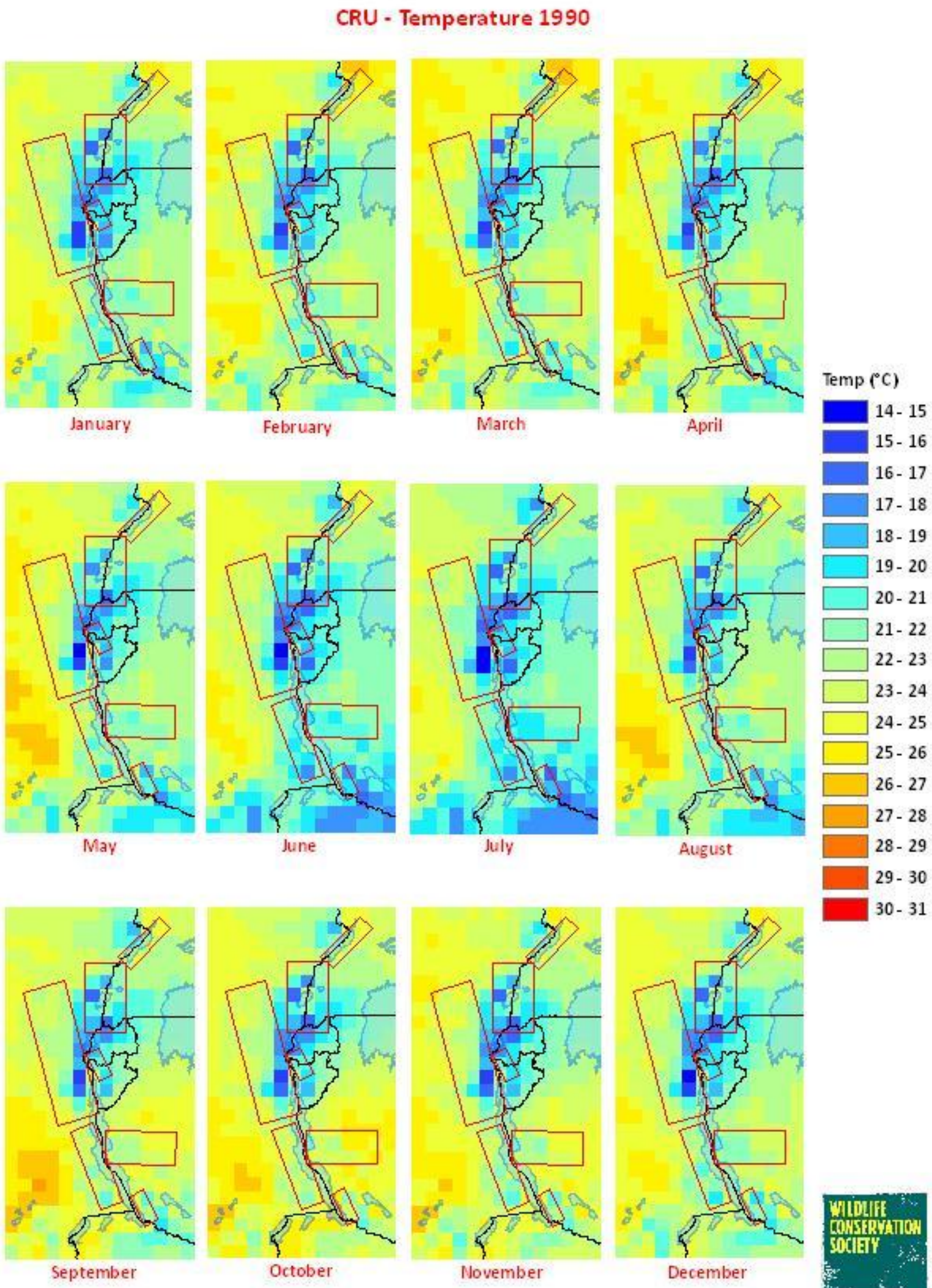
Climatological representation of monthly mean precipitation amount over the Albertine Rift project domain, based on 1980-1999 interpolated data.



Temperature climatology

Climatological representation of monthly mean surface temperature over the Albertine Rift project domain based on 1980-1999 interpolated data.

Spatial variation remains fixed in place over time, reflecting control of terrain elevation over temperature.



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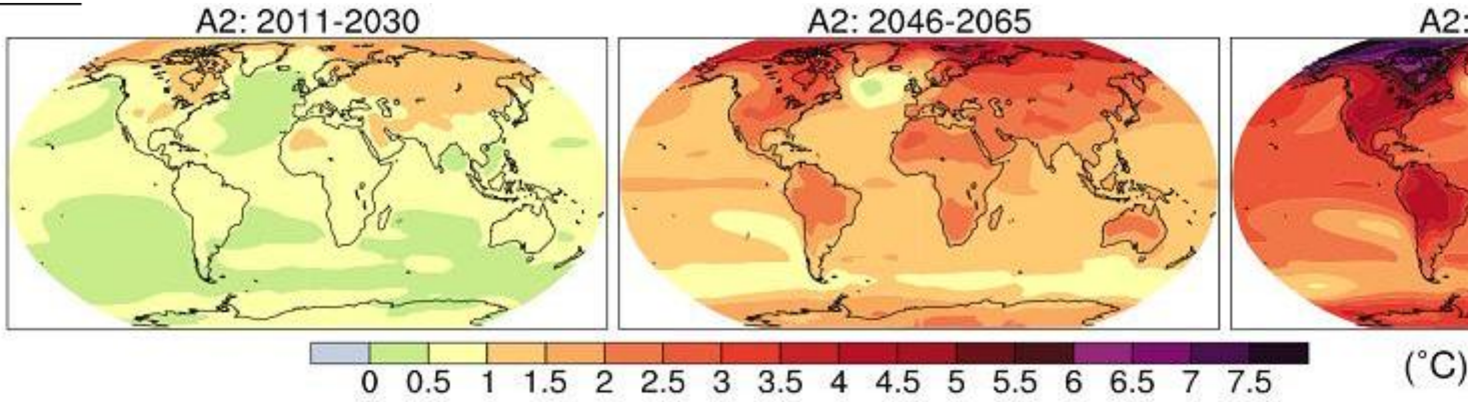
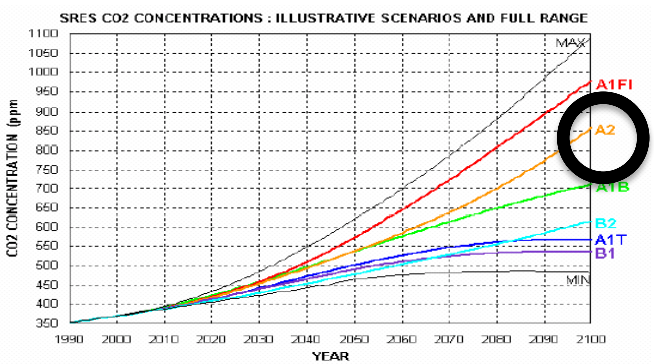
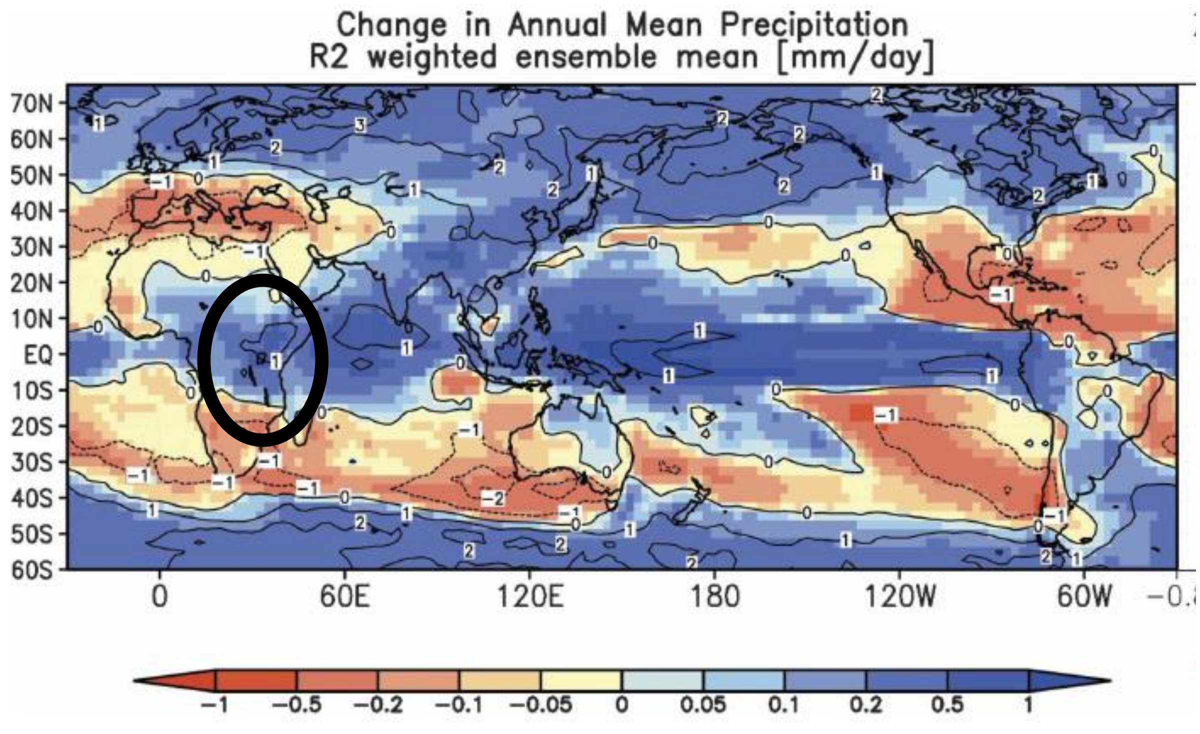
IPCC A2 scenario







IPCC multi-model projections for end of 21st century compared to present

Noharaet al.,*Journal of Hydrometeorology,* 2006

River discharge changes in 2100

derived product combining modeled precipitation and evaporation

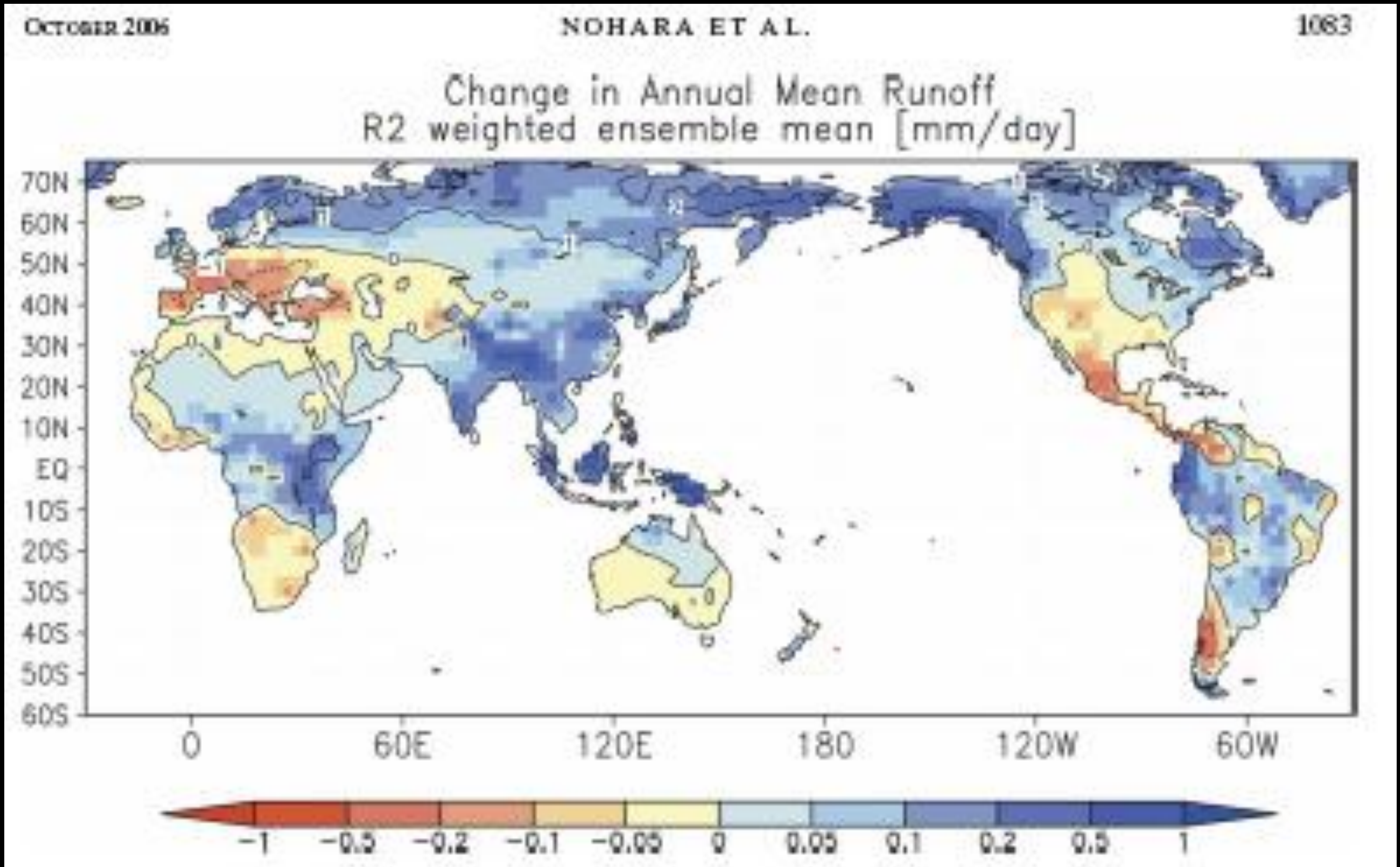


FIG. 6. As in Fig. 5, but for runoff.

Impact of Climate Change on River Discharge Projected by Multimodel Ensemble
Nohara et al.,*Journal of Hydrometeorology,* 2006

Albertine Rift modeling approach

IPCC models → inputs to dynamic vegetation models → GIS processing → products

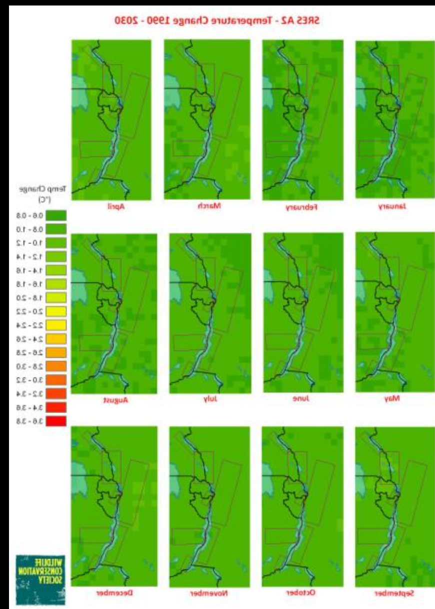
Downscaled GCM output statistics averaged over the Albertine Rift model domain – A2 emissions scenario

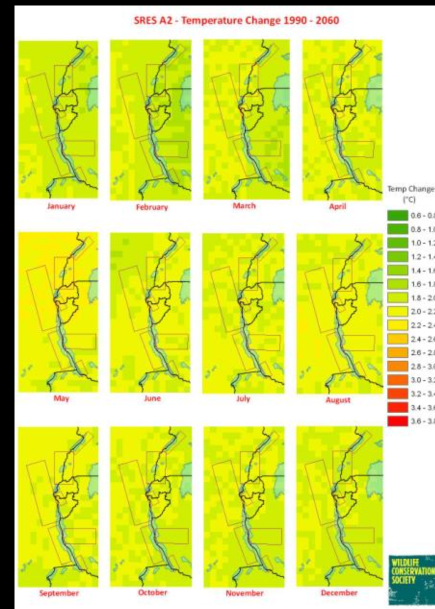
Baseline | Future →

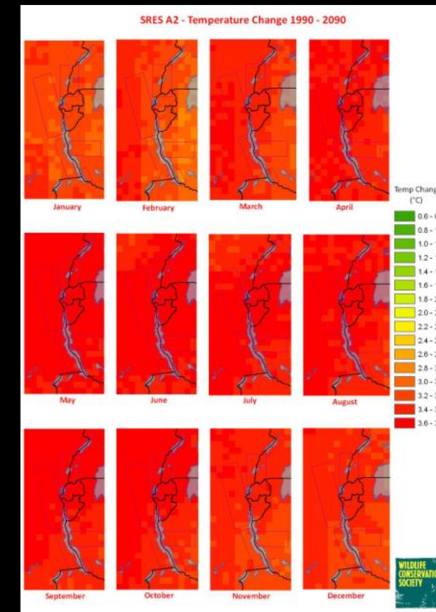
Max & Min = gridpoint extremes across the project domain
Mean = average of all gridpoints.

Downscaled climate parameters – A2 scenario

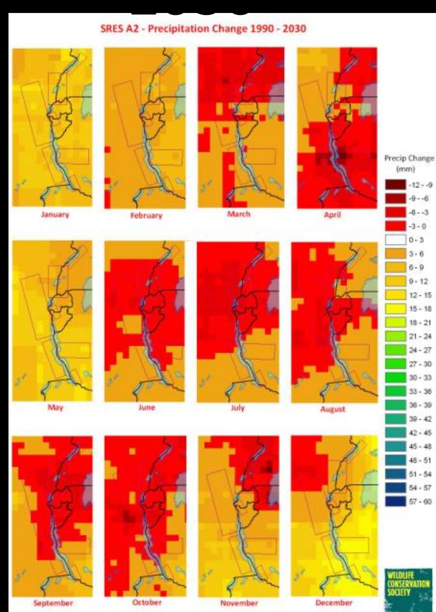
Monthly temperature changes (A2)

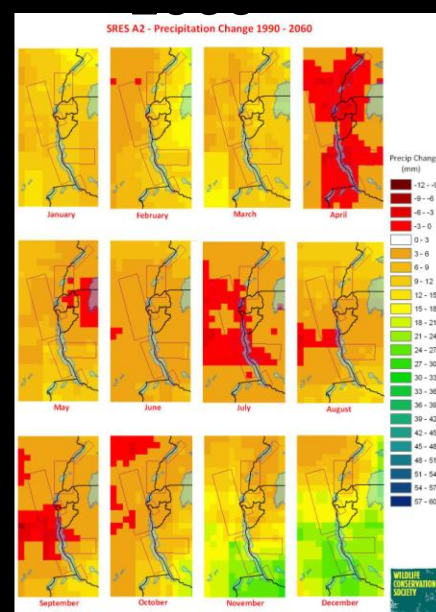


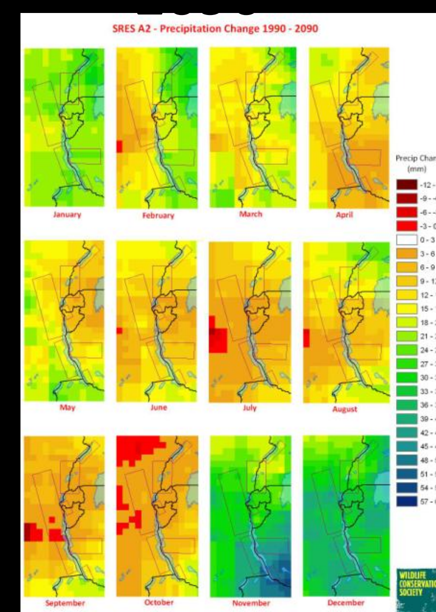




Monthly precipitation changes (A2)







Albertine Rift temperature projections – 21st century

- In the A2 simulations, temperature increases occur at an steepening rate during the course of the 21st century.

- All locations will experienced strong and sustained warming relative to current conditions.

- Lapse rate: temperatures change as a function of elevation in tropical atmospheres average 5-6°C per 1000m of elevation; region-wide thermal increase of 3.6°C under the A2 scenario would translate to upward displacements in the range of **600-720 meters**.

Albertine Rift precipitation projections – 21st century

- A2 simulations:precipitation changes are both high in magnitude and vary by location across the Albertine Rift
- Increase in net annual precipitation. Relative to the 1990, rainfall increases by 3%, 7% and 17% in 2030, 2060 and 2090, respectively.
- Redistribution in fraction of rainfall during twin wet seasons. From mid-century onward: large increase in November-December rainfall little net change in March April.

Lund-Potsdam-Jena Vegetation Model simulations

- Driven by climate and soils inputs, LPJ simulates:
  - Daily: carbon and water fluxes
  - Annually: vegetation dynamics and competition amongst 10 Plant Functional Types (PFTs)
- Average grid-cell basis with a 1-year time-step
- Spin-up period of 1000 years to develop equilibrium vegetation and soil structure at start of simulation

Procedure used to generate products specific to the Albertine Rift from raw, low resolution climate model output

OUTPUT PARAMETERS
available for each grid cell:

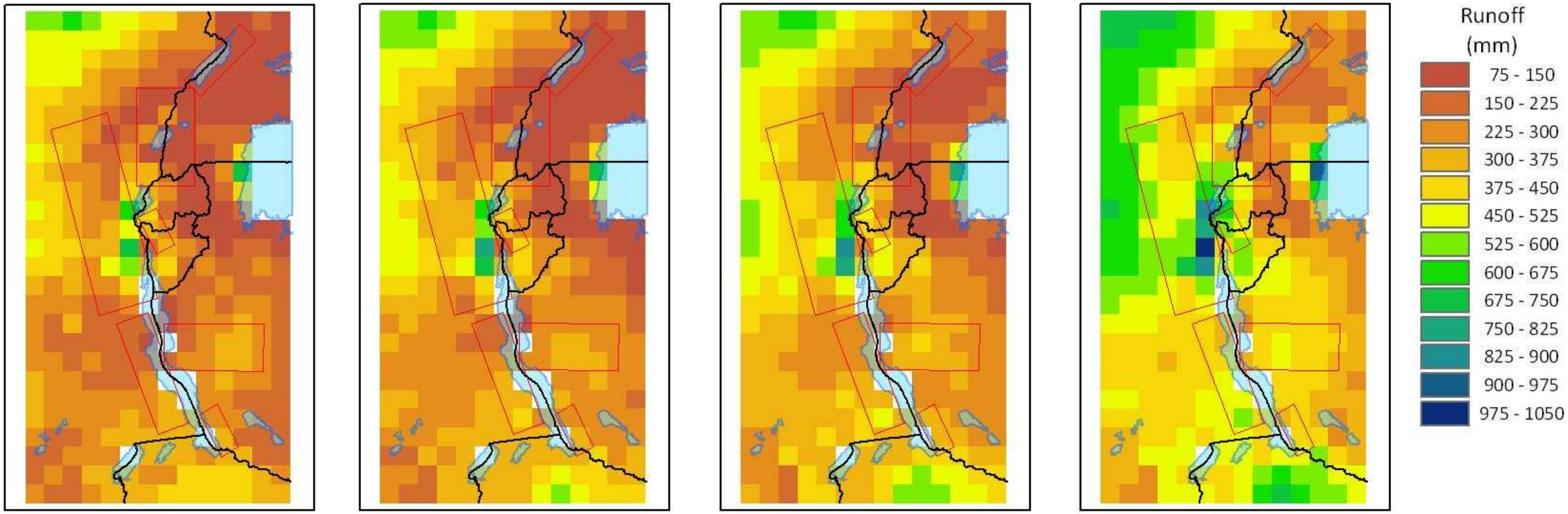
1. Climatological variables
- Monthly mean temperature (°C)
- Monthly mean precipitation amount (mm)
- Monthly mean cloud cover (%sky coverage)

2. Carbon Fluxes
- Net Primary Production (NPP)
- Land-Atmosphere flux
- Carbon Loss from Fire
- Heterotrophic respiration (Rh)

3. Carbon Pools
- Vegetation Carbon
- Soil Carbon
- Litter Carbon
- Annual Total Carbon

4. Hydrological Variables
- Total Runoff (mm)
- Actual Evapotranspiration (mm)

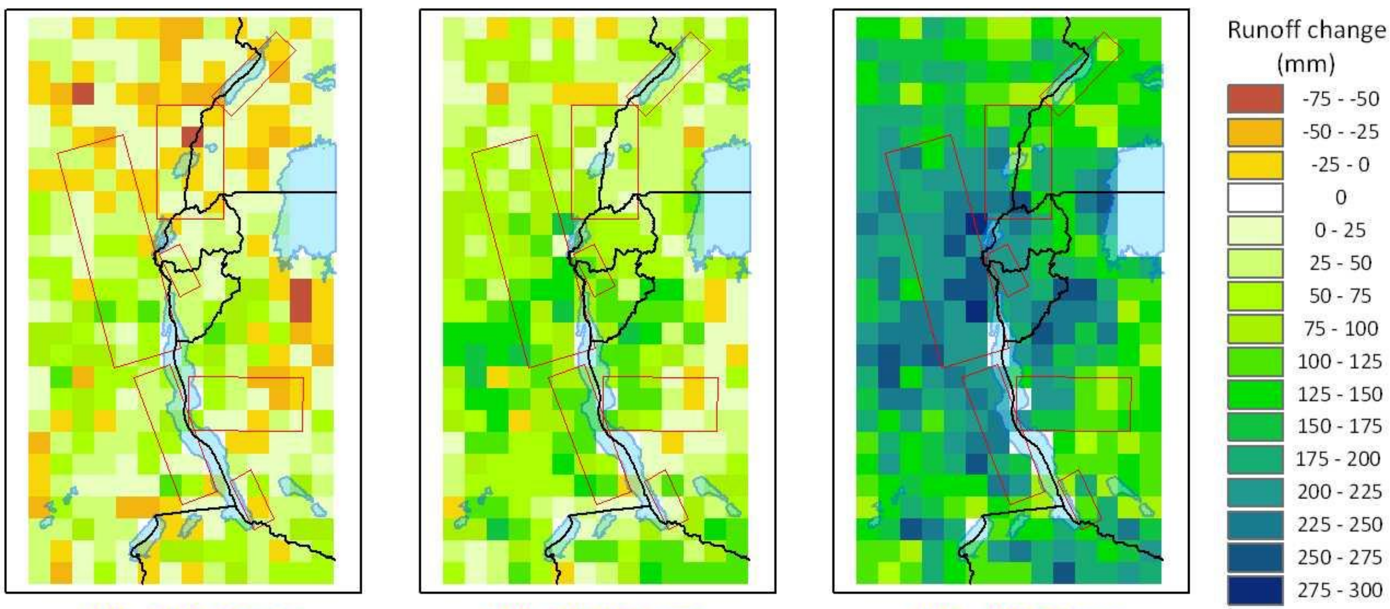
5. Vegetation and agriculture
- Annual Phaseolus Bean Yield (kg ha^{-2})
- Annual *Brachiariadecumbens* Yield (kg ha^{-2})
- Annual Maize Yield (kg ha^{-2})
- Fractional Cover of Plant Functional Type (%0



1990 | 2030 | 2060 | 2090

LPJ predicted hydrological variables and change in hydrological variables under the SRES A2 scenario

Total runoff



1990 - 2030 Change | 1990 - 2060 Change | 1990 - 2090 Change

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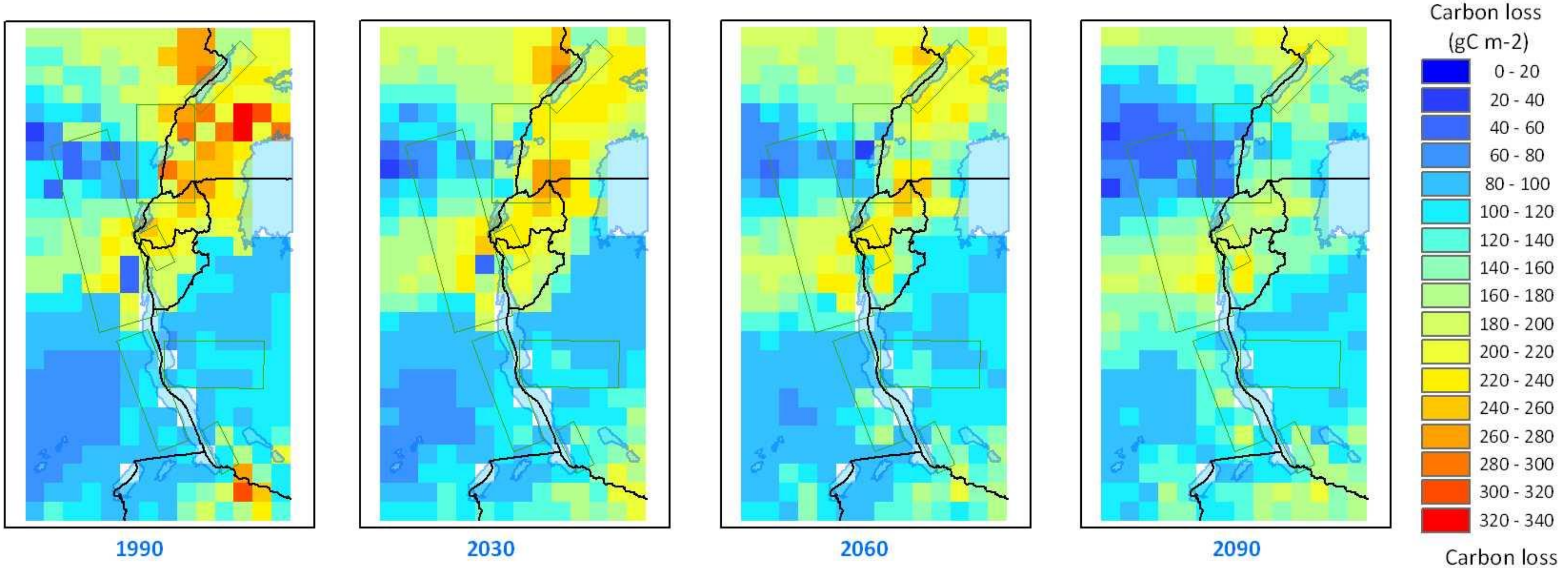
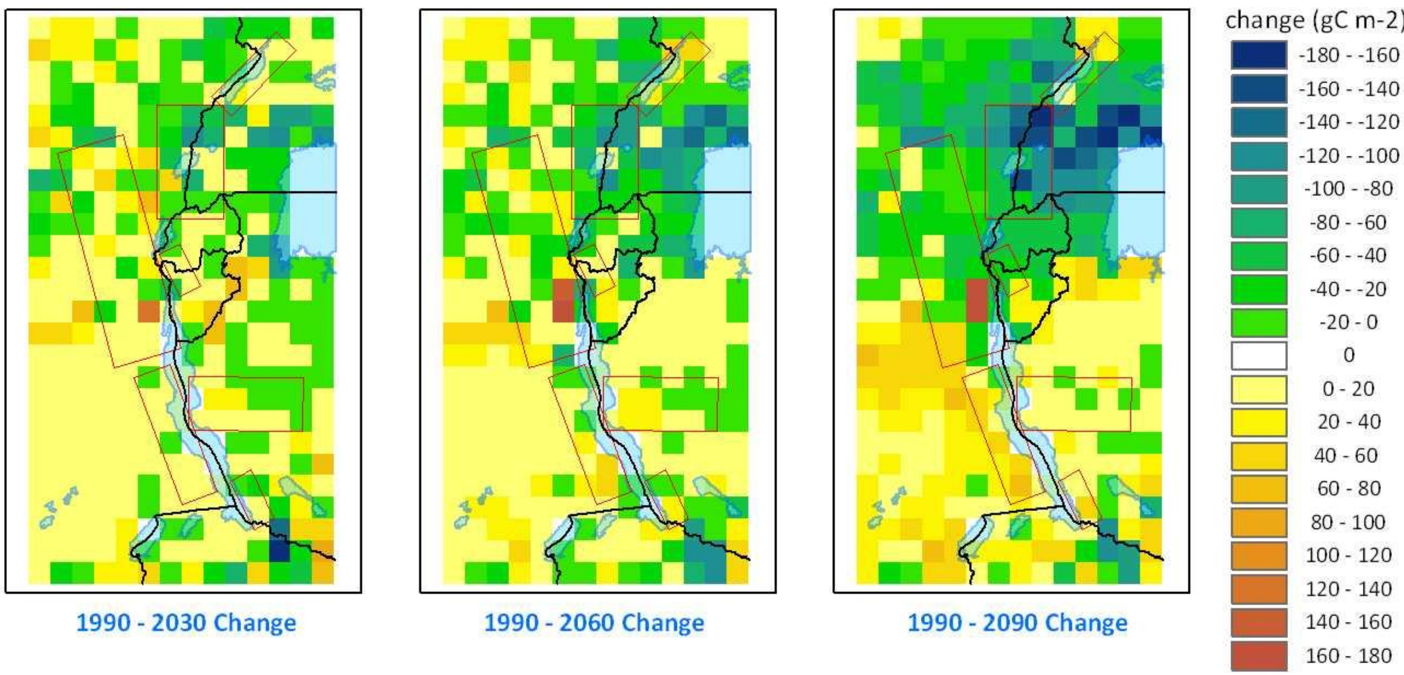


LPJ predicted carbon flux and change in carbon flux under the SRES A2 scenario

Carbon loss from fire



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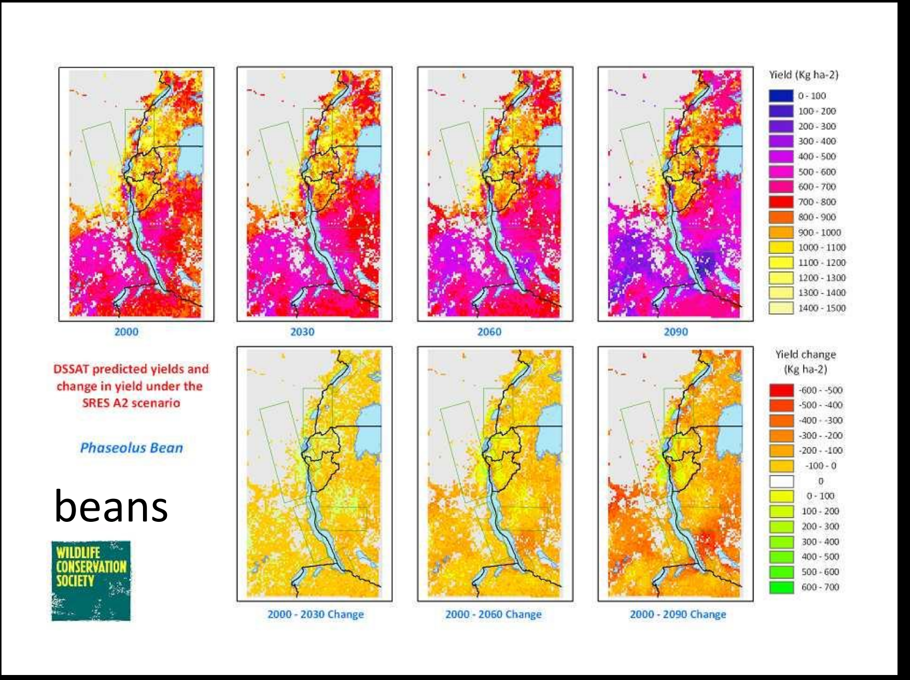
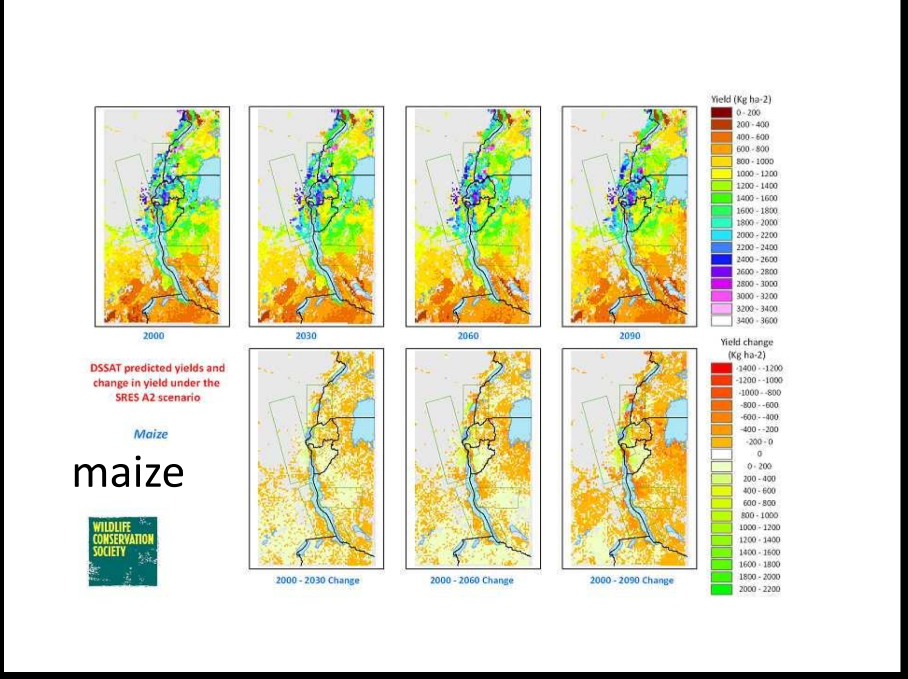
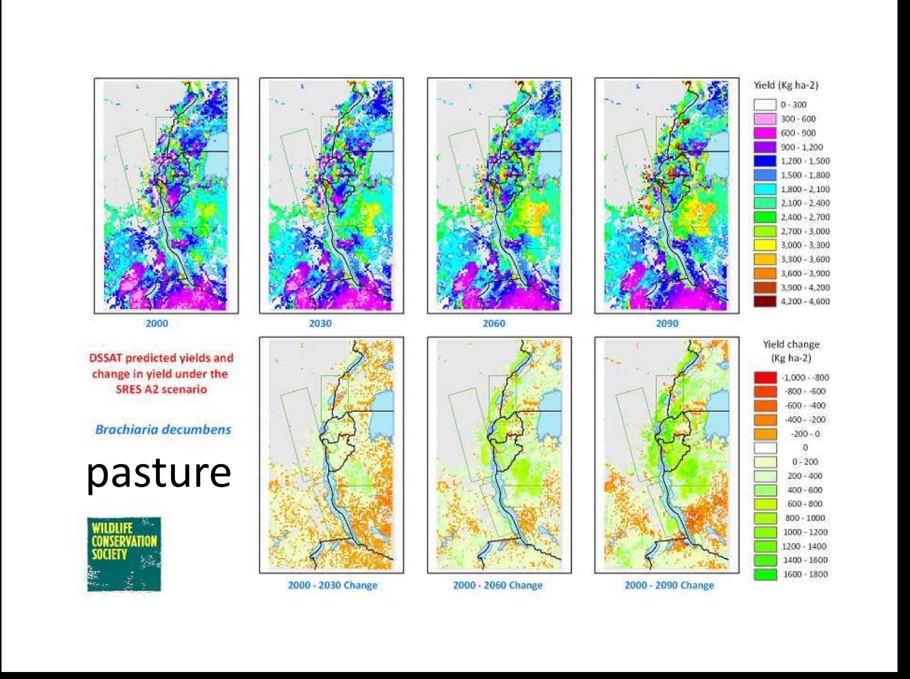
Modeled changes in crop yields

Crop model output can serve as indicators of human response in rain-fed agricultural regions

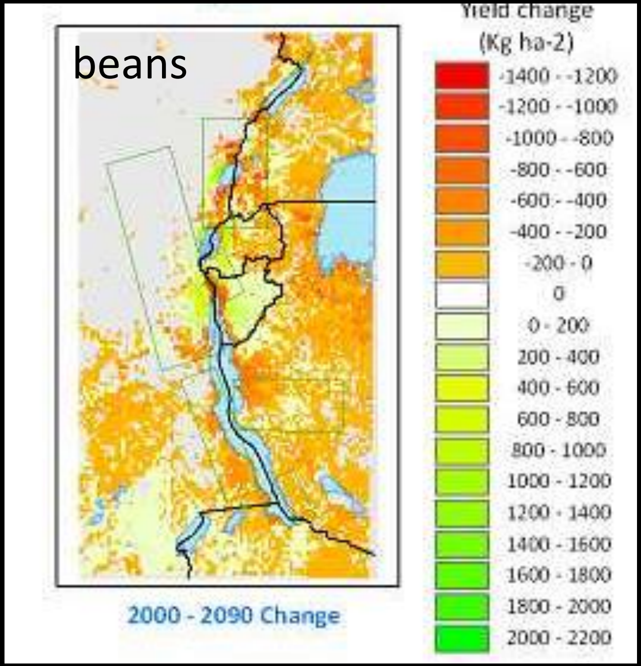


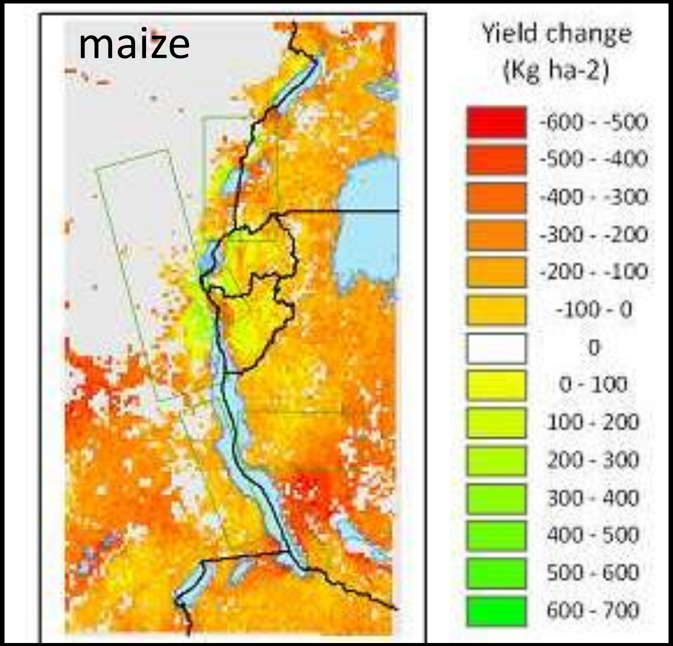


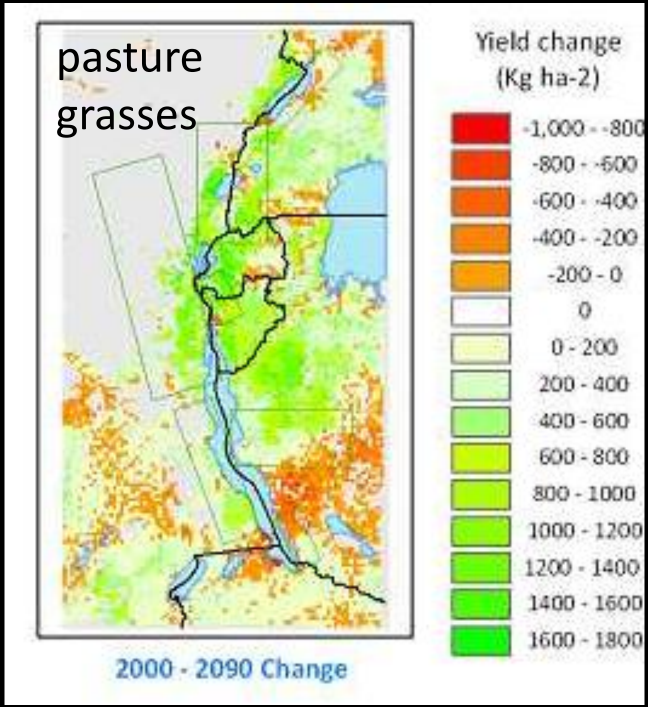


Modeled change in cropyields by 2090 under the A2 scenario

Suggests greatly increased pressureon highlands for foodproduction







Human pressure along park margins

Already a very intense factor for many national parks

Will continue to intensify with increasing populations

Like to become much more intense around protected areas as "climate refugees" migrate to highlands to sustain food sources and livelihoods

The Boundary of Volcanoes National Park, Rwanda Photo by Andy Plumptre

Intensified seasonal drought in 2009: an analog for future dry seasons?

Volcanoes National Park, Rwanda, July 2009.

http://www.igcp.org/putting-out-the-fire/

Phase II: Comprehensive Monitoring for Climate Change Adaptation and Management in the Albertine Rift Protected Area Network

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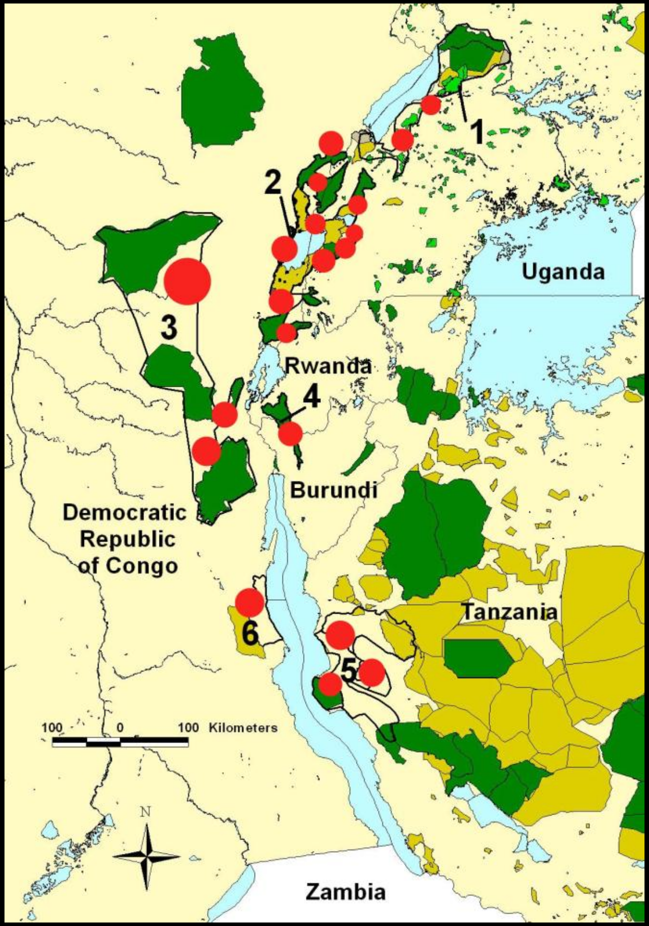
Climate monitoring: establish a long-term, scientific-quality climate monitoring network designed to detect changes in climate, and make the data widely available to conservation managers.

Vegetation monitoring: Establish long-term vegetation monitoring sites designed for detection and quantification of climate change impacts.

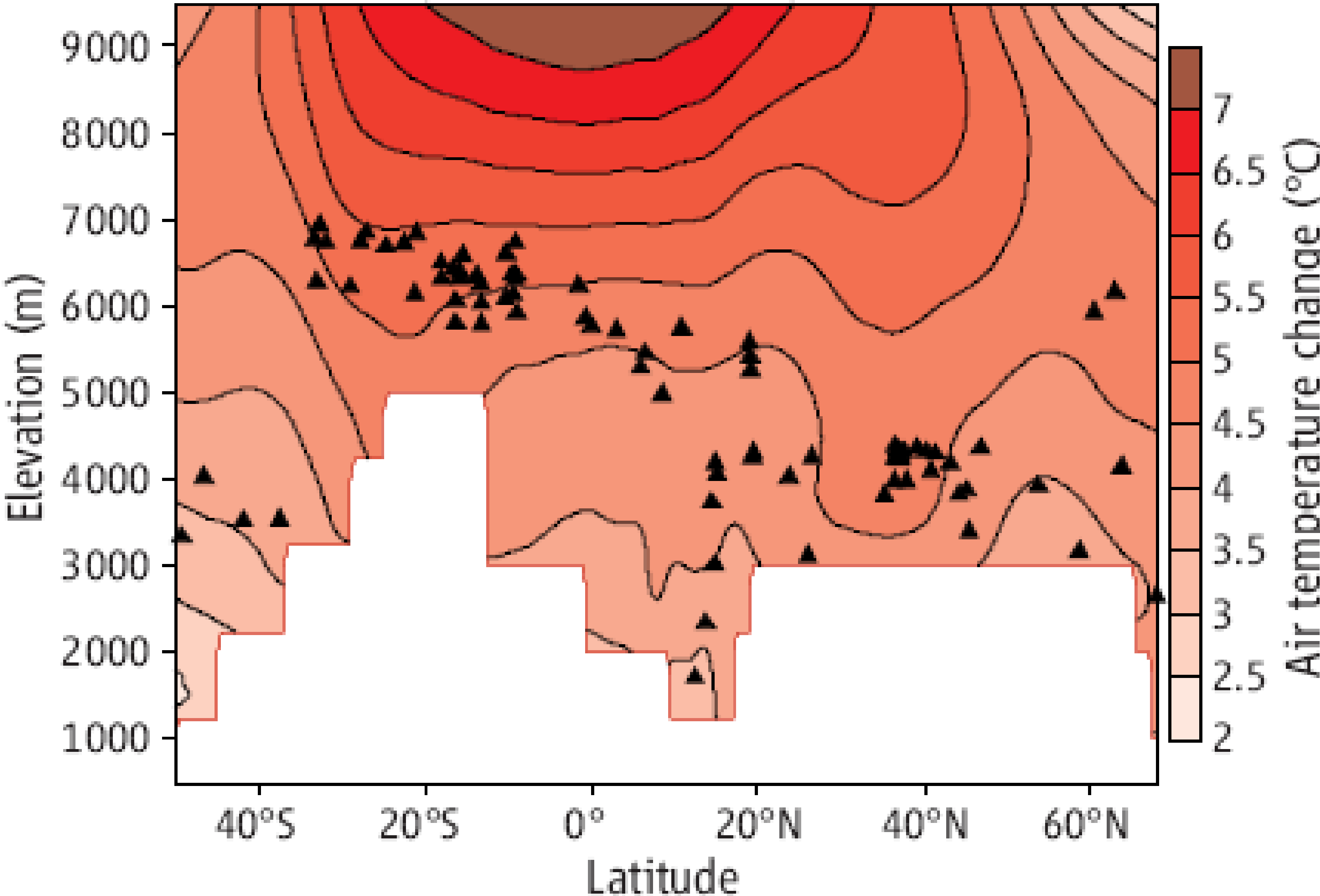
Species response monitoring: Establish long-term faunal monitoring of vertebrate species with enhanced susceptibilities to climatic perturbation.

Assessment of corridors: Assess the effectiveness of current and proposed wildlife corridors between protected areas to allow for adaptation to climate change

Red circles = corridors that link areas of natural habitat across an elevational gradient, potentially important for future migration with climate change.



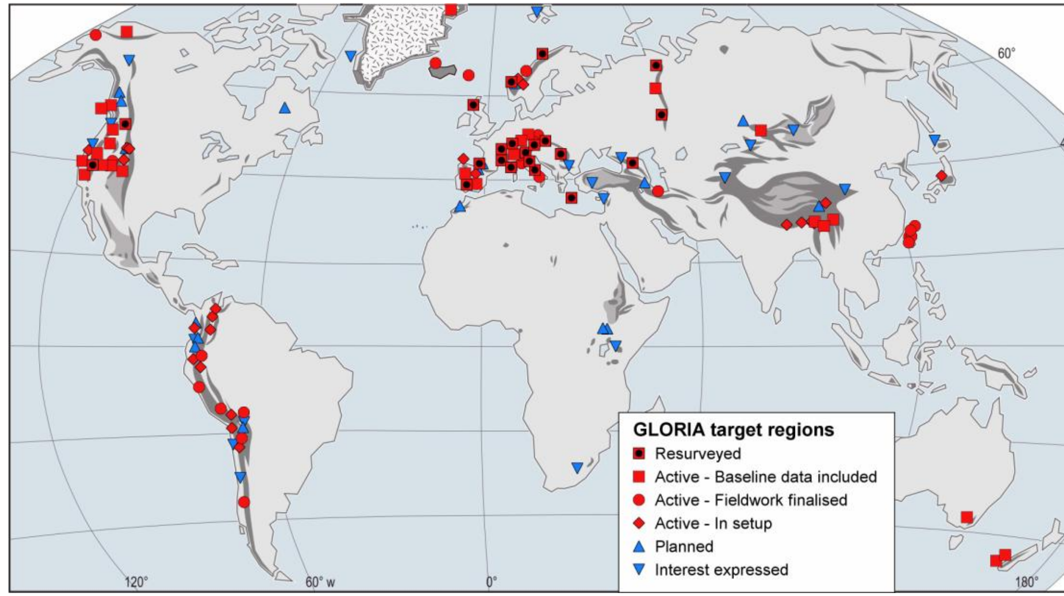
Sites for new research grade climate monitoring in protected areas



Bradley et al.,Threats to Water Supplies in the Tropical Andes*Science* 2006

GLORIA: Global Observation Research Initiative in Alpine Areas

Ecological monitoring to detect climate change effects using multi summit approach



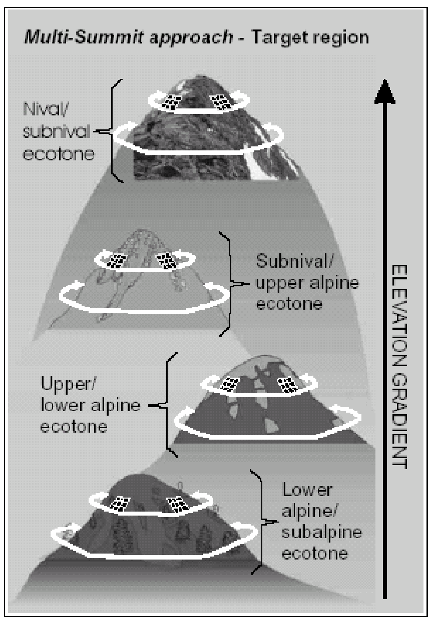
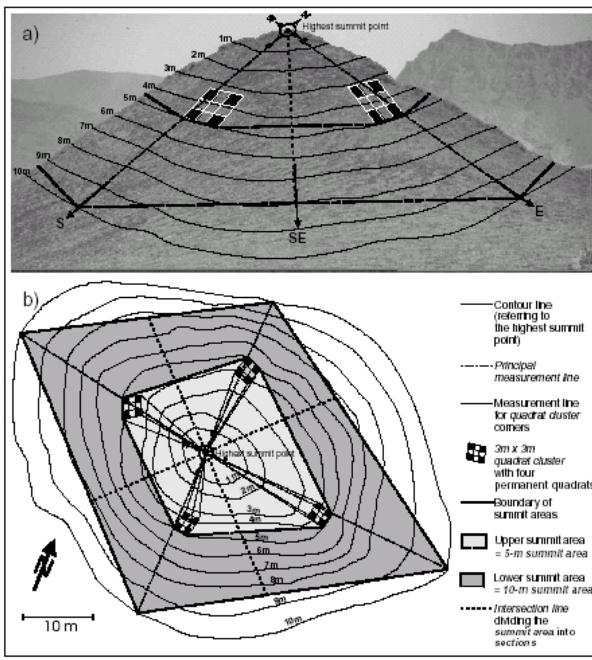
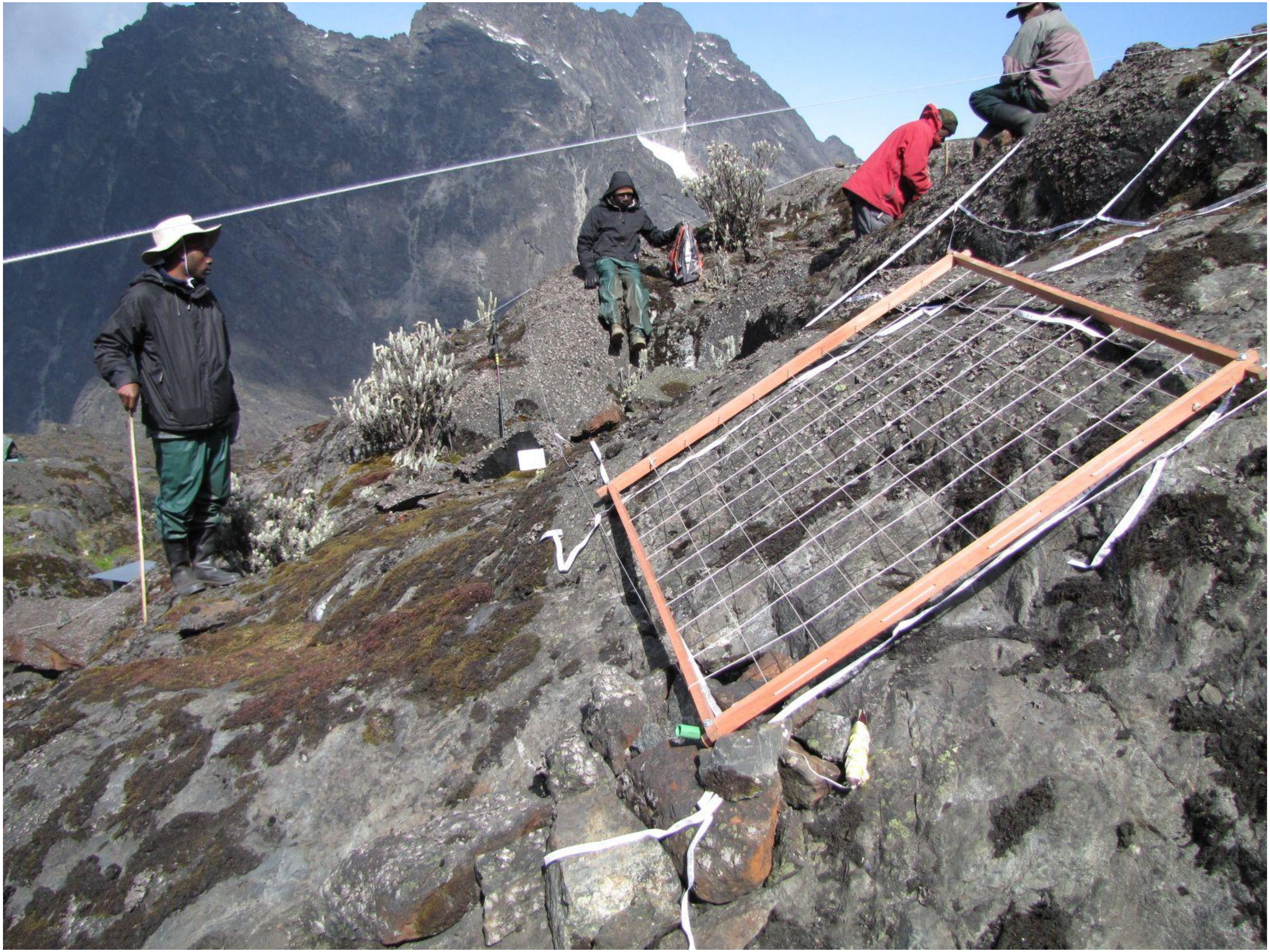


Fig. 7.1 Four summits of different altitude represent a *target region* (compare Box 7.1). The white lines indicate the lower boundaries of the *5-m* and of the *10-m summit area*, respectively; for explanations see chapter 8.1).





Phase III: Albertine Rift Stakeholder Meeting on Climate Change Adaptation, Gashora, Rwanda Feb 2011

Objectives

- Bring together principal stakeholders and research groups for direct dialog on climate change and conservation

- Provide a forum for both presenting the challenge and the research results to date to a wider audience concerned with implementing conservation and applying adaptations across the Albertine Rift

- Provide a forum for comparison of results collected by different groups and for discussion on where the climate science work should go from here to best address conservation stakeholder concerns

- Begin a discussion about next steps in conservation planning incorporating adaptation.


BUILDING CONSENSUS ON ALBERTINE RIFT
CLIMATE CHANGE ADAPTATION FOR CONSERVATION:

Key summary points

Albertine Rift highland protected areas are among best-hope locations for Africa wildlife conservation

Must increase efforts to measure and monitor climate, ecology and species

Direct climate change induced impacts will be significant, with major horizontal and vertical range reconfigurations of habitats, species distributions, agriculture, human livelihoods, etc.

Human response likely to increase pressure for highland forest conversion to cultivation to levels far greater than present

Disease threat is largely unknown, research critically needed

Acknowledgements

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