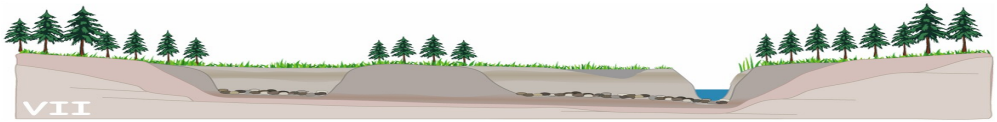
# A landscape-based model to characterize the evolution and recent dynamics of wetlands in the Umzimvubu headwaters, Eastern Cape, South Africa

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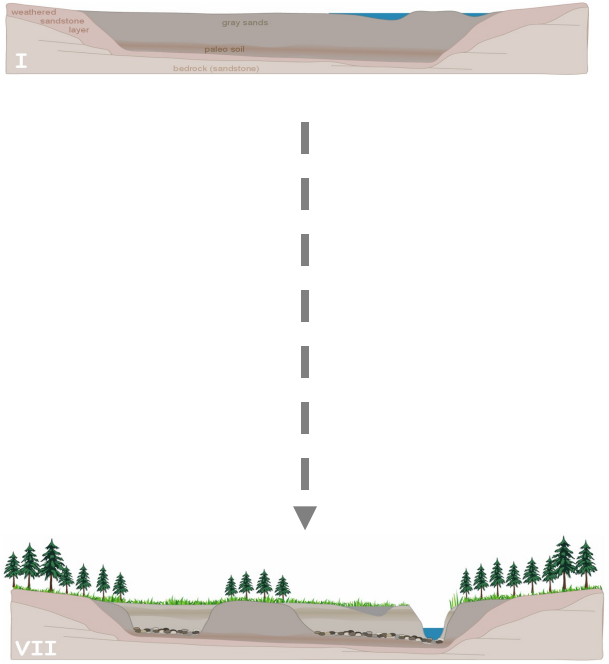
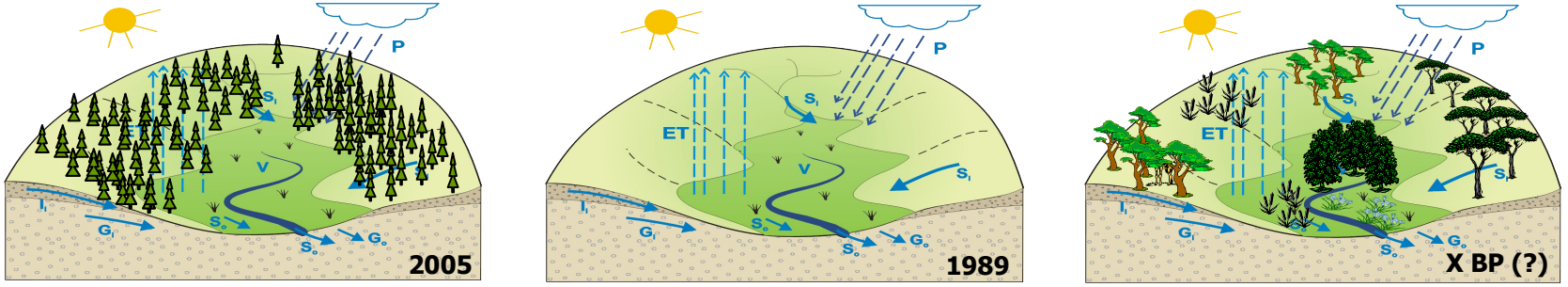
# OUTLINE

- Introduction
- Study Area
- Climate History
- Human‘s History
- Methods & Results
- Landscape Model
- Conclusion
- Acknowledgements



# PROJECT BACKGROUND

- Study on landscape dynamics due to the temporal and spatial impact of large scale afforestation on different wetland types within the semi-arid headwaters of the Umzimvubu catchment, South Africa.




## The Problem

- South African scientists emphasize that the landscape of the Eastern Cape that we are facing today is very old and mainly formed by climatic and geological conditions
- in addition, it is assumed that grassland is predominant since 1000s of years, because of there is no potential for the growth of higher vegetation: ***to high, to dry, poor soils*** (?)

# THE REALITY

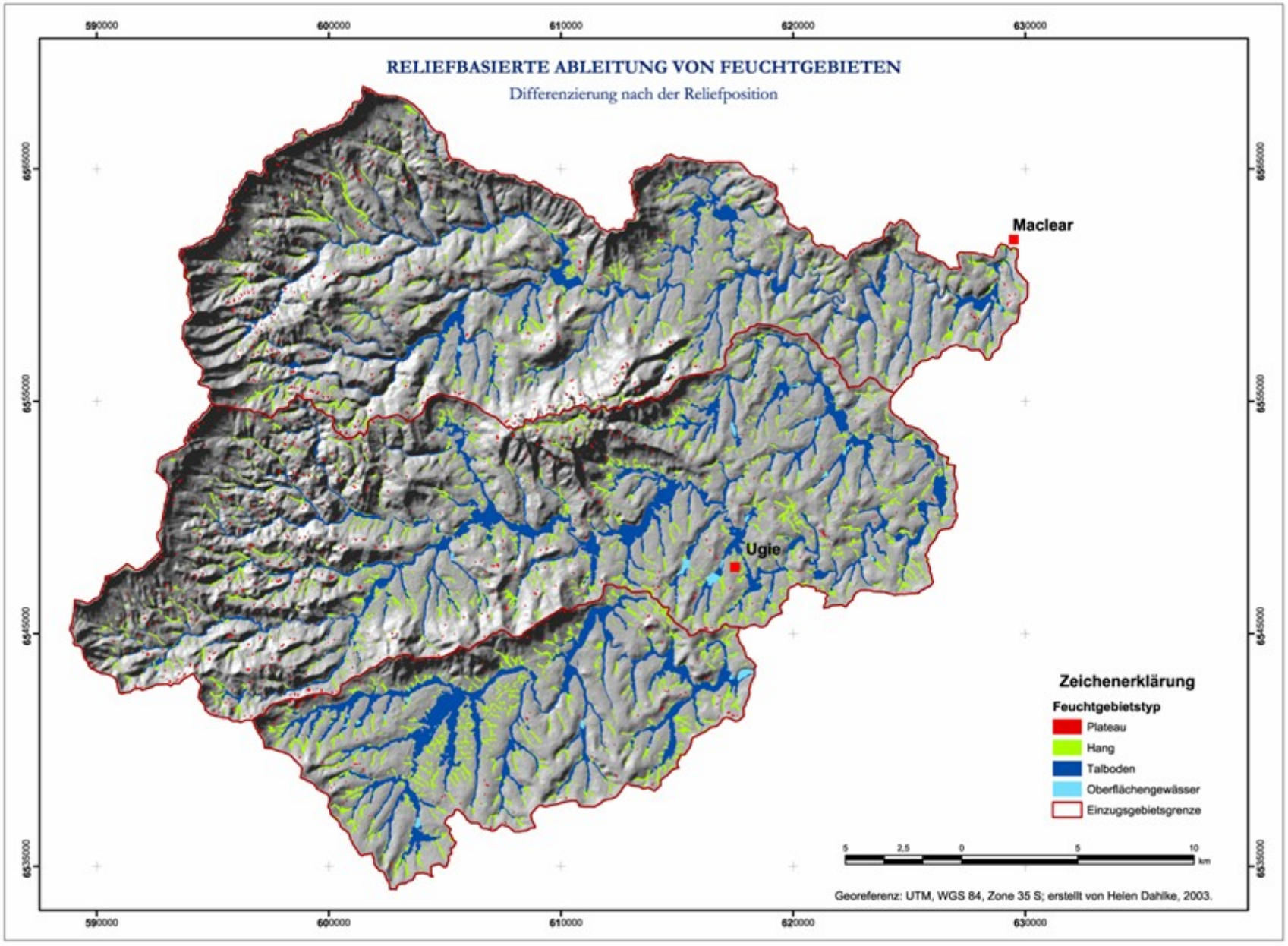
- relics of indigenous Podocarpus forest in the kloofs
- good conditions for commercial forestry
- annual burning since 100s or even 1000s of years reduced biodiversity and the growth potential for other vegetation then fast growing grasses

## SO WHAT?

## HOW WAS THE LANDSCAPE FORMED?

## Is there any human impact on wetland formation?

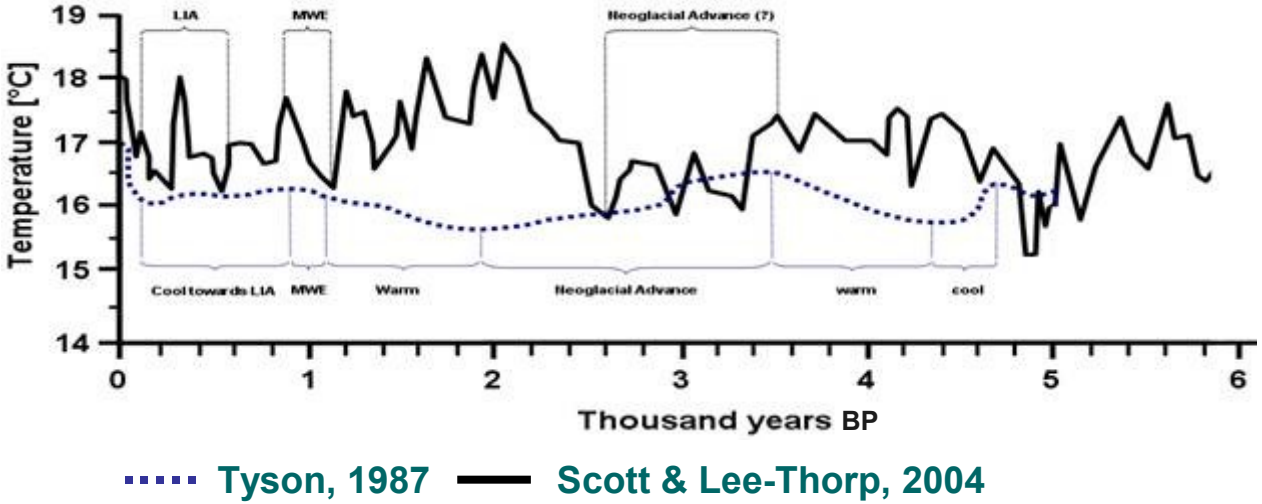
# STUDY AREA


RELIEFBASIERTE ABLEITUNG VON FEUCHTGEBIETEN
Differenzierung nach der Reliefposition
590000
600000
610000
620000
630000
6560000
6550000
6545000
6535000
Maclear
Ugie
Zeichenerklärung
Feuchtgebietstyp
Plateau
Hang
Talboden
Oberflächengewässer
Einzugsgebietsgrenze
5
2,5
0
5
10
km
Georeferenz: UTM, WGS 84, Zone 35 S; erstellt von Helen Dahlke, 2003.

# STUDY AREA

- ***Cooling phases*:** i) 5 100 yrs BP with minimum at 4 850 yrs BP; ii) 4 700 yrs BP with minimum at 4 300 yrs BP and iii) 3 300 yrs BP with minimum at 2 500 (Scott & Lee-Thorp, 2004), but different to Tyson (1987)

- ***Temperatures :*** ranging between 15.2 and 18.6°C, but depending on the author (Tyson, 1987; Scott & Lee-Thorp, 2004)




- ***Rainfall:*** similar rainfall conditions over the last 2 000 years with some fluctuations in terms of variability and intensity (February, 1994; Tyson, 1987)

# Historic and Recent Land Use

only limited knowledge is available due to human activities in the Transkei and Eastern Cape area, but some studies give evidence on the behavior of hunter-gatherers and early farmers:

- ***29 000 – 26 000 yrs BP*: caves near Maclear were occupied by hunter-gatherers at several times (Oppermann, 1996)
- ***25 000 – 1 600 yrs BP :*** archaeological evidence of hunter-gatherers at the Sehonghong Caves in Lesotho at several times providing information on hunting techniques, occupation associated with climate phases (Mitchell, 1996)
- ***5 000 yrs BP:*** hunter-gatherers activities due to intensive resources exploitation (deforestation of riverine vegetation, hunting by burning) increased significantly; peak: 3 100 yrs BP; related to cooling phase 3 200 yrs BP (Hall, 2000; Scott & Lee-Thorp, 2004)

# Historic and Recent Land Use (cont.)

- ***1 700 yrs BP:*** farming activities by early pastoralists, prefered settling in areas with woody vegetation (Feely, 1987)
- ***1 400 yrs BP:*** evidence of burning for land preparation (grazing) in the Transkei (Feely, 1987)
- ***900 yrs BP:*** settlements (kraals) along the Umzimvubu River, extensive grazing management (Feely, 1987)
- ***15th-16th Century:*** mixed farming of crops, extensive stock-farming (Feely, 1987)
- ***18th Century:*** introduction of maize, crops, large scale farming activities and extensive stockfarming (Feely, 1987)
- ***20th Century:*** large scale farming (Natal), extensive stock-farming (Transkei, Natal), commercial forestry (Eastern Cape Province)

HUMAN'S HISTORY

# Sedimentological Analysis

have been applied to open soil pits, soil cores and samples from 7 wetland transects to delineate

- ***soil physical parameters*****:** grain size distribution & statistics
- ***geochemical parameters:*** CNS, pH, Al, Fe, K, Mg, Na, Ca
- ***Soil hydrological parameters:*** pF, hydraulic conductivity

## Results:

- each site showed a ***similar soil profile,*** i.e. A-horizons are less developed (10-20 cm), clay horizon combined with congretions of Fe/Mn (impermeable) varying between 40 and 110 cm, sandy base (220 – 380 cm), gravel at the bottom
- ***congretion horizon of Fe and Mn*** takes a minimum of 500 yrs to be developed (Fey, 2004; pers. note)
- pieces of charcoal at several depths, bioturbation

# Refraction Seismics

22 profiles have been measured within 7 selected reference wetlands to provide information about:

- ***thickness*** of wetland sediments above bedrock
- ***structural layering*** of the paleorelief
- ***physical properties*** of the wetland sediments

## Results:

- wave velocities indicate relatively ***homogenous sediments*** with a varying ***thickness of 2 – 4 m*** overlying the triassic sandstone
- little variation in terms of physical properties indicates ***homogenous layers***, and thereby relatively ***constant conditions*** during deposition
- layer thickness is related neither to size or type of wetlands nor to the size of the contributing area

# $^{14}C$ Dating

- samples of organic material (decomposed roots) were taken at the base of the Gatberg Vlei (Valley Bottom wetland), i.e. at depths between 240 and 220 cm
- Accelerator-Mass-Spectrometry (AMS Erlangen)

## Results:

- sample ages ranging between ***3 500 and 3 300 yrs cal BP*** and thereby give a minimum age for the valley sediments

## Hypothesis :

- the cooler conditions between 4 700 and 3 500 yrs BP (Tyson, 1987; Scott & Lee-Thorp, 2004) caused increasing fluvial dynamics and sediment transport
- warmer conditions at 3 500 yrs BP (s. auth.) combined with increased human activities in the valleys and at slopes indicate that the deposition of recent sediments started at this time

# Pollen Analysis

- 52 samples have been taken from open soil pits along the Mooi River and the Gatberg River
- 5 sites were analyzed in detail

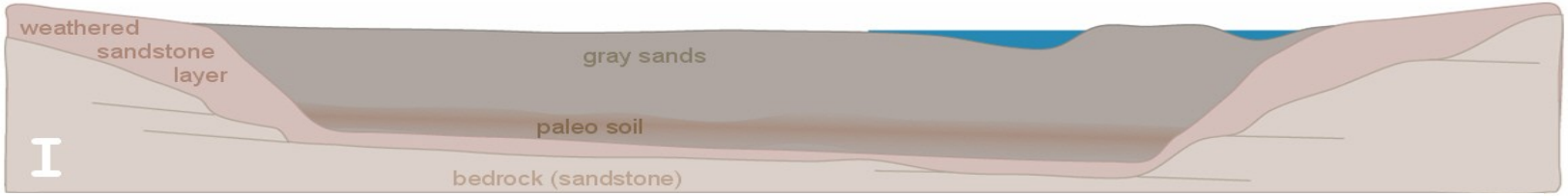
## Results:

- independent of the sample depth, all samples showed ***abundance of grass species*** with dominance of *Poaceae* species (sweet grasses), 1 sample showed dominance of Cyperaceae species (sour grasses)
- evidence is given due to the occurence of ***open land vegetation*** like herbacous perennials
- with the exception of willow (Salix) and pinus, groves were not certainly identified in the samples
- indigenous forest is still preserved in the kloofs but no notice is given to related grains or spores in the analyzed profiles

# Pollen Analysis (cont.)

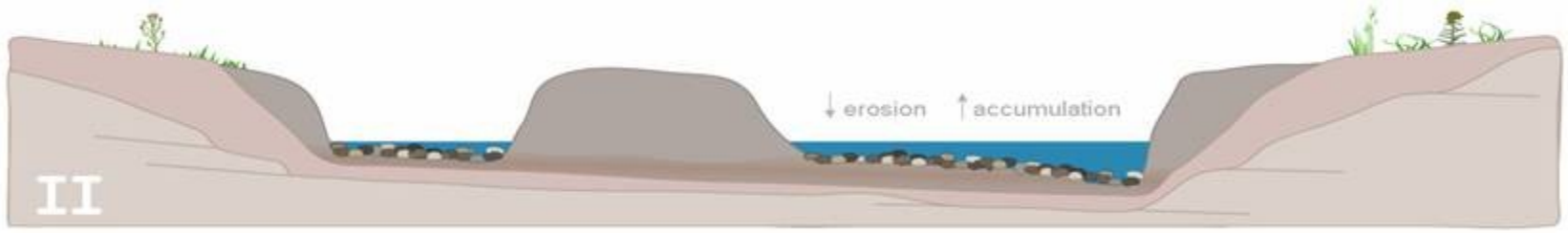
## Hypothesis :

- since particularly grass pollen were found throughout the samples and less evidence is given for groves and reeds, it is assumed that the ***surroundings were covered by grassland*** when sediments were deposited (appr. 3 500 yrs BP)
- indigenous vegetation does not provide preservable grains or mechanisms are insufficient to transport grains and spores over long distances (needs verification)
- the ***grassland composition has been changed*** over time, since the sweet grass portion is assumed to be reduced in the upper parts in relation to the lower parts, i.e. burning and grazing management since over 900 yrs (Feely, 1987) evidently contributed to a succession or even degradation of the sweet grass dominated veld towards a more resistant sour grass veld




**Geomorphodynamics**
Sedimentation of grey sands into deep incised red clays over sandstones; formation of terraces

**Vegetation**
???

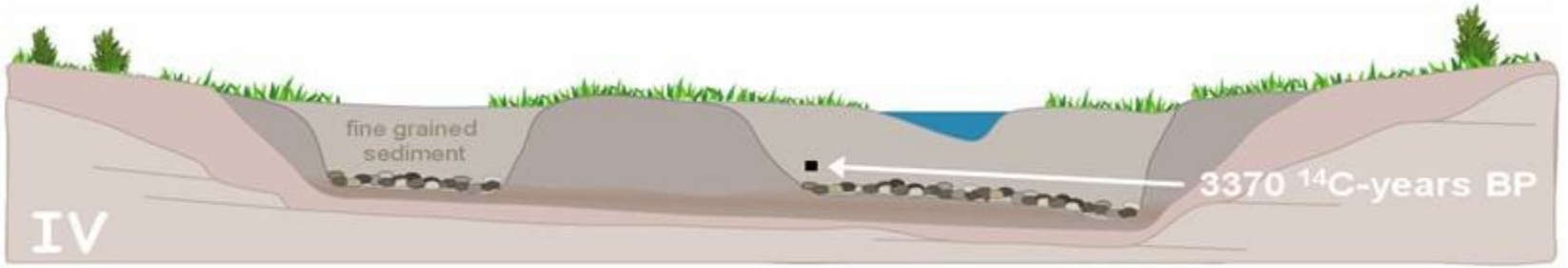



**Geomorphodynamics**
Incision followed by deposition of gravels due to changes in fluvial dynamics corresponding to early Holocene climate phases

**Vegetation**
Sparse vegetation (?)


**Geomorphodynamics**
Stable phase

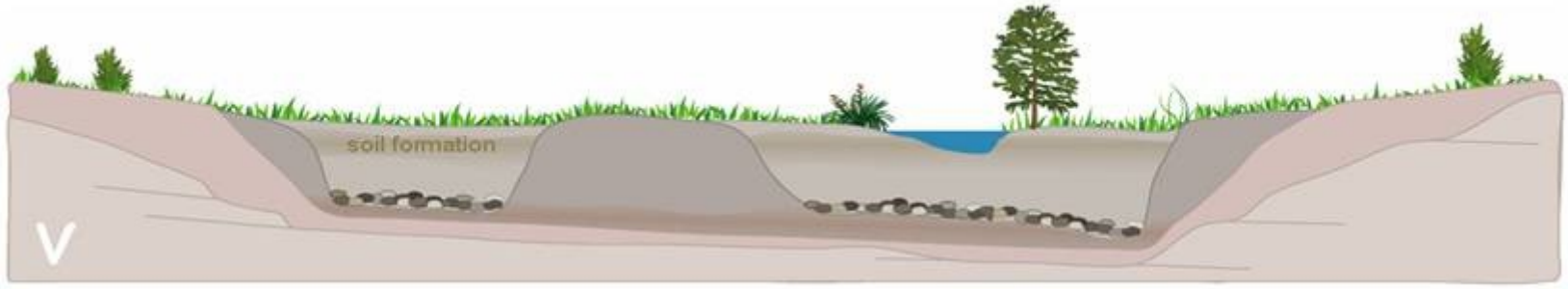
**Vegetation**
Indigenous, species-rich, dense vegetation (?)




**Geomorphodynamics**
increased sediment input as a consequence of natural and/or anthropogenic fires and/or climate change led to infilling with fine grained sediments up to recent level in a relatively short time

**Vegetation**
Shift to grassland and shrubs

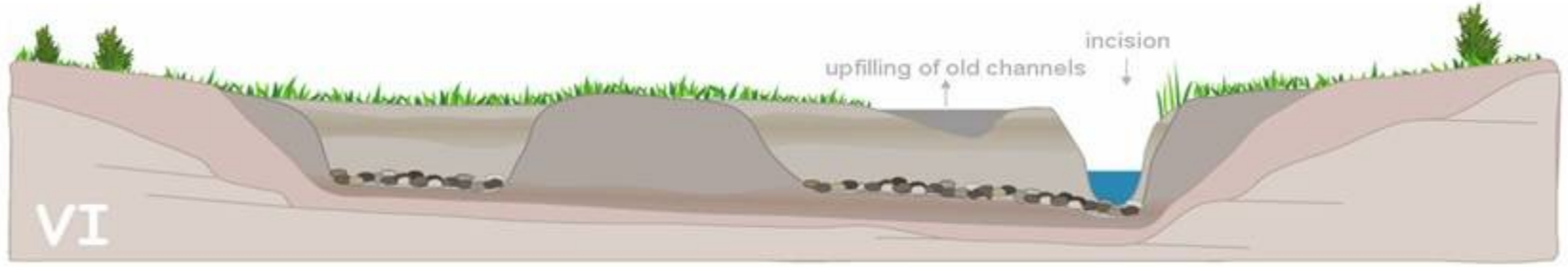
**Land use**
Exploitation of natural resources by hunter-gatherers




## Geomorphodynamics
Stable conditions; soil formation processes; development of an impervious layer enabling wetland formation

## Vegetation
Grassland, shrubs and riverine vegetation

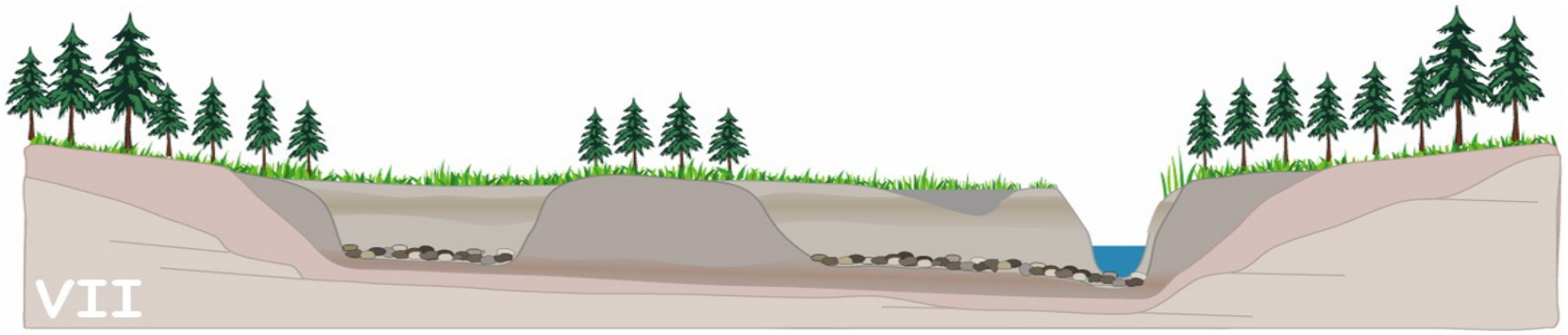
## Land use
Early farmers (1 700 yrs BP), hunter-gatherer




## Geomorphodynamics
Incision (geological base), gully erosion, partially enforced by channelization

## Vegetation
Grassland, patches of indig. forests

## Land use
Extensive stock-farming (600 BP), fire management, (over) grazing




**Geomorphodynamics**
sedimentation (?),
erosion (?)

**Vegetation**
Grassland, pine and eucalyptus forests, patches of indig. forests

**Land use**
Extenisve stock-farming, intensive forestry since 1989

# The study has shown that

- there is some indication of changes of landscape dynamics during the Holocene, and thereby a new perspective on wetland formation.
- an alternative model was developed which describes wetland evolution based on sedimentological, geophysical and palynological analysis combined with anthropological studies and climate reconstruction.
- the presented model indicates that human‘s contributed to wetland formation, if not even caused it.
- more work is needed to ***verify*** or ***modify*** the presented model by additional dating, pollen analysis, isotope analysis and others...

# ACKNOWLEDGMENTS

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## Thank you very much for your attention!


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