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Log book

Ekblom *et al.* A Historical Ecology of Limpopo

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1st reviewer Innocent Pikirayi

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Greetings!

Thank you so much for giving me the honor and privilege to review the paper by Anneli Ekblom et al that you are considering for your journal. I hereby present my comments.

The paper is most certainly well researched, using original data to present its arguments. I was very much fascinated by the use and interpretation of Elton's travelogue to inform the archaeological, historical and even environmental record of the late 19th century. The strength of this paper lies in the ability to use well-sampled pollen data to interpret a millennium-long cultural sequence of the lower Limpopo Valley. In that regard, it should be accepted for publication in your journal.

content

I have no problems with the content except that in some places there may be need to cut down on what is clearly extraneous detail. I leave this to the authors to decide, especially where a balance is required between environmental, archaeological and historical data. What I find most problematic is the structure, a point which I address in the next section of my e-mail.

structure

The paper is poorly or weakly structured, making reading very difficult or cumbersome. This compromises the high quality of data invested in the article. It is not clear for example, where the introduction ends, as there is another introduction within the introduction. The pollen diagrams do provide the corpus of the data, but there are other forms of data that are also part of this project as well - the historical and archaeological. To encourage a smooth flow of their presentation, I would like to suggest that the paper be re-ordered to reflect the following categories or headings:

Introduction

Data - palaeo-ecology, archaeology, history

Interpretation of the data

Discussion [This is where details presented on pp. 16-18 should fall in]

General comments

I do agree with the editors that there is need for language revision in final stages of the paper. However, there are some technicalities to do with terminologies or place/geographical names which also need to be rectified in the presentation of the landscape in the opening pages. I would like to caution against the use of the much broader term, Shashe-Limpopo basin, when making references to a much smaller area within basin. I would encourage the authors to distinguish their research area, which is the lower Limpopo valley from the middle Limpopo valley, where you find Mapungubwe

and K2 (Bambandyanalo).

I do not think there is anything called Shashe-Limpopo valley, technically speaking.

Specific comments

p.3 References to Makalaka is almost certainly Kalanga or possibly Karanga

p.11 With references to Thulamela, please note that there other stonewalled sites in the general area that are either not yet excavated or totally unresearched, which may have served equal or complementary roles.

Why is it enigmatic to have fish at Thulamela? I grew up eating a lot of fish netted from rivers, some 80 km north of Great Zimbabwe!

p.18. There is no need to italicize names such as Mzilikazi, Nebelele and Soshangane. Also, crosscheck how the name of the latter is spelt. See also p.3 where you do the same for Makalaka and other names.

Regards,

Innocent

2nd reviewer

Dear Editors,

I have been asked to review of the article "A historical ecology of Limpopo and Kruger National Parks and Lower Limpopo Valley" by Ekblom et al., submitted to the Journal of Archaeology and Ancient History.

Below are the major comments on the content, structure and originality of the paper. Based on this, I strongly recommend the paper for publication after minor revision.

Some detailed remarks are listed at the end of the document (see page and line numbers in attached version of the manuscript).

Content

The authors attempt to integrate data from different disciplines in order to shed light on inter-connections between environmental and social-economical factors affecting vegetation and ecology in north-eastern South Africa during the last two millennia. The authors summarize their previously published paleo-ecological reconstructions from the region, together with unpublished data from one new site, and review archaeological and written sources from the area. They interpret the composite paleo-ecological dataset in a local as well as regional context, and relate it to socio-economical aspects as well as to climatological and environmental change. The paper is written with an interdisciplinary focus, avoiding deterministic assumptions.

Structure

The paper is well structured and the text concise.

Originality

The paper presents a valuable contribution towards the understanding interaction between society and environmental historical in southern Africa. Furthermore, the composite paleo-ecological record is unique and much-needed, as this region more or less lacked reconstructions of past vegetation dynamics covering this time period. The study also pre-dates the timing of the spread of maize cultivation in the region. The concluding discussion opens up for novel explanations of the social-environmental interactions in historical time perspective. For example, the authors show that the earlier assumption that historical farming practices expanded in favour of forest-coverage, must be re-evaluated.

Major concerns:

- The un-published paleo-ecological dataset (Maludzi) would favour from a more detailed description of the methodology and results, perhaps in a short appendix.
- The Appendix with Table 2 is missing.
- The paleo-climatic reconstructions that are referred to and used for comparison of the authors data are complex and not always straight forward in terms of interpretation and co-variation. The discussion around the paleoclimatic evolution is sometimes, to my

opinion, somewhat oversimplified. It should be mentioned that these reconstructions “suggest” a certain climate situation, but that there also exist anomalies between them.

- When it comes to the introduction of maize cultivation into the region, the age models of the two actual cores are central. Judging from Fig 1, there seems to be several 14C-dates bracketing this event, however, what is the possible error here after calibration? How much may the 1500-AD-date of the maize introduction vary according to calibration and age modelling?

- The reference system is sometimes insufficient. At several passages, references appear only at end of each paragraph, which makes the referencing unclear (but perhaps this is according to the guidelines of the paper?). Further, authors shift between referring to author name/year and just a reference number. Clear referencing is particularly important as the text is interdisciplinary and probably will reach colleagues from different disciplines.

- Several typos need to be corrected in the text.

Minor comments

Page 3, Line:

37: Clarify “sodic areas”. Meaning saline soils? Alkaline?

38-47: The latest reference to the Makapansgat isotope data should be used (Holmgren et al 2003, QSR 22, p 2311-2326).

40: the Medieval Warm period: mainly a European phenomenon, which should be mentioned here, as well as referred to as such. Check spelling of “medieval” (throughout the document).

40: last word, spelling “which”

41: “..., as the Intertropical convergence zone expanded southwards.” This is discussed as one possible explanation among others within the literature, so please clarify the source of this statement.

44:46: “...droughts occurred around c. 1750 AD...” Ref? Also Huffman? Makapansgat?

Page 4, line:

1-2: This information should be available from meteorological stations in the region.

6: Clarify: “The Mozambique current..” meaning “The SST of the Mozambique current/Indian Ocean...”?

Page 5, line:

3: However, there seems to be an increase in herbs and savanna vegetation around c1100AD at Mafayeni?

7-9: It is difficult to see the suggested increase in riparian vegetation at 900AD. Further, this concerns only the Chixuludzi core. From the text it sounds like this is supported from both Chix and Mapimbi cores.

15: Map. The abbreviations (in Map 2a) are confusing. Please consider to use the full names of the sites in text and map.

Page 6, Figure 1:

- Consider to arrange the diagrams according eg site-preferences (river-sites next to each other), for easier overview of the results. Further, to make it even clearer that the records are plotted on same time scale, add a common time scale, as y-axis, to the left in the figure.

- Consider placing the Chinyangani and Byarinama diagrams on the same chronological axis as the other diagrams (are they arranged like this to save space?).

- I would have appreciated if the related reference was mentioned along with each site name.
- Lithology: The symbol/legend for "Clay" comes out irregular in my printed version. Perhaps only a technical printing issue but consider to change to another symbol/pattern.
- In the Maludzi (Malu)-diagram: Change "Age AD" to "Age BP"
- Is it possible to add charcoal data?
- Line 8: "table 2 in appendix" The appendix is missing.

Page 7, line;

33: "Figure 2a" Change to "Figure 2b".

33: "..pollen <40ym" do you mean "..pollen >40ym"?

Page 8, line:

19: "and K2." Clarify.

Page 9:

Line 2: An additional/alternative explanation could be that warmer and wetter conditions supported the (natural) fires with additional fuel (grasses), thereby the positive correlation between charcoal peaks and increase in forest taxa.

Figure: Include figure-signs. a), b), c).

Page 10, line:

17-22: Refer to fig 2b.

21: "...between 950-1400.." should be: "...between 950-1400 AD.."

26: "Figure 2b" should be "Figure 2a"

34: different referencing (Steyn et al. 1998) – should be replaced by a number?

41: "power to Khami, Khami,.." remove repeated word

Page 11, line:

16-17: This is interesting. It seems that maize was present even earlier, at c 1450 AD at Chixulduzi!

35: "...Thulamedia was supposedly abandoned." Add reference

45-46: "...associated with the Little Ice Age." Add references.

Page 12, line:

6: Spelling of "Chixuludz"

12: "...an increase in rainfall..." Add references

35: "...droughts in the 12th century..." Add refs.

Page 13, line:

13: "Chilutse" this site is not in the figure. Should be Chinyangani?

41: "Tyson et al " should be "Tyson et al 2002.."?

Page 16, line:

30-34: references?

48: "highveld" –local term that need clarification?

Page 17, line:

8: spelling "proably" should be "probably"

Page 18-25:

Check the reference list for missing references, formatting etc.

Corrections in the reference list, page 18: "Mitchell 2003" should be "Mitchell 2002"?, "Norström and Holmgren 2005" should be "Norström et al 2005".

Missing refs in the list, for example: Bond 1997, Pwiti 2005...

A HISTORICAL ECOLOGY OF LIMPOPO AND KRUGER NATIONAL PARKS AND LOWER LIMPOPO VALLEY

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Abstract

The paper uses new palaeo-ecological data and a selective review of archaeological and written sources to construct a historical ecology of Limpopo National Park and northern Kruger National Park for the last 1200 years. The analysis shows how social and natural history have interacted over time to form the present day landscape. The long-term mosaic of different communities in this landscape, hunter and gatherers, pastoralists, farmers and traders has, over time, contributed to shape and reshape a heterogeneous landscape. While some features in this landscape, such as water scarcity, have remained *quasi*-stable over time, there have also been major transformations in both the physical landscape and social life. The natural mosaics have been utilised and enhanced over time, and the combination of natural and cultural mosaic is reflected in the landscape through archaeological sites and/or in the form of vegetation patterns reflected in the pollen record and in the present day landscape.

Introduction

Few works have discussed the long term cultural transformations of the lower Limpopo valley, and the Limpopo (PNL) and Kruger National Parks(KNP) landscapes in detail. Archaeological surveys in this area are rare, and to date there have been no palaeo-ecological studies carried out. Using new palaeo-ecological data¹ and a selective review of archaeological and written sources we will attempt to show here how both social and natural histories are embedded in this landscape and how they have interacted over time. Far from being isolated and marginalised, communities in these areas have, over time, negotiated their daily lives in the context of an unpredictable climate, and political and social transformations in southern Africa. We will follow the traces of people in the palaeo-ecological record which offers not only the chronological framework, but also the structure, to this historical ecology. We will focus on the PNL area and the northern part of KNP in particular, but will also bring into discussion the lower Limpopo valley as a whole, more specifically the Shashe-Limpopo area.

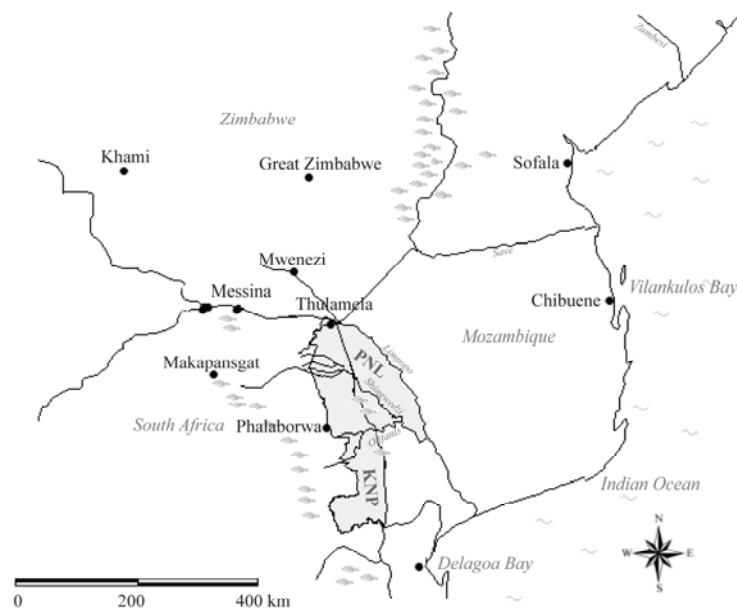
Introducing the landscape

In introducing the landscape of the Limpopo valley, we will borrow the words of the British explorer, Frederick Elton, who described the area between the Shashe-Limpopo and the Elephant-Limpopo confluences in 1872. The landscape near the river was reported by Elton to be fertile and well populated with surface water throughout the year. The interior region between the rivers was another story²:

“...between the river ... Water-pools are few and far between, all those situated away from the rivers drying up during the hot season, and travellers eat their bread with carefulness, and drink their water with astonishment”.

Surface water availability was, and is, of major importance to both people and animals. Rainfall in this region is low, presently ranging between 300 mm/year in the Shashe-Limpopo confluence to 600 mm/year near the Elephant-Limpopo confluence. Rainfall is also markedly seasonal with 95 percent of the yearly rainfall occurring between October and April, i.e. the southern hemisphere summer, when evaporation is at its greatest. The length of growing season in PNL and the major part of northern KNP today is short, presently 101–110 days, while in the drier western part the length of growing season is even shorter (91–100 days)³. In the days of Elton, as indeed today, cultivation and villages were concentrated along the Limpopo River and its tributaries.

The landscape at this time, as we will show, would have been dominated by grassland savanna in the drier areas interspersed with mopane woodland (*Colophospermum mopane*), much as it is today. Elton vividly describes the dense riparian forests along the Limpopo river. He also describes farming in the area and its produce, listing sesame, maize, sorghum, millet, sweet potatoes, manioc, pumpkins and ground-nuts, adding that other plants such as the castor-oil plant, hemp, and tobacco were grown in the valley⁴.



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11 *Map 1. Limpopo valley and archaeological sites and localities discussed in the text.*

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The ethnographic descriptions are, as would be expected, heavily biased by Elton's personal preferences, and the political geography as described by him is somewhat confusing. This may well be a reflection of the actual political and social unrest that afflicted the region. He describes several different groups residing in the area. Along the Shashi Limpopo confluence there was the *Makalaka* (eg, Venda or Kalanga, part of the Shona speaking group). They were paying tribute to the *Matabele* (eg. Ndebele a breakaway Nguni group) since they had been overrun by *Moselikatze* (e.g. the Ndebele chief whose power expanded in the area in the 1840s). He also encountered *Makalaka* tribes who were intermixed with *Masaras*, in turn described as affluent hunter and gatherers using bow and arrow. Dwellings of the *Masaras* could also be found in the drier areas away from the rivers. Elton describes a typical village, stockaded and consisting of a mix of people from surrounding tribes. He reports on the *Knobnuitzen* who, similar to the *Masaras*, were affluent, relied on wild resources and hunted with bow and arrow, but occasionally also planted millet. The *Maloios* occupied the area below the Livubu River. They were part of the *Amatonga* (eg. the Tsonga) that paid tribute to *Umzila*, ruler of the Gaza state. South of the *Lipalule*, i.e. the Elephant river, the country was described as well populated by the *Amatonga* who were under direct control by a governor of Umzila⁵.

31 **The long term physical formation of the landscape**

32 The Limpopo valley is found on one of the oldest surfaces of the world. The area has had an
33 immensely long period of formation reflected in the metamorphic rocks to the far west of
34 KNP, the Lebombos range that now forms the southern border between KNP and PNL and
35 the sandstones, shales and conglomerates belonging to the Karoo formation found near the
36 Limpopo and east of the Lebombos. The majority of loose soils formed during the Quaternary
37 and consists of saline to sodic, calcareous, sandy clay loams. These soils formed large
38 plateaus in the landscape, but have since been eroded in places to expose the basal
39 conglomerates of gravel and sands. KNP and PNL is dominated by regosols (i.e. weakly

1 developed soils with low amount of nutrients) and arenosols (i.e. geologically young soils,
2 with a very low capacity for storing water, and low nutrient content). Sodium affected soils
3 that can form sodic crusts also occur in a belt running north–south in the middle part of PNL⁶.

4 The long history of formation of bedrock and soils determines the availability of water
5 and, in turn, sets boundaries for vegetation and animal life. Pans, defined as closed seasonal
6 or semi-seasonal water bodies, are present in the drier areas between the permanent rivers.
7 The formation of pans has not been explained, however, it is likely that they were originally
8 formed as part of old drainage lines, and they also occur in sodic areas⁷.

9 During the last 2000 years, the time period which will be our focus, two centennial scale
10 climatic trends have occurred. A period of warming c. 900–1200 AD, often referred to as the
11 Mediaeval Warm Period, resulted in wetter conditions in the summer rainfall region, to which
12 PNL and KNP belongs, as the Intertropical Convergence Zone expanded southwards. A
13 globally recognised period of cooling, referred to as the Little Ice Age occurred 1400–1800
14 AD. The Makapansgat valley speleothem isotopic sequence indicates that a cooler and drier
15 climate occurred only from c. 1500–1600 AD⁸. Huffman has suggested, on the basis of
16 archaeological data, that the region of the Shashi and Limpopo basin was dry from 1300 AD⁹.
17 The most extreme period of droughts occurred around c. 1750 AD and this is also reflected in
18 a number of reports on droughts and famines in written records. From 1850 AD rainfall
19 increased again in the summer rainfall region. From this time rainfall has been high overall
20 but with recurring droughts, notably at the beginning of the 20th century and in the 1980s¹⁰.

21 Alongside these centennial scale variations in rainfall, a c. 20 year cycle of dry and wet
22 years has been present for the last 6000 years. On top of this there is a marked inter-annual
23 seasonality in the region that is shaped partly by El Nino, which generally causes below
24 average rainfall in the summer rainfall region. The Mozambique current also affects regional
25 rainfall, which is why the Limpopo valley may experience rainfall variations that are not felt
26 in other parts of the summer rainfall region¹¹.

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Plate 1 a) The landscape of the dry interior, near Radio lake, PNL, b) Riparian vegetation near Pafuri, PNL, c) Grasslands near Lake Maludzi, PNL, d) Typical mopane shrub, PNL.

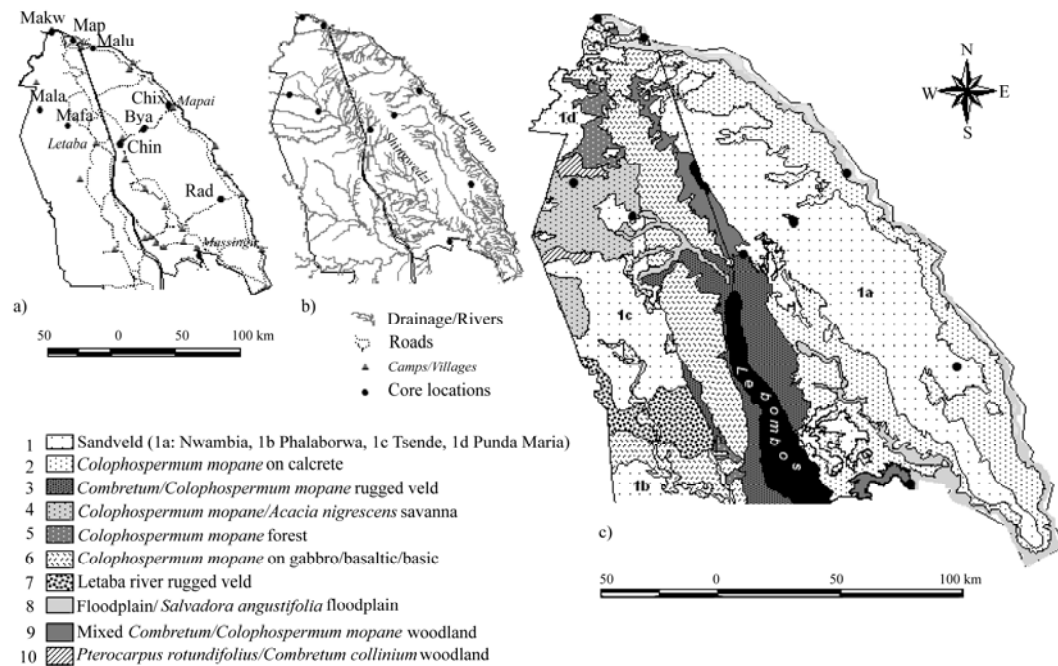
Changes in the physical landscape since the first centuries AD

Pollen, charcoal and spores and from the sediments of pans and lakes, shown in map 2, are archives of landscape change (for methodology see original publications). As the sequences reviewed here represent different drainage systems they give an overview over local vegetation changes and possible links between rainfall changes and hydrological systems.

The drier areas represented by sequences from Malahlapanga, Mafayeni and Radio pan show very little variation in vegetation over time (see Figure 1). They are presently dominated by an open savanna with few mopane trees. In the Malahlapanga case, a sequence that covers the last 6000 years, a shift in vegetation from grassland to savanna can be seen around 800 AD. The Mafayeni and Radio pan sequences go back 1300 and 600 years respectively and show a stable vegetation during this time, dominated by grasses, with single occurrences of trees/shrubs. The ability of trees to recruit in these areas is most probably restricted by the low water availability. The stability of vegetation in this area indicates a high resilience and we can assume that vegetation here has been similar throughout the last millennia and probably longer¹².

The vegetation near the rivers has fluctuated over time. The Mapimbi and Chixuludzi sequences, discussed in detail here, are both responsive to the Limpopo River and situated in or close to what is presently a riparian type vegetation (i.e. Moraceae, *Dialium* spp, *Diospyros*) (see Figure 1 and 2a and 2b). The local signatures of these records are variable, but overall, riparian vegetation and arboreal pollen expanded as rainfall increased from c. 900 AD. The response of vegetation during the Little Ice Age is more complex to evaluate and

1 will be discussed below. The sequence from Lake Maludzi, a grassland area situated near
 2 Pafuri on the plain of Limpopo River, illustrates the long term presence of such grasslands
 3 within this riparian dominated area. This core, not presented previously, dates back c. 3400
 4 years and shows very low percentages of arboreal pollen over time (Figure 1).



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 6 Map 2. Location of paleo-ecological sites, core locations abbreviated (left), main rivers
 7 (centre) and landuse for Limpopo National park and Northern Kruger national park (right).
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Summary of vegetation changes in relation to the Makapansgat record

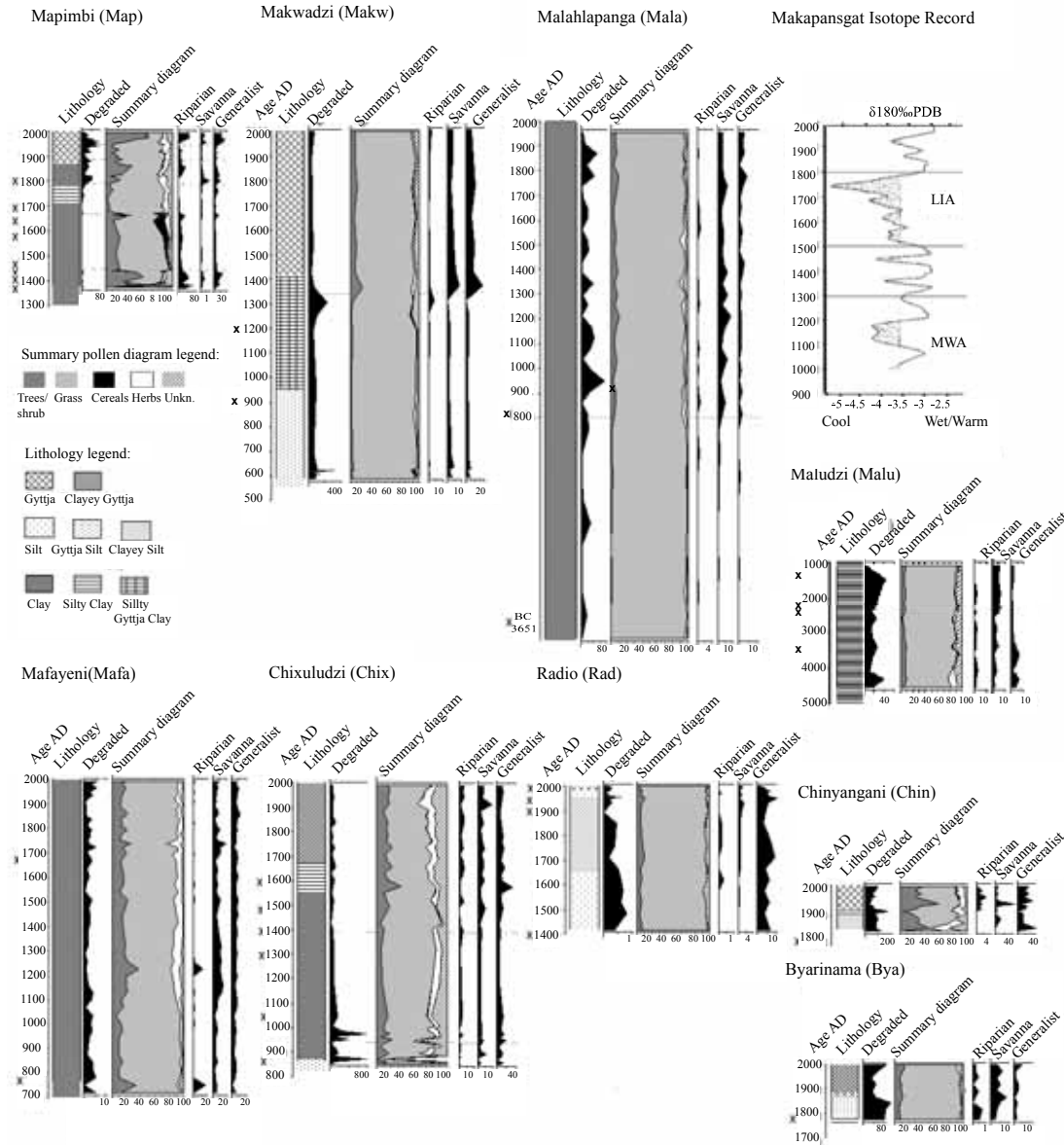


Figure 1. Summary diagrams of all the sequences discussed in the text showing (from left to right) age depth (vertical axes) lithology (column), the number of degraded pollen grains and the percentage distribution of pollen from trees/shrubs (dark grey), grass (light grey), cereals and possible cereals (black), herbs (white) and ungrouped/undetermined (hatched). Main ecological groupings of pollen taxa are also shown. Location of ^{14}C dates in the profile is marked by x (see also table 2 in appendix). Black silhouettes show the contributions of riparian, savanna and generalist taxa in tree tree/shrub group. The isotopic sequence from Makapansgat valley (after Tyson et al 2002) and the inferred changes in temperatures/rainfall is shown (upper right) for comparison.

Socio-environmental interactions

Both social and climatic history is embedded in the physical landscape of KNP and PNL and its traces can be seen in pollen-diagrams and at archaeological sites. To hunter-gatherers, the scarcity of water was an advantage as wildlife aggregated around the pans. The lithic assemblages identified by the pans in the dry interior, as shown in map 3, bear witness of the preference for these pans for settlement. These lithic scatters are the result of temporary settlements. They are not dated but may range in age from historical times, i.e. 1800 AD to 2000 years. Hunter-gatherer groups were reported by Elton in the 1870s. The interactions of groups of different economic specialisation is a long term feature of this landscape and in the 1870s hunter-gatherer groups lived amongst and intermarried with farmers¹³.

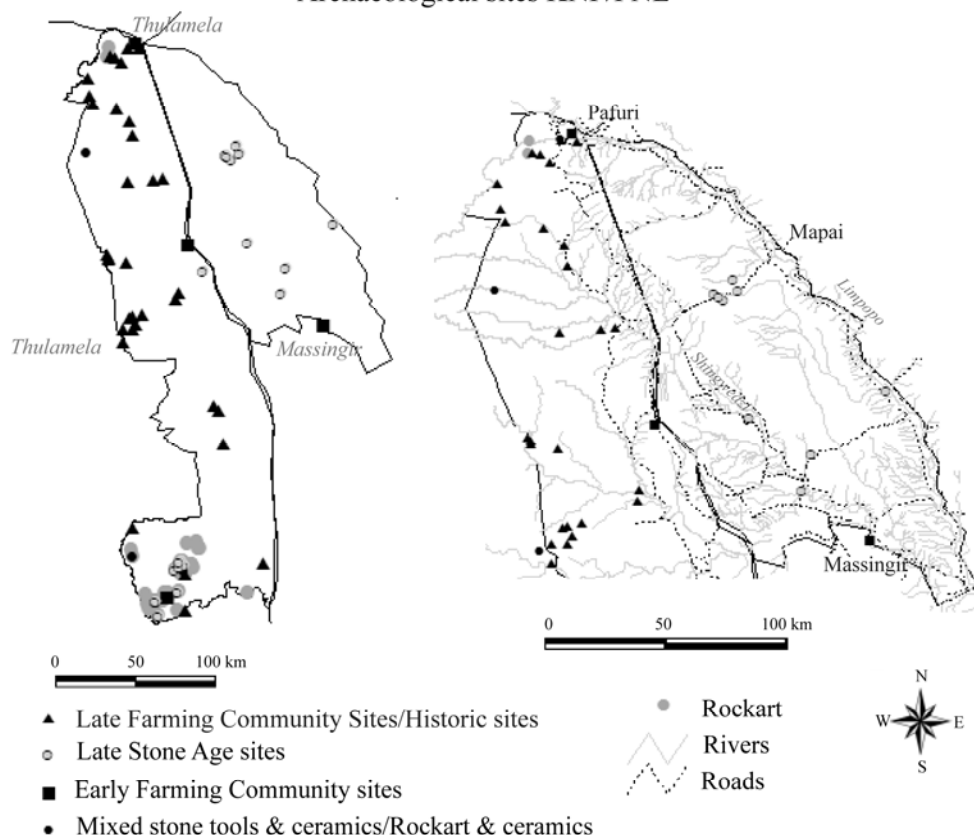
Fires have been an ever present feature in this landscape, as indicated by the adaptation of many of the savanna taxa to fire¹⁴. Fires were probably used by hunter-gatherer groups to create fresh grazing for animals in order to attract them to specific locations. This should be seen not only as a means to facilitate the hunt but also as a kind of environmental management. We have little direct evidence of this practice, however, with most palaeo-ecological records going no further back than 500 AD. It is also impossible to separate man-made fires from naturally occurring ones in such records.

In the early first millennium AD people in the southern African lowveld were either experimenting with locally available wild grasses of cereal value, or cultivating cereal grasses originating from central Africa (*Pennisetum americanum*, *Sorghum bicolor*, *Eulusine coracana*), peas (*Vigna sinensis*) and groundnuts (*Voandzeia subterranean*). These early farmers were most probably living by the rivers¹⁵. A few, so called, Early Farming Community sites, dated 350–450 AD, have been located in the Shashe–Limpopo Valley, and undated sites with similar types of pottery are also found in KNP¹⁶. The evolution of farming in the region is not likely to have resulted in a large scale transformation of the landscape. The earliest farmers probably favoured open grassland areas, such as that near Lake Maludzi, where the wild edible grasses grew and avoided forests near the rivers and woodlands.

The end of the first millennium

From the 9th century AD we may have the earliest traces of people's activities in the pollen-records. The sequence from Chixuludzi pan, situated close to the village Mapai and 1 km from Limpopo, show high values of charcoal and spores that can be associated with fungi that thrives in animal dung (i.e. coprophilous fungi) (Figure 2a). Poaceae pollen < 40 µm, which may represent indigenous cereal grasses, are also present¹⁷. The combination of coprophilous taxa, cereal grasses and charcoal is suggestive of the presence of farmers and domestic stock. This is supported by the Early Farming Community site, Hapi Pan, located close to Mapimbi, dated c. 800 AD (map 3). This site yielded bones from both sheep and goat, but no macrofossil remains¹⁸.

Archaeological sites KNP/PNL

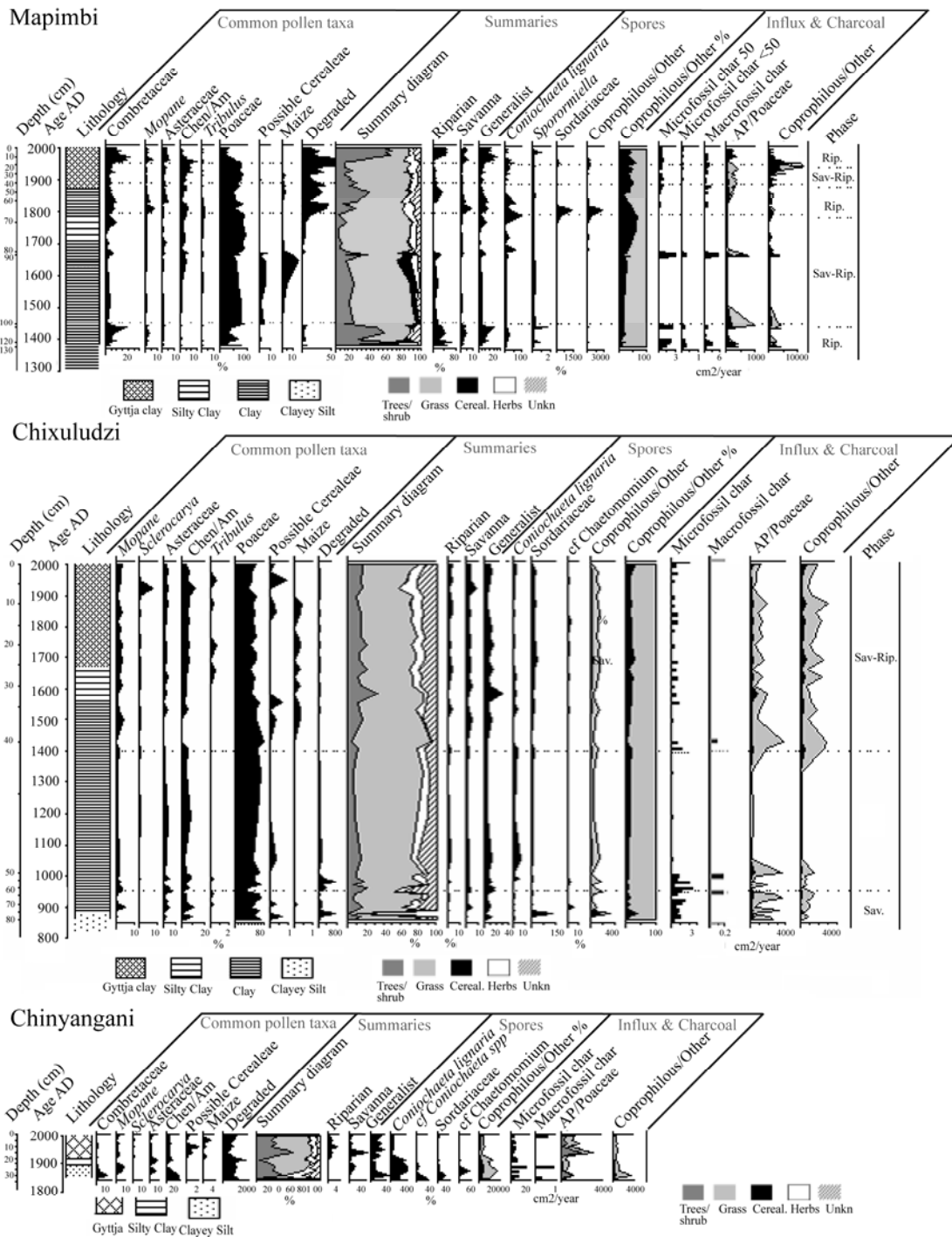


Map 3. Archaeological sites in KNP and PNL, detail of northern KNP and PNL to the right showing the sites in relation to roads and rivers. Data for KNP were provided by SanParks, based on rockart inventories carried out by C. de Rosner, and C. de Rosner, and M. English. Note that the surveys by Birkholtz 1997 in southwestern part of KNP are not shown. Sites listed by Plug in Northern KNP have been added¹⁹. PNL sites were located during surveys 2006 by A. Ekblom and M. Notelid and have not previously been published

The communities in the lower Limpopo valley gradually became included in the socio-political sphere of emerging centres in the Shashe-Limpopo basin. As such, they were highly involved in the cattle economy, where cattle constituted bridewealth and a marker of social status²⁰. By the end of the first millennium, Limpopo River had also become the main trade route between the coast and interior. Long distance trade goods, glass beads, are found from the 7th century AD in the interior of southern Africa. A trading site has been located in Massingir, PNL, dated to 800 AD. From the 9th century iron and copper were produced in great quantities in Phalaborwa, just on the border of KNP. Other iron production sites can be found west of KNP. Messina, situated on the Limpopo was another important copper mining centre. Ivory was being processed in the in the Shashe-Limpopo Valley, particularly in Shroda, and K2. Metals and ivory were probably traded with the coast via the Limpopo²¹.

The strengthening of socio-political centralised control and long distance trade relations seen from c. 800 AD, may suggest an agricultural expansion in the Limpopo valley. The high amount of charcoal in the pollen diagram of Chixuludzi could indicate clearances of new areas for farming. Charcoal influx shows quite high values in the period 800–950 AD compared to later periods. However, overall, there is no correlation between increases in charcoal and decrease of woody taxa. Rather, increases in abundance of woody taxa seem to

- 1 concur with charcoal peaks. This would suggest that farmers utilised and preferred forest gaps
- 2 for farming rather than clearing forested areas.



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Figure 2a-c. Pollen-diagrams of sequences from Lake Mapimbi (a), Chixuludzi pan (b) and Chinyangani spring (c). Vertical axes show (from left to right), dated levels (x), depth (cm from surface), estimated age depth (age AD), and the lithology with legend below. Horizontal axes show the percentage distribution of the more common pollen taxa, possible cerealea and maize pollen and degraded grains. A summary pollen-diagram displaying the main physiognomy is shown in the centre (dark grey silhouette: AP, grey: grasses, black: cereals, white: herbs, shaded: ungrouped/unknown) with main ecological groupings of tree-shrub taxa; riparian, savanna, generalist. To the right the more common coprophilous spore taxa are shown and a summary of the distribution of coprophilous/non coprophilous spore types by per cent. Black bars show the influx of microscopic and macroscopic charcoal (cm²/year). The influx of both trees/shrubs (black silhouette) – other pollentaxa (grey silhouette) and coprophilous (black silhouette) – non coprophilous spore taxa area (grey silhouette) are shown to the right.

The early second millennium AD

The jagged look of the Chixuludzi pollen curve and high amount of degraded pollen grains suggest that the pan was frequently dry before 950 AD. After 950 AD there is an overall decrease in charcoal, but potential cereal pollen and spores from coprophilous fungi are still present, leading us to infer that farmers were still present in the area. Sediment accumulation is fast between 950–1400 which may be linked to higher rainfall associated with the Mediaeval Warm Period²².

From 1300 AD, the pollen record from Lake Mapimbi, situated in the northernmost KNP close to the PNL border, shows evidence of human activity in the landscape. The landscape around Mapimbi at this time was a dense forest, riparian taxa were represented by c. 40 percent, which is very high (Figure 2b). There is also a very high amount of charcoal at the start of the core, which may perhaps be linked with human induced burning and clearances; however this was not linked with a significant decrease in trees/shrub taxa. Cereal grains and spores from coprophilous fungi are not well represented in this early part of the core. From 1400 AD there is an increase in possible cereal grains. This increase can be linked with the emergence of Thulamela, situated by the Levhuvhu River, c. 7.5 km southwest of Mapimbi. This stone walled settlement was occupied from c. 1250 AD. Walls were constructed from 14th–15th century with its largest extent in the mid 17th century, after which it appears to have been abandoned (Steyn et al 1998). The population of Thulamela, at its height, has been estimated to represent 3000 inhabitants, and the site has evidence of elite burials, ivory working and trade links with the coast and transoceanic trade²³. People of Thulamela and the Mapimbi area probably took advantage of the Limpopo River to produce floodplain crops. This production was localised, as we do not see large increases in cereal pollen grains in the Makwadzi sequence (Figure 1)²⁴.

The decline of centres in the Shashe-Limpopo Basin and the later Great Zimbabwe with a relocation of power to Khami, Khami, situated in southwestern Zimbabwe, was to the advantage of Thulamela. It is generally assumed that the elites of high status settlements, such as Thulamela, displayed and consolidated status through the ownership of cattle²⁵. The majority of the bone assemblage from Thulamela consists of wild game and fish which is somewhat enigmatic. A similar pattern can be seen in the contemporary settlement of Mwenezi and Malumba, both situated within the Limpopo watershed c. 100 km north of the KNP border in present day Zimbabwe. Also in these sites, high status indications such as stone walling and ivory handicraft is present but bone assemblages have a predominance of

1 wild game and very little cattle²⁶. The pollen-record of Mapimbi give some clues when it
2 comes to the presence/absence of cattle in the area. The amount of spores from coprophilous
3 fungi is higher overall in Mapimbi than in any other KNP and PNL cores, but the amount of
4 spores from coprophilous is low during the period 1300–1700 AD, relative to later periods,
5 which suggests that small cattle herds may have been kept here but not on a significant
6 scale²⁷.

7 Metal working has also been suggested as an import item of export from Thulamela.
8 This would have required large amounts of charcoal and cutting of forests. Neither Mapimbi,
9 nor Makwadzi, show high values of charcoal in this period which would be expected if there
10 was large scale clearing of forests. From 1400 AD there is a marked decrease in woody taxa
11 and riparian-type taxa in the Mapimbi record but it cannot be excluded that this is linked with
12 a drier climate, assuming that droughts were felt in this area already at this time, an issue
13 which is yet to be resolved (see discussion above).

14 15 **The 16th–18th century AD**

16 Maize, a new world crop that is the most important crop in the area today, appears in both the
17 Mapimbi and Chixuludzi records from 1500 AD. There is no firm mention of maize, *milho*
18 *zaburro*, until the 1560s in written documents from the east African coast. Earlier documents
19 from the Portuguese fort at *Sofala*, probably located at the mouth of the Save river, do,
20 however, list *milho* as a crop purchased locally, although Hair has argued that *milho* in this
21 document designates sorghum. João de Barros possibly mention maize in 1516, though this
22 may in fact also designate other local grains²⁸.

23 Whatever the mode and timing of the spread of maize it seems to have been earlier and
24 quicker in the region than previously expected. By 1640 people in Mapimbi were growing
25 maize on a larger scale (maize representing c. 10 percent of the pollen sum), and maize pollen
26 exceeds the amount of pollen from other possible cereal grass from this time. In Chixuludzi
27 maize appears to have replaced local cereal grains from 1560 AD. Pollen representative of
28 possible indigenous cereal grains reappear only from c. 1830 AD. The peak in maize pollen in
29 Mapimbi is preceded by a gradual increase of both indigenous cereal grasses and maize pollen
30 from c. 1560 AD. The Chixuludzi sequence shows smaller peaks in possible indigenous
31 cereal grasses from the same time, and this may perhaps indicate a gradual regional expansion
32 of cultivation.

33 There is no increase in charcoal or decrease in tree/shrub pollen in any of the cores to
34 indicate that forest areas were cleared for new agricultural land. Interestingly, the peak of
35 maize pollen in Mapimbi is dated to around the time Thulamela was supposedly abandoned.
36 After c. 1670 AD both maize and possible cereal grains are present only in very low numbers,
37 suggesting a lower agricultural activity which can be linked with the supposed decline of
38 Thulamela. Parallel to the decrease in cereal pollen, there is an increase in arboreal pollen
39 (primarily shown in the generalist taxa Combretaceae). This may perhaps represent an
40 expansion of pioneering woody taxa on old farmlands. Maize cultivation continues in the
41 Limpopo valley after this, however, as in the Chixuludzi sequence maize pollen occurs
42 disparately through time.

43 In the time period 1700–1800 AD arboreal pollen in the lake Mapimbi sequence
44 decreases to its lowest ever values (c. 5 percent), mainly due to a decline in riparian taxa. This
45 change is probably linked with the extreme droughts experienced in this period, associated
46 with the Little Ice Age. In Mapimbi there are no indications of farming in the form of cereal
47 grains, but spores from coprophilous taxa increase to very high numbers. With the absence of

cultigens this is not likely to represent an increase in domestic stock, but more likely an aggregation of animals (both domestic and wild) to the river as water in the interior was very scarce/absent due to droughts. The Chixuludzi sequence in the same time period does not show any clear changes in vegetation, but rather an expansion of generalist taxa and probably the vegetation composition here was more resilient to drought than that at Mapimbi. Maize pollen occurs in the Chixuludzi record throughout this period and there is no increase in coprophilous spore taxa similar to Mapimbi. It is possible that the slightly higher rainfall in Chixuludzi Pan compared to Mapimbi may have been enough to counter the effects of the droughts, both in relation to vegetation and farming.

The 19th century

The 19th century saw an increase in rainfall, and this is reflected in the Mapimbi core by the increase of riparian taxa and woody taxa overall. In the beginning of the 19th century, conditions for cultivation improved and maize pollen reappears in the pollen-record. There is a decline of coprophilous spore taxa to very low numbers c. 1870, and this decrease parallels an increase in woody taxa. While the increase in woody taxa is probably due to a wetter climate, the decline of coprophilous spore taxa is similarly linked with the dispersal of wild herbivores in the landscape as there were now more seasonal waterbodies available. The depression of coprophilous spore taxa may also perhaps be linked with the cattle raids of Nguni armies. Umzila, ruler of the Gaza state, evidently had effective power in the PNL area, as Elton reported how by Umzila's order villages (possibly in the area near present day Mapai), for reasons unknown, had been moved from the east bank of the river to the west²⁹.

By the end of the 19th century wildlife in the whole of southern Africa was also severely diminished due to commercial hunting. The rinderpest, which struck the area in 1896 also took a large toll on both domestic and wild cattle. Despite the combination of cattle raids and disease spores of coprophilous fungi are well represented in the pollen-diagram of Mapimbi from 1900 AD. We believe this represents an expansion of cattle rearing in the area in the 20th century. The area was known to be a tse-tse fly infested in the 19th century, but Elton, when discussing this, claimed that local communities did not regard this as a serious obstacle to cattle rearing as tse-tse only affected cattle when they had a low resistance due to lack of grazing or water³⁰.

The 20th century

A decline of woody taxa can be seen in the Lake Mapimbi sequence in the beginning of the 20th century. Again, this may be concurrent with droughts in the early 20th century. Maize pollen is no longer present in the record. Spores of coprophilous fungi continue to be well represented, and remain so until the present day. Charcoal values are high throughout this period. An expansion of woody taxa can be seen from c. 1950s, while the amount of coprophilous spores and charcoal remains high. The forced resettlement of local communities by KNP authorities from the Pafuri area in the 1950s is not clearly reflected in the diagram³¹. Possibly the increase of woody taxa actually represent a colonisation of pioneering taxa on farmlands and grazing lands but we would then expect a decline in charcoal and coprophilous spore taxa. In the Chixuludzi sequence the variation in woody taxa is much lower. The irregular cereal pollen curves (indigenous cereals making a return in the last 200 years) and the small peaks in charcoal reflect a rotation of cultivation: first a period of cultivation; then a longer period of fallow when cattle were allowed to graze the area and there was an expansion

1 of woody shrub; and then after 50 years shrub was cleared with the use of fire and a field was
2 reopened. Cultivation and grazing of domestic stock do not seem to have competed with
3 woody taxa as there is no decrease in these pollen-types linked with peaks in charcoal or
4 cereal grains.

5 A similar rotation may be reflected in a third palaeo-ecological sequence, namely
6 Chilutse taken from a spring close to the Shingwedzi, PNL, in what is presently a well
7 populated area. Despite the short, 150 year, time span of this sequence and the tentative
8 character of the chronology (based on interpolation from only one ¹⁴C date), this sequence is
9 important as it gives clues to agricultural practices (Figure 2c). The amount of coprophilous
10 spore taxa is very high in the beginning of this core and this is most likely due to domestic
11 cattle in the area. After c. 30 years of high herbivore densities, there is an increase of charcoal
12 and a concurrent decrease of woody taxa which may be linked with clearance of vegetation.
13 Maize and possibly other cereal grains are present in high numbers after this, at the same time
14 savanna tree/shrub elements increase. This suggests that the phase of cultivation also allowed
15 for new woody taxa to colonise the outer limits of the fields.

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39 Table 1. Summary of socio-political changes in the coastal Mozambique region and the
40 interior in relation to local events, as suggested by the palaeoecological records and
41 archaeology, and climate history based on Tyson et al and summary of written documents
42 presented in Ekblom and Stabell³².

Year	Coastal area	Interior	Trade relations	Local events	Climate
2000	1980-1992 civil war			Civil war in Mozambique	1680 droughts
1950	1974 Mozambique independence, liberation war	Apartheid regime in South Africa 1973 Zimbabwe independence		Relocation of court in KNP	
1900	Portuguese colonisation	Zimbabwe colonised by British Boer Transvaal republic			Warmer and wetter overall dry in the beg. of cent. (Droughts: 1903, 1908, 1912, 1922)
		British col. of south Africa			
1850	Consolidation of Gaza state with the reign of Umzila	Boer wars clashes between Nguni & British/Boer	1870 labour migration	1870s Ebor travels the valley No cultivation of cereals in Mapimbi	Warmer and wetter overall (Droughts: 1858-1863, 1870s, 1875, 1880, 1896-1897)
1800	1823 Nguni expansions	1843 tributary rule of Mzilikazi over Venda	Large export of slaves from Delagoa bay after 1823	Cultivation in Mapimbi	Warmer and wetter (Droughts: 1820s)
1750	Tembe chiefdom disintegrates Expansion by Sotho & Tsonga speaking peoples	Political unrest, population movements	Height of ivory trade in Delagoa bay (decline by 1750s)	Breakdown of political and social life, warfare and famines	Extreme droughts! (1758-9, 1777, 1790-91, 1794-1802)
1700	Population movements from Political unrest in Delagoa bay	Political unrest	Expansion of slave trade from other parts of the coast	No signs of cultivation in Mapimbi Continued cultivation in Chikuldz Thulamela abandoned?	Extreme droughts (1714, 1717, 1744-45) Droughts (1642-1847)
1650		Torwa empire			LJA (cold and dry) (1642-1647)
1600		Torwa empire		Large scale maize cultiv. Mapimbi	LJA (cold and dry)
1550	Maize cultivation on the coast	Torwa empire		c. 3000 inhabitants at Thulamela	LJA (cold and dry) (1564, 1560s, 1582, 1595)
1500		Torwa empire	Portuguese attempts to control trade	earliest signs of maize cultivation?	Onset of LJA? (cold and dry) Droughts from c. 1530s
1450-		Great Zimbabwe		Thulamela is established	Warmer and wetter overall
1250					Short drier periods 1250, 1350
1200-		Macungubwe		Farming & herding in Mapimbi	MMA (warm and wet)
950					Dry 1100-1200
900		Schroda and K2			
850	Trade centres along the coast starts to emerge		As an glassbeads in the interior		
800	Expansion of cattle economy, intens. of long distance trade		Formation of proto Swahili & coastal trade centres	Farming & herding in Chikuldz	

The historical trajectories in the PNL and KNP landscapes

Ecological management

Overgrazing and rapid deterioration of the savanna has been noted in the Limpopo valley where areas abandoned for 40 years were reportedly denuded of vegetation in the 1980s³³. However, the palaeo-ecological analyses reviewed here show the fallacy of such assumptions. The interactions between climatic variability and impact of people are complex, and cause and effect difficult to disentangle. It is emerging from the paleo-ecological analyses that there is no direct correlation between farming and degradation in the form of loss of arboreal taxa or homogenisation of vegetation. Overall, decreases in arboreal taxa seem to be interlinked with drier periods rather than expansions of farming.

In the riverine areas riparian type vegetation is likely to have expanded during periods with high rainfall, there were also natural gaps in these forests. These natural mosaics of forests, forest gaps and open grassy areas were probably utilised by farmers, with open areas used for farming and grazing. The shifting agriculture and rotation of crops and grazing that might be reflected in the palaeoecological sequences would have further encouraged the vegetation mosaics.

Historic records do not go into detail when it comes to agricultural practices and customary laws and regulations regarding use of natural resources. In the late 19th century Elton and Erskine, who travelled the area from Inhambane to Save, and Junod, based in Delagoa bay, noted how the Tsonga preferred to build their houses and villages amongst trees in contrast with other groups that preferred to clear vegetation around the settlement of trees and shrubs. The Tsonga had a customary practice of preserving forest areas which is still in practice today in many areas. Junod gives examples of settlements in the coastal region surrounded by forests that were considered sacred as they contained burials of powerful chiefs. These forests were important for rainmaking practices, as ceremonies where chiefs invoked their dead ancestors to make the rains fall would take place in these groves. The evidence of local incentives for conservation can be seen in the mopane forests by Mapai today. These consist of mature, tall mopane trees, which must be of considerable age, and therefore have been protected over time³⁴.

Landscape invariables

Droughts have been a recurring feature in this landscape, affecting both the dry interior and river valleys. Both vegetation and animals have resultingly built up resilience to, and methods of countering the effects of, water scarcity and irregularity. Similarly the irregularity of nature is embedded in people's everyday practices. The foundation of social cohesion and political power that emerged in the late first millennium was embedded in the use of ritual power over the elements to provide rain and fertility of the land. A similar role for chiefs was also reported in written documents from the 16th century and later periods. Rainmaking shrines are common in the Shashe-Limpopo area, normally situated on hilltops and used over long periods of time. The use of these and domestic rainmaking ceremonies have been shown to have intensified in times of droughts³⁵.

A flexible and experimental approach to cultivation is a prerequisite for any successful farmer in this area. The region today is regarded as a high risk cultivation area, with probable risk crop failure in 45–75 percent of years. This is due to the unpredictable nature of the beginning and end of the rainfall season, making it difficult for farmers to decide when to plant. A common practice for families today is to spread risk by having several plots for

1 farming, one in the more fertile river areas were maize, beans, groundnuts and manioc are
2 grown and one in the less fertile higher grounds were more drought-tolerant crops as
3 sorghum, millet, pulses are grown³⁶. This practice has been suggested to have been in place in
4 the Limpopo valley since 1000 AD. In 1873, Elton similarly reported how the low alluvial
5 lands near the Limpopo River specifically were used to grow maize and millet³⁷. The quick
6 adoption and expansion of maize farming may be one example of the flexibility of local
7 farmers. Maize requires 624 mm rain/year or 450 mm rain over at least 110 days³⁸. This
8 means that growing maize in the Limpopo valley region is a calculated risk. By the 17th
9 century AD, when maize cultivation began, the effects of the Little Ice Age droughts were
10 definitely felt in the Limpopo valley and maize cultivation would have been an even riskier
11 venture than it is today. Though a high risk crop, maize has some advantages to indigenous
12 cereals as it has a quicker growing period, and can be eaten green whilst maturing in the field,
13 thus it could be termed an emergency crop. Thus the expansion of maize cultivation could be
14 explained due to the onset of droughts³⁹. However, the expansion of maize cultivation can
15 also be explained in the context of trade, as maize is easily transported and readily eaten
16 without processing.

17 Another way of buffering risk is through labour migration, this has been an important
18 part of household economies since the 19th–20th century⁴⁰. In the 1870s Elton estimated that
19 half of the male population had moved away from the region for work (his impression was
20 than in the whole district of 100 x 80 miles there were only about 100 ‘able bodied men’).
21 Though the growing industry in South Africa certainly provided new and unprecedented
22 opportunities for salaried labour, migration for access to resources or exchange networks was
23 not a new phenomenon. Indentured labour, for local chiefs or chiefs in other areas, had long
24 been practiced. Written documents describing in the Zambesi valley report how people
25 submitted themselves to contracts of service to chiefs, thus ensuring not only protection and
26 food, but also resources that would otherwise not be available to them, for instance cattle, and
27 with that, marriage alliances⁴¹.

29 **Reorganisation in nature and society**

30 The importance of small scale variability in maintaining relative stability is often used to
31 describe the interplay between variability, stability and change in nature. Small scale
32 variability, continuously going through cycles of build up, transformation and reorganisation
33 act as a buffer against systemic shifts and creates resilience. However, larger scale changes –
34 or disturbances – may cause a systemic shift and a reorganisation into another phase.
35 Fluctuations in rainfall did not lead to any large scale shifts in vegetation at the sites in this
36 study. The vegetation in KNP and PNL appears to have been resilient to droughts, as the
37 extreme droughts in the 18th century are not seen clearly in the pollen-diagrams. Rather, small
38 scale variations countered any large scale shifts, which is why we describe these areas as
39 *quasi*-stable. There are, however, also examples of rapid transitions in vegetation (for instance
40 Malahlapanga) once a critical ecological thresholds is crossed⁴².

41 Similarly, in society, small scale mechanisms for buffering risk, some of which have
42 been exemplified above, would provide a *quasi*-stable state until a threshold is reached. It is
43 tempting to relate the social and political turmoil of the 18th century with the severe droughts
44 in this century and, as such, a systemic collapse. Written sources report droughts in different
45 parts of the summer rainfall region of southern Africa in 1717, the 1740s and 17050s, 1777
46 and in the 1790s⁴³. From the early 18th century there were several movements and clashes
47 between population groups as the Sotho-Tswana groups moved down to the Limpopo valley
48 from the Highveld, and as the coastal Tsonga chieftancies expanded, resulting in warfare and

1 social unrest⁴⁴. Similarly the early 19th century saw continued droughts and warfare. The
2 initial northward movements of the Nguni created a ripple effect of migrations and warfare
3 from various Nguni groups. As related by Elton above, *Mzilikazi* the chief of a breakaway
4 group of Nguni, the *Ndebele*, expanded in the middle Limpopo region in the 1840s. In the
5 coastal region there were several expansions and internal strife amongst the Nguni themselves
6 until *Shoshongane* in the 1830s consolidated the Gaza empire and was succeeded by Umzila
7 in the 1860s⁴⁵.

8 There are many explanations to this long period of instability and most probably the
9 answer lies in the combination of different factors. The ivory trade expanded from 1750 in
10 response to global demands. This reshaped power relations in the region and some of the
11 movements of chiefs and army bands was probably motivated by the ambition to control or
12 gain direct access to this trade. Both the Tsonga and Nguni political systems were politically
13 and structurally unstable with frequent conflicts around succession in particular. The ivory
14 trade itself has also been thought to exacerbate political instability as the power of the new
15 rulers was mainly based on the appropriation of wealth provided by the taxation on ivory
16 trade rather than agricultural production. As the wealth of the rulers increased the base of their
17 wealth, the elephant herds, diminished, leading to increasing competition between rulers and
18 groups⁴⁶. The fact that agricultural production was limited at this time, due to both frequent
19 droughts and warfare, provided an important incentive for local communities to engage in the
20 ivory hunt. It may also have put additional pressure on political entities to control and expand
21 the ivory trade and commercial hunting in general.

22 Whatever the combination of different factors and their internal relationships, almost
23 two centuries of recurring warfare in combination with recurring droughts, was detrimental to
24 social life. By this time cattle herds in the KNP and PNL area had most likely been
25 appropriated by the Gaza state rulers. At the same time wild life was also severely
26 diminished, through commercial hunting by local, European and Boer hunter. Hunting
27 became a less viable option for household subsistence or as a potential source of extra
28 household income in the form of commercial sale⁴⁷. Instead, migrant labour became an
29 increasingly attractive option both for buying food and for taking part in the network of
30 alliances that the cattle economy usually provided. In the early 20th century peaks in labour
31 exports also correlate clearly with draughts and famine. Though, as discussed above, migrant
32 labour was probably not a new occurrence, this practice took unprecedented scales⁴⁸.

34 Conclusion

35 Much of the transformations in the landscapes discussed here, i.e. contraction of riparian type
36 forests, reduction of cover of trees/shrubs, and the expansions of grasslands, have previously
37 been attributed to the negative influences of farming, herding and iron production. However,
38 as shown here the physical landscape is susceptible to such changes through physical
39 processes that people cannot control. Instead, the long-term geological processes and the
40 century scale trends in rainfall variability together sets the physical boundaries within which
41 vegetation, animal life and people interact. While we have shown that there are some features
42 in this landscape that has remained relatively stable, there have also been major
43 transformations in both the physical landscapes and social life.

44 From the 9th century AD we may have the earliest traces of people's activities in the
45 palaeo-ecological record, with the presence of coprophilous spore taxa, charcoal and cereal
46 grasses. There is no correlation between increases in charcoal and decrease of woody taxa
47 which suggests that farmers utilised and preferred forest gaps. From 1400 AD there was an
48 agricultural expansion in the Mapimbi area, related to the Thulamela centre. Maize cultivation

1 took place in both the Mapimbi and Chixuludzi area from 1500 AD. The droughts in the time
2 period 1700–1800 AD resulted in a contraction of riparian forest in Mapimbi and there is little
3 indication of cultivation in Mapimbi at this time. The Chixuludzi area appears to have been
4 more favourable during this time, cereal pollen grains continue to be present and there is no
5 reduction in riparian-type vegetation. In the 19th century climatic amelioration resulted in an
6 expansion of riparian taxa and cultivation in Mapimbi while a decline of woody taxa can be
7 seen in the early 20th century linked, again, with droughts. The higher resolution of the
8 records in the 20th century allows for the identification of a rotation of cultivation.

9 We have attempted to explain how socio-political changes have interacted with
10 environmental variability to counteract the environmental vulnerability of the region. While
11 many questions remain, it is clear that the PNL area and northern KNP, is far from an isolated
12 wilderness area. This understanding of the landscape is of acute relevance today as the area is
13 in the process of being converted into a national park. The wilderness idea and the
14 modernisation discourse have been used to motivate the relocation of communities to lands
15 outside the park area, and one reason for this is the lack of appreciation of the long-term
16 cultural history of this landscape.⁴⁹ With this study we hope to have conveyed that the PNL
17 and KNP landscapes are embedded with cultural history.

¹ Most of this palaeo-ecological work have been published elsewhere (Gillson and Ekblom 1 2009a, Gillson and Ekblom 2009b, Ekblom and Gillson 2010 a, 2010 b, 2010c, however these publications have focused primarily on the natural dynamics rather than socio-environmental dynamics which will be discussed here.

² Elton 1873.

³ FAO 2004.

⁴ Elton 1873.

⁵ Elton 1873. Tsonga was originally a Nguni term, designating the peoples who had been conquered and were not incorporated or resisted the incorporation into the Nguni social and political hierarchy (Harries 1981). It designates what today is defined as Tsonga but may in fact in the days of Elton have designated many groups (see also Smith 1973).

⁶ FAO 2004

⁷ see review in Goudie and Thomas 1985.

⁸ Tyson et al 2000, Lee Thorpe et al 2001, Tyson et al 2002, Scott and Lee-Thorpe 2005, Smith 2005, Norström and Holmgren 2005.

⁹ Huffman 2008.

¹⁰ Pikirayi 2003, Nicholson 2000, Ekblom and Stabell 2008, Young 1977, Tyson and Preston-Whyte 2000.

¹¹ Tyson and Preston Whyte 2000, Nicholson 1994, 2000, Venter et al 2003.

¹² Gillson and Ekblom 2009a, Gillson and Ekblom 2009b, Ekblom and Gillson 2010a, 2010b, 2010c.

¹³ Elton 1873.

¹⁴ Bond 1997.

¹⁵ Mitchell 2003, 274, 169, 188, Jonsson 1998, 91-93.

¹⁶ Huffman 2009, Korfmann et al 1986, Meyer 1989.

¹⁷ Ekblom and Gillson 2010b. Unfortunately pollen of the domesticated cereal grasses overlap in size and are morphologically similar to wild grass pollen (Tomlinson 1973). Larger grass pollen (eg < 40 µm) tend to occur in larger numbers later with maize pollen that are easily identifiable on the basis of both size and morphology why it is likely therefore that they do represent indigenous cereal grasses.

¹⁸ Plug 2000.

¹⁹ Plug 2000.

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- ²⁰ Beach 1980, 1998, Hall 1990, Pwiti 1991, 2005. Huffman 2000, 2009, Calabrese 2000, Mitchell 2002, Kim and Kusimba 2008.
- ²¹ Wood 2000, 2005, van der Merwe and Scully 1971, Evers 1982, Evers and van der Merwe 1987, Huffman 2000, Duarte 1995, Mitchell 2003, 357-358.
- ²² Ekblom and Gillson 2010c.
- ²³ Küsel 1992, Steyn et al 1998, Meskell 2007.
- ²⁴ Makwadzi, due to its basin size, should reflect the regional vegetation (Ekblom and Gillson 2010 a).
- ²⁵ see for instance Pwiti 1991, Beach 1998, Huffman 2000, 2008, 2009, Mitchell 2002, 328.
- ²⁶ Steyn et al 1998, Plug 2000, Manyanga 2006, 71.
- ²⁷ Ekblom and Gillson 2010b.
- ²⁸ Dos Santos in Theal 1964, II, 127, Miracle 1963, Hair 1966-67.
- ²⁹ Newitt 1995, 255-266, 348-351, Péliissier 1984, 115.
- ³⁰ Carruthers 1995, 41, Carruthers et al 2008, Young 1977. Elton 1873.
- ³¹ Pollard et al 2003, Carruthers 1995.
- ³² Tyson et al 2002, Ekblom and Stabell 2008.
- ³³ Hanish 1980 in Plug 2000.
- ³⁴ Elton 1873, Erskine 1875, 55, Junod 1927, vol II, 376-384, 316-322. We were informed by local residents that the local chief has imposed a ban on cutting these trees, and that anyone breaking this customary law would be obliged to pay a considerable fine.
- ³⁵ Huffman 2000, 2008, 2009, Ekblom 2004, Young 1977.
- ³⁶ FAO 2004.
- ³⁷ Elton 1873, Huffman 2008.
- ³⁸ Goodman 1976 in Huffman 1996.
- ³⁹ Crais 2003. Huffman (1996) associates the spread of maize in Natal in the end of the 18th century with the return of a wetter climate and the end of the Little Ice Age, however in the Limpopo valley maize cultivation was earlier than previously thought.
- ⁴⁰ Harries 1981, Harries 1994, First 1983, Newitt 1995, 408.
- ⁴¹ Newitt 1995, 233-237.
- ⁴² See for instance Holling 1996, Gundersson 2000, Holling et al 2001, Berkes 2003.
- ⁴³ Pikirayi 2003, Nicholson 2000, Ekblom and Stabell 2008.
- ⁴⁴ Smith 1973, Liesegang 1987, Newitt 1995, 154-159.
- ⁴⁵ Newitt 1995, 255-266, 348-351, Péliissier 1984, 115, Elton 1873.
- ⁴⁶ Smith 1973, Liesegang 1987, Eldredge 1995, Newitt 1995, 156-157, Harries 1981, Carruthers et al 2008.
- ⁴⁷ Carruthers et al 2008.
- ⁴⁸ see First 1983, 28, 183, and discussion in Ekblom 2004.
- ⁴⁹ The PNL area will be included in the (36 000 km²) Transfrontier Natural Park, incorporating also the Kruger National Park (KNP) in South Africa and the Gonarezhou Park in Zimbabwe. For critical analyses of the creation of the Limpopo national park in the present see Milgroom and Spierenburg (2008) and a discussion on the wilderness idea in relation to PNL see Rogers (2009). For a discussion on the rethorics behind the creation of KNP (Carruthers 1995) and a comparison between PNL and KNP and the modernisation discourse see Ekblom and Notelid (2010).

Acknowledgements

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Authors comments

(Authors specific comments to reviewers are italicized)

In general both reviewers were overall positive and we are very grateful to the response and advice given! One reviewer found the paper well structured, the other found the structure poor making the paper cumbersome to read and to his mind compromising the quality of the data. We were recommended by the editors to consider changing the structure. However, before submitting this paper, we carefully considered the structure and decided not to follow a conventional structure. If we had followed a conventional structure the paper would have been twice as long, spending the first c. 10-15 pages presenting the data and then 20 pages on discussing them. Now p. 5-17 is really a discussion based on results. Disciplinary presentations of this data already exists and we will also publish the archeology separately in 2012 which I hope will satisfy reviewer 1 when it comes to the transparency and quality of data.

As the data has been published elsewhere the point of this paper and the reason for choosing to publish in JAAH is that it provides the opportunity, for once, to present a coherent story. This is rarely possible in other journals either because of the word limit of the journal or because of a rigorous disciplinary scope. From experience (for instance the thesis of the main author) we also know how difficult it is to present a coherent narrative on the basis of the structure suggested by the reviewer. It often risks becoming a long description of results which we wanted to avoid here.

Therefore, while we have carefully considered the recommendations from reviewer 1 and the editors we have decided keep the structure as in the first version submitted. We now attempt to explain briefly why in the introduction and also introduce the frame of the text that is basically chronologically structured using vegetation and landscape history as a base of the discussion. We hope however that by cutting out some detail from the main body of the text (now in footnotes) it is less cumbersome to read and that reviewer 1 will be satisfied.

Main changes to the manuscript after revision is that it has been cut down, as stated above. Some of the detail when it comes to the pollen diagrams have been moved from the body of the text to footnotes. The referencing has also been revised to the format of JAAH. While we have attempted to follow the recommendations of JAAH in some cases references have been given with paragraphs and sentences for clarity as is also recommended by the anonymous reviewer. We have also cut out some references that were not needed. Apart from recommendations to change the structure we have carefully followed the advice and specific comments of both reviewers as specified below.

The modifications to figure 3 suggested by the anonymous reviewer have been partly followed. However as we did want to fit all diagrams in one page, we could not accommodate all changes.

As for language, it seems that the editors told reviewer 1 that a language revision was needed. We have run the text through language revision already in the first submission but are happy to do this again. We are grateful to the reviewers for the typos identified and hope that we have now amended these.

Authors comments to reviewer 1

Content

I have no problems with the content except that in some places there may be need to cut down on what is clearly extraneous detail. *We have now moved some descriptions and paleoecological discussions to footnotes which we hope will make it easier to read*

Structure

The paper is poorly or weakly structured, making reading very difficult or cumbersome. This compromises the high quality of data invested in the article. *As we now explain, the raw data is presented elsewhere.*

It is not clear for example, where the introduction ends, as there is another introduction within the introduction. *I think this confusion may have arisen from the fact that the heading after the "introduction" was named introducing the landscape this title has now been revised to "the landscape" and it is also more clear with the JAAH formatting*

The pollen diagrams do provide the corpus of the data, but there are other forms of data that are also part of this project as well - the historical and archaeological. To encourage a smooth flow of their presentation, I would like to suggest that the paper be re-ordered to reflect the following categories or headings: Introduction, Data - palaeo-ecology, archaeology, history Interpretation of the data, Discussion [This is where details presented on pp. 16-18 should fall in] *See comment above*

General comments

I do agree with the editors that there is need for language revision in final stages of the paper. *It has already been revised and we can revise it further if recommended by the editors*

However, there are some technicalities to do with terminologies or place/geographical names which also need to be rectified in the presentation of the landscape in the opening pages. I would like to caution against the use of the much broader term, Shashe-Limpopo basin, when making references to a much smaller area within basin. *This is now rephrased to be more specific geographically using Shashe-Limpopo confluence instead*

I would encourage the authors to distinguish their research area, which is the lower Limpopo valley from the middle Limpopo valley, where you find Mapungubwe and K2 (Bambandyanalo). *Now rephrased accordingly*

Specific comments

p.3 References to Makalaka is almost certainly Kalanga or possibly Karanga *Now rephrased*

p.11 With references to Thulamela, please note that there other stonewalled sites in the general area that are either not yet excavated or totally unresearched, which may have served equal or complementary roles. *This is now commented on in a footnote.*

Why is it enigmatic to have fish at Thulamela. I grew up eating a lot of fish netted from rivers, some 80 km north of Great Zimbabwe! *What is enigmatic rather is the absence of cattle in a high status settlement. This has now been rephrased accordingly.*

p.18. There is no need to italicize names such as Mzilikazi, Nebelele and Soshangane. Also cross-check how the name of the latter is spelt. See also p.3 where you do the same for Makalaka and other names. *We have now taken away the italicizes on these names and doublechecked the names, consequently we use the names as referred to first by Elton 1873 and then “present day” denominations following Newitt as this is our main reference. As for Soshangane he is not mentioned in the text only his son Umzila.*

Authors comments to anonymous reviewer

Major concerns:

- The un-published paleo-ecological dataset (Maludzi) would favour from a more detailed description of the methodology and results, perhaps in a short appendix. *This is now added as a footnote*
- The Appendix with Table 2 is missing. *Now added*
- The paleo-climatic reconstructions that are referred to and used for comparison of the authors data are complex and not always straight forward in terms of interpretation and co-variation. The discussion around the paleoclimatic evolution is sometimes, to my opinion, somewhat oversimplified. It should be mentioned that these reconstructions “suggest” a certain climate situation, but that there also exist anomalies between them. *Now revised accordingly*
- When it comes to the introduction of maize cultivation into the region, the age models of the two actual cores are central. Judging from Fig 1, there seems to be several 14C-dates bracketing this event, however, what is the possible error here after calibration? How much may the 1500-AD-date of the maize introduction vary according to calibration and age modelling? *This information is now added as a footnote and is also shown in table 2*
- The reference system is sometimes insufficient. At several passages, references appear only at end of each paragraph, which makes the referencing unclear (but perhaps this is according to the guidelines of the paper?). Further, authors shift between referring to author name/year and just a reference number. Clear referencing is particularly important as the text is interdisciplinary and probably will reach colleagues from different disciplines.
- Several typos need to be corrected in the text. *The references have now been revised and to include references i paragraphs when necessecary*

Minor comments

Page 3, Line:

37: Clarify “sodic areas”. Meaning saline soils? Alkaline? *Now explained*

38-47: The latest reference to the Makapansgat isotope data should be used (Holmgren et al 2003, QSR 22, p 2311-2326). *Now revised*

40: the Medieval Warm period: mainly a European phenomenon, which should be mentioned here, as well as referred to as such. *Now revised accordingly* Check spelling of “medieval” (throughout the document). *Done*

40: last word, spelling “which” *Done*

41: “..., as the Intertropical convergence zone expanded southwards.” This is discussed as one possible explanation among others within the literature, so please clarify the source of this statement. *This has now been taken out as there is no need to go into this here, a discussion would take to long and distract from the contents of the paper*

44:46: “...droughts occurred around c. 1750 AD...” Ref? Also Huffman? Makapansgat? *Done*

Page 4, line:

1-2: This information should be available from meteorological stations in the region. *Yes it should but there is no space to display this here and references are given to Tyson who has used meteorological data over the region to argue this*

6: Clarify: “The Mozambique current..” meaning “The SST of the Mozambique current/Indian Ocean...”? *Now revised accordingly*

Page 5, line:

3: However, there seems to be an increase in herbs and savanna vegetation around c1100AD at Mafayeni? *This is now commented in footnote*

7-9: It is difficult to see the suggested increase in riparian vegetation at 900AD. Further, this concerns only the Chixuludzi core. From the text it sounds like this is supported from both Chix and Mapimbi cores. *Now revised to discuss Mapimbi only*

15: Map. The abbreviations (in Map 2a) are confusing. Please consider to use the full names of the sites in text and map. *Now changed accordingly*

Page 6, Figure 1:

- Consider to arrange the diagrams according eg site-preferences (river-sites next to each other), for easier overview of the results. *This is now done*

- Further, to make it even clearer that the records are plotted on same time scale, add a common time scale, as y-axis, to the left in the figure. *This has been done already*

- Consider placing the Chinyangani and Byarinama diagrams on the same chronological axis as the other diagrams (are they arranged like this to save space?). *Yes it is to save space but we have now revised it somewhat*

- I would have appreciated if the related reference was mentioned along with each site name. *This is not possible due to space*

- Lithology: The symbol/legend for “Clay” comes out irregular in my printed version. Perhaps only a technical printing issue but consider to change to another symbol/pattern. *This comes out in print*

- In the Maludzi (Malu)-diagram: Change “Age AD” to “Age BP” *Done*

- Is it possible to add charcoal data? *The charcoal data is now added*

- Line 8: “table 2 in appendix” The appendix is missing. *Now added*

Page 7, line;

33: “Figure 2a” Change to “Figure 2b”. *Done*

33: “..pollen <40ym” do you mean “..pollen >40ym”? *Done*

Page 8, line:

19: “and K2.” Clarify. *Done*

Page 9:

Line 2: An additional/alternative explanation could be that warmer and wetter conditions supported the (natural) fires with additional fuel (grasses), thereby the positive correlation between charcoal peaks and increase in forest taxa. *Yes, and we discuss this elsewhere, but forests dont burn naturally and with warmer conditions we expect riparian forests to have expanded on the cost of grasslands*

Figure: Include figure-signs. a), b), c). *Done*

Page 10, line:

17-22: Refer to fig 2b. *Done*

21: "...between 950-1400.." should be: "...between 950-1400 AD.." *Done*
26: "Figure 2b" should be "Figure 2a" *Done*
34: different referencing (Steyn et al. 1998) – should be replaced by a number? *Now revised*
41: "power to Khami, Khami,..." remove repeated word *Done*

Page 11, line:

16-17: This is interesting. It seems that maize was present even earlier, at c 1450 AD at Chixulduzi!
Now commented in a footnote
35: "...Thulamedia was supposedly abandoned." Add reference *Done*
45-46: "...associated with the Little Ice Age." Add references. *Done*

Page 12, line:

6: Spelling of "Chixuludx" *Done*
12: "...an increase in rainfall..." Add references *Done*
35: "...droughts in the 12th century..." Add refs. *Done*

Page 13, line:

13: "Chilutse" this site is not in the figure. Should be Chinyangani? *Yes now changed*
41: "Tyson et al " should be "Tyson et al 2002.."? *Done*

Page 16, line:

30-34: references? *Done*
48: "highveld" –local term that need clarification? *Done*

Page 17, line:

8: spelling "proably" should be "probably" *Done*

Page 18-25:

Check the reference list for missing references, formatting etc.
Corrections in the reference list, page 18: "Mitchell 2003" should be "Mitchell 2002"? , "Norström and Holmgren 2005" should be "Norström et al 2005". *Done*
Missing refs in the list, for example: Bond 1997, Pwiti 2005... *Now revised and doublechecked*