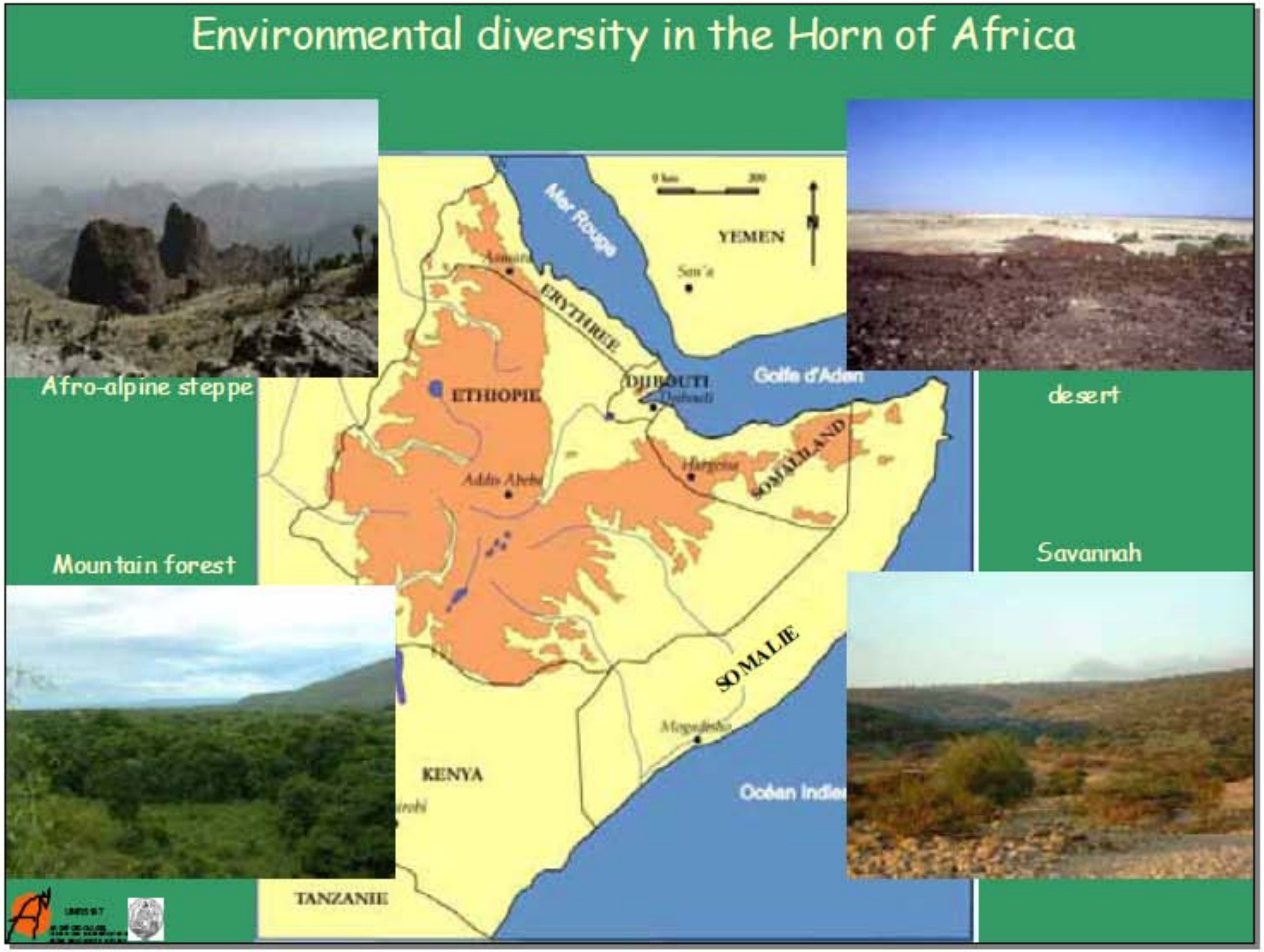
Regional Integration of Past Records For Management of Modern Resources and Landscapes In East and NE Africa

Aim: To show to what extent information is available but not integrated

Sites

- Northern Ethiopia
- East Africa (Kenya, Uganda, Tanzania)

About The Region



- Ethiopia - special challenges
- Indigenous and non-indigenous crops
- Archaeological evidence
- Aksum: its rise and fall
- Research questions
- Ashenge, Hayk: the lake-sediment records
- Interim conclusions, proposed research

Map of East Africa showing locations of some of the major archaeological sites; also shown are locations of major ethnic groups, major cities and towns of archaeological importance (Schmidt, 1997).

Records

- Geo-arhaeology
- Paleorecords (lakes and valley deposits)
- Historical accounts

Problems

- Origin and expansion of agriculture
- Impact on landscape
  - Regional Models vs Local Findings
  - Human Impact vs Climate

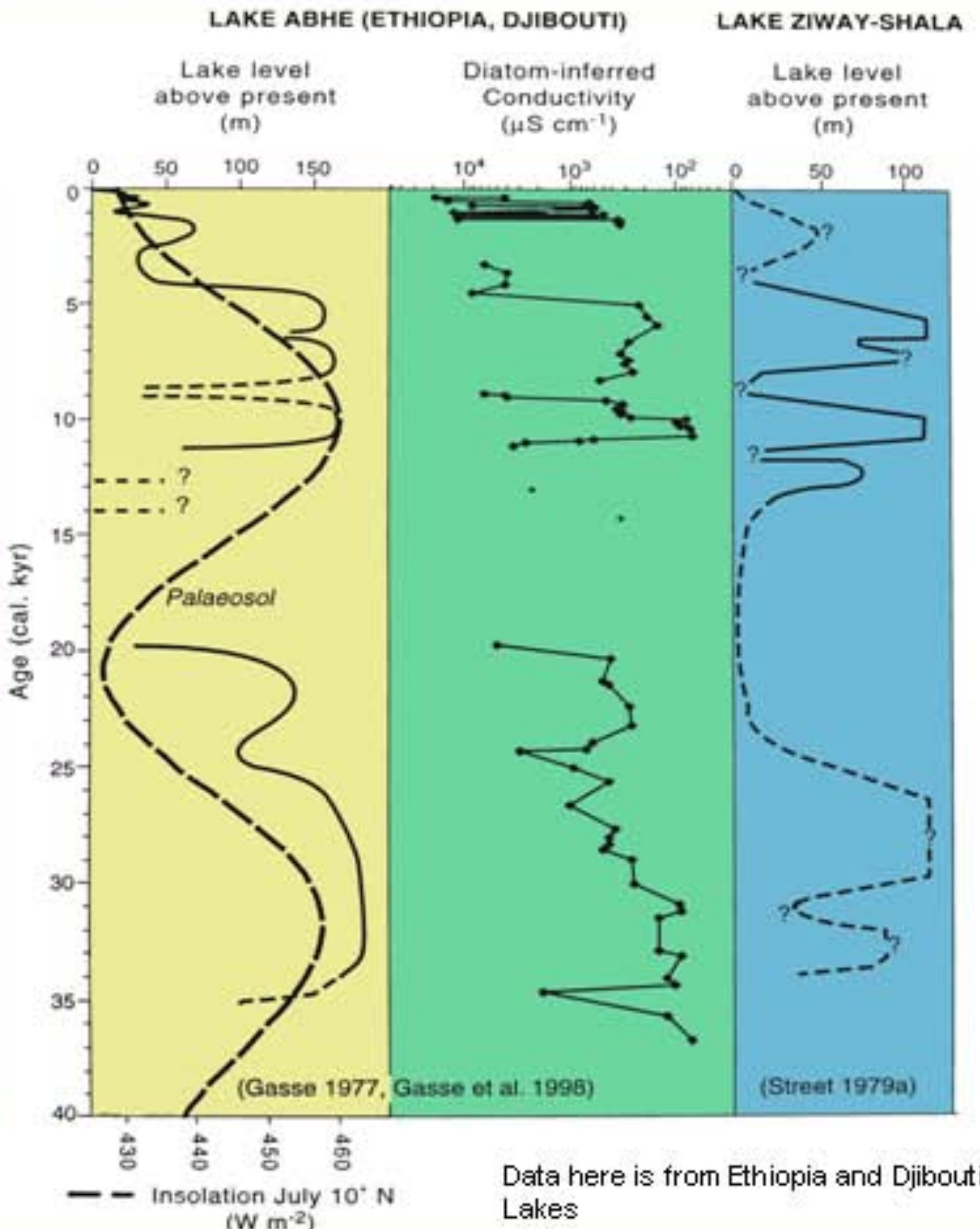
Millennial Scale Climate changes from Lake Level Records of NE Tropical Africa

Abrupt aridity from 5000 years onwards-Today's Sahara Desert

African Humid Phase-Green Sahara 10000-5000 years ago

Last Glacial Maximum Aridity-Lake level falls and Drying

Humid Stadial 40,000-20,000 years ago



Data here is from Ethiopia and Djibouti Lakes

Agricultural origins in Ethiopia: special challenges

Theory echoes the usual drivers:

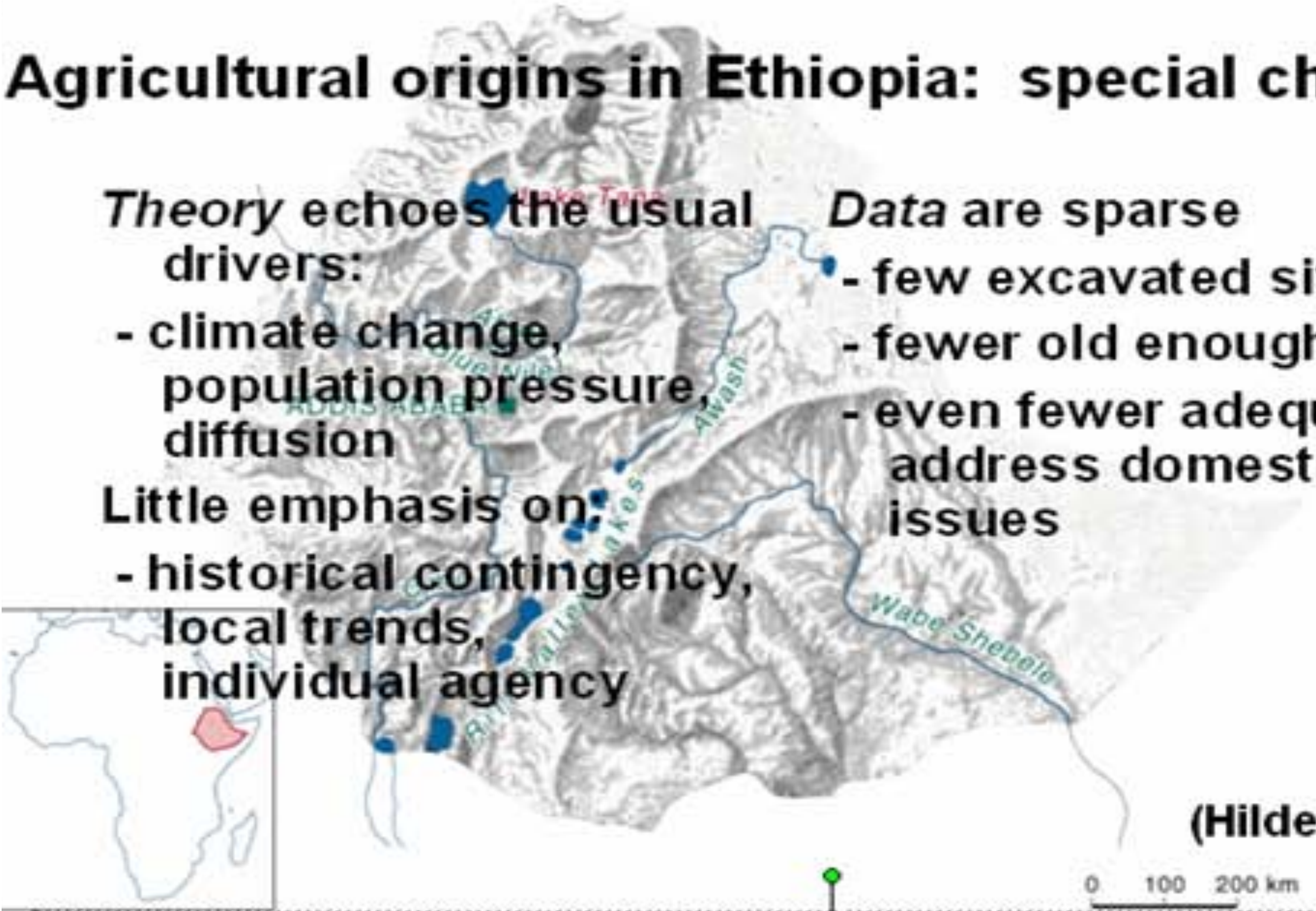
- climate change, population pressure, diffusion

Little emphasis on:

- historical contingency, local trends, individual agency

Data are sparse

- few excavated sites
- fewer old enough
- even fewer adequate to address domestication issues

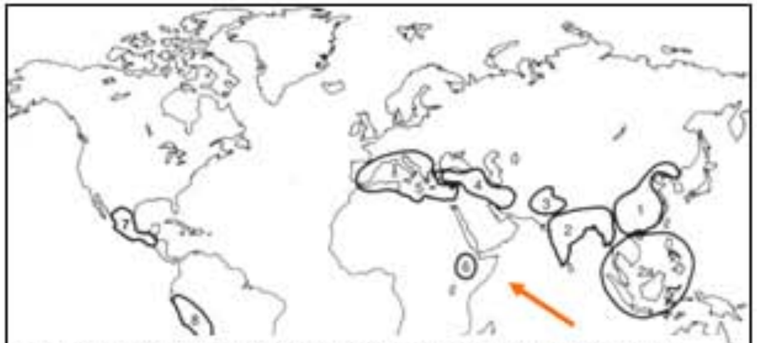


(Hildebrand 2005)

We know appreciably more about the behaviour of early hominids in Ethiopia than we do about the origins of its traditional agricultural systems.

J. Desmond Clark 1988

Ethiopia: "one of the world's greatest and oldest centers of domestic seed plants" (Sauer, 1952)


Independent agricultural origins in eight "hearth" areas

(Vavilov, 1926; Harlan, 1971)

Ethiopia's indigenous crops:

Eragrostis tef (T'ef)

Eleusine coracana (Finger Millet)

Guizotia abyssinica (Noog)

Ensete ventricosum (Ensete, False banana)

Sorghum bicolor: (SW Ethiopia / Sudan)

Coffea arabica

Archaeological evidence for food production in highland Ethiopia

~7000 BP cattle rock paintings

~3500 BP pottery and domestic cattle

~**2500 BP** (Aksum): te'f, emmer wheat, barley, oats, linseed, Brassicaceae.

2335 ± 20 bp (Bieta Giyorgis, Ona Negast II): wheat, barley

~1600– 1300 BP (Ona Negast III): t'ef, lentils, grapes

1500 – 1400 BP (Aksum): te'f, emmer wheat, barley, oats, linseed, Brassicaceae, bread wheat, finger millet, sorghum, lentil, pea, grass pea, chick pea, noog, cotton, grape, gourd, *Cordia africana* (wanza tree)

Hildebrand 2005, citing Bard et al, 1997; Phillipson 1997; Boardman 1999;.

Domestic plants

- ***~ 2500 BP and later***
- ***Includes both Ethiopian and southwest Asian crops.***

The Aksumite empire, ca AD 300 – 800 (1700 – 1200 BP)

Sub-Saharan Africa's first indigenous literate civilisation, only sub-Saharan kingdom known to classical world

Controlled trade across N Ethiopia, Sudan and S Arabia, financed by first sub-Saharan African coinage

Butzer (1981): soil and forest degradation caused abandonment of Aksum by AD 800

ck to add notes

Northern Ethiopia
Axum

- The economic base and forms of resource management that underlie the origin, expansion, and decline of this early state still remain unclear.
- The importance of Aksum lies in its history and environmental setting and it can be summarized in four main points

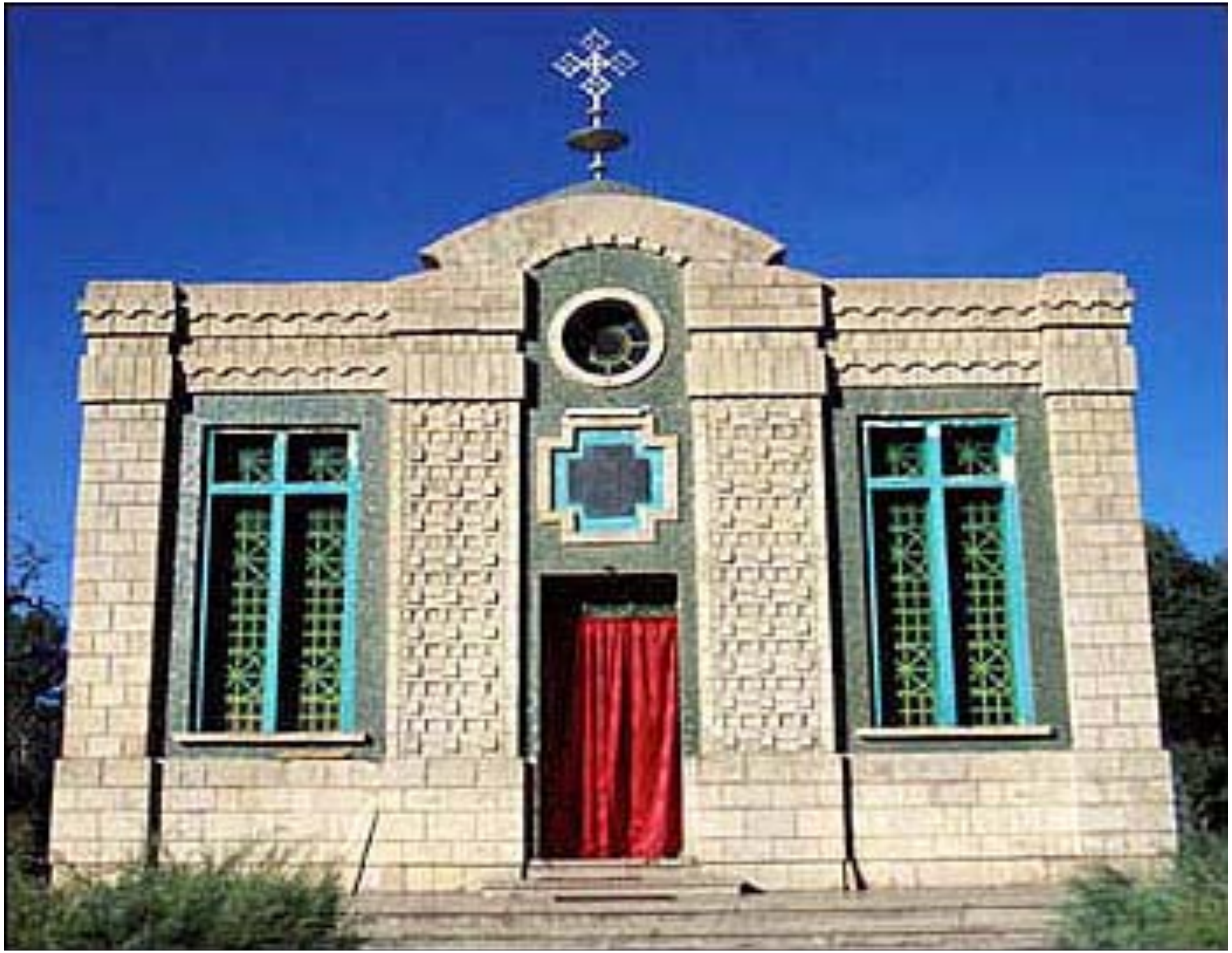
1) Aksum is at the crossroad of contrasting environments that include the arid lowlands of Sudan and Eritrea, the fertile Nile Valley, the coastal plains of the Red Sea and the great Rift Valley;

2) the region has a long history of plant exploitation, leading to the domestication of important staple crops and plough-farming;

3) Aksum is the centre of an ancient literate civilization;

4) The region is the gateway for the introduction and spread of Christianity and Islam in Africa and Aksum is second only to Armenia in the adoption of Christianity as state religion.

(http://www.phytolith.net/projects_collaborations/aksum_ethiopia.html# Madella 2009).

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Axum

- Located on Shire Plateau (2100-2400m a.s.l and mean annual temperature is 10-15˚C)
- The city itself lies at 2100m a.s.l with mean annual temperature 15-20˚C
- Rainfall is 600-800mm and adequate for agriculture
- Rainfall can fail leading to catastrophic famine
- Rainfall is seasonal (small rain march-may and big rain June to September)
- Physiographically the town is located at the base of several hills in a depression of 24 sq km.
- Soils: **Vertiso**l in the valley (fertile), **Cambisols** (not rich) are found on the highlands and slopes.
- Vegetation: Montane savanna (grass, herbs, scrub, few trees such as Acacia).
- Natural vegetation seems to be Dry upland with *Juniperus* and *Podocarpus ???*

Some historical events

Fig. 2. Summary of some human historical factors that may be interrelated with environmental change … lates are discussed in the text. Dates and names of periods are from Phillipson (1998) and Fattovich et al. (200

Origin of Agriculture ?

- For the region several models exist and excavated evidence not yet sufficient to prove or disprove them.

- **Little is known about the Axumite and Pre-axumite agriculture ?**

- Since the earliest kingdom (Daamat- 800-300 BC) plow agriculture was practiced (Fattovich, 1993) and was associated with irrigation from the 1st millennium BC (Butzer, 1981).

- Artifitial terraces are found at settlements of the Axumite period, Axumite and pre-Axumite dams and cisterns have been preserved in some localities (Axum and Kohahito)

Butzers 1981

	Events		
	Activity	*Impact*	*Reconstructed Climate*
Early Axumite	Concentrated population	Intensified efforts by subsistence farmers	Moister and cooler climate
AD 100-350	Strain on land	Accelerated Erosion Pop- estimated at 10,000-20,000	
Ad 650-800	Second phase of aggradation	Culturally induced environmental degradation After major building phase and military expansion	Heavy rains
8^{th} C AD			Possibly un-reliable rain fall

Questions?

- These reconstructions according to Bard 1997 leave several unanswered questions
  - The history of irrigation and plough agriculture in northern Ethiopia
  - The use of cultigens during pre-axumite and Axumite periods
  - Climatic change in northern Ethiopia- long and short term
  - The long term effect of Axumite agricultural practices on the landscape, resulting changes in subsistence practices, especially cycles of drought and famine
  - The effects of climatic change and subsistence practices on political and evolution and devolution

In General

The distribution, exploitation and management of natural resources supporting the Aksumite society are still poorly understood (French et al. 2009)

French et al. 2009, Catena

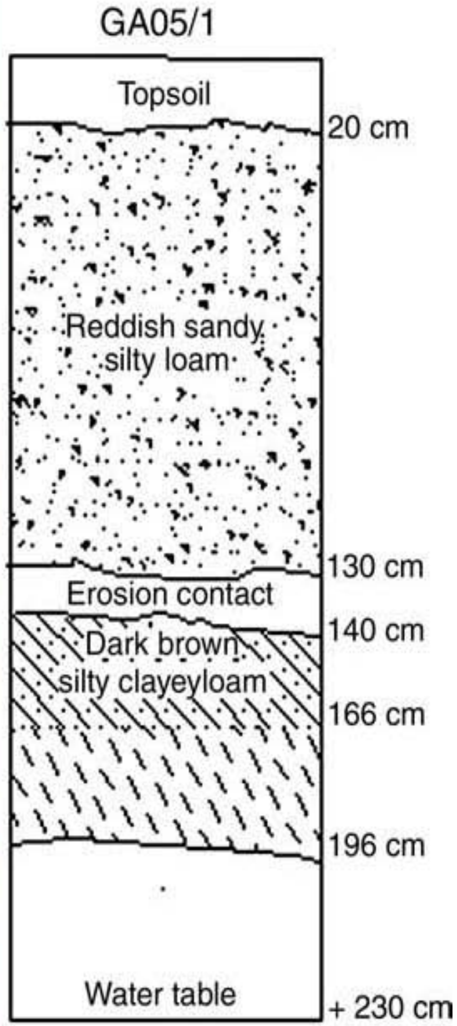


Table 1
Profile 1 (GA05/1) field description and micromorphology observations.

Depth	Field description	Micromorphology observations
0–20 cm	Topsoil; reddish (2.5 YR 5/6) silty sand loam; crumb to loose structure, friable, dry, with coarse sands and quartz gravels; common rooting; diffuse boundary	
20–130 cm	Reddish (2.5 YR 4/6) silty sand loam; weakly developed crumb structure; friable, dry and dominated by fine sands with few quartz gravels; few earthworm and root channels; diffuse boundary	80–87 cm: moderately sorted clay loam; weakly developed, porous crumb structure; strong amorphous iron impregnation; common micro-laminated limpid clay; limited organic matter and commonly iron-replaced; limited charcoal and rare excremental features
130–140 cm	Reddish silty clay loam (2.5 YR 4/4); pH is slightly basic 6.9 and water content is very low; positive correlation between magnetic susceptibility value and clay content; sharp boundary	122–134 cm: as above, porosity drastically reduced; amorphous iron-manganese, micro-laminated limpid clay, and organic matter decrease; rare excremental features; thin *laminae* (5 mm) of coarser sands
140–166 cm	Dark brown (10 YR 3/3) silt clay loam; small irregular sub-angular blocky structure displaying oxidized organic matter and sand-size mottles of manganese	160–175 cm: moderately sorted silty clay loam with well developed angular blocky structure; moderate plane-dominated porosity with ped boundaries well expressed; moderate amorphous iron impregnation; limited micro-laminated clay and common coarse clay; limited amorphous organic matter is limited
166–194 cm	Dark brown (7.5 YR 4/3) silty clay loam; well developed columnar blocky structure; highly organic and oxidized with peak in total organic and calcium carbonate contents; phytolith assemblage shows a predominance of long-cell and bulliform types, and few short-cells	176–191 cm: silty clay loam with moderately developed sub-angular blocky structure; channel-porosity slightly increased; moderate amorphous iron impregnation; limpid and dusty clay very common; increased organic matter
196–230 cm	Dark brown (10 YR 3/4) silty clay loam; massive columnar blocky structure; moist and plastic with high water content and slightly acidic pH (5.9)	191–204 cm: silty clay loam with well developed columnar structure (191–201 cm), degrading to angular blocky and crumb down-profile; vughy porosity and amorphous iron impregnation as above; common dusty clay and decreased micro-laminated clay; abundant charcoal and limited organic matter; rare excremental features
+230 cm	Water table	

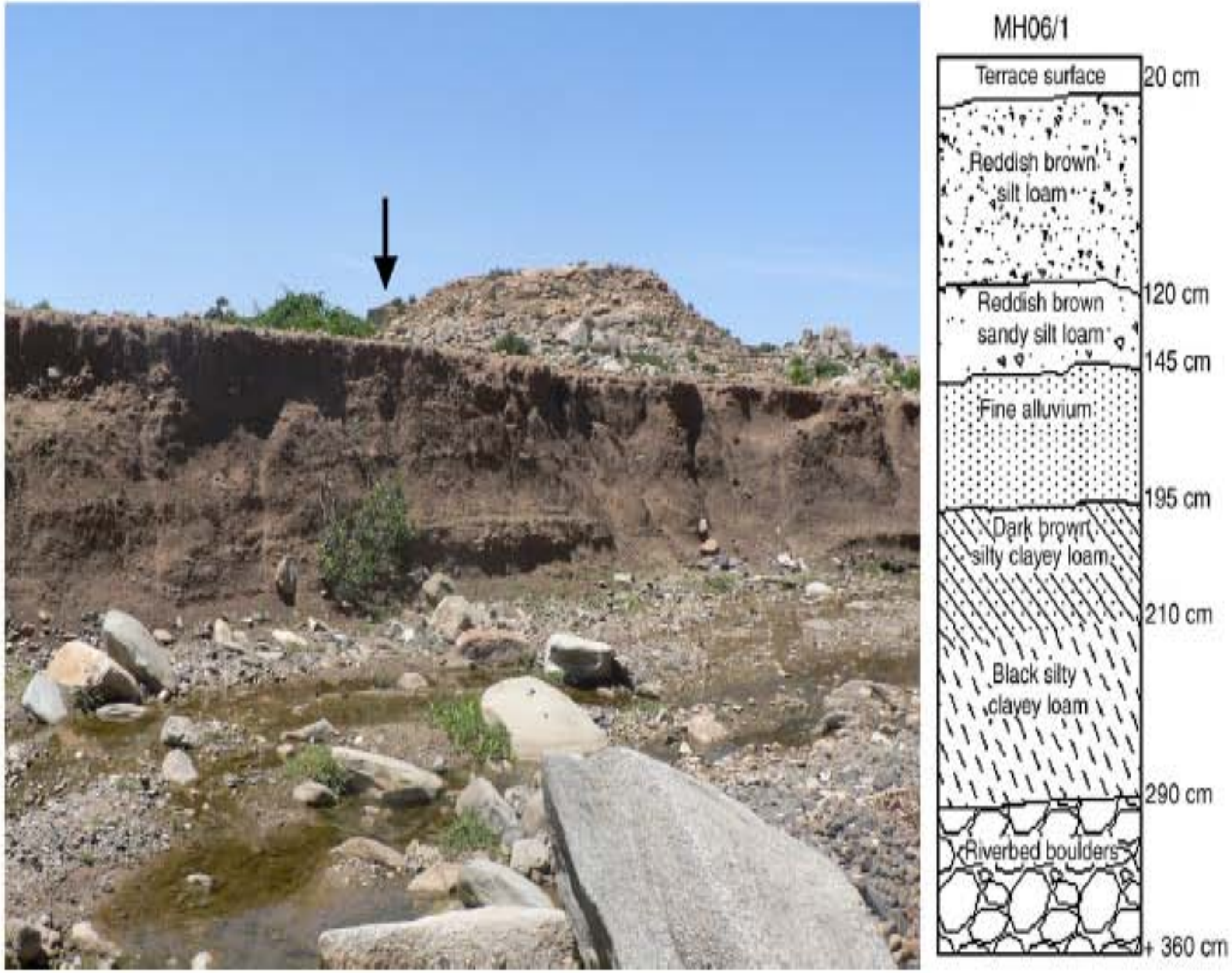
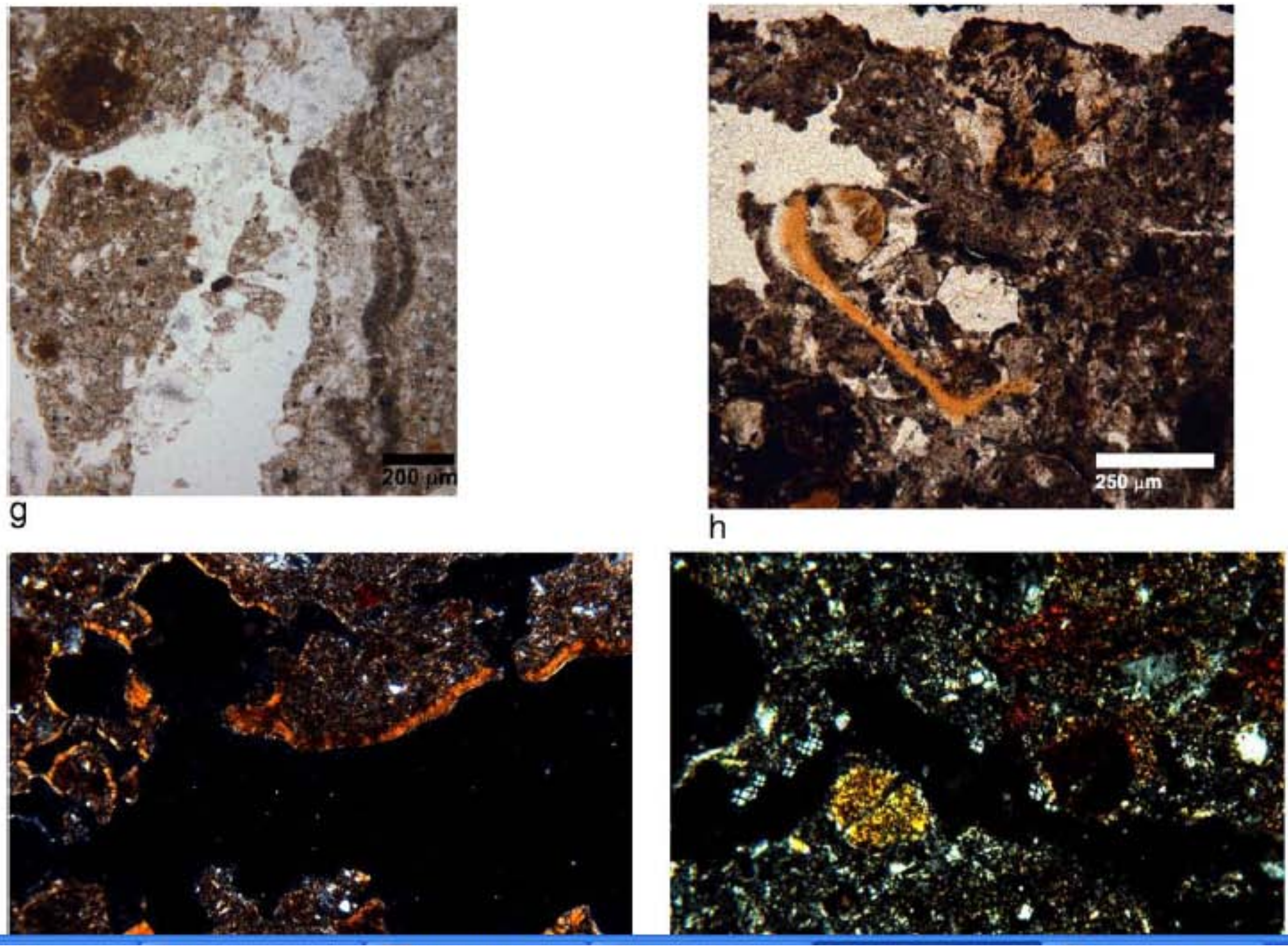
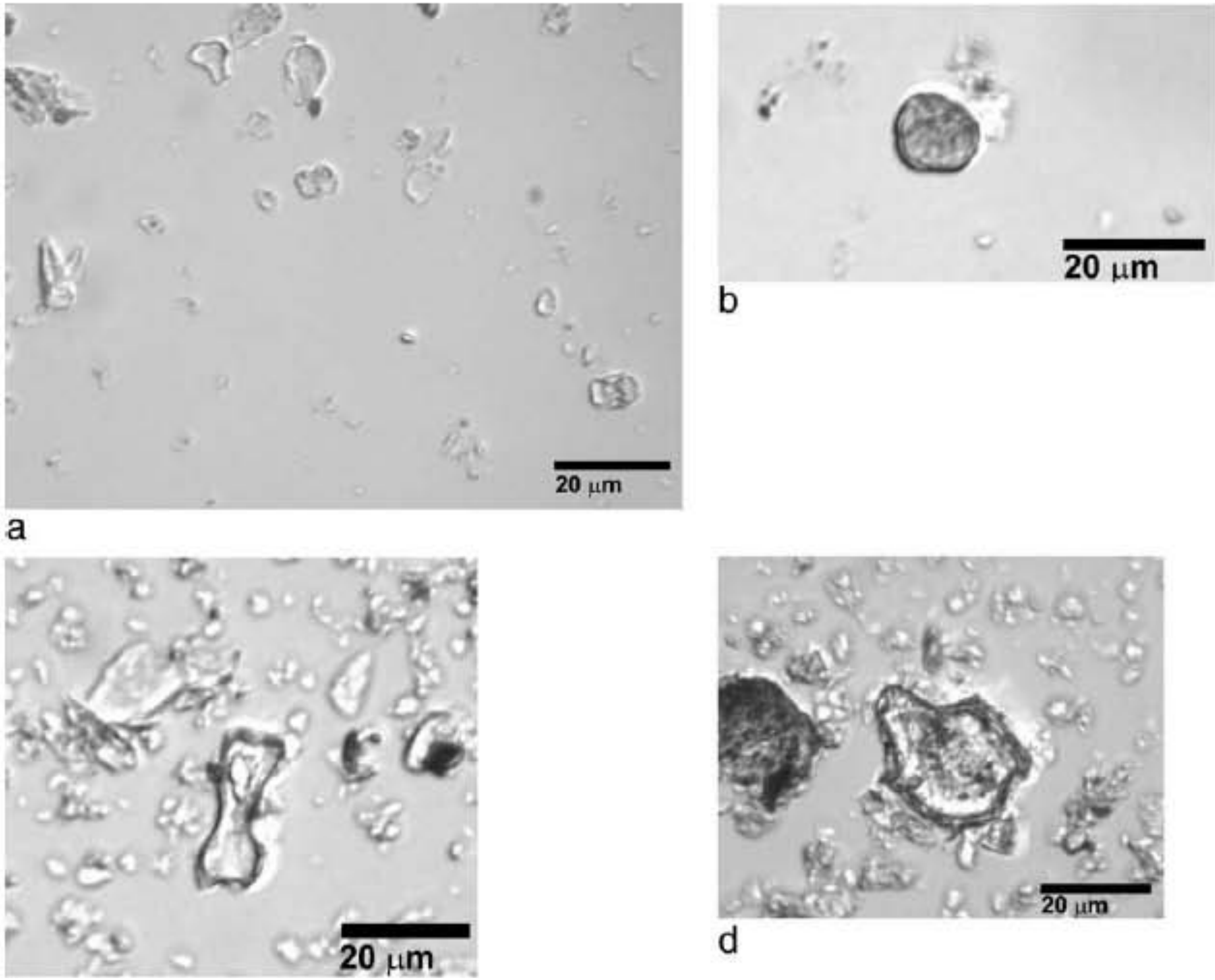


Fig. 4. Profile 2 view and section.

Micromorphology




20 μm
20 μm
b
a
20 μm
20 μm
d

The physical properties of the clay-enriched brown soil, together with the phytolith evidence, point to considerable landscape stability and resilience, both prior to and during the Aksumite Period. Major aggradation and alluviation episodes appear to have occurred only during the last four to five centuries, at least in our study area. This pattern, if confirmed by further research, will require a profound reconsideration of both the environmental history and the development of farming in the Aksum region.

History from Plough Marks: Ciampalini et al 2008. Catena

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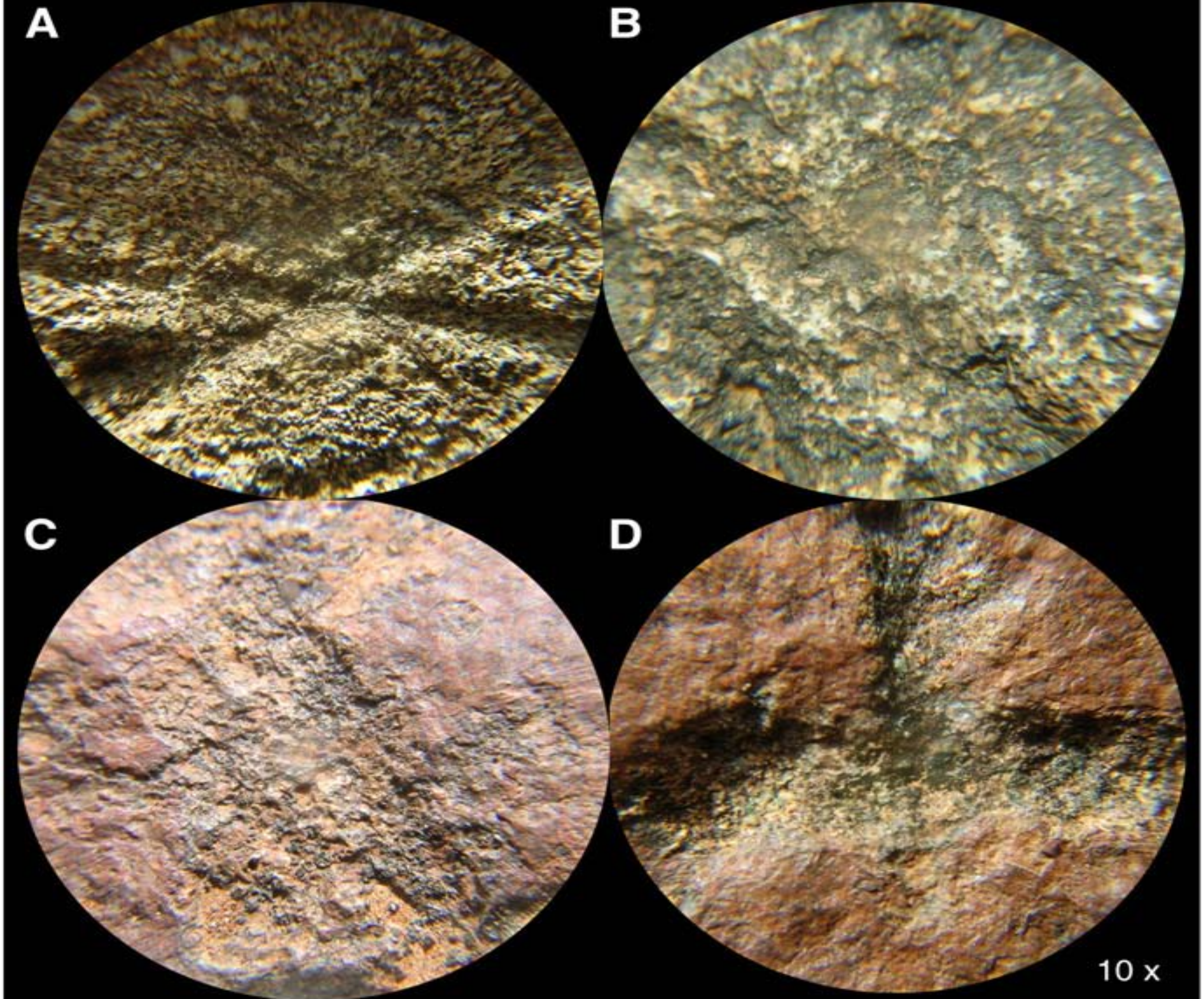
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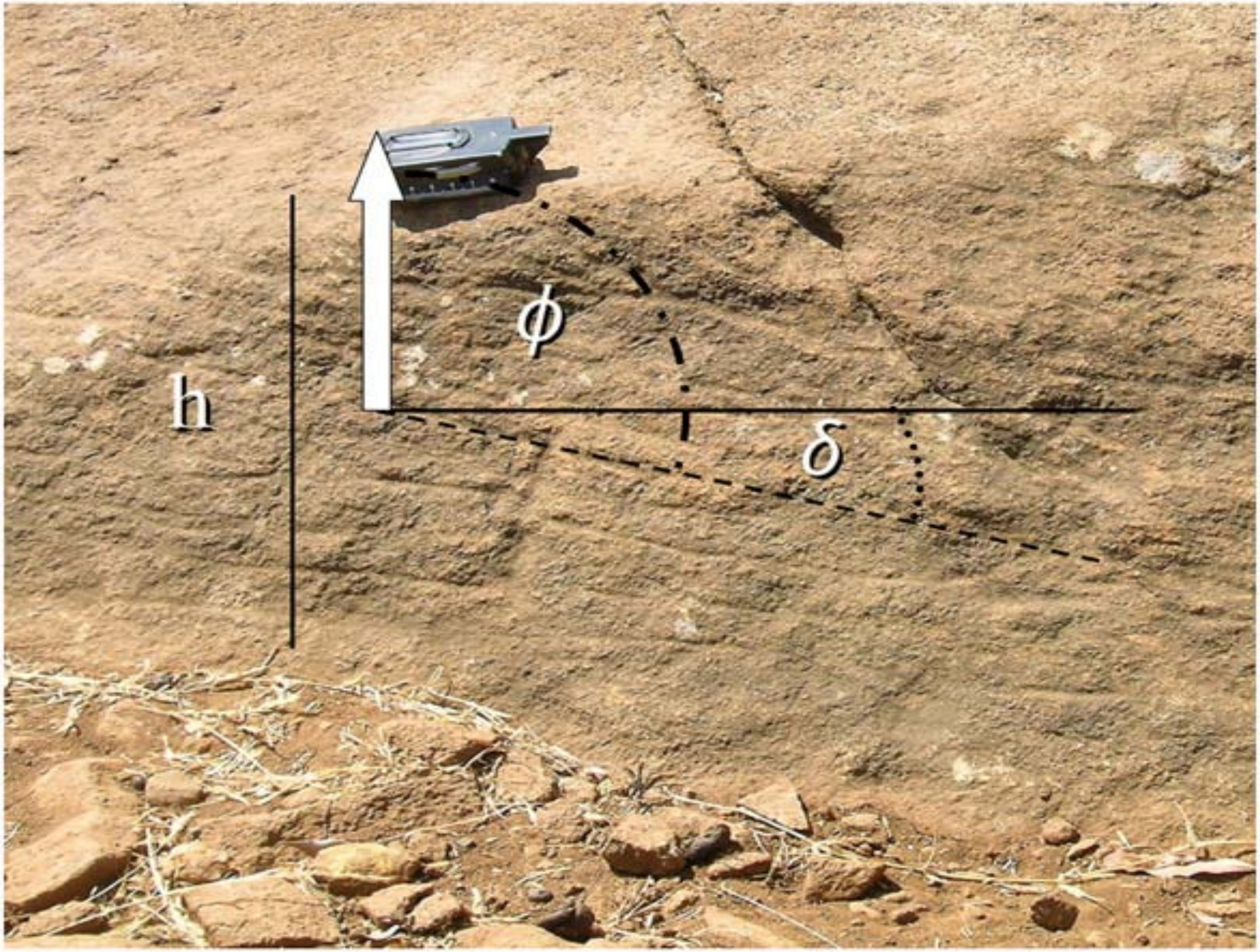


h
ϕ
δ

Conclusions From Plough Marks

For the main time intervals of the Axumite history, corresponding to

the rise and fall of the Axumite civilization and to variable conditions of human pressure on the land, the maximum erosion rates inferred are of the order of 3.4 Mg ha^{-1} y^{-1}.

Old Photograph Records

- On Display Via Poster

REGIONAL STUDIES

- Buried soil sections
- Lakes

RELATIONSHIPS OF ENVIRONMENTAL CHANGE TO THE EVOLUTION OF HUMAN SOCIETIES IN THE TIGRAY PLATEAU

V. Terwilliger[1], T. Gebru[2], M. Umer[2], Y. Huang[3], Z. Eshetu[4]

[1]University of Kansas, Lawrence, Kansas, USA; [2]Addis Ababa University, Addis Ababa, Ethiopia; [3]Brown University, Providence, RI, USA; [4]Ethiopian Institute of Agricultural Research, Addis Ababa, Ethiopia.

Some methods:

Soil sample collection from exposed ravine walls.

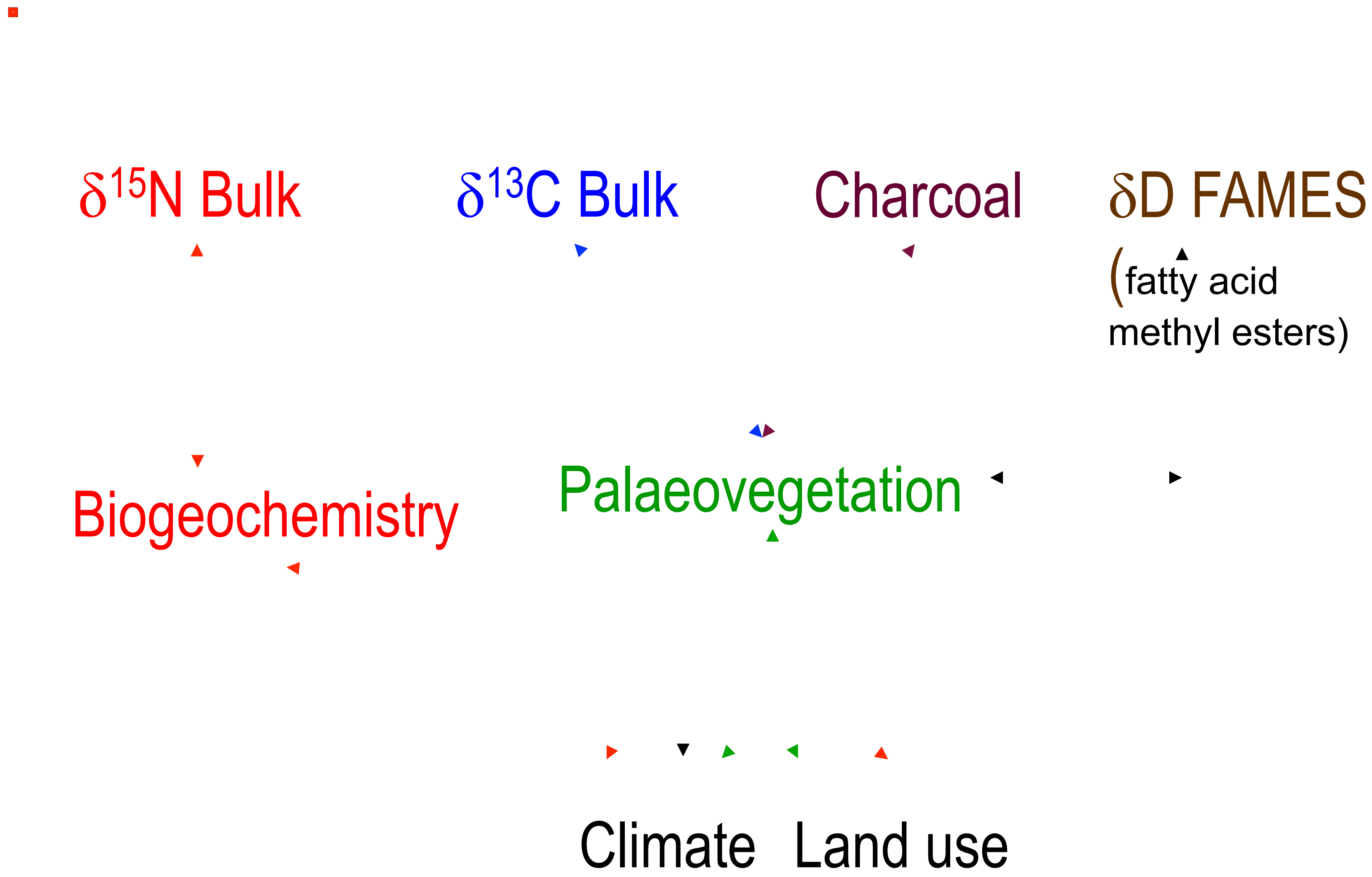
Analyses of organic materials:

Stable isotopes

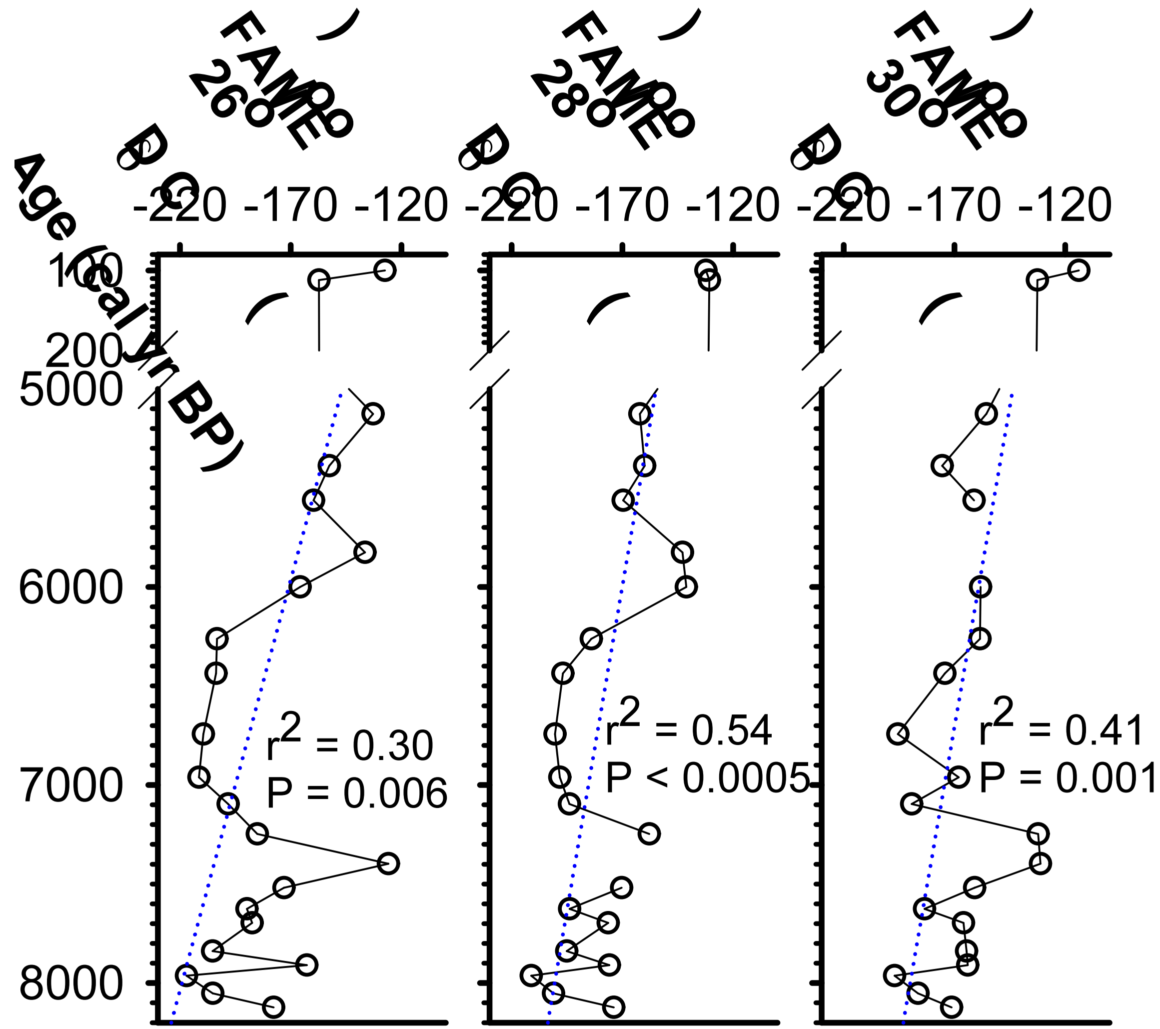
- Bulk carbon and nitrogen in soil organic matter
- Hydrogen in specific lipid compounds
  (Fatty acid methyl esters ≥ C_{26})

Charcoal

- ^{14}C dating by AMS
- Identification


δ15N Bulk
δ13C Bulk
Charcoal
δD FAMES
(fatty acid methyl esters)
Biogeochemistry
Palaeovegetation
Climate
Land use

MMII



δD values significantly decrease with time. Important shift at ca. 5800 cal yr BP.

Oscillations in δD match among FAMEs.

Some statistics and interpretations

1) MMII : δ values since 5800 cal yr BP > earlier δ values.
   - Precipitation ↓ since 5800 cal yr BP.
   - But another dry period occurred ca. 7500 -7300 cal yr BP.

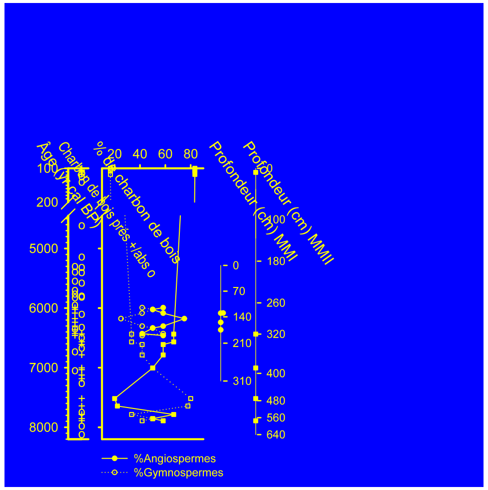
2) AKIII: δ values ↓ with time but δD FAMES suggest
   - Important dry period ca. 3700 – 3300 cal yr BP.

3) MMII : $\delta^{13}C$ values (%C_4 plants) ↓ when %TOC ↑.
   AKIII : $\delta^{13}C$ values (%C_4 plants) ↓ when %TOC ↓.
   - Climate is wettest (coolest) when $C_4 : C_3$ is lowest.
   - Fire may have led to high $C_4 : C_3$ from ca. 3400 – 2200 cal yr BP.

Vegetation history????

1) Are juniper forests the principle natural vegetation ?

2) Were juniper forests the principle natural vegetation in wetter times?

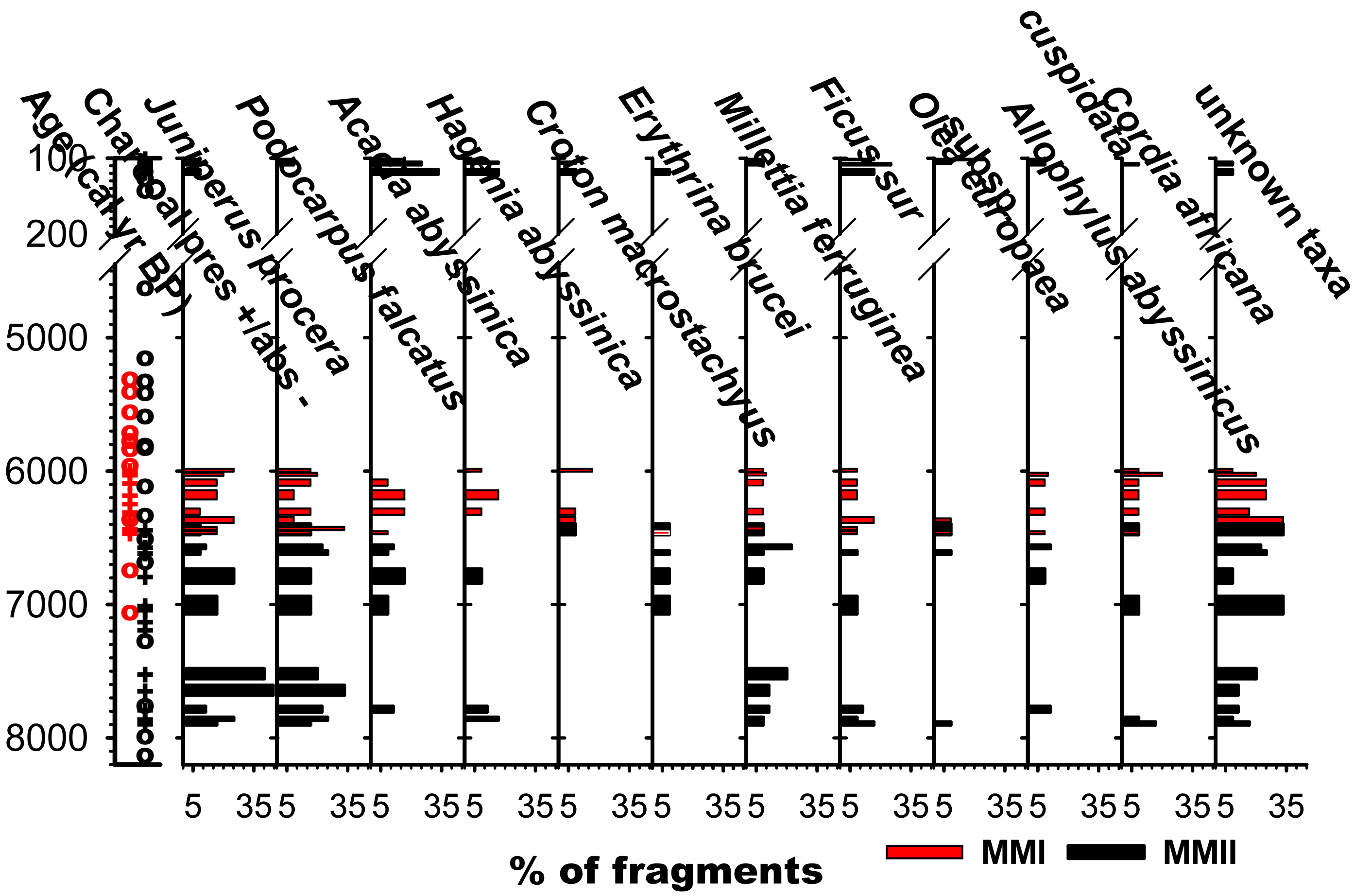


1) Gymnosperm (juniper) forests have disappeared only very recently.

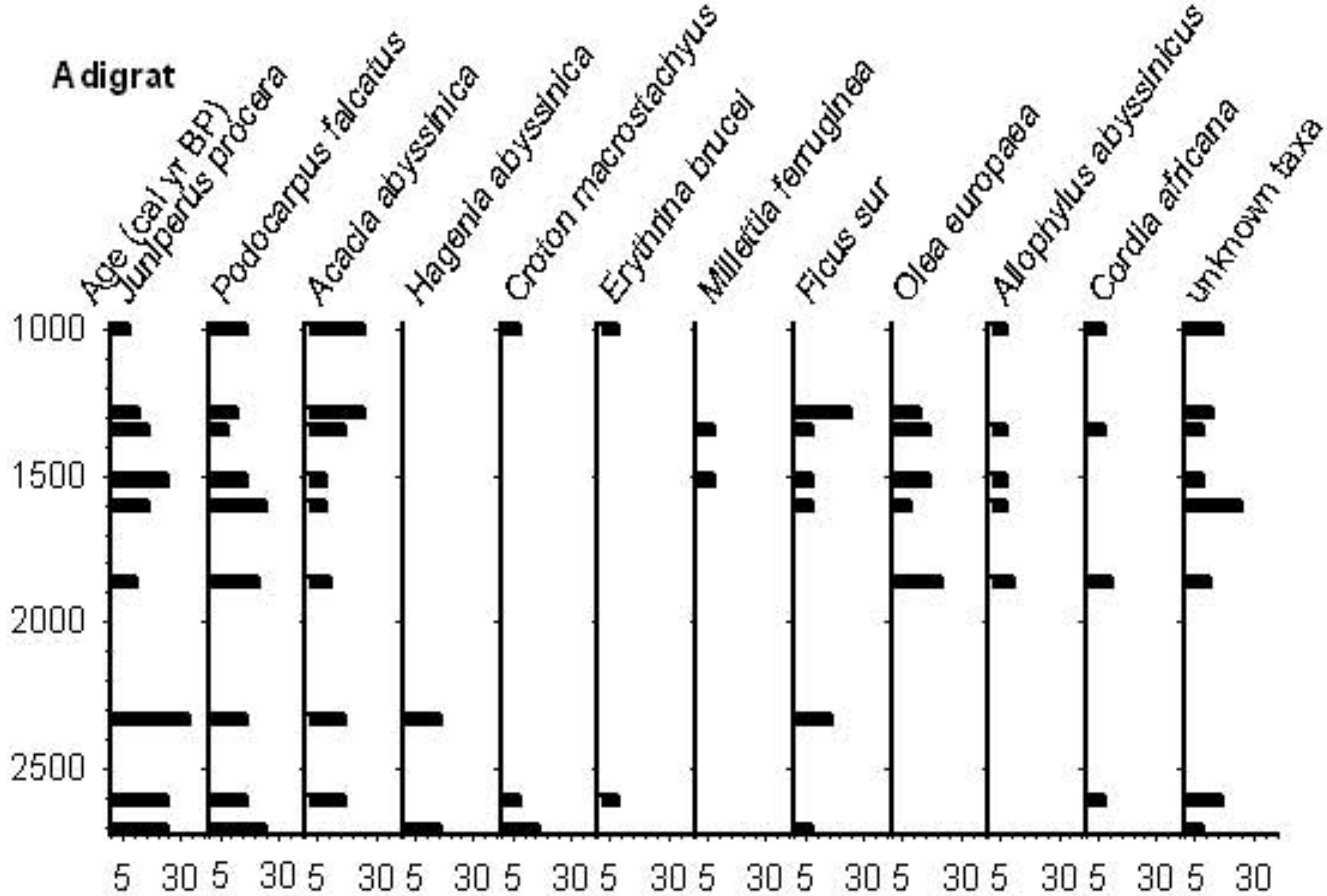
2) Gymnosperms were more widespread in earlier times but were rarely the dominant vegetation.

3) The landscape was very deforested when the expansion of C_4 plants and shift to drier climate began.

(Gebru et al. submitted)



Acacia ecosystems, which tolerate aridity and fire, have a long history.



Adigrat
Age (cal yr BP)
Juniperus procera
Podocarpus falcatus
Acacia abyssinica
Hagenia abyssinica
Croton macrostachyus
Erythrina brucei
Millettia ferruginea
Ficus sur
Olea europaea
Allophylus abyssinicus
Cordia africana
unknown taxa
1000
1500
2000
2500
5 30 5 30 5 30 5 30 5 30 5 30 5 30 5 30 5 30 5 30 5 30 5 30

3000 years of vegetation change
in Welo Province, Ethiopia

Forest regrowth after 1800 years of clearance

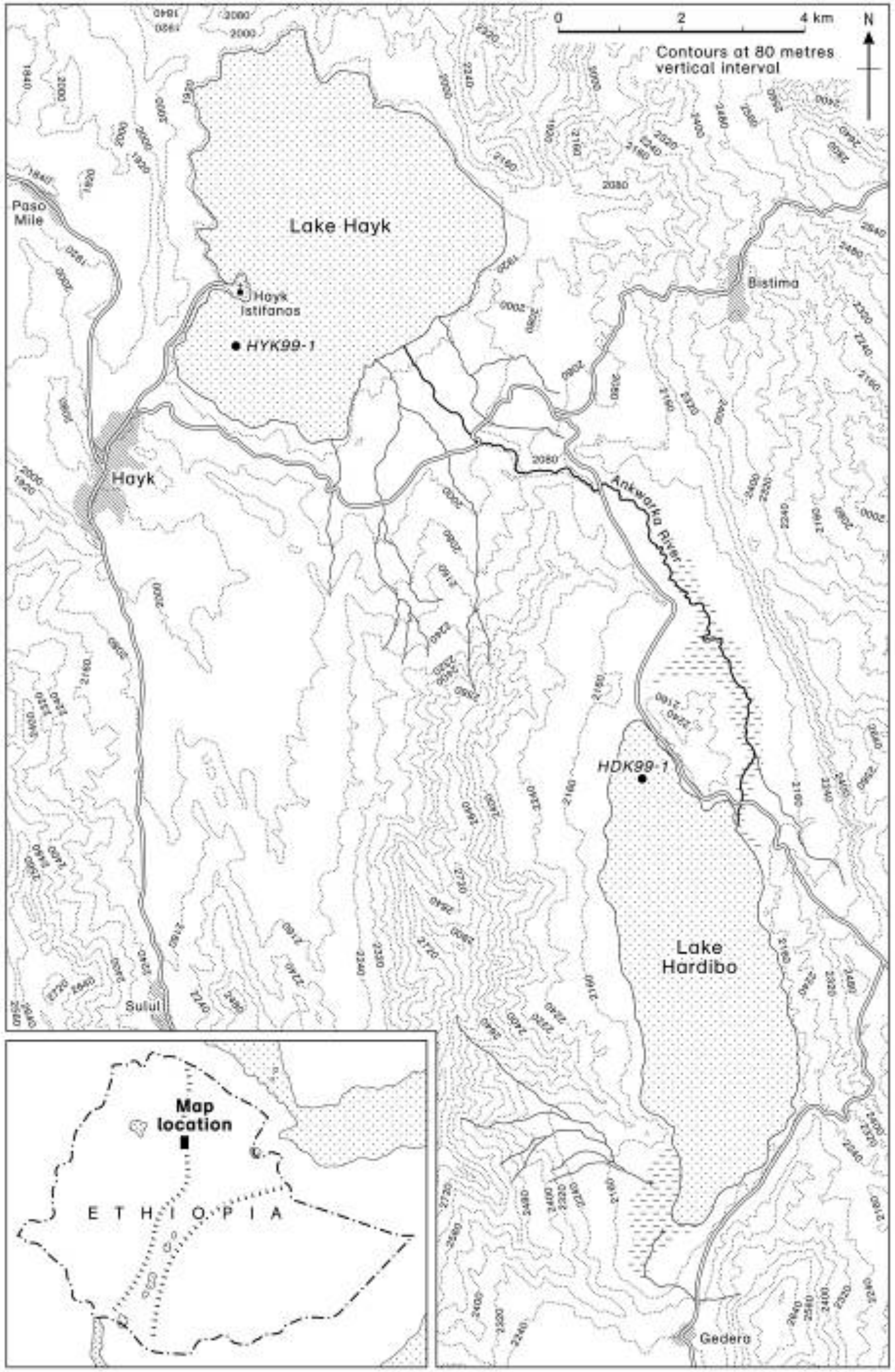
Iain Darbyshire
Henry Lamb
Mohammed Umer

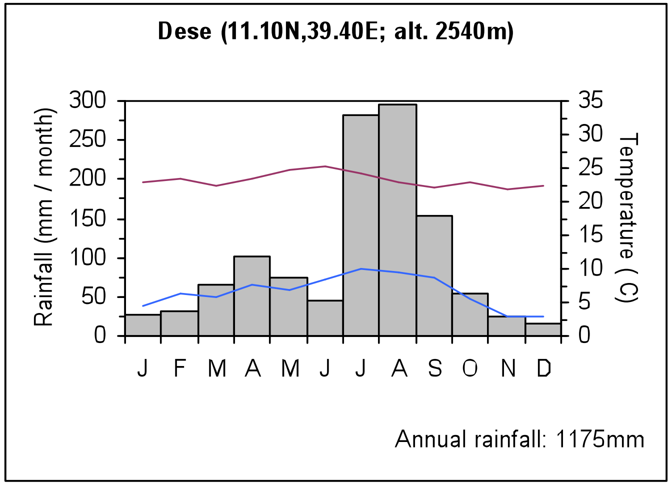
Lake Hayk, sketched by Lefebvre in 1848

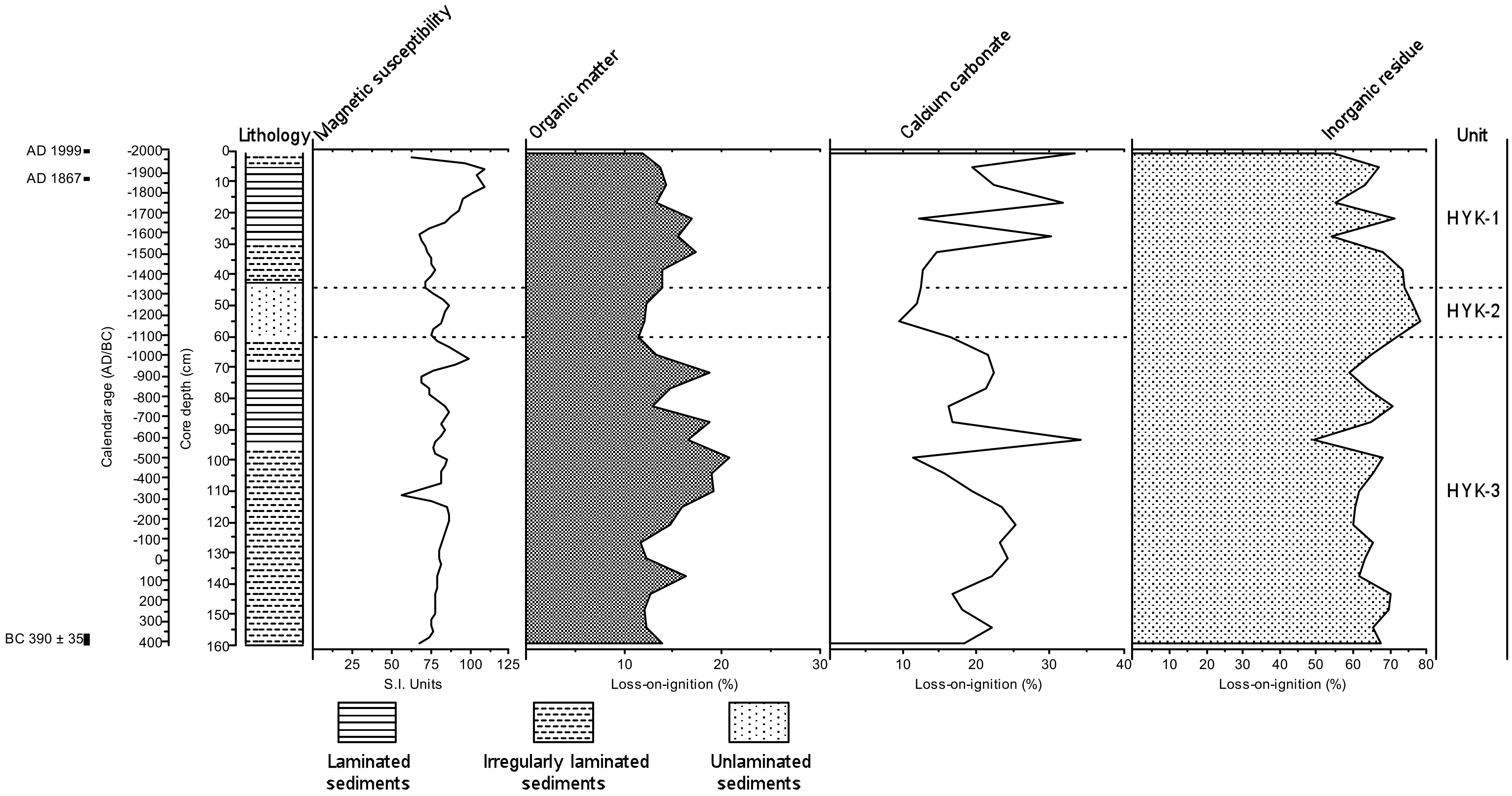
The lake today

Study area and core sites

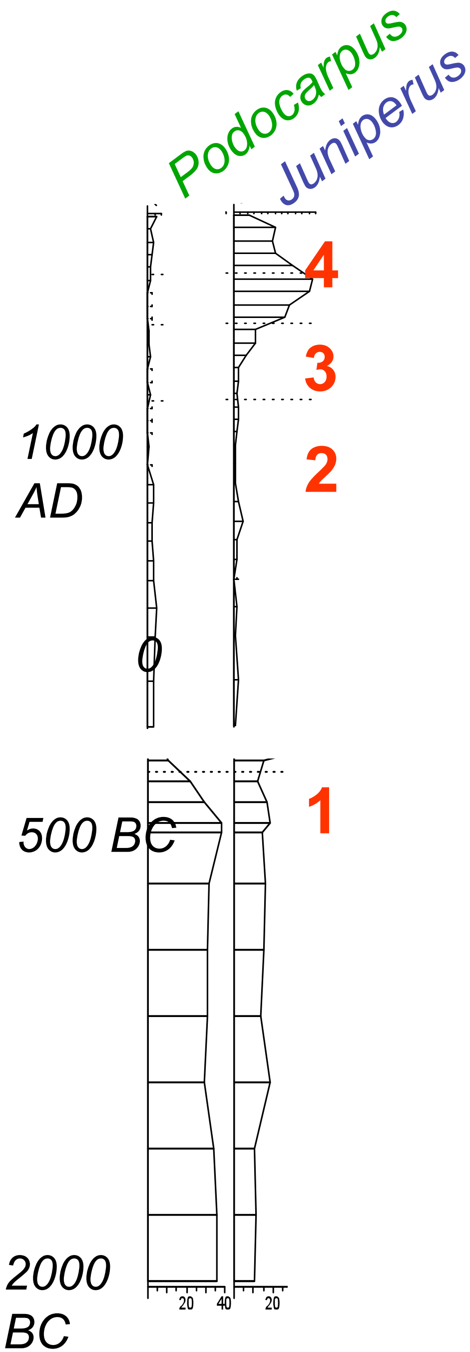
Lakes Hayk and Hardibo, near Desse, Welo Province







Lake Hayk: core lithology



Major vegetation changes

1. Clearance 500 BC
   - semitic immigration

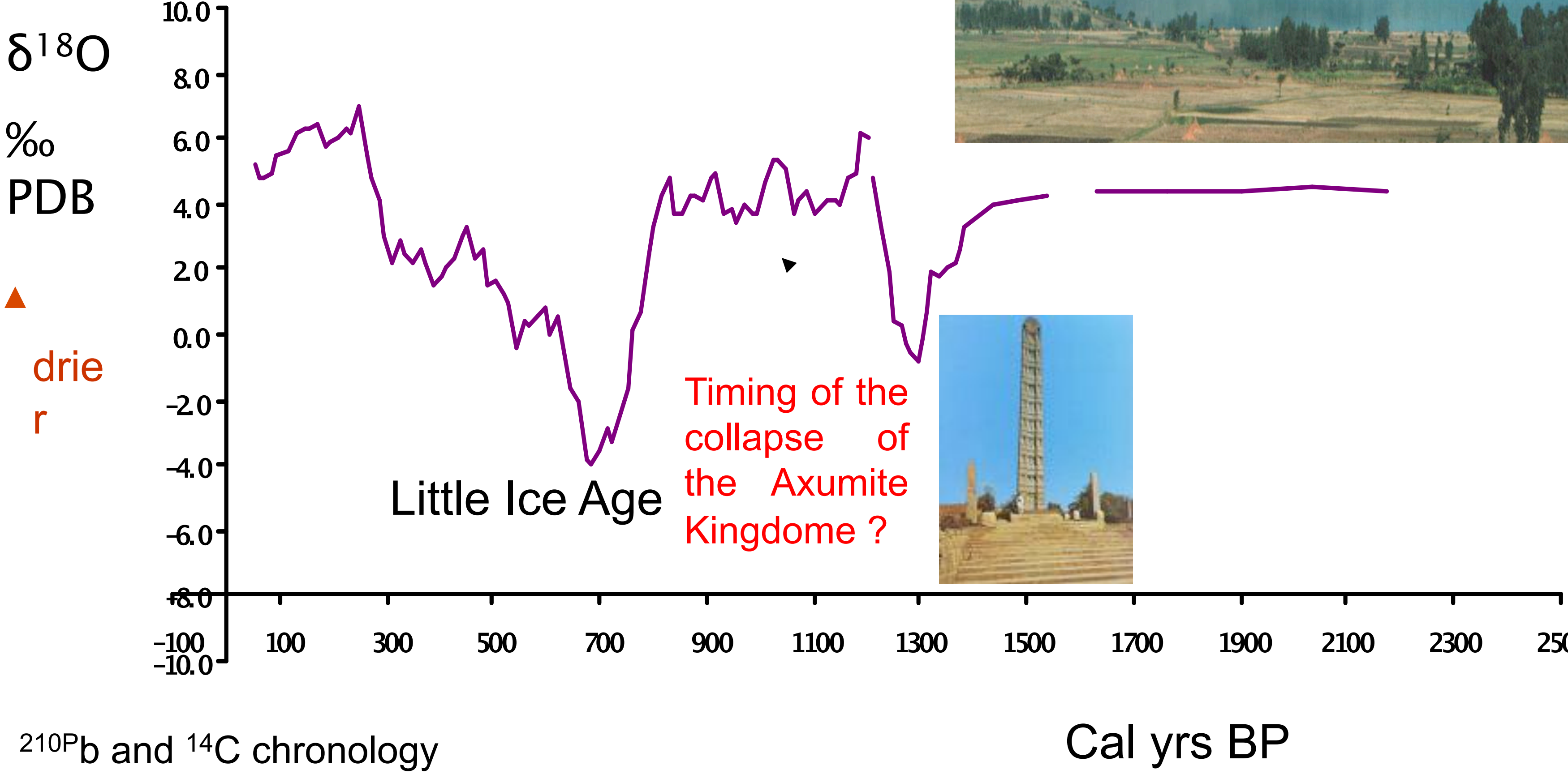
2. Bushland decline 1100 AD
   - drought (Medieval Warm Period)
   - stock grazing

3. Regeneration 1350 AD
   - depopulation
   - end of drought (Little Ice Age)

4. Decline 1750 – present
   - rising population

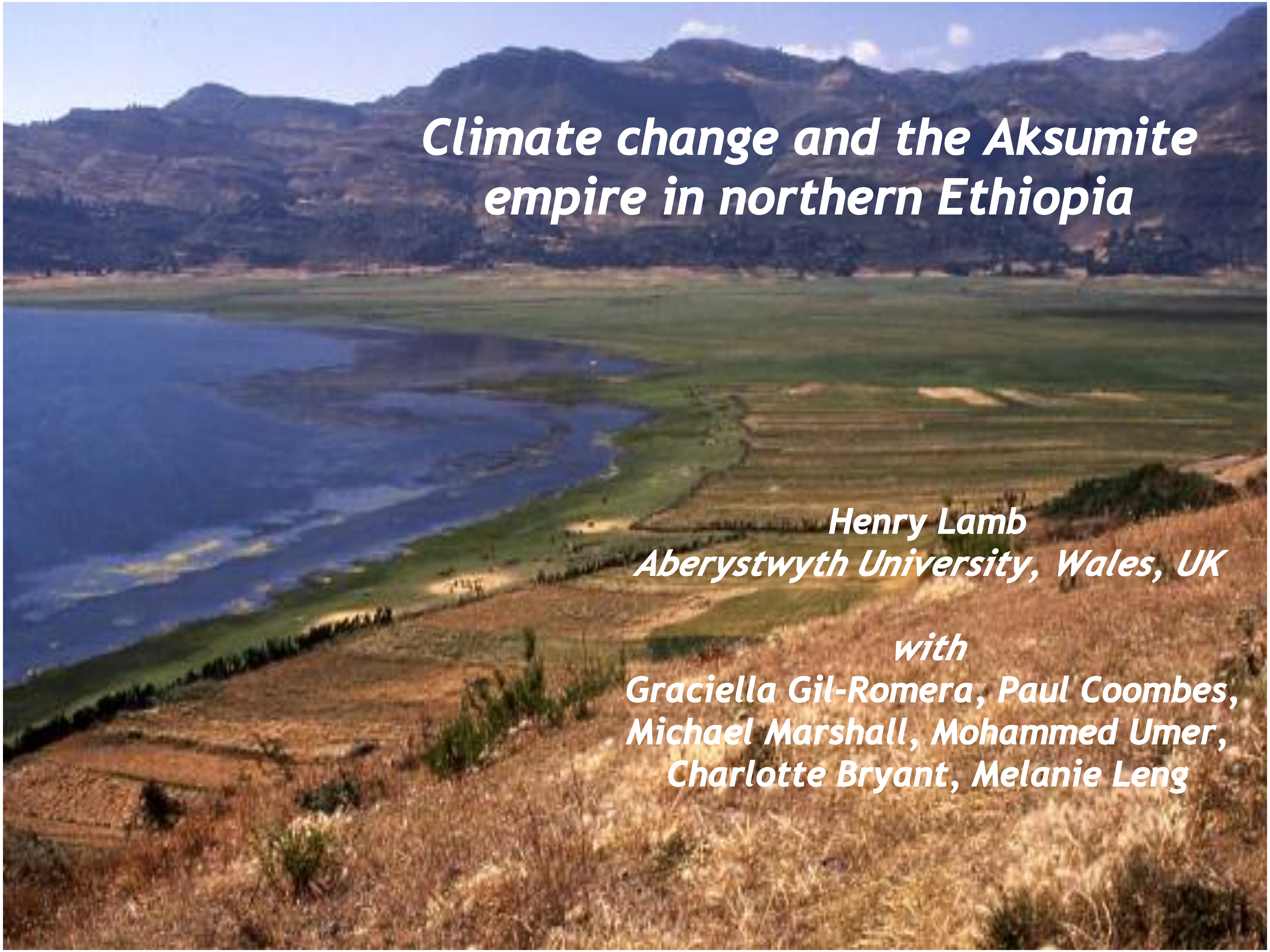
Climate driven lake level fluctuations of the last few millennium

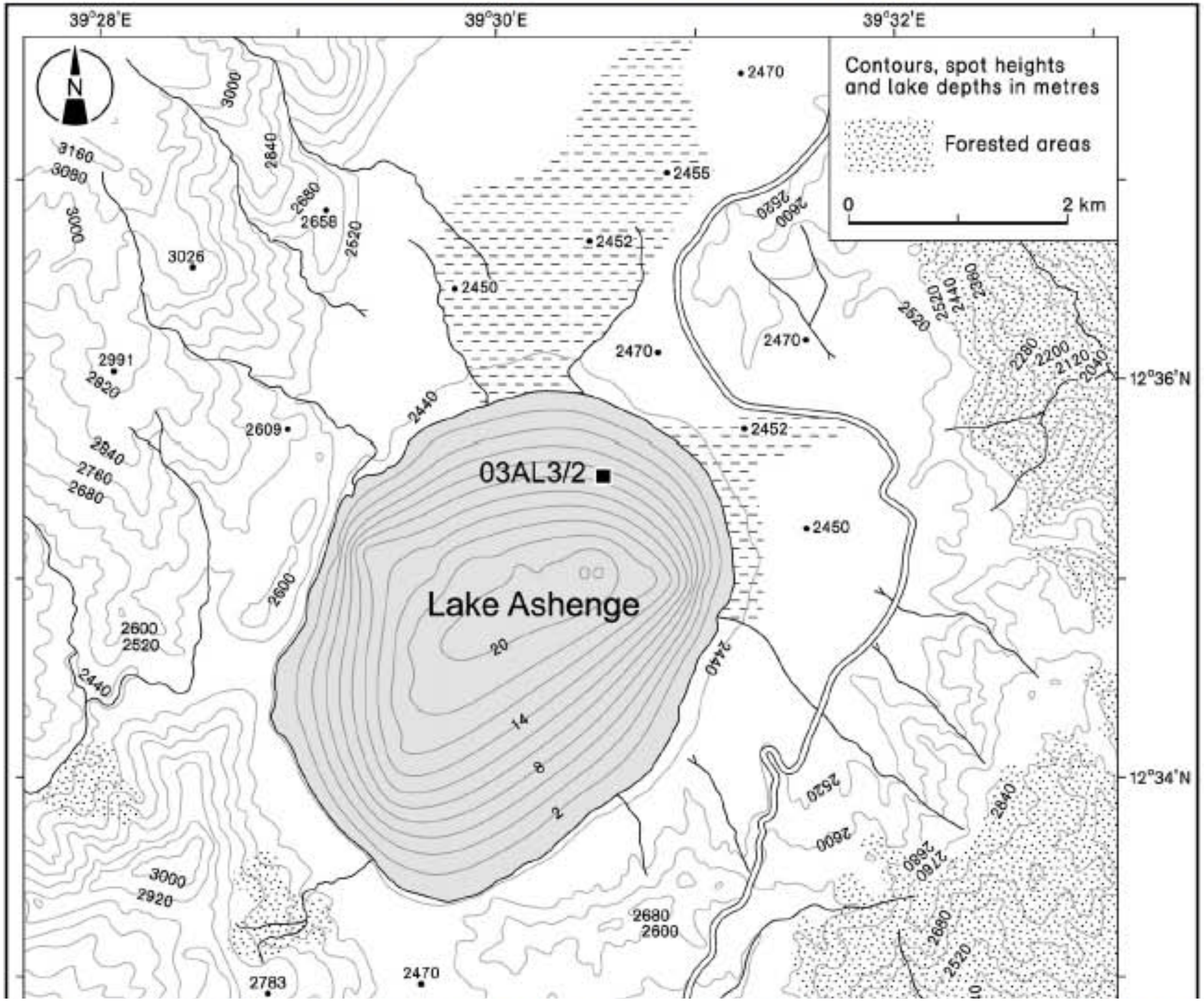
Lake Hayk, northern Ethiopia:
2000 – yr oxygen isotope record
(Lamb et al. 2007-The Holocene)



^{210}Pb and ^{14}C chronology

1cm sample interval; 5-sample running mean.

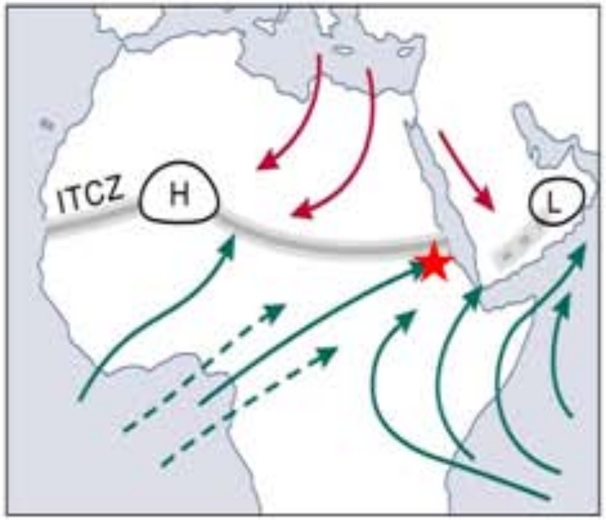

Climate change and the Aksumite empire in northern Ethiopia
Henry Lamb
Aberystwyth University, Wales, UK
with
Graciella Gil-Romera, Paul Coombes,
Michael Marshall, Mohammed Umer,
Charlotte Bryant, Melanie Leng


39°28'E
39°30'E
39°32'E
12°36'N
12°34'N
Contours, spot heights and lake depths in metres
Forested areas
0
2 km
N
03AL3/2
Lake Ashenge

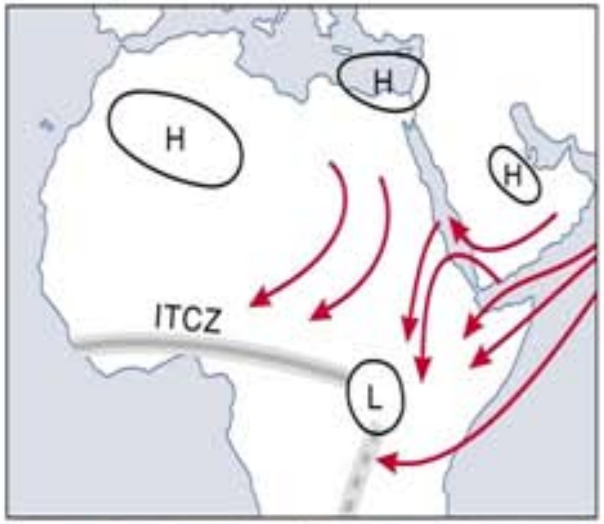
Lake Ashenge

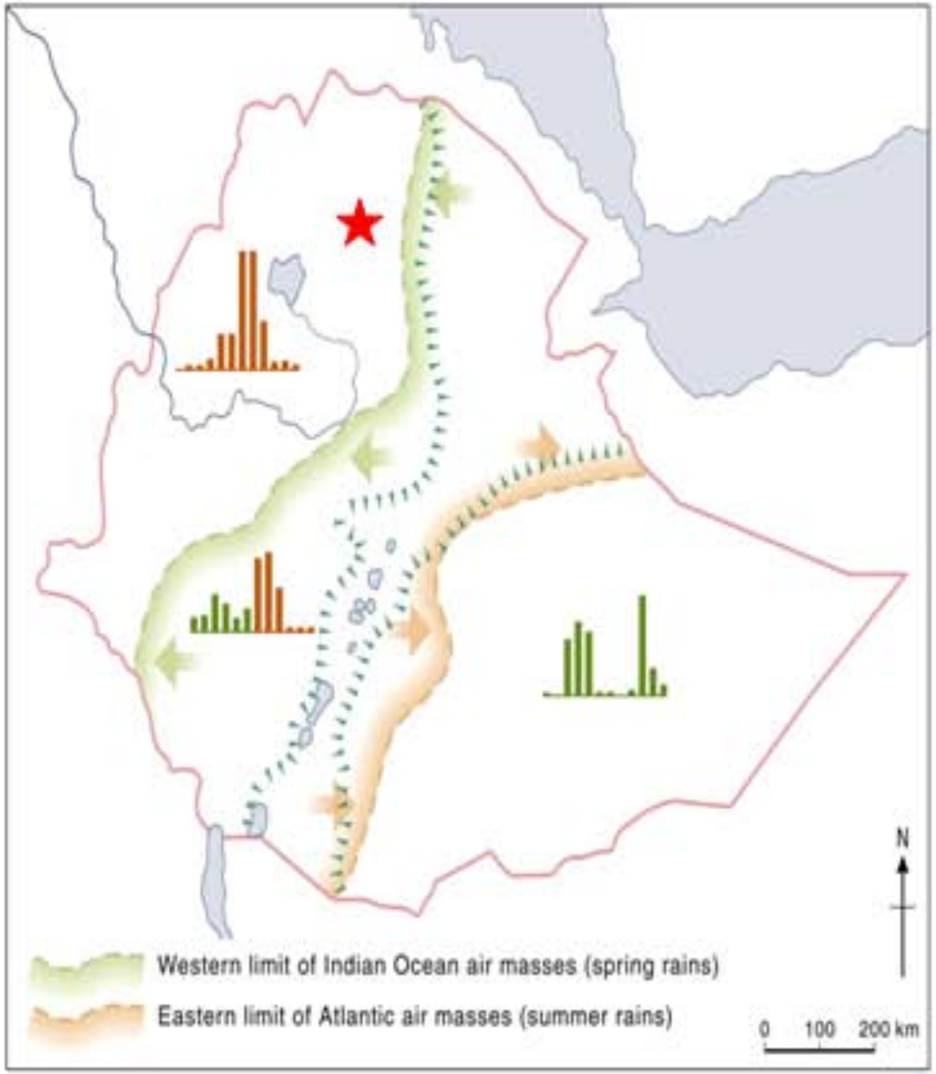
12º35'N, 39º29'E; 2440m

July



January





818 mm rainfall dominantly from Atlantic monsoon

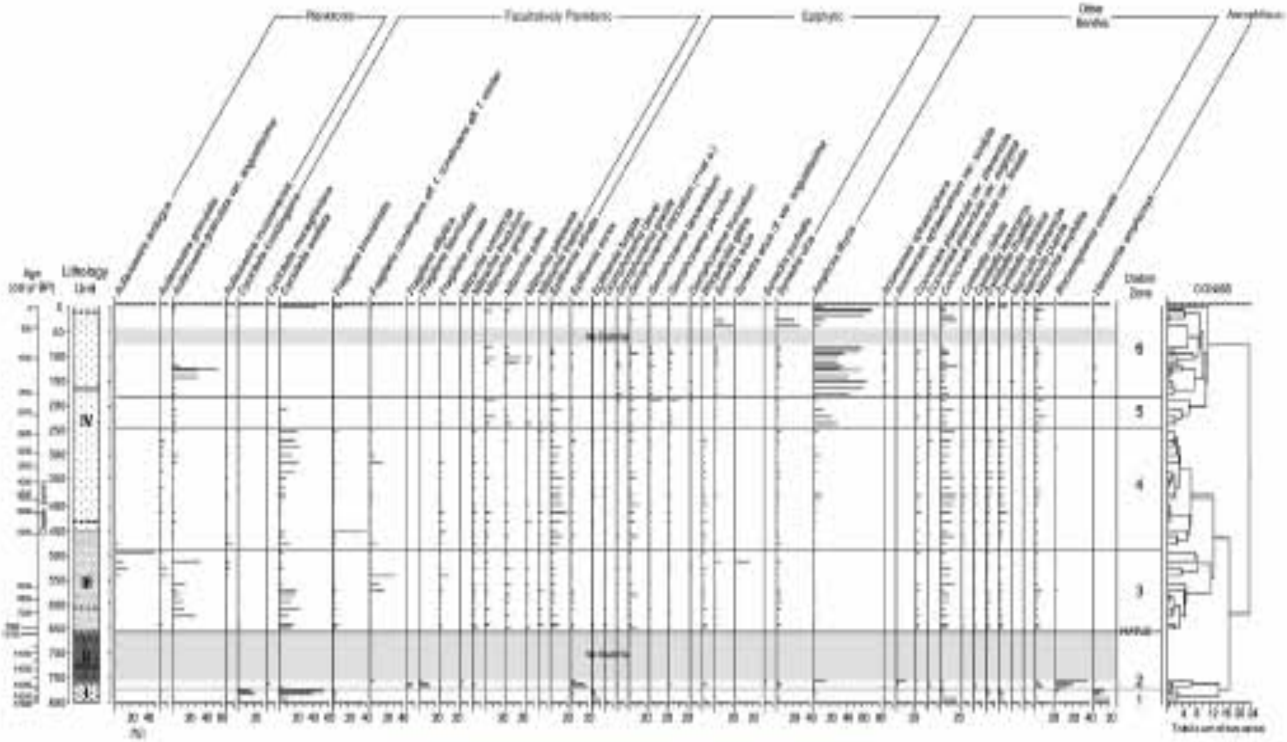
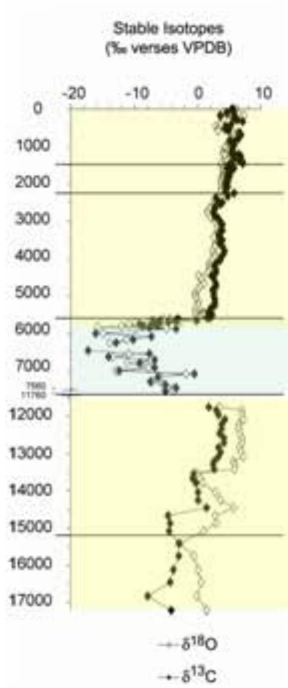


Fig. 4. Diatom diagram showing species abundance (%) grouped by habitat preference.

-

Date (cal kyr BP)	Indicators	Hydrology	Climate	Remark
2.3 and 2.2	- Dominance of benthic species *Amphora libyca Eh* - Minor and short lived positive excursion in δ18O and δ13C	Lowering of lake level	Dry	
2.2-1.5 cal	decreased abundance of *Amphora libyca*, and increase to dominance by freshwater taxa that thrive in low mineral waters (*Gomphonema sp.),*	More dilute lake waters	Wet	Isotopic evidence not clear **PRE AXUMITE/** **RISE OF THE AXUMITE EMPIRE**
1.5-1.2	-Deposition of shell layer -shallow-water diatom taxa -presence of the aerophilous species *Hantzschia amphioxys* -Positive excursion of oxygen isotope values	Low water	Dry	**DECLINE OF THE AXUMITE EMPIRE**
1.2 and 1.0	- Marked increase in *A.granulata* var. *angustissima*	Dilute water	Wet	
1.0-0.5	Decline in *A.granulata* var. *angustissima* -increase in carbonate ppt. -increase in calciferous *Amphora libyca*	Increased salinity	Dry	No diatom record between 0.8-0.5 cal kyr bp. **DARK AGE**
0.5-0.3	Reduction in co3 ppt Dominance of Synedra species	Fresh water	Wet	
From 0.3	Littoral taxa replacing Increased stable isotope	Low lake	Dry	

Ashenge 03AL2, $\delta^{18}O_{carbonate}$: background climatic change (p-e)



5.6 ka – present: gradually increasing aridity

7.6 – 5.6 ka dilute, overflowing lake; high p/e

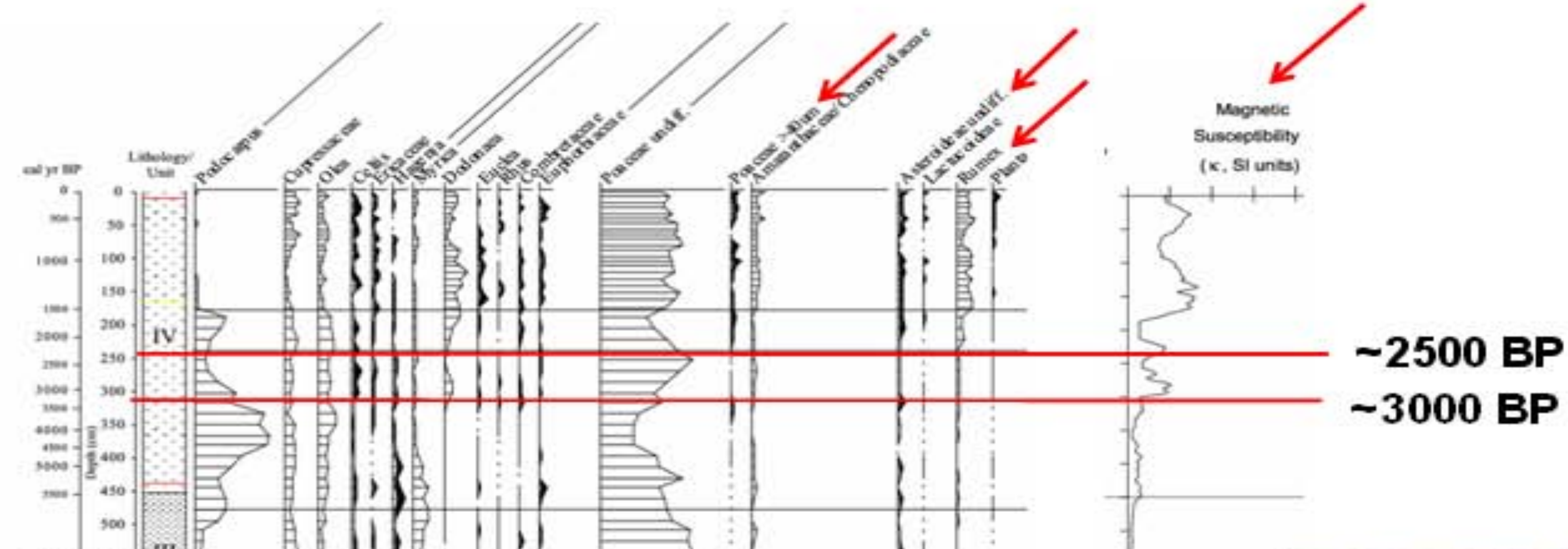
17 -11.8 ka: arid

especially before and during Y Dryas

wetter ⟷ drier

ka: cal yrs x1000 BP

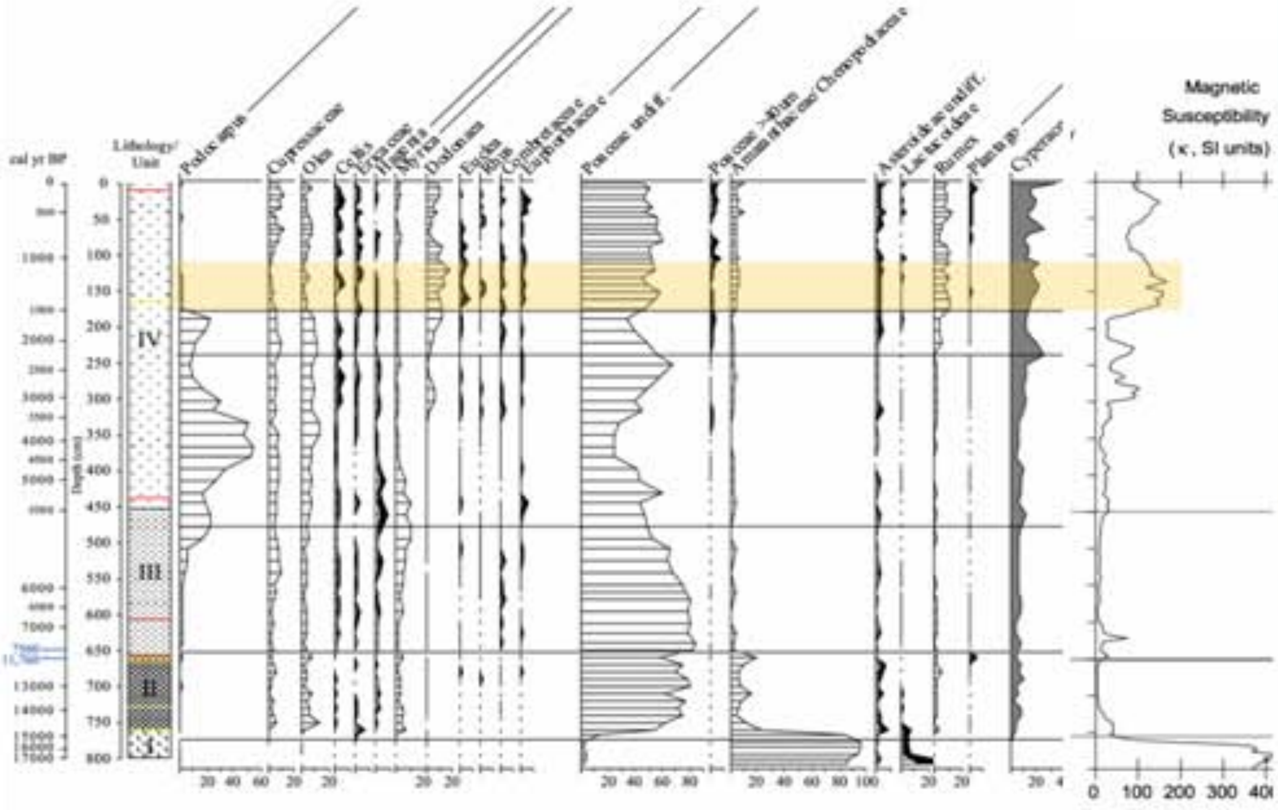
Ashenge 03AL2, pollen and mag sus data: pre-Aksum human impact?



Rumex nepalensis,
R. abyssinicus abundant arable weeds

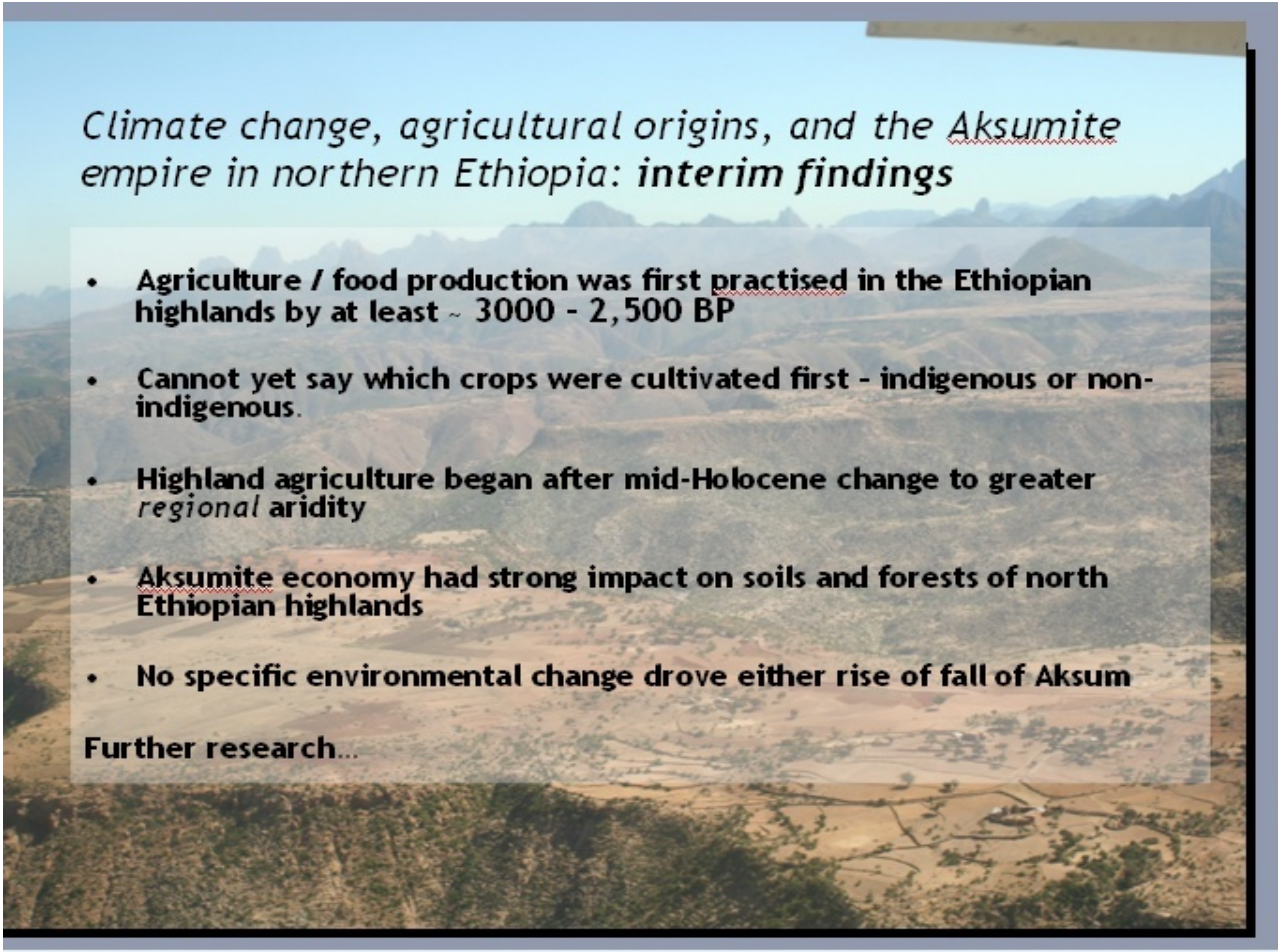
Ashenge 03AL2, pollen and mag sus data:

- Abrupt *Podocarpus* decline, enhanced soil erosion ~1500 BP
- Aksumite impact



Aksumite empire, ca AD 300 – 800

(1700 – 1200 BP)


Climate change, agricultural origins, and the Aksumite empire in northern Ethiopia: ***interim findings***
Agriculture / food production was first practised in the Ethiopian highlands by at least ~ 3000 - 2,500 BP
Cannot yet say which crops were cultivated first - indigenous or non-indigenous.
Highland agriculture began after mid-Holocene change to greater *regional* aridity
Aksumite economy had strong impact on soils and forests of north Ethiopian highlands
No specific environmental change drove either rise of fall of Aksum
Further research...

OTHER EAST AFRICAN REGIONS

-The “Pastoral Neolithic” (PN) is a regional developmental stage in East Africa between the LSA and the Early Iron Age (EIA) sometimes known as Pastoral Iron Age (PIA) between **7000-2500 yr BP** (Bower and Nelson, 1978; Bower and Lubell, 1988).

-During this time, there was a transformation to a pastoral lifestyle thought to be associated with the arrival of people with a general southward movement (Ambrose, 1982; Schoenbrun, 1993).

-The linguistic work by Schoenbrun (1993) suggests the presence of Cushitic cattle-herders in the interlacustrine region at about **3000 yr BP. By 2500** yr BP mixed pastoralism was widely spread throughout East and Central Africa (van Norton, 1979).

-**The transition to food production** marked the agricultural changes associated with noticeable impact on vegetation changes (Marchant and Taylor, 1997) that grew and went through to the Later Iron Stage to the present.

Human impacts in the Kuruyange pollen record are inferred from **~3800** cal yr BP (3500 C^{14} yr BP),
coincident with the Early Iron Age in Burundi (Jolly *et al.*, 1994).

Clear signals of decline in *Podocarpus* and *Psychotria* pollen in the Dama Swamp record from the Eastern Arc suggests
possible forest clearance starting **3000 C^{14} yr BP** (Mumbi *et al.*, 2008). Starting around ~2200 cal yr BP (2200 C^{14} yr BP), **there is considerable pollen evidence for forest disturbance** at Muchoya and Ahakagyezi in the Rukiga Highlands (Taylor, 1990).

This evidence manifests itself in the replacement of forested areas by open vegetation and degraded scrub, and is likely to be related to human activity. Late Holocene forest clearance is indicated by the pollen record at Rumuiku, Mt. Kenya (Rucina *et al.*, 2009), which shows an opening up of the vegetation coupled with pronounced increases in fire frequency.

Crops in East Africa. The two main subsistence crops of today in East Africa are maize and green plantain / banana – both of these being exotic**.**

It is always difficult to differentiate a climate signal from the impact of anthropogenic activities, particularly when there is lack of direct archaeological evidence to constrain the interpretation (Robertshaw et al., 2003). Although there are few archaeological data from the Amboseli Basin, within the wider area of the Rift Valley there are an abundance of archaeological sites that date from 2500 cal yr BP and document a transition through Iron Age development with associated movement of migrants and increases in food production to support a growing population (Marshall, 2000; Robertshaw, 1990; Sutton, 1998).

The presence of *Cannabis sativa*, cereal and *Ricinus communis* pollen grains in the Namelok sediments as early **as 2650 cal yr BP** is thought to reflect early settlement around the swamp.

The cultural transformation is thought to be part of a regional development stage: ceramic wares and other material culture found in the Rift Valley being associated with the so called Savanna Pastoral Neolithic (SPN) (Robertshaw, 1988; Marshall, 2000; Sutton, 1998). During this time, the pastoralists with cattle moved into Rift Valley grasslands practicing transhumance, moving through many areas from Laikipia to northern Tanzania (Sutton, 1998).

HUMAN_ENVIRONMENT INTERACTIONS

The preservation of animal/plant species was done through poaching taboos, the importance of community member connections to each other and to the land, low population densities, low levels of technology and gender divisions. Management practices have been construed through religious beliefs and cultural compatibility between cultural groups.

The selection and demarcation of these protected areas demanded traditional knowledge and ideological understandings of their places within the ecological dynamics. For example, the Maasai held a deep reverence for the animals and plants around them, and felt a deep connection with the semi-arid landscape of East Africa (Emmons, 1996). This connection with the land was absolutely necessary in allowing the Maasai to have survived as a cultural group and physically as a people; based on the semi-arid and drought-prone conditions. While the Maasai had developed low-impact strategies (such as nomadic movement of families and livestock which allowed for the long-term fertility of the land), relied on minimal forms of technological exploitation, and shaped their socio-cultural values in close connection with the surroundings; the Sambaa and their immediate neighbours, the Zigua, developed adherence to land values and the natural (forest) resources by setting aside the sacred areas under chieftainships.

The Maasai, considered as the local community, traditionally practice semi-nomadic pastoralist on communally owned land.

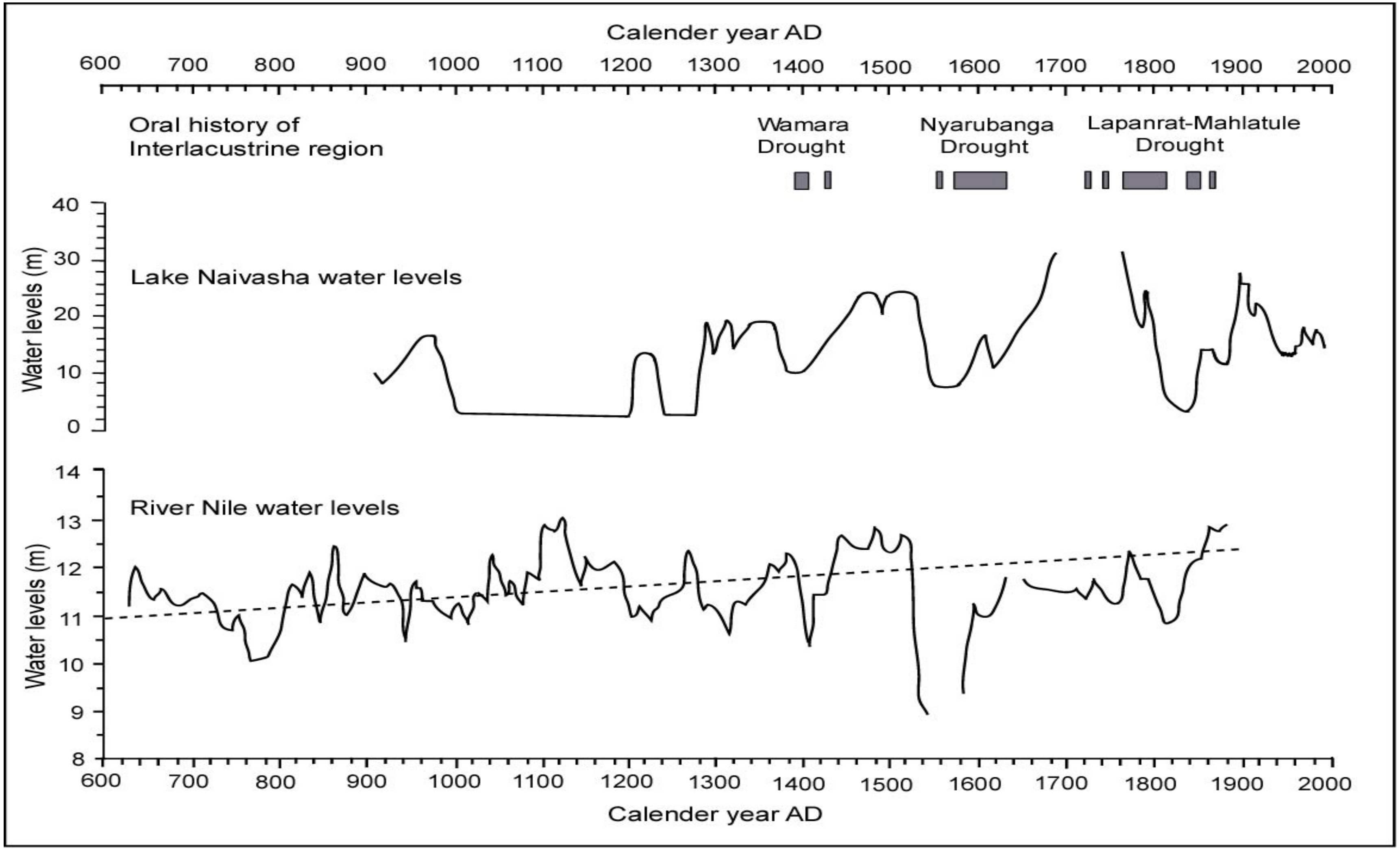
However, this lifestyle has undergone rapid recent change due to on-going land tenure changes and sub-division of group ranches leading to individual land ownership.

These changes have encouraged farming communities from other parts of Kenya to migrate to the areas of relatively high agricultural potential.

Land sold is mainly of high and medium potential, thus pushing the local pastoralists to drier, more marginal parts of the district.

Due to these recent changes in lifestyle, particularly restrictions imposed on migration, the Maasai are increasingly turning to subsistence farming.

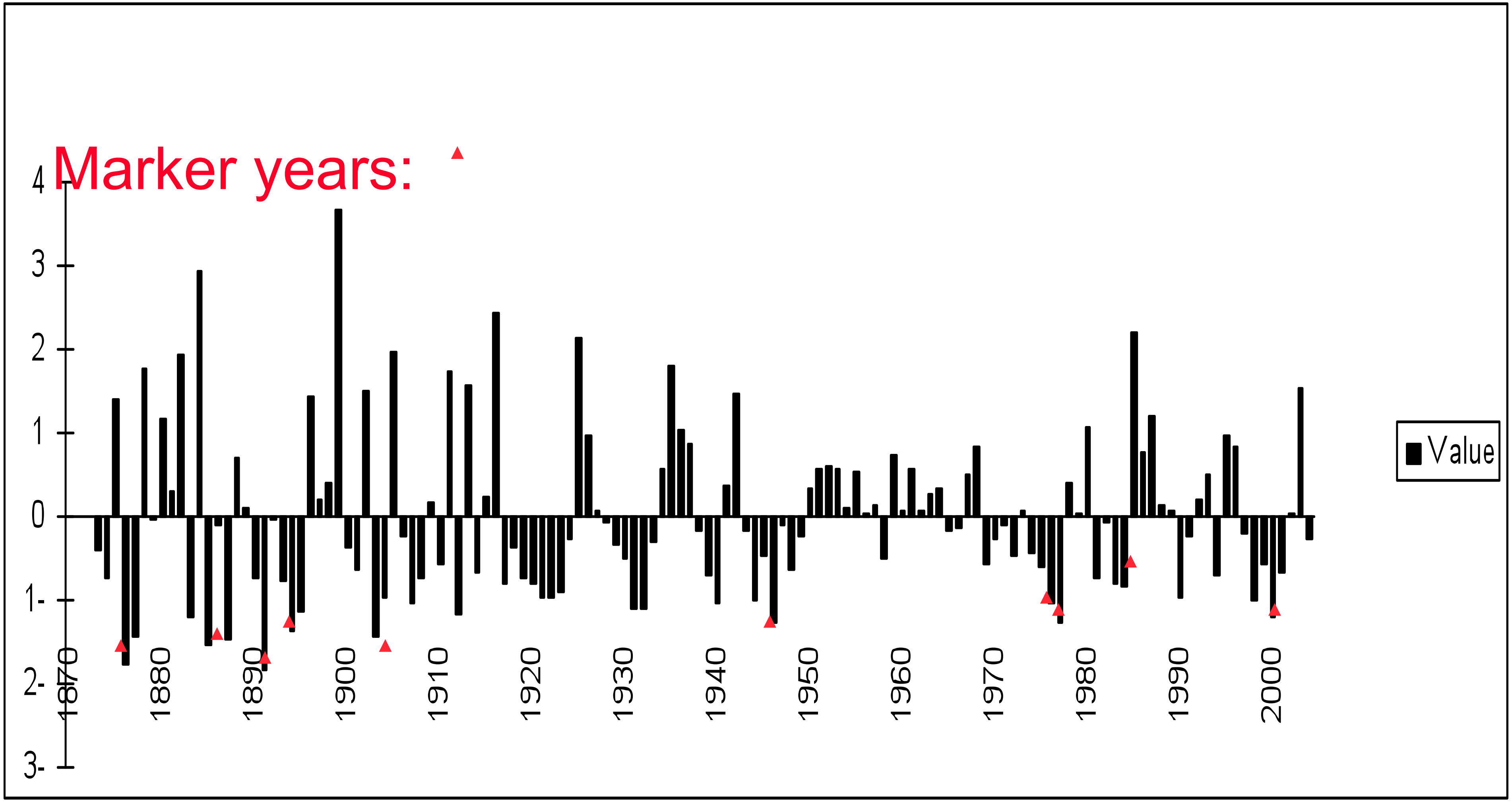
Comparison of major droughts recorded in oral histories with documented water levels for Lake Naivasha and the Nile River summer minimum levels
(Adopted from Webster, 1979; Nicholson, 1998 and Verschuren et al., 2000).



Result 1. Dendro-Climatological Evidences of Climate variability in Ethiopia (Objective 1)

By Zewdu Eshetu et al

i. Drought events and frequencies (objective 1)



Pointer Years and historical Drought Events

- 1876-1878 (Tigray Famine, live stock death)
- 1885, 1888, 1891, 1903 (Whole Eth. Famine)
- 1895-96 (summer &spring rains fail)
- 1932-34 (whole Eth., low levels of lake Rudolf &Nile)
- 1945 (Famine in Ethiopia, Bad days)
- 1957-58 (Tigray, Lasta Famine)
- 1962-63 (western Ethiopia)
- 1974-1977 (1974 Wollo famine)
- 1983 (1982-83 El Nino)
- 2000-2001 (Eth, Southern Africa)

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Summary **of inferences**

- Spring rainfall (February, April-June) is more important than summer rainfall,

- Because : 1. Too much rain in summer causes poor soil aeration, tree's growth is reduced.
  2. Too much cloud cover in summer reduces photosynthesis

- decline in / unreliable spring rain might cause declining of northern civilization

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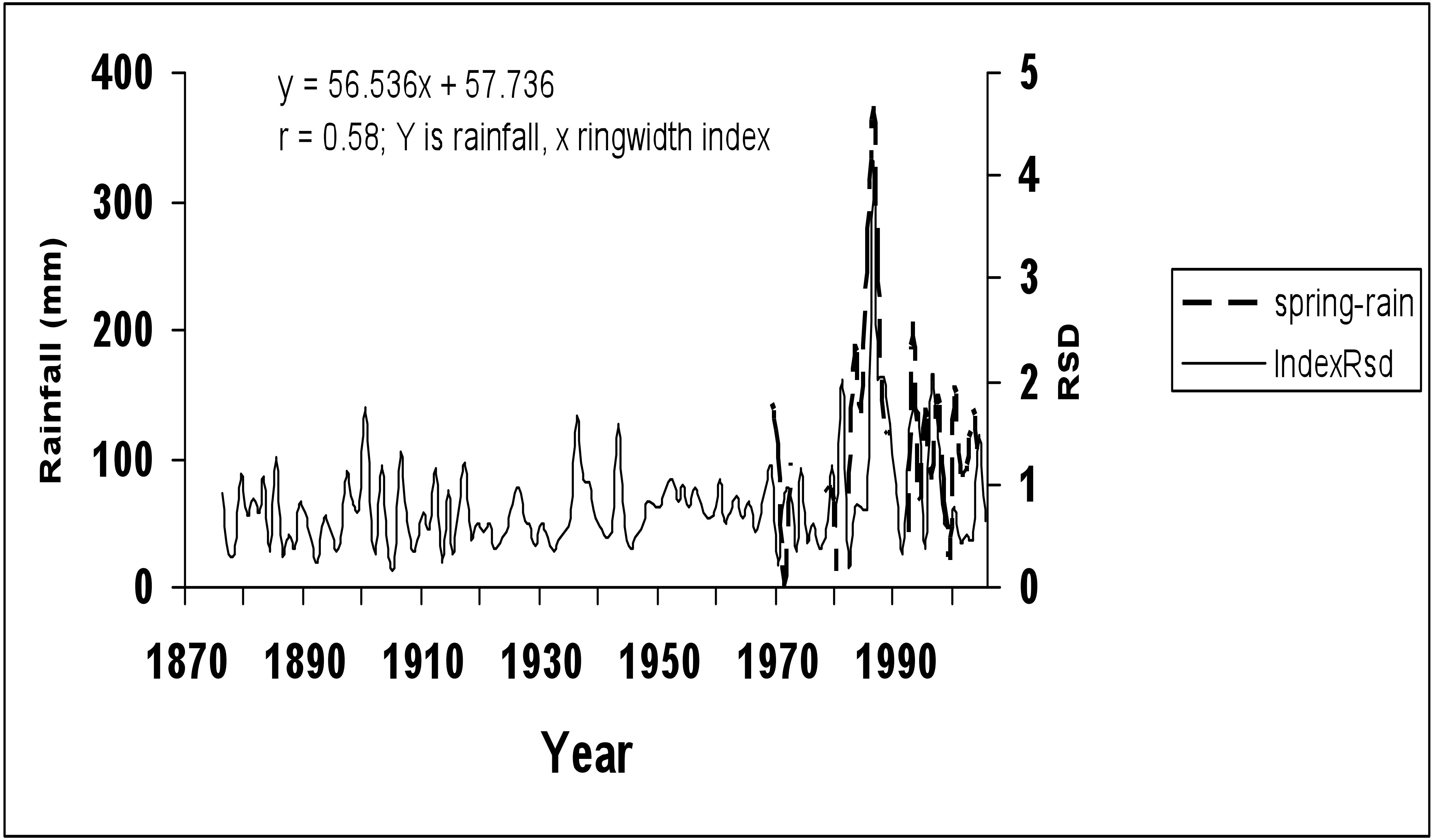
iii. Reconstructing past spring rainfall



Summary **of inferences**

- 22 drought-events observed in Northern Ethiopia 1874- 2005 an average cycle of every six years

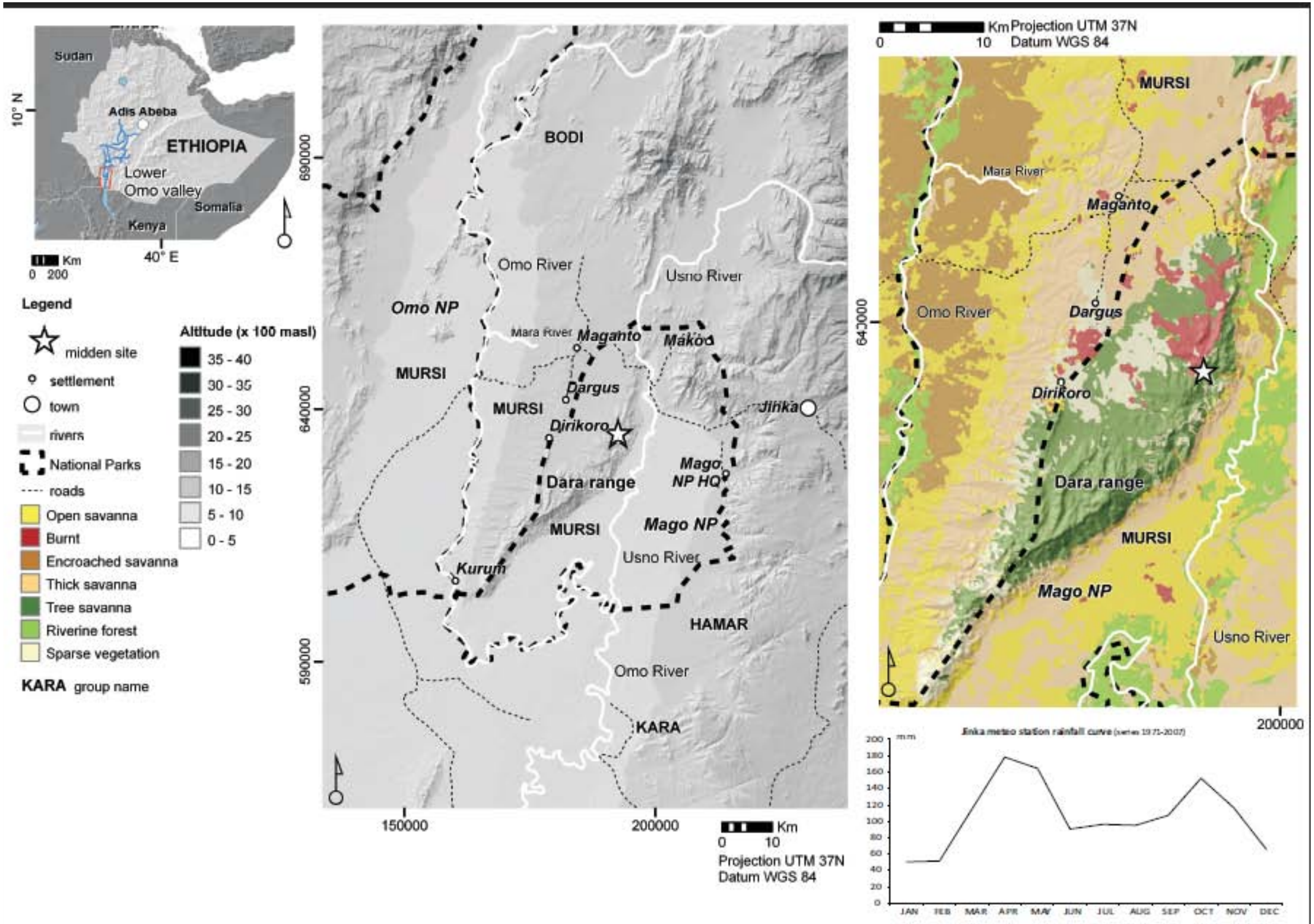
- 70 % of tree-ring growth was below average; suggesting a decline of agricultural production at least by 70% due to climate anomalies

By Zewdu Eshetu et al

Long-term resilience, bush encroachment patterns and local knowledge in an East African savanna

-Evidence From Hyrax Middens

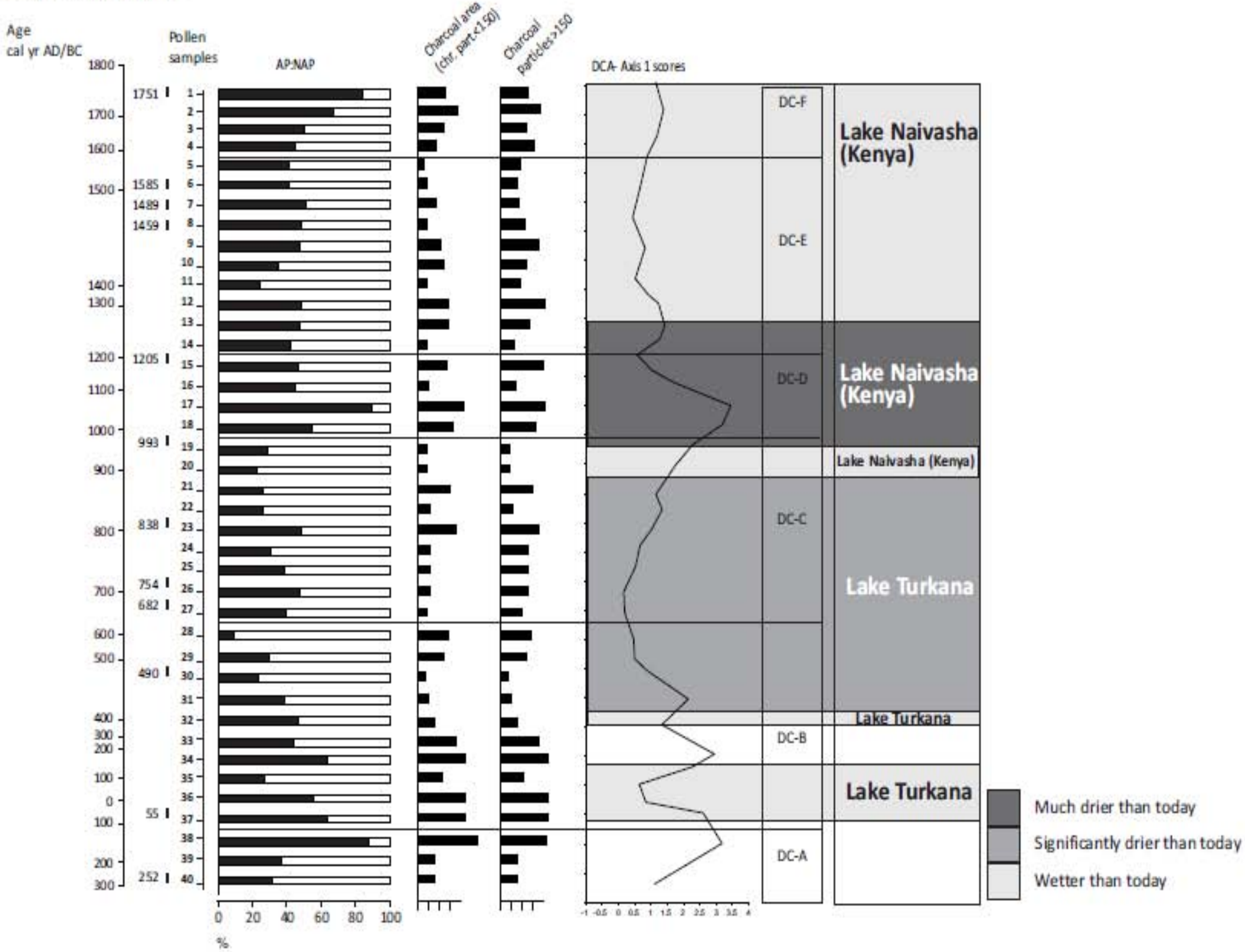
Graciela Gil-Romera[1,2], Henry F. Lamb[2], David Turton[1], Miguel Sevilla-Callejo[2,3] and Mohammed Umer[4]


Sudan
10° N
Adis Abeba
ETHIOPIA
Lower
Omo valley
Somalia
Kenya
40° E
Km
0 200
Legend
midden site
settlement
town
rivers
National Parks
roads
Open savanna
Burnt
Encroached savanna
Thick savanna
Tree savanna
Riverine forest
Sparse vegetation
KARA group name
Altitude (x 100 masl)
35 - 40
30 - 35
25 - 30
20 - 25
15 - 20
10 - 15
5 - 10
0 - 5
BODI
Omo River
Usno River
Omo NP
MURSI
Mara River
Maganto
Makob
Dargus
Jinka
Dirikoro
Dara range
Mago
NP HQ
Mago NP
Kurum
HAMAR
KARA
690000
640000
590000
150000
200000
Km
0 10
Projection UTM 37N
Datum WGS 84
643000
Jinka meteo station rainfall curve
mm
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC

Dewachaga, Dara range

1009 masl

South Western Ethiopia



Conclusion

Several works with similar general spatial frameworks, different local stories and sometimes contradicting results.

Human Impact on landscape seems late in East Africa and intensified with Climate drying/high seasonality, the advent of agriculture and iron use. But cultural and religious beliefs could have helped management and

resilience.

Conclusion Cont…

Recent management also shows recovery (photographic data 1860-present)

When this is not hapenenning, consequences seem dramatic and coincide with

climate variability, uncertainties in climate change and population pressure

Sufficient archaeological data is still lacking combining the spatial and temporal coverage depicting human movements and their impacts on the past landscape-

Existing data itself needs integration