Past climate and environmental dynamics

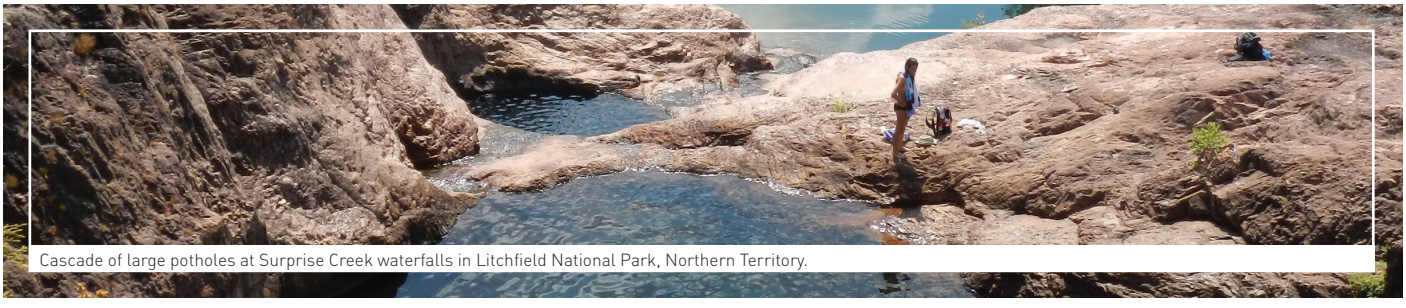
Dr Jan-Hendrik May is committed to understanding how Quaternary landscapes have responded to climatic, environmental and anthropogenic change. Here, he talks about what sparked his interest in geomorphology and the wider implications of his research

Can you begin by giving a brief synopsis of your research career to date?

My strong interest in the evolution of Quaternary landscapes was triggered by studying geography at the University of Würzburg, Germany; a year at the University of Texas, USA; and a research internship in Salta, Argentina. Following this, my PhD project at the University of Bern, Switzerland, looked at the impact of late Quaternary climatic changes on environments and landscapes in eastern Bolivia – in a rather remote region along the southern margin of the Amazon basin. The successful completion of this project led to further interest in South America and Southern Hemisphere palaeoenvironments in general. In recent years, I have held postdoctoral positions and scholarships in Beijing, China, and Wollongong, Australia, and am currently employed as Assistant Professor at the University of Freiburg, Germany.

What are the characteristics of a Quaternary environment?

The Quaternary is the most recent chapter in the Earth's history, spanning from just over 2.6 million years ago to the present day. It is characterised by particularly marked global changes between relatively short periods of warm conditions and longer periods of cold climate, or ice ages. Not surprisingly, these global reorganisations in the climate system



Cascade of large potholes at Surprise Creek waterfalls in Litchfield National Park, Northern Territory.

Australia's geological archives

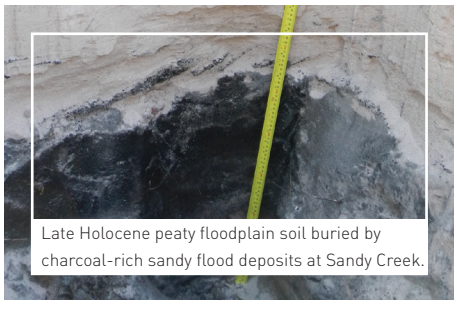
In an attempt to better inform policy makers, ongoing research at the **University of Freiburg**, Germany, is using geomorphic and sedimentary archives to reconstruct past environments and the evolution of landscapes

IN MANY COUNTRIES around the world, clear plans of how best to respond to impending climate change have not yet been developed. In Australia, for example, where environmental sustainability has been highlighted as a National Priority Research Area, there remains uncertainty over how the damaging effects of predicted climate change can be minimised. Despite this incertitude, the hydrological shifts expected across Australia are not without precedent.

As a result, a new study is seeking to better understand Quaternary climate change in order to unravel the complexities of current and future trends and enable policy makers to arrive at better informed decisions. The team, led by Dr Jan-Hendrik May who is now based at the University of Freiburg, Germany, is conducting cutting-edge research into Quaternary palaeoclimate and environmental dynamics, a key topic in comprehending current global climate change. The group's work has been focusing on rivers, flooding and long-term flow in Australia's so-called Top End, or the northernmost section of the Northern Territory, the fluvial systems of which account for around 70 per cent of the country's water – a figure that is expected to rise. There is much hope that, through a more thorough understanding of the region's climate history, the effects of future climate change on Australia's biodiversity, tourism and agriculture can be significantly mitigated.

A MULTIPLICITY OF SCALES

Landscapes are complex, often vast systems that play host to processes that are continuously adjusting to changing boundary conditions such as climate and anthropogenic impacts. Consequently, landscape development is often nonlinear and can be subject to permanent change: "Because landscapes are characterised by differing sensitivities with relation to changes in climate, event-scale processes such as floods, and longer-term climatic phenomena such as droughts, pose vastly different but ultimately destructive threats," May elucidates. In light of this, in order to guarantee a high level of relevance and accuracy, the team's research has



Late Holocene peaty floodplain soil buried by charcoal-rich sandy flood deposits at Sandy Creek.

have regionally variable impacts on hydrology, landscape processes and environments. Therefore, Quaternary past landscapes and environments provide analogues for studying how future climate change might affect our environmental resources such as water, soil and atmosphere, which are of vital importance to securing our longer-term survival on this planet.

Why does this area of geomorphology interest you?

I am particularly fascinated by our ability to 'read' into past landscapes and explore the links between the various features and forms of the Earth's surface and the physical processes that are shaping them. For this purpose, the wide range of forms and sediments serve as pieces in a puzzle, illustrating the dynamic changes that the surface of our planet is undergoing over timescales longer than the perception of the individual human. This throws up new, pertinent perspectives on human civilisation and our relationship with the planet. Reconstructing past landscapes also holds the key to understanding potential future interactions between climatic changes and the Earth's surface.

Looking ahead, how might your research contribute to a more sustainable environment?

A detailed understanding of past environments and landscape evolution can provide the basis for establishing relationships between both climate and landscape changes. In order to better protect the environment and its natural resources, and ensure sustainability and the survival of ecosystems and entire landscapes, I consider it necessary to gain a detailed and comprehensive understanding of the causes and effects of landscape change to identify particularly sensitive or vulnerable environments. Equally important, however, will be the clear communication of these scientific results to allow their implementation into public policies.

Close-up of Wangi Falls in Litchfield National Park, Northern Territory, during the dry season 2013.

incorporated data from multiple spatial and temporal scales – a challenge May and his colleagues have relished.

GEOMORPHIC AND SEDIMENTARY ARCHIVES

In addition to considering multiple spatial and temporal scales, the researchers have been drawing on numerous forms of data. By analysing sediment from tropical swamps and floodplains, they have been able to ascertain levels of pollen, isotopes and trace elements, which can be used as indirect indicators of vegetation cover, weathering and dust influx over the course of around 50,000 years. This information is central to reconstructing past changes in climate and hydrology. On top of this, the study has integrated river sediment and channel form data in order to highlight other gauges of hydrological change such as increased erosion, flooding and sediment transport.

Through a combined approach, the researchers have succeeded in producing a more accurate picture of how landscapes and environments in Northern Australia have been affected by changes in climate in the recent geological past. Studies with regard to the Mid- to Late Quaternary evolution of fluvial systems in this region are still scarce. Therefore, the information being generated is expected to shed light on the causes, mechanisms and landscape-scale impacts of changing climates across much of the country.

REGIONAL VERSUS GLOBAL

To date, May and his colleagues have conducted studies on the waterfalls, plunge pools, swamps and patches of monsoonal rainforest along the plateaus and escarpments of Litchfield and Kakadu National Parks, as well as on the Adelaide River system. They have collaborated extensively with the Australian Nuclear Science and Technology Organisation in Sydney, and scientists from the universities of Queensland and Adelaide. The next step is to gain a fuller picture of what the regional versus global controls on changes in landscape and environment have been over the last 2 million years. "I consider it necessary to test our ideas and hypotheses in larger-scale contexts, and am aiming to intensify research concerned with regional and even intercontinental comparison, such as between similar landscapes in tropical Australia and South America," May reveals. In this way, the researchers hope to assist policy makers in predicting and thus guarding against the economically, socially and environmentally damaging effects of our changing climate.

QUATERNARY LANDSCAPES AND ENVIRONMENTAL CHANGES

OBJECTIVE

To understand how Quaternary landscapes have responded to climatic and environmental changes or human impacts across a range of spatial and temporal scales by exploring the use of geomorphic and sedimentary archives in reconstructing (past) environments and the evolution of landscapes.

KEY COLLABORATORS

Dr Samuel Marx; **Dr Timothy Cohen**; **Professor Gerald Nanson**, University of Wollongong, Australia

Dr David Fink; **Dr Toshiyuki Fujioka**; **Dr Debashish Mazumder**, Australian Nuclear Science and Technology Organisation (ANSTO)

Dr Patrick Moss; **Dr Annegret Larsen**, University of Queensland, Australia

Dr Jorg Hacker, Flinders University Adelaide, Australia

Professor Frank Preusser, University of Freiburg, Germany

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DR JAN-HENDRIK MAY is interested in Southern Hemisphere Quaternary palaeoenvironments (with particular focus on South America and Australia); sediments, landforms and late Quaternary evolution of alluvial fans; geomorphology of foreland fluvial systems and megafans; paleosols in the Quaternary stratigraphic record; and human-environment interactions and geoarcheology (with particular focus on pre-Colombian Amazonia).

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