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CLIMATE CHANGE IMPACTS ON POLLINATION AND INSECT PEST MANAGEMENT IN THE EAST AFRICAN MOUNTAIN ECOSYSTEMS

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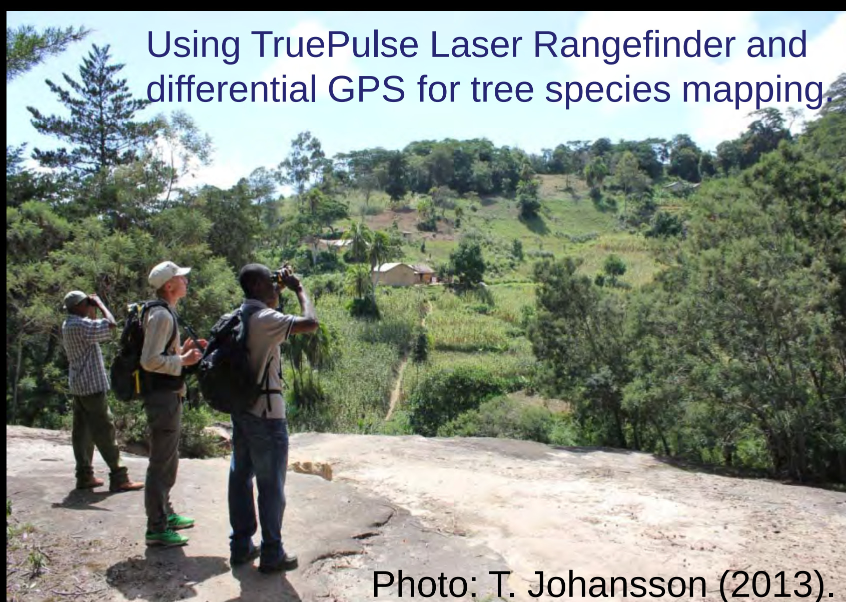

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Outline of the presentation

- Potential impacts of climate variation and change on insects
- Remote Sensing and aerial imagery in LC/LU change detection
- Expected outputs
- Concluding remarks

Climate Change Impacts on Ecosystem Services and Food Security in Eastern Africa

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Why study insects in the mountains?

- in mountain ecosystems climate change impacts on insect species are discernible
- steep elevational gradients allow ectotherms to shift to suitable habitats uphill over relatively short distances in response to increasing annual air temperature
- warming climatic conditions also allow insects to grow and reproduce faster
- the expansion in geographic range combined with increase in abundance will likely result in escalated insect invasions on mountain farms

  ⟹ food security

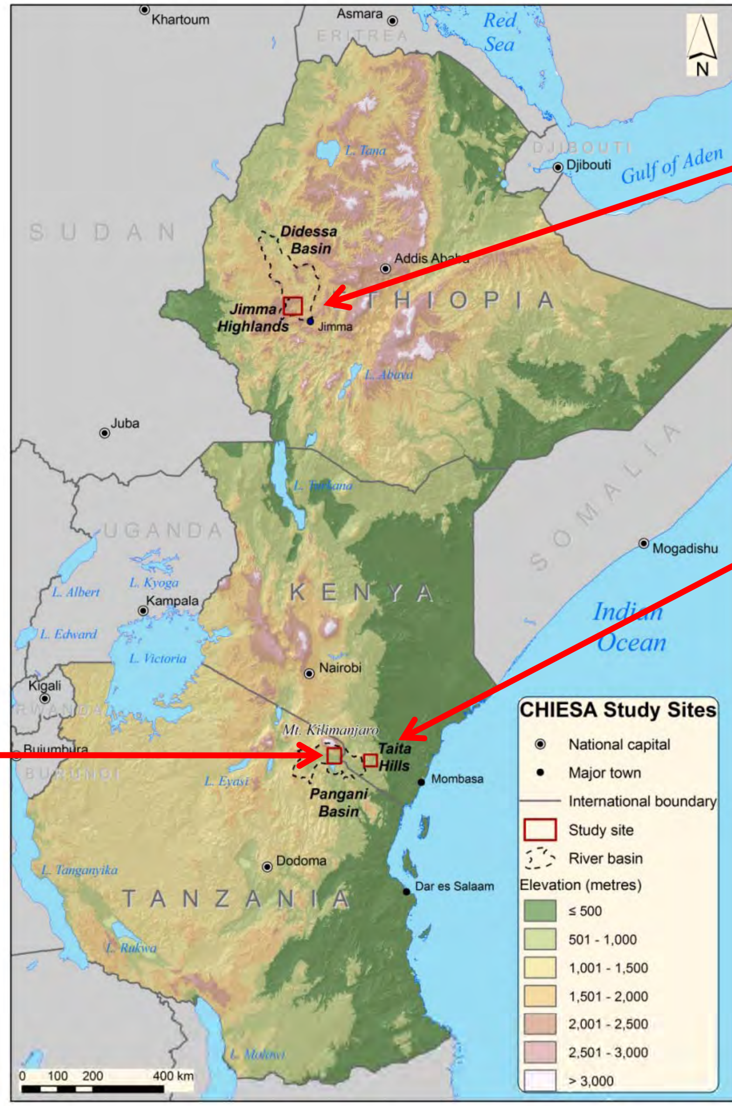
Why study insects in the mountains?

- climate-driven changes in the pollinator and pest diversity, abundance and geographical distribution may lead to impaired pollination and reduced fruit sets as well as more serious pest outbreaks

- insect pests, such as stem borers, may reduce maize yields over 13% per annum in Kenya (Mugo and Gichuki, 2009)

- in the Kenyan highlands, the estimated damage caused by the maize stalk borer *(Busseola fusca)* is about 15 million US$ per year (Mugo and Gichuki, 2009)

Research transect locations



Data: Administrative boundaries - GADM; Elevation - ESRI SRTM; Water bodies - Natural Earth; Gazetteers - Africover, IGAD; River basins, Study sites - CHIESA GeoNetwork (http://chiesa-gis.geography.helsinki.fi:8080/geonetwork).
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Jimma Highland, Ethiopia

The Taita Hills, Kenya

Mount Kilimanjaro, Tanzania

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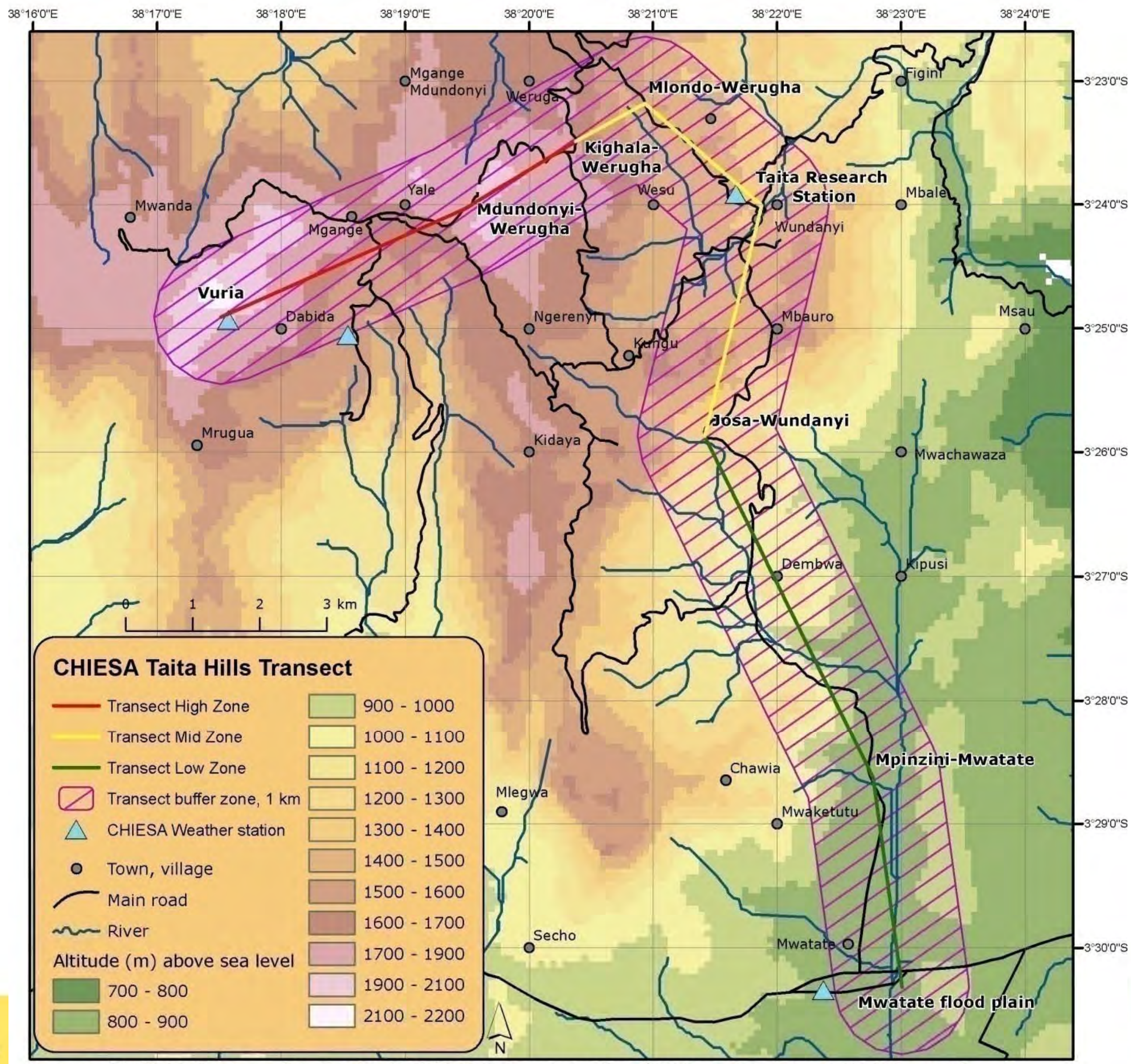
Research transect locations



Base map: (C) CHIESA 2012. Source Data: Elevation (C) USGS SRTM, Rivers derived from SRTM, Roads digitized from 1:50 000 Survey of Kenya topographic maps, Gazetteer (C) geonames.org.

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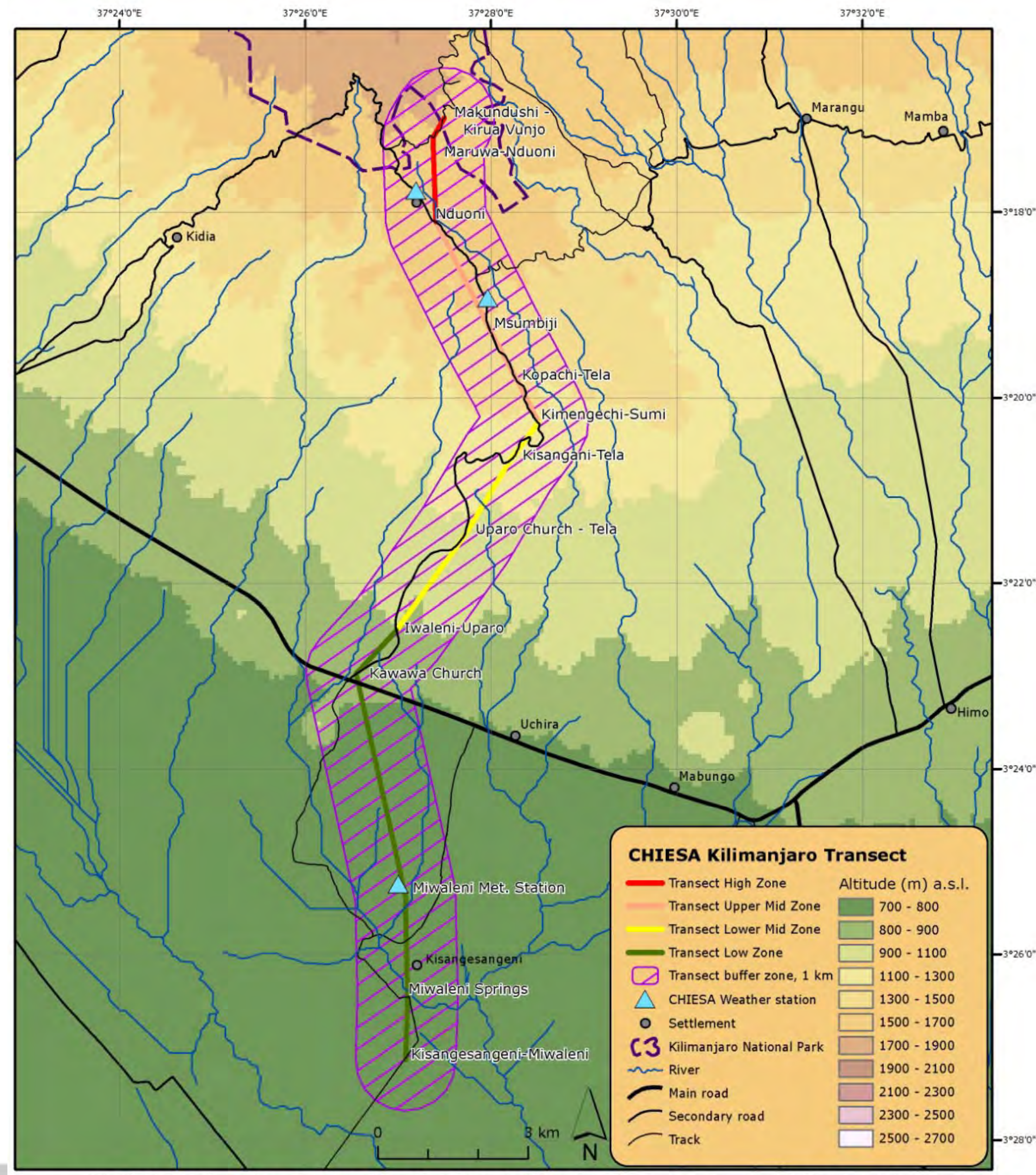
Research transect locations



Base map: (C) CHIESA 2012. Source data: rivers derived from 30m DEM, roads digitized from SPOT5 satellite images and GPS tracks, park boundary (c) WPDA/TANAPA, place names digitized from 1:50k topographic maps, elevation (C) USGS SRTM

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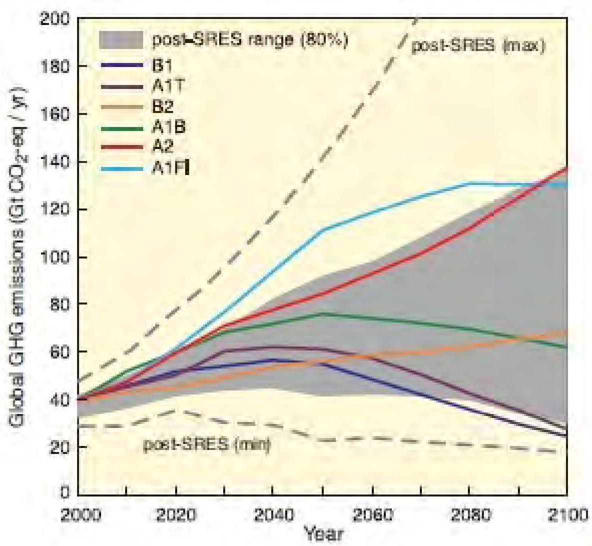
Global climate change scenarios

Case	Temperature change (°C at 2090-2099 relative to 1980-1999) [a, d]		Sea level rise (m at 2090-2099 relative to 1980-1999)
	Best estimate	*Likely* range	Model-based range excluding future rapid dynamical changes in ice flow
Constant year 2000 concentrations[b]	0.6	0.3 – 0.9	Not available
B1 scenario	1.8	1.1 – 2.9	0.18 – 0.38
A1T scenario	2.4	1.4 – 3.8	0.20 – 0.45
B2 scenario	2.4	1.4 – 3.8	0.20 – 0.43
A1B scenario	2.8	1.7 – 4.4	0.21 – 0.48
A2 scenario	3.4	2.0 – 5.4	0.23 – 0.51
A1FI scenario	4.0	2.4 – 6.4	0.26 – 0.59

Scenarios for GHG emissions from 2000 to 2100 in the absence of additional climate policies



Projected global average surface warming and sea level rise at the end of the 21st century. (IPCC 2007: 45).

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Climate change scenarios for East Africa

- regardless of the SRES scenario, regional models produced for East Africa all indicate a warmer future (Downing et al., 2008)

- in most of Africa the annual mean temperatures are projected to rise more than the global averages (James and Washington 2012)

- wetter climate with more intense wet seasons (OND and MAM) and less dry extremes incl. severe droughts (Shongwe et al. 2011)

Improving weather monitoring facilities

Photo: T. Johansson (2012).

Photo: T. Johansson (2011).

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Potential impacts of climate change on insects

Stalk borer sampling in the Taita Hills, Kenya.

Busseola fusca larvae

Photo: B. Le Ru (2011).

Photo: T. Johansson (2012).

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Potential impacts of climate change on insects

- development rates of *B. fusca* eggs, larvae and pupae stages increase towards a certain threshold temperature level
- thermal tolerance of the target insect species
- insect pests for maize, crucifers, avocado and coffee
- parasitoids (natural enemies) of the insect pests

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Human-induced changes in habitats

- land use change
- fragmentation of natural habitats
- use of synthetic pesticides

→ disruption of the interactions in agro-ecosystems

- unfavourable conditions for natural enemies, such as wasps, have ensured optimal growth environments for the insect pests and lead to increased damage to crops

SOLUTION: Integrated Pest Management

- to harness ecosystem functionality and dynamic interactions between plants, insect pests and their natural enemies using the biological characteristics of their position in the food chain

Remote sensing in land cover/land use change detection

- satellite imagery processed and interpreted, e.g. LANDSAT, SPOT5, Formosat2, and MODIS, for land cover mapping
- MODIS Land Surface Temperature, NDVI (vegetation index) and Land Cover datasets

Remote sensing in land cover/land use change detection

- pre-prosessing (ERDAS Imagine) of four SPOT5 satellite scenes and eight Formosat2 images which are provided by ESA
- geometric, radiometric and topographic corrections
- image fusion between panchromatic and multispectral bands
- further prosessing into LU/LC classification based on multi-scale segmentation and object-based classification methodology

Aerial imagery in land cover/land use change detection

- historical black-and-white aerial imagery (1955–1994)
- digital aerial imagery (Nikon D3X true color digital camera system)
- AISA Eagle hyperspectral sensor (64 spectral bands)
- processed with EnsoMOSAIC software

Subset of the final aerial image mosaic taken over Jimma transect (left) and the flight crew (right). Photos: P. Pellikka (2012).

Aerial imagery in land cover/land use change detection

- geometric and atmospheric corrections
- ground resolution 0.5 meters

Expected outputs: Capacity building

- short courses, workshops and academic degrees


Photo: S. Achola (2012)


Photo: S. Achola (2012)


Photo: K. Kathure (2013)

Expected outputs: Capacity building

- awareness-creation, sensitization, learning with the communities, participatory research approaches

Photo: T. Johansson (2013).

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Expected outputs: Capacity building

- support equal opportunities, incl. minority groups

Photo: T. Johansson (2013).

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Expected outputs: geospatial data sets

- classified LU/LC maps, species distribution predictions and models, risk maps

- new methodologies for discriminating indigenous and exotic forests

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Expected outputs: adaptation options

- Integrated Pest Management

- baseline data and models to support sustainable and ecologically sound management arrangements in the forest-agriculture mosaics of the mountain areas

- scientifically-grounded farming methods which help enhance functional agro-ecosystems, their services, and simultaneously provide biological control of insect pests, e.g. push-pull strategy

Farms on the border of Nganagao Forest in the Taita Hills, Kenya.

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Concluding remarks

- very high resolution imagery required for insect habitat change detection
- ground-based surveys integrated with EO data analyses
- on-going interdisciplinary research and development project
- dissemination of outputs to the end users at different levels

Photo: T. Johansson 2012.

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The CHIESA Project

To learn more about the CHIESA (Climate Change Impacts on Ecosystem Services and Food Security in Eastern Africa) Project... please visit:

http://chiesa.icipe.org

Photo: T. Johansson(2013).

Thank you!

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