Geophysical Research Abstracts
Vol. 13, EGU2011-9144, 2011
EGU General Assembly 2011

Western Sahel hydrology and land use over the last three millennia: natural versus anthropogenic influences

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The African Sahel is a semiarid ecosystem extremely prone to changes in precipitation and therefore one of the most vulnerable regions of the world with respect to global climate change. However, the reasons for severe droughts in the 1970s and 1980s and most recently in 2010 are not fully understood. These decadal-scale variations seem to be related to temperature variations in the Atlantic and Indian Ocean and may be overprinted at least partly by anthropogenic activities. We therefore need a better understanding of past Sahelian climate variability.

With our study, we aim at disentangling land-use effects from other variations (e.g., river input, atmospheric circulation, upwelling) during the Late Holocene. We present a record of the past 3200 years from a marine site off Mauritania (GeoB 9501-5 and 9501-4) at 323 m water depth using a combination of terrestrial and marine proxies. The terrestrial palynomorph signal (pollen grains, spores) is used to reconstruct vegetation changes on the continent whereas the marine palynomorph signal (organic-walled dinoflagellate cysts (dinocysts)) reflects local oceanographic conditions. The stable nitrogen isotopic signal (δ^{15}N) is used to determine the character of discharge water drained into the research area by the Senegal River.

The palynomorph record shows that between 1200 BC to 200 BC relatively wet conditions on land coincided with more stratified conditions in the water column. From 200 BC to 1900 AD, several dry phases occurred on the continent as reflected by increased Saharan elements in the pollen association. Contemporaneous changes in the dinoflagellate cyst association suggest that these changes are related to increased upwelling. This points to enhanced trade wind activity as a cause for continental aridity at these times. From about 1600 AD onward, relative abundances of the dinocyst species *Lingulodinium machaerophorum* increase continuously. This species is typical for river plume areas where fluvial input is influenced by agricultultural or industrial activities. As its increase coincides with the beginning of commercial agriculture in the Sahel, we suggest that it is due to the nutrient input by fertilizers. At about 1930 AD, a major change in both the dinocyst and pollen associations can be observed. From 1930 AD onwards, fluctuating pollen percentages of savanna and Saharan elements indicate strong rainfall variability. Within the dinocyst assemblage, *L. machaerophorum* becomes increasingly dominant and reaches exceedingly high accumulation rates. We suggest that its extreme increase could be due to the utilization of artificial fertilizers which became available after $\sim$ 1914 AD. To test this hypothesis, we will analyze δ^{15}N in order to trace which type of nitrogen fertilizer has been used (artificial or natural).

Our study gives evidence that signals for anthropogenic activity are superimposed on to the natural hydrological variability of the Western Sahel from about 1600 AD onward, highlighting the role of humans in altering the regional environment.