Landcover changes in the Rwenzori Mountains: the glaciers retreat

Thomas Gumbricht, www.mapjourney.com
FAO Information Products for the Nile Basin, GPC/INT/945/ITA

Rwenzori 1906-2006

Landcover changes in the Rwenzori Mountains: the glaciers retreat

East Africa and the Rift Valley

East Africa and the two arms of the Rift Valley enclosing Lake Victoria between them. The Eastern Rift has several volcanic mountains – Kilimanjaro, Kenya, Elgon, The Western Rift instead contains a block mountain – Rwenzori.

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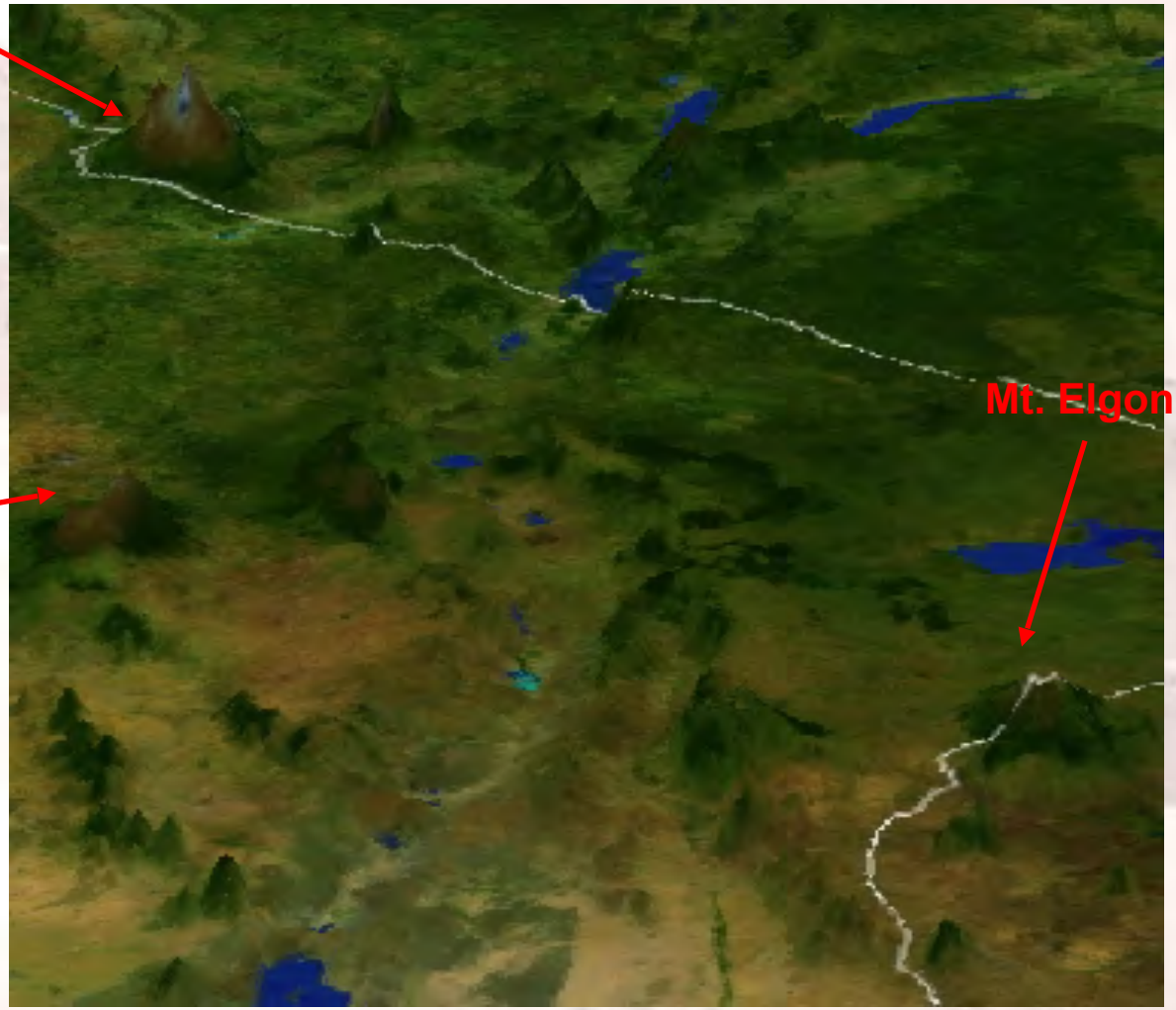
Rwenzori 1906-2006

Landcover changes in the Rwenzori Mountains: the glaciers retreat

East Africa and the Rift Valley



Detail showing the Eastern arm of the Rift Valley, with the volcanic mountains Kilimanjaro, Kenya and Elgon.

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Rwenzori 1906-2006

Landcover changes in the Rwenzori Mountains: the glaciers retreat

Mountain Rwenzori straddling the Uganda- DRC border

MODIS satellite image showing the Rwenzori Mountains. The Rwenzori Mountains lay in the Western arm of the East African Rift Valley, and is a block mountain (it is not a volcanic mountain)

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Rwenzori 1906-2006

Landcover changes in the Rwenzori Mountains: the glaciers retreat

Mountain Rwenzori straddling the Uganda- DRC border

TERRA ASTER satellite image showing the Rwenzori Mountains. The edges of the Rift valley can be seen in the upper part of the image.

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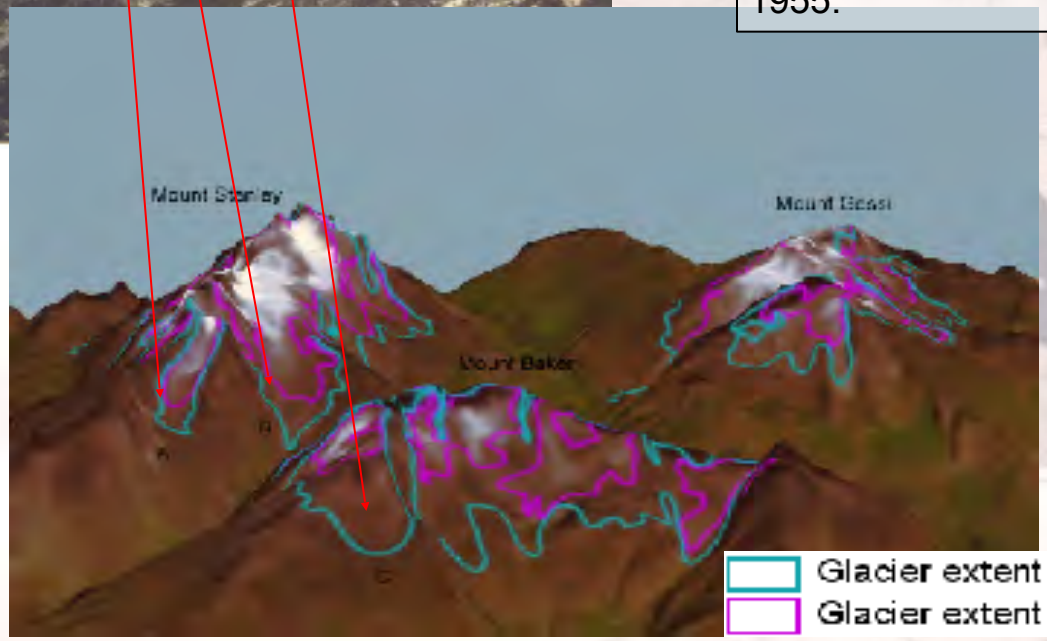
Rwenzori 1906-2006

Landcover changes in the Rwenzori Mountains: the glaciers retreat

Glaciers in the Rwenzori Mountains: a reinterpretation

Photograph by Sella taken the 12th of July 1906 from Stairs Peak, showing Mount Baker and Mount Stanley.

Satellite generated image of the peaks of the Rwenzori Mountains (2005), also showing glacial extents in 1906 and 1955.



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Rwenzori 1906-2006

Landcover changes in the Rwenzori Mountains: the glaciers retreat

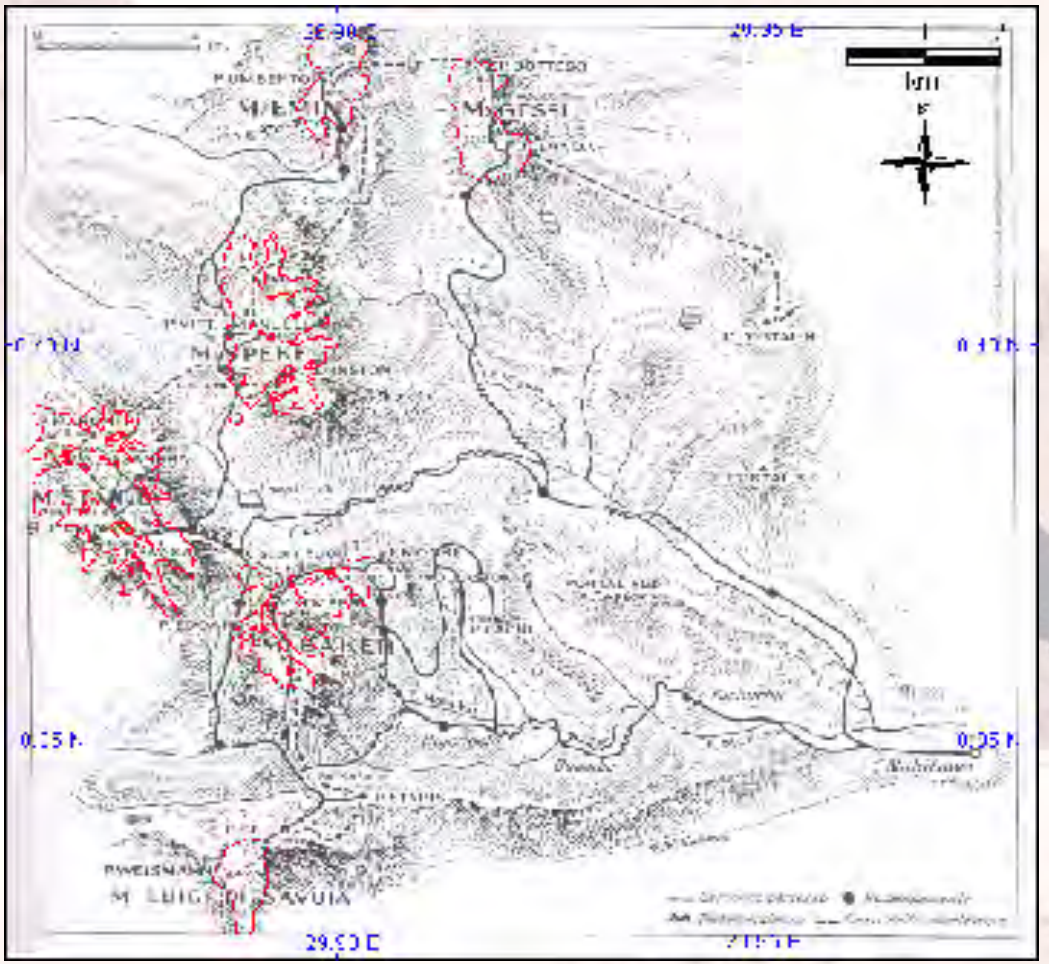
Duke of Abruzzi expedition peak map from 1906

Map published in Geographical Journal, 1907. Reprint by A.A. Michieli, Milan, 1937.

Rwenzori 1906-2006

Landcover changes in the Rwenzori Mountains: the glaciers retreat

Duke of Abruzzi expedition peak map from 1906



The extent of the glaciers 1906 as mapped by the Duke of Abruzzi expedition. Interpreted by Kaser and Noggler, 1996.

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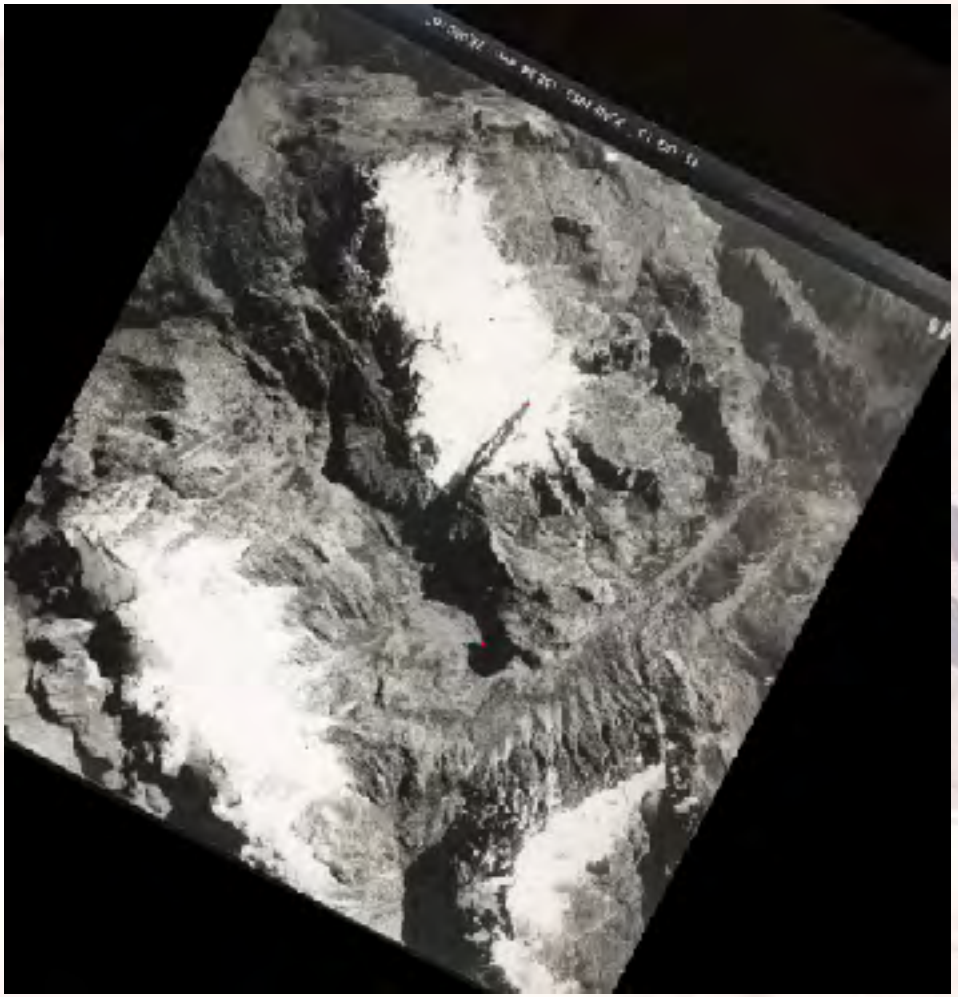
Rwenzori 1906-2006

Landcover changes in the Rwenzori Mountains: the glaciers retreat

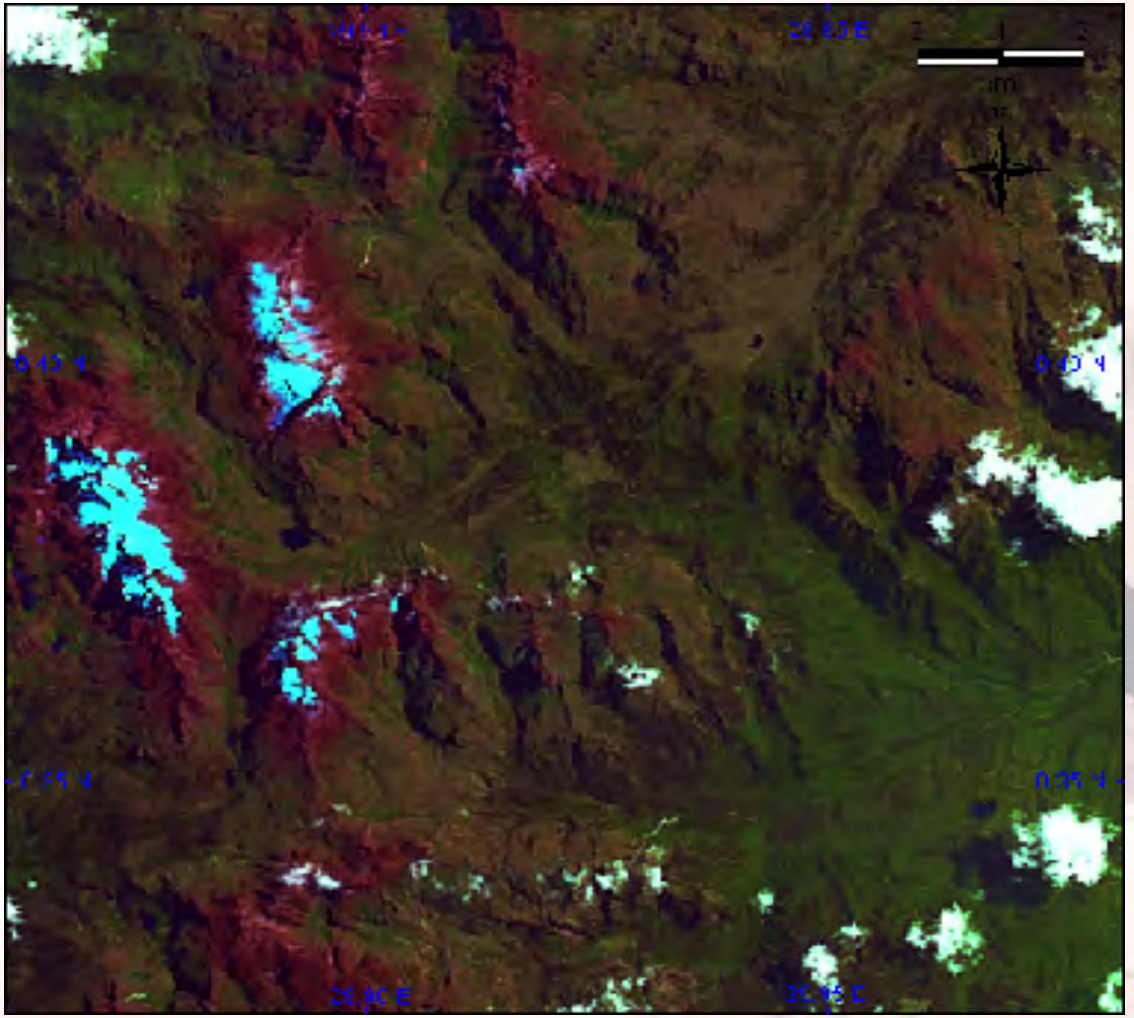
Aerial photograph acquired June 1955



Rwenzori 1906-2006

Landcover changes in the Rwenzori Mountains: the glaciers retreat

Landsat TM satellite image acquired 7th of August 1987



In this satellite image the glaciers stand out as light blue. Clouds are white.

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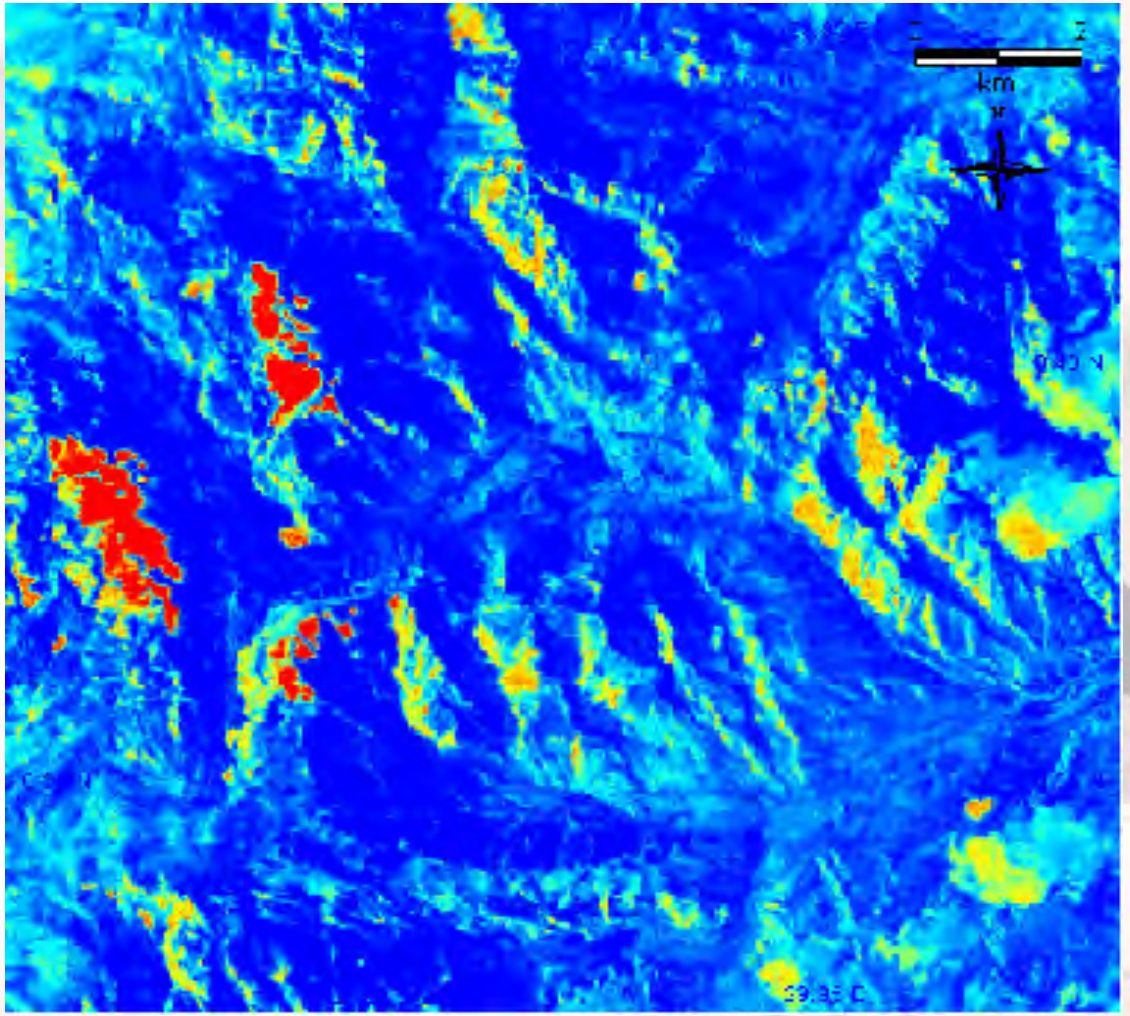
Rwenzori 1906-2006

Landcover changes in the Rwenzori Mountains: the glaciers retreat

Landsat TM satellite image acquired 7th of August 1987



This image shows the snow content (red) in the satellite image.

*Normalised Difference Snow Index (**NDSI**)*
(Band2 – Band5) / (Band2+Band5)

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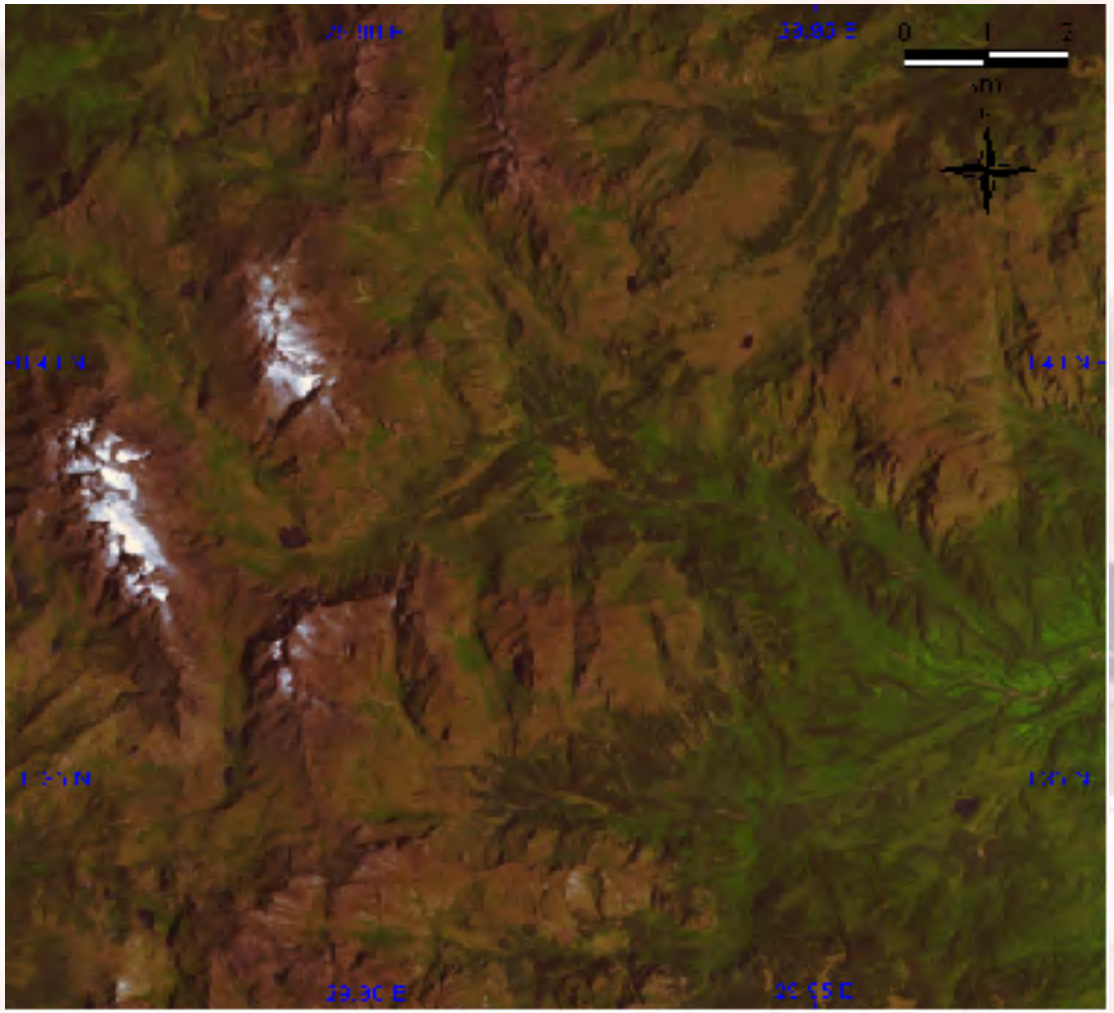
Rwenzori 1906-2006

Landcover changes in the Rwenzori Mountains: the glaciers retreat

TERRA ASTER satellite image acquired 22nd of February 2005

There are no clouds in this image and the glaciers stand out as white, with off-white probably representing newly fallen snow and exposed rock (glacial retreat)



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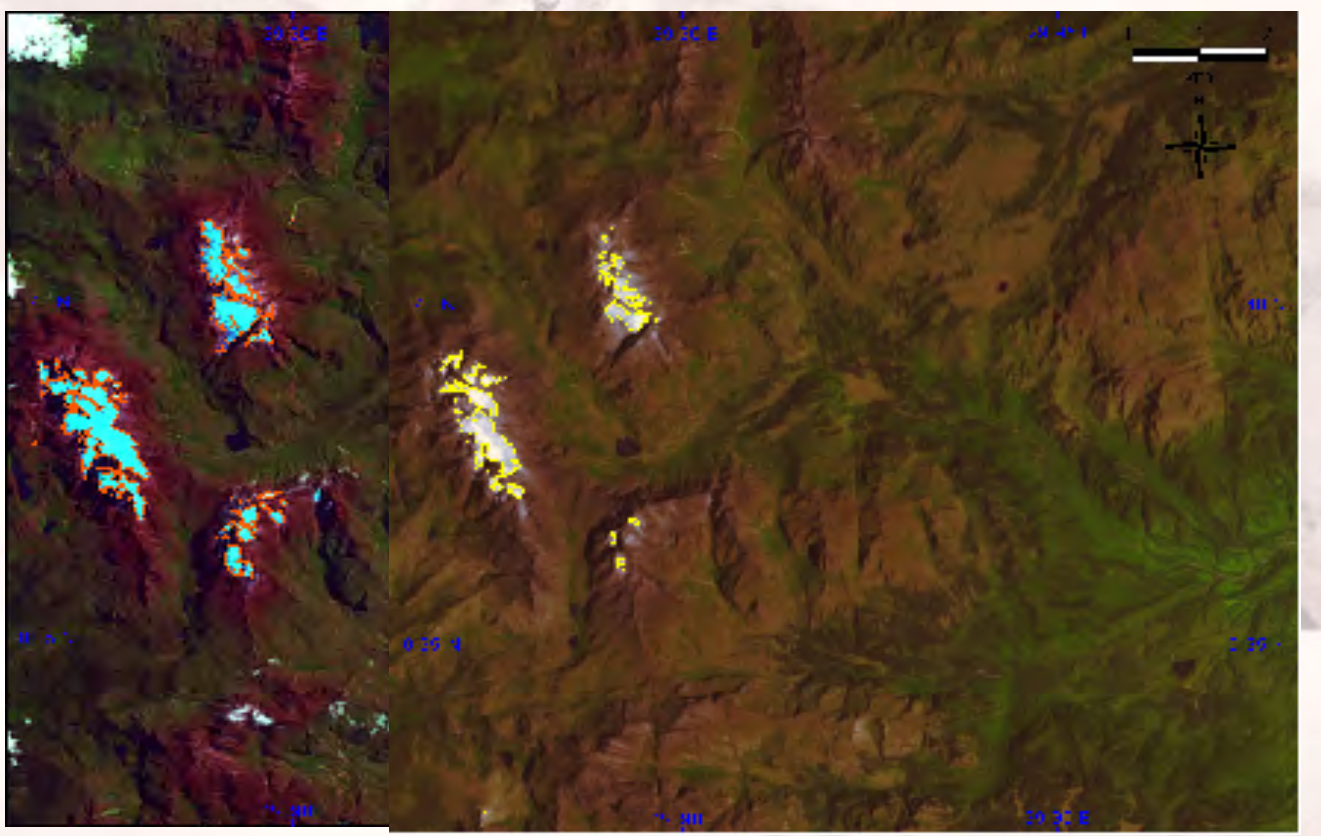
Rwenzori 1906-2006

Landcover changes in the Rwenzori Mountains: the glaciers retreat

Comparison Landsat TM 1987 and TERRA ASTER 2005

Comparison of extent of the glaciers in 1987 and 2005 interpreted from the backdrop satellite image.



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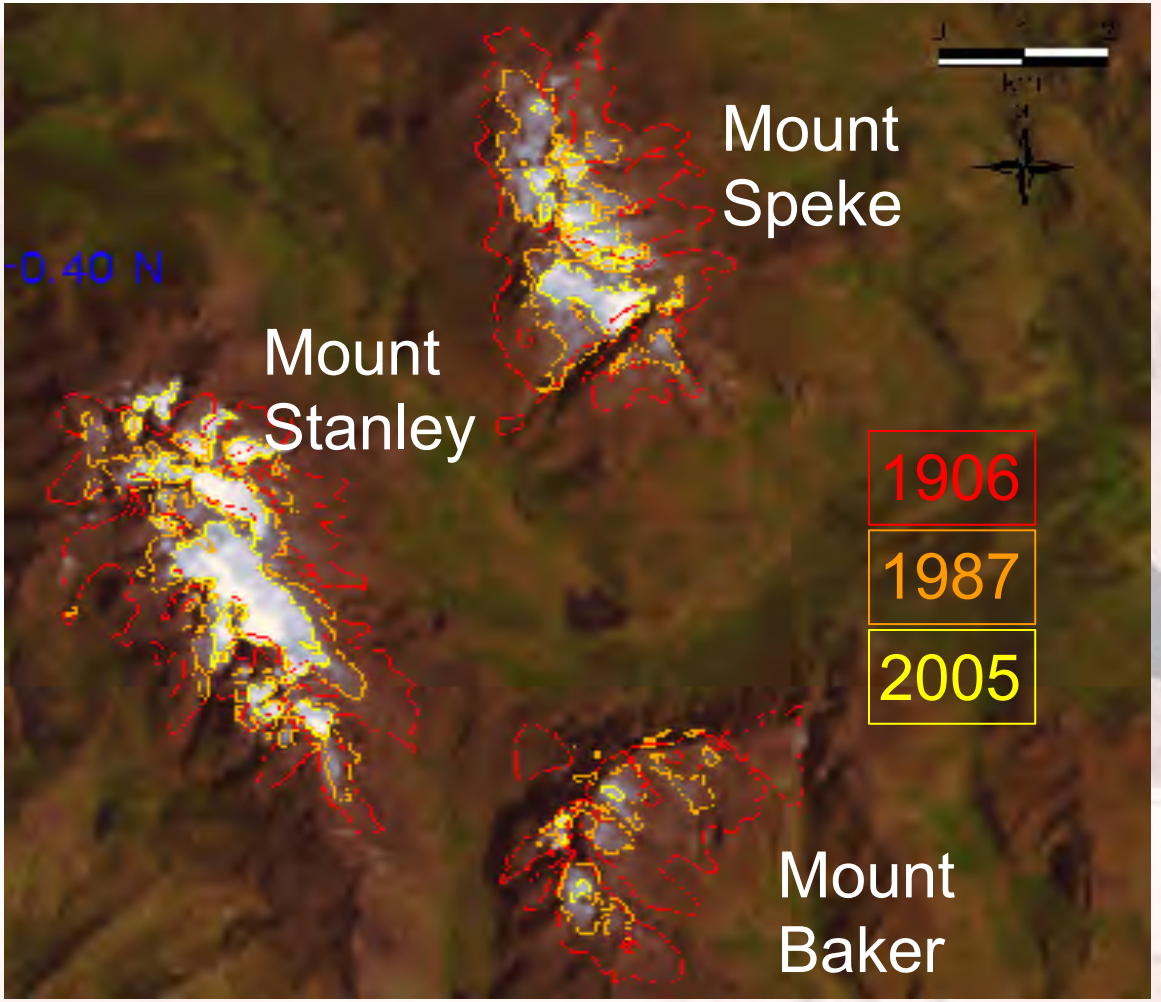
Rwenzori 1906-2006

Landcover changes in the Rwenzori Mountains: the glaciers retreat

Mountain Rwenzori Glacier Changes 1906-2005



The extent of the glaciers of Mountain Rwenzori 1906, 1987 and 2005.

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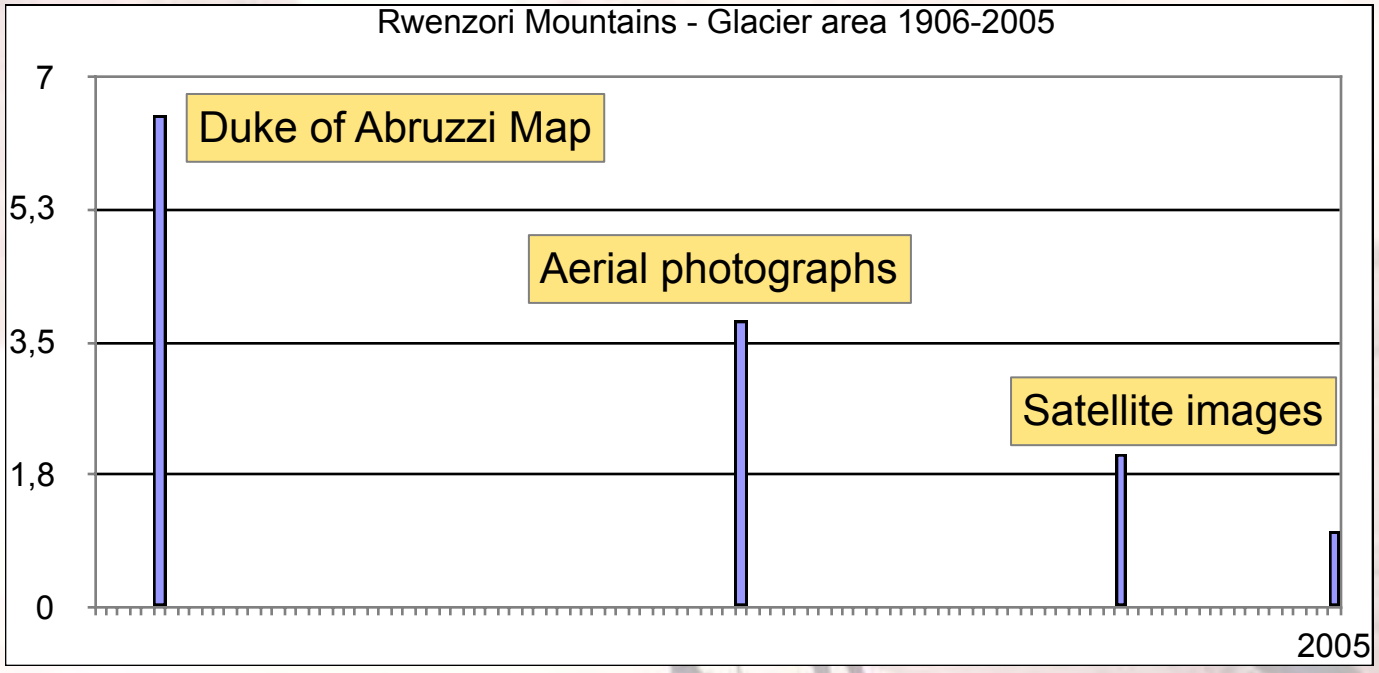
Rwenzori 1906-2006

Landcover changes in the Rwenzori Mountains: the glaciers retreat

Duke of Abruzzi expedition peak map from 1906

Since 1906 the glaciers of the Rwenzori Mountains have decreased from around 6.5 km2 to 1.0 km2. If the trend continues the glaciers will disappear in 20 years.



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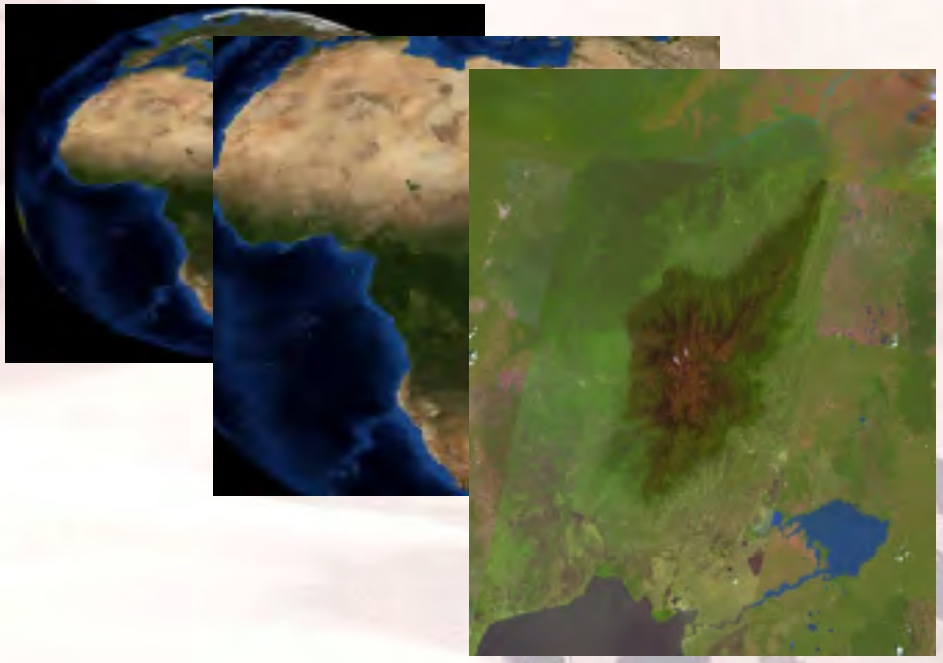
Driving forces contributing to glacier retreat



a) Global changes in temperature and atmospheric circulation patterns.

b) Continental drying (less precipitation and more sunshine)

c) Local changes in land use and land cover (documented in other Mountains in East Africa, but not the Rwenzoris)

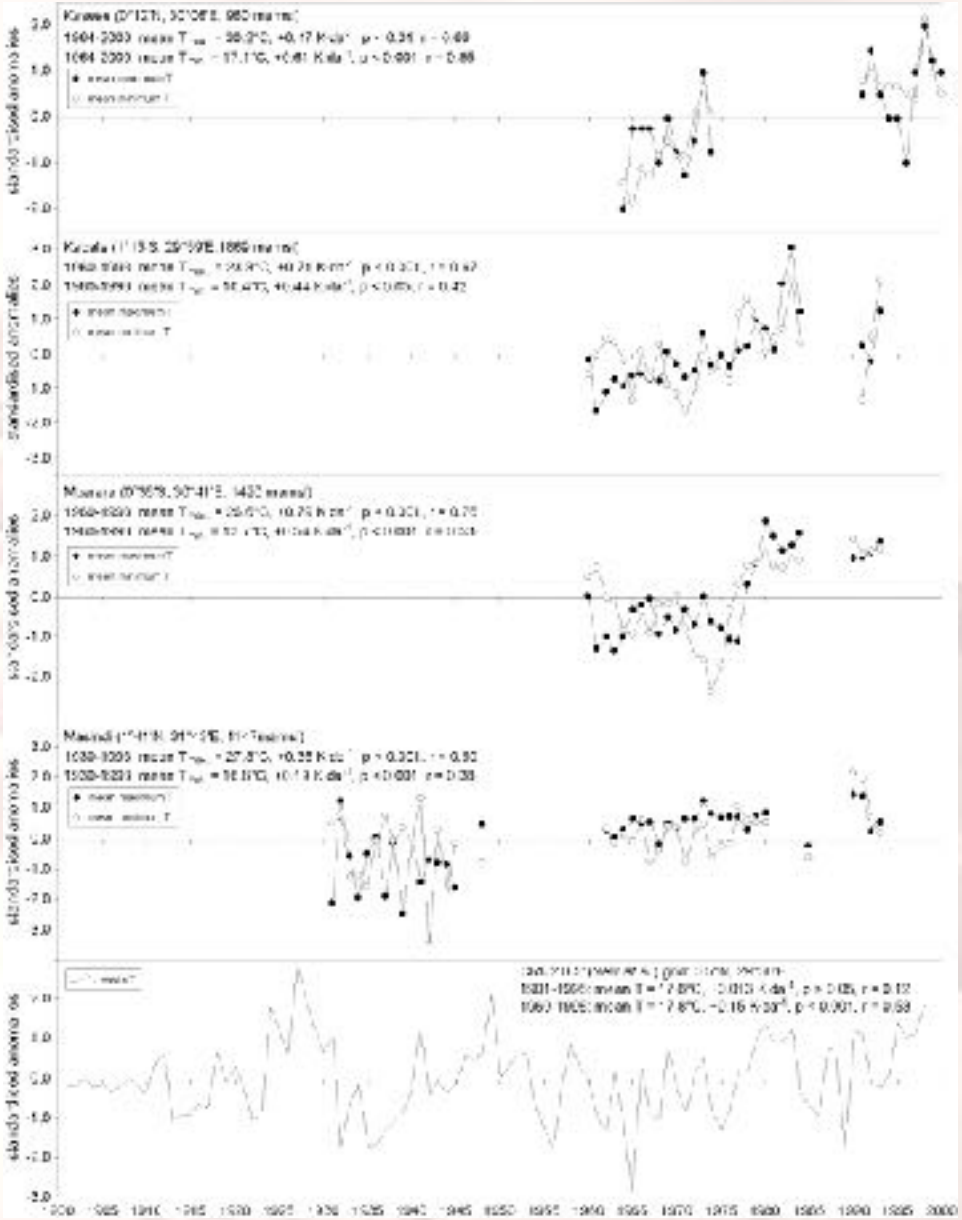
Rwenzori 1906-2006

Landcover changes in the Rwenzori Mountains: the glaciers retreat

Driving forces contributing to glacier retreat

Global changes in Temperature

- Significant trends of increasing surface air Temperature
- But glaciers reside at elevations 3 to 4 km higher in the troposphere



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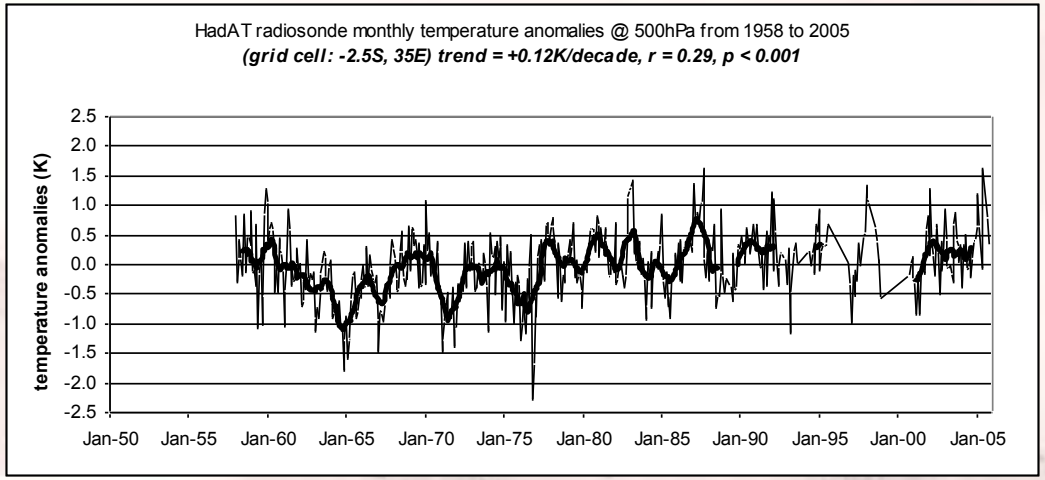
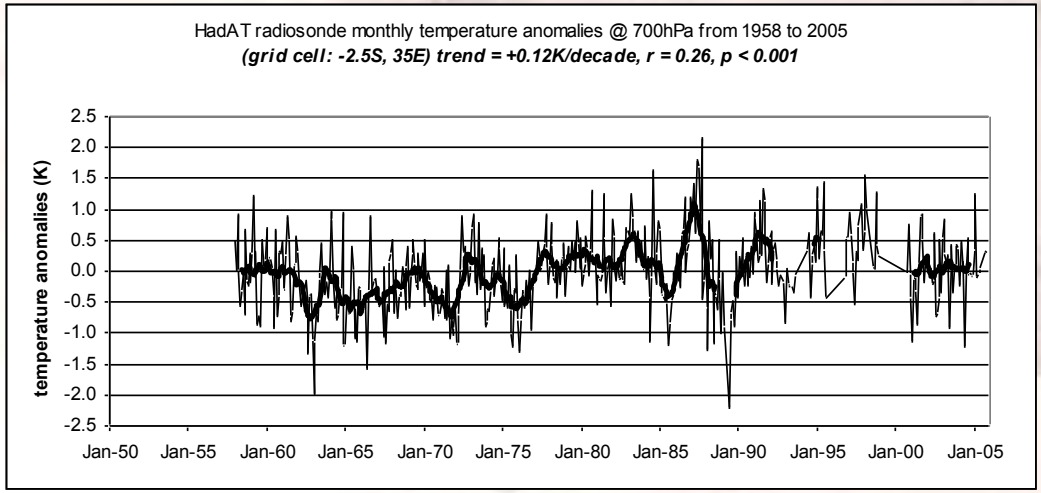
Rwenzori 1906-2006

Landcover changes in the Rwenzori Mountains: the glaciers retreat

Data are very limited but significant trends of increasing air temp also observed in the troposphere.





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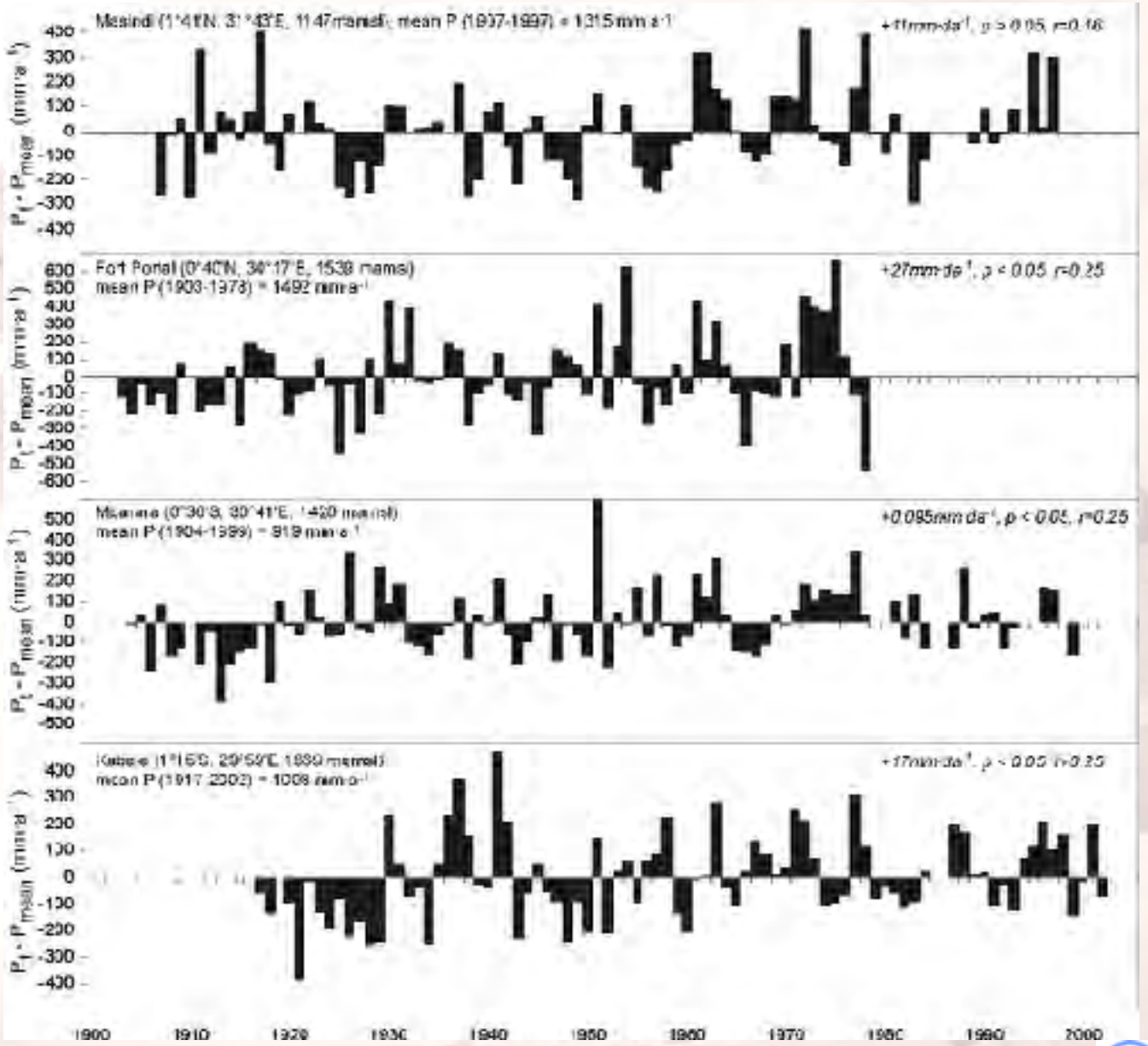
Rwenzori 1906-2006

Landcover changes in the Rwenzori Mountains: the glaciers retreat

Driving forces contributing to glacier retreat

Continental drying

- no evidence of decreasing humidity in western Uganda from station rainfall records.



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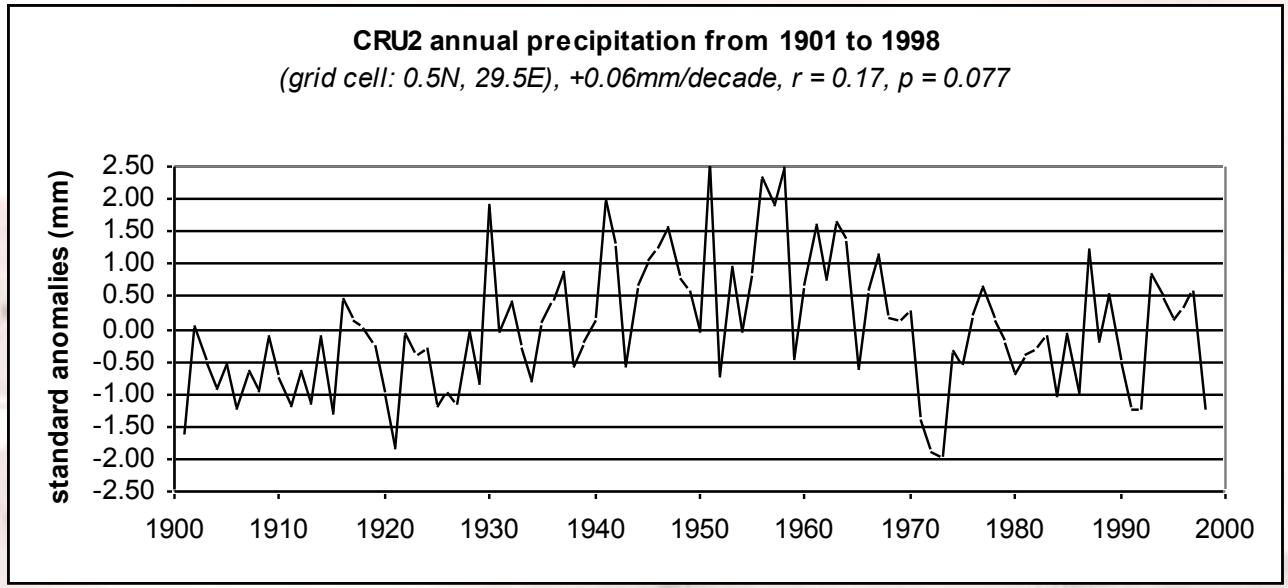
Rwenzori 1906-2006

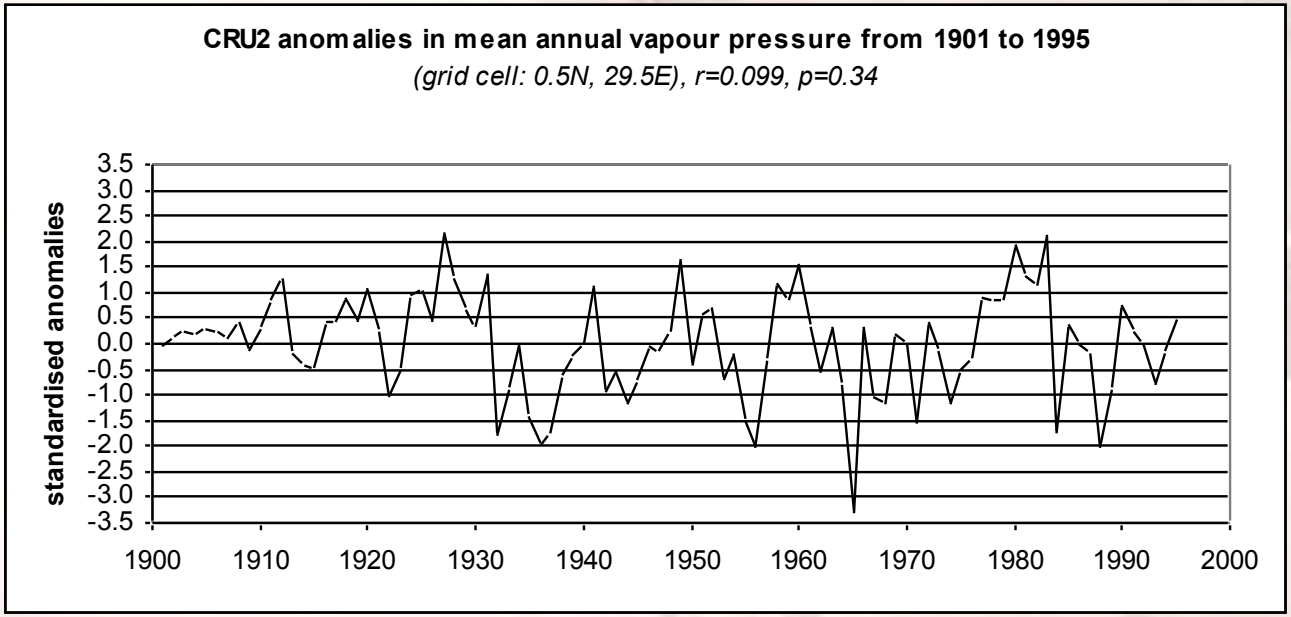
Landcover changes in the Rwenzori Mountains: the glaciers retreat

Driving forces contributing to glacier retreat

Continental drying

- no evidence of decreasing humidity in western Uganda from gridded climate datasets (CRU2).





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Rwenzori 1906-2006

Landcover changes in the Rwenzori Mountains: the glaciers retreat

Driving forces contributing to glacier retreat

Local changes in land use and land cover

Population growth (3% yr)

↓

Agricultural activity (incl. slush&burn)

↓

Reduction of vegetation growth

↓

Drying out of local atmosphere

↓

Less precipitation and more sunshine

↓

Negative mass balance of ice and snow

↓

Retreat of glaciers

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Rwenzori 1906-2006

Landcover changes in the Rwenzori Mountains: the glaciers retreat

Landcover and vegetation (Africover and National Biomass project)

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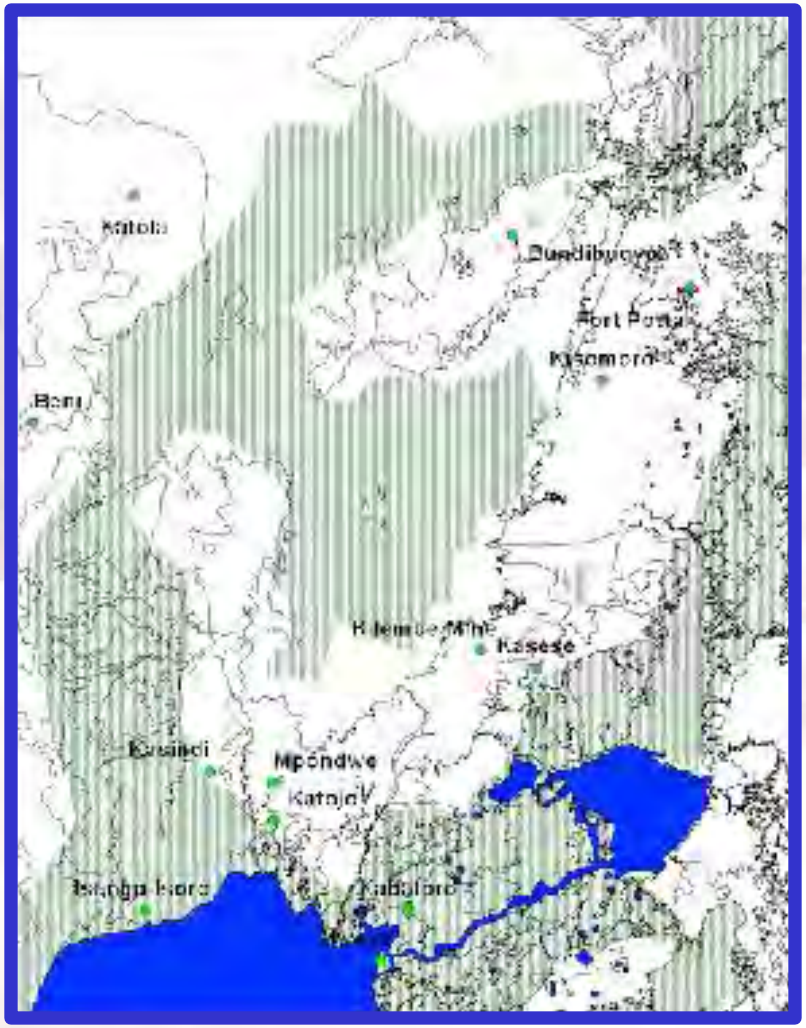
Rwenzori 1906-2006

Landcover changes in the Rwenzori Mountains: the glaciers retreat

Protected Areas (PA)



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Rwenzori 1906-2006

Landcover changes in the Rwenzori Mountains: the glaciers retreat

Ag + PA

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Rwenzori 1906-2006

Landcover changes in the Rwenzori Mountains: the glaciers retreat

Population distribution (Landscan 2002)

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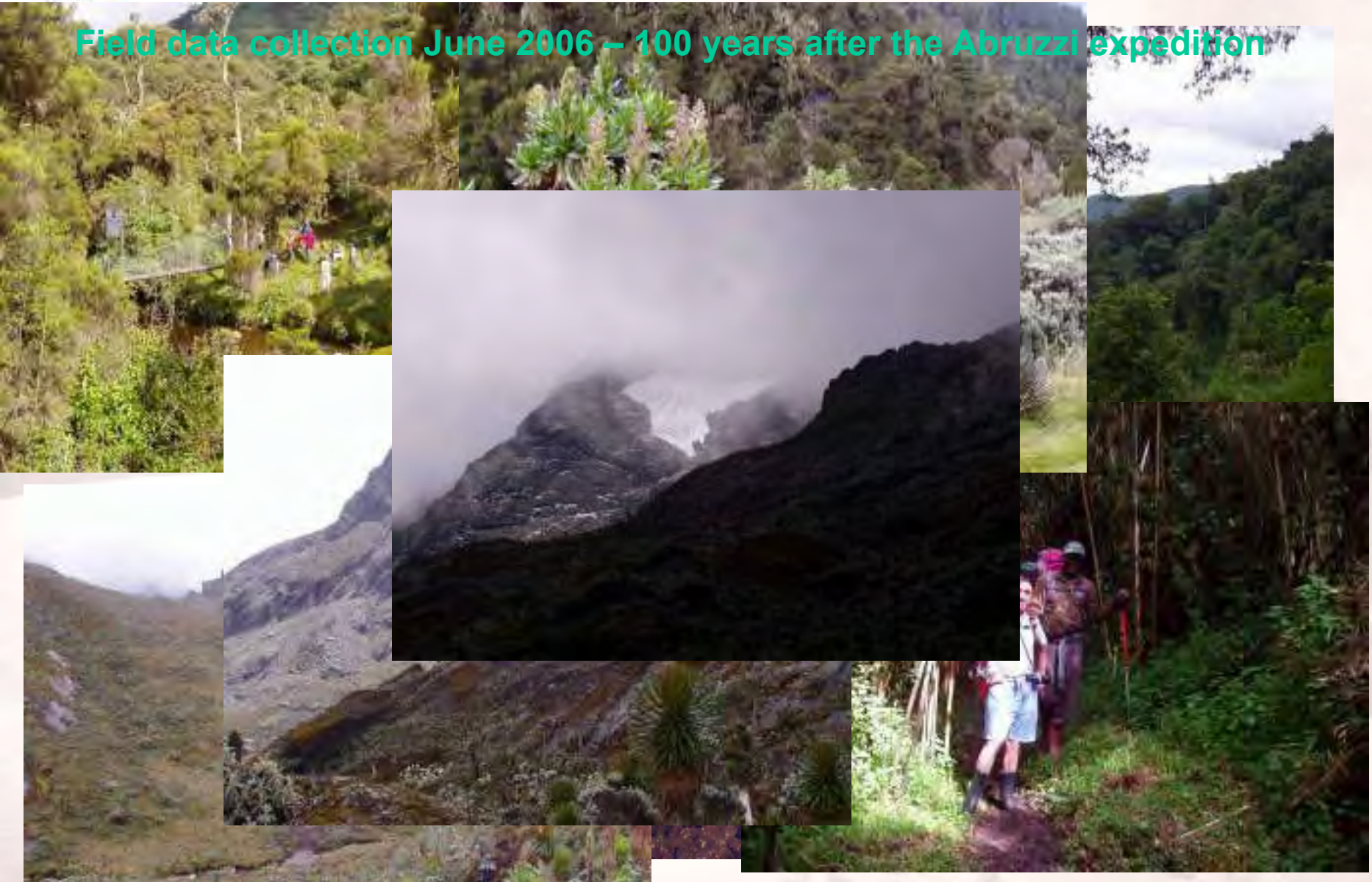
Rwenzori 1906-2006

Landcover changes in the Rwenzori Mountains: the glaciers retreat



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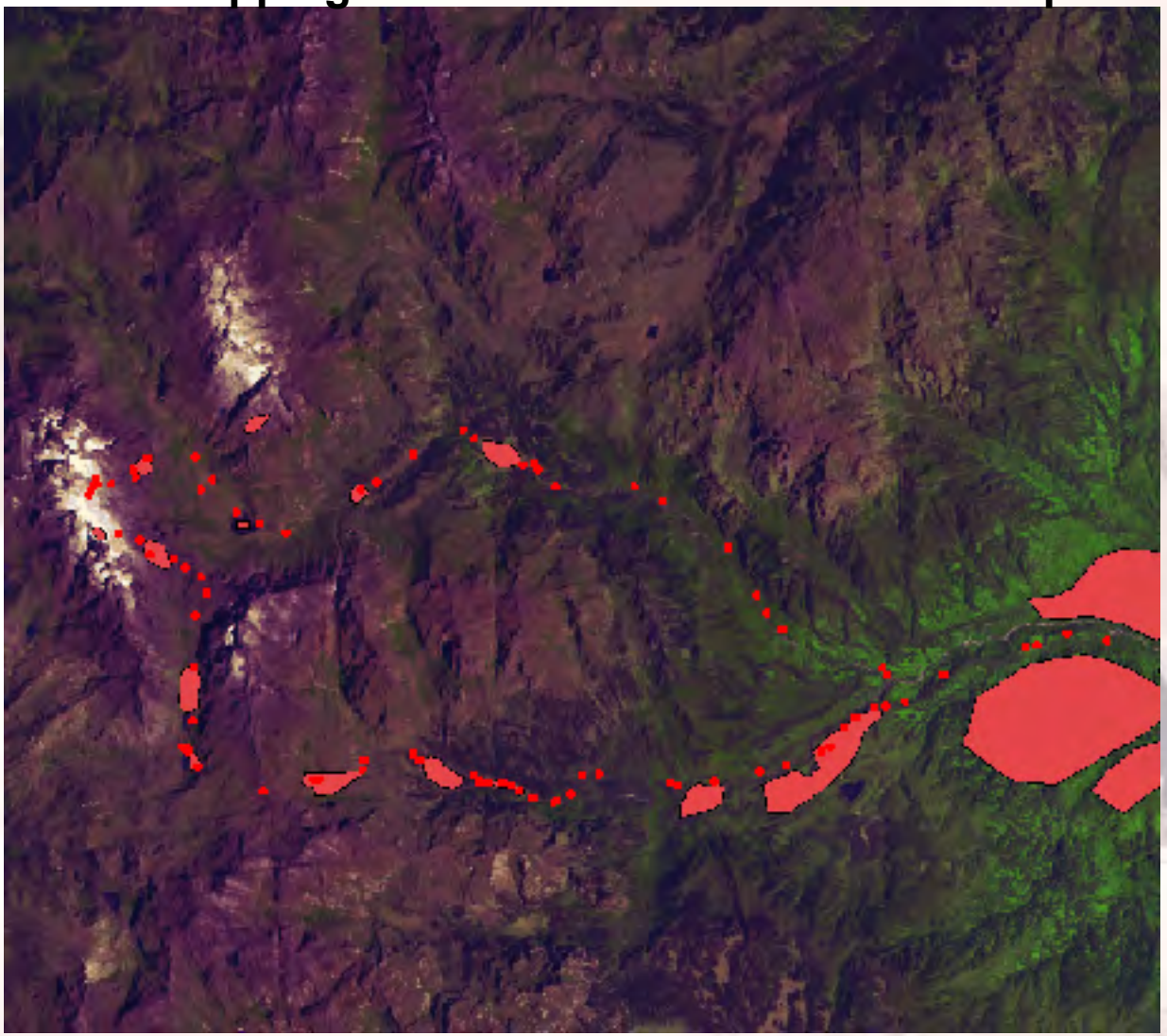
Rwenzori 1906-2006

Landcover changes in the Rwenzori Mountains: the glaciers retreat

Landcover mapping from ASTER data – a first attempt



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Rwenzori 1906-2006

Landcover changes in the Rwenzori Mountains: the glaciers retreat

Landcover changes - high resolution satellite imagery 1975-2005

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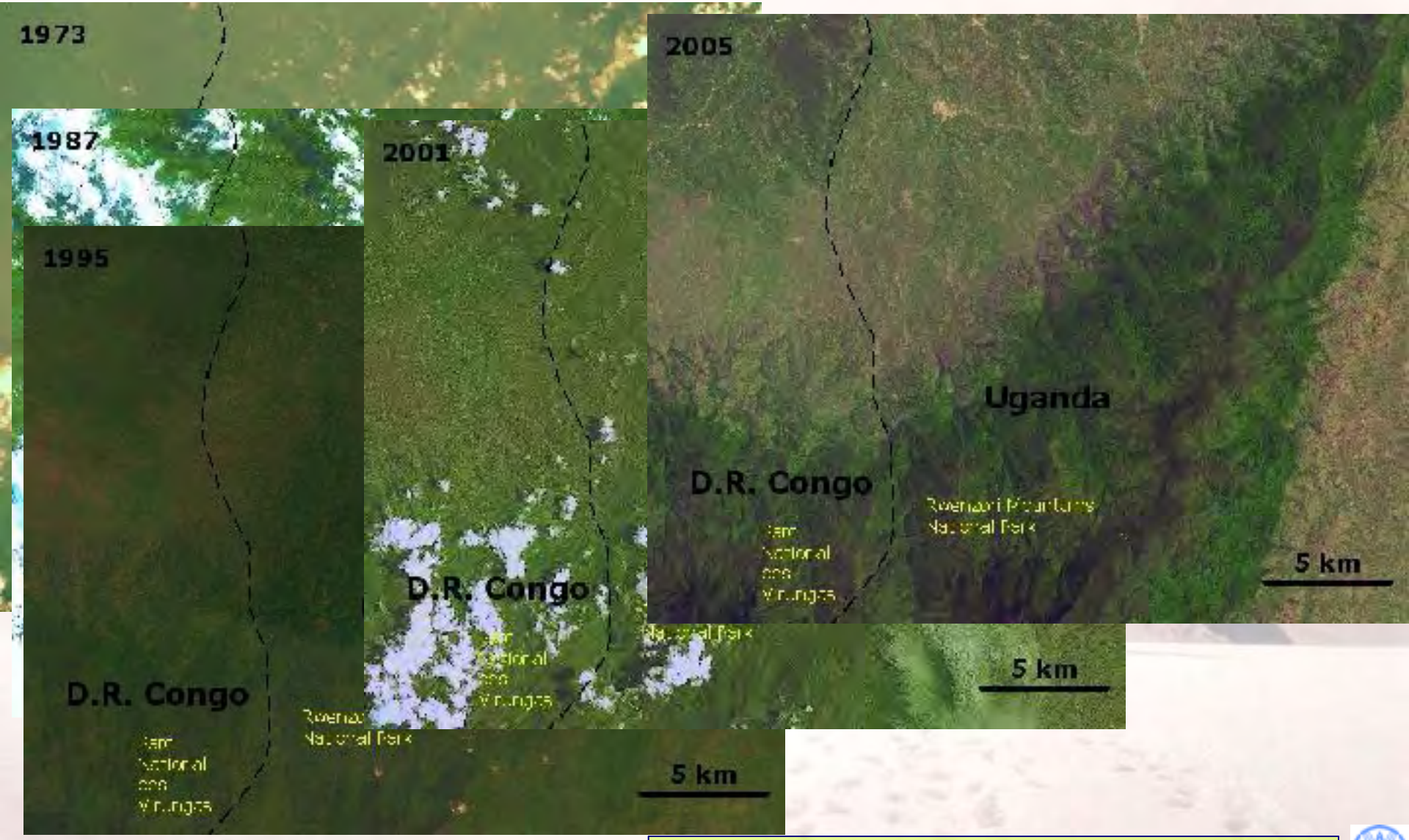
Rwenzori 1906-2006

Landcover changes in the Rwenzori Mountains: the glaciers retreat

Landcover changes - high resolution satellite imagery 1973-2005



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Rwenzori 1906-2006

Landcover changes in the Rwenzori Mountains: the glaciers retreat

Landcover changes – Adjusted NDVI trend 1973-2005

Landsat MSS

Path 185: row 60: date 19730204

Path 186: row 60: date 19730205

Path 186: row 60: date 19750312

Landsat TM

Path 173: row 060: date 19870807

Path 173: row 060: date 19950117

Landsat ETM

Path 173: row 059: date 20010109

Path 173: row 060: date 20010314

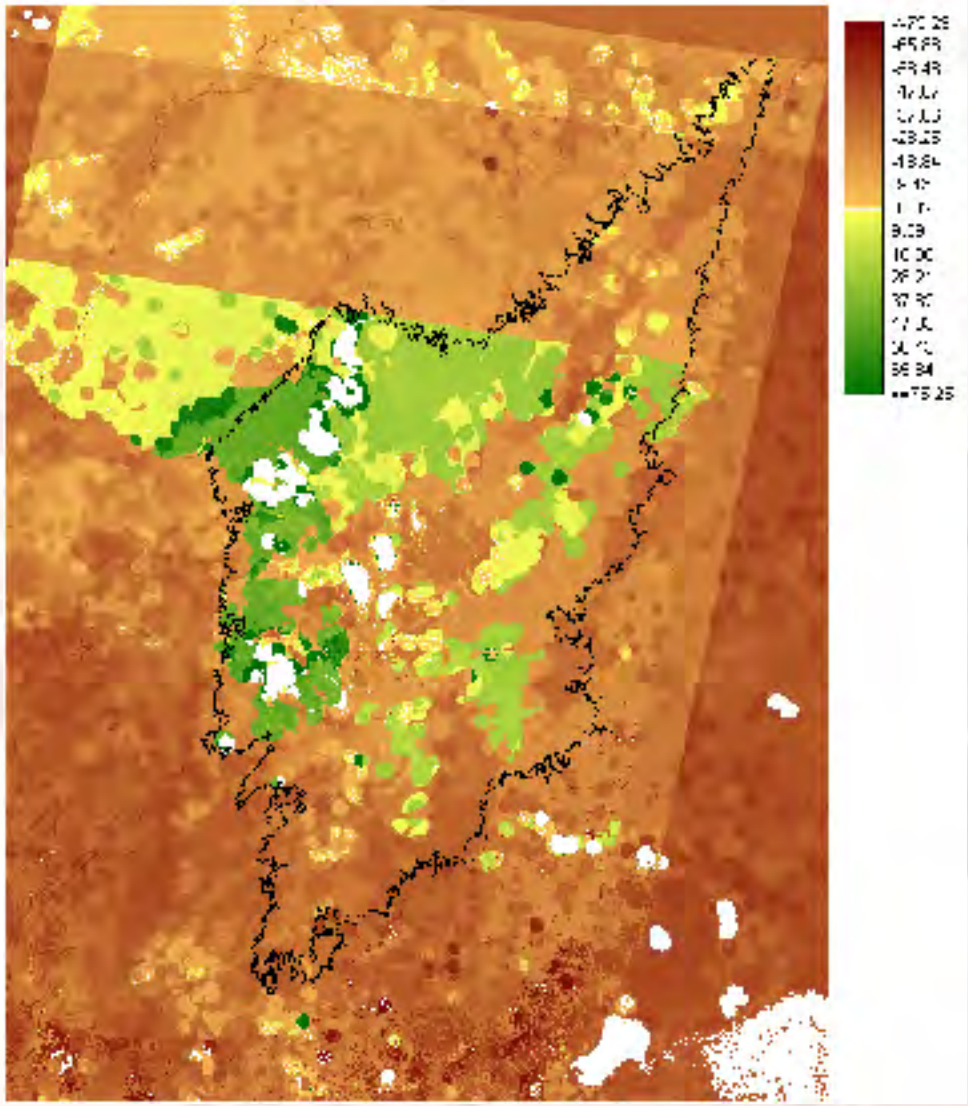
Path 173: row 060: date 20011211

Path 173: row 060: date 20030131

ASTER

AST_L1B_00302212005083011_02282005091034

AST_L1B_00302212005083003_02282005090940



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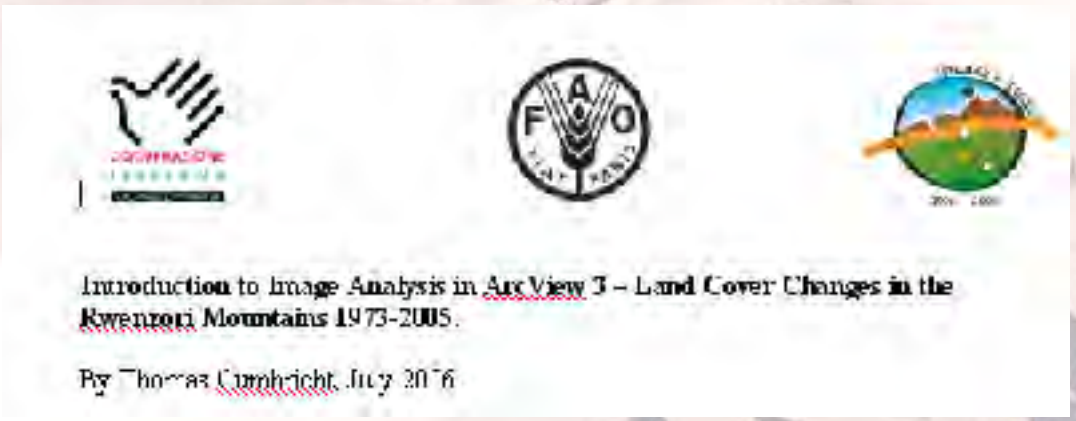
Results

- Glaciers reduced from **6,5** Km^2 to **1** Km^2 in 100 years
- Glacier retreat dependent on several factors
- If the trend continues the glaciers will disappear in 20 years

Thank you



Introduction to Image Analysis in ArcView 3 – Land Cover Changes in the Rwenzori Mountains 1973-2005.

By Thomas Gumbricht, July 2006