Geophysical Research Abstracts
Vol. 12, EGU2010-11274, 2010
EGU General Assembly 2010

Sahara and Sahel vulnerability to climate changes, lessons from the past – Focus on the Ounianga lake region (NE Chad)

Christophe Grenier (1), Weipeng Zheng (1,2), Anne-Marie Lezine (1), Pascale Braconnot (1), Gerhard Krinner (3), Marie-Alice Harel (1), Juliette Anglade (1), and Philippe Paillou (4)

(1) LSCE, CEA-CNRS-UVSQ, CEA/Saclay, 91191 Gif sur Yvette, France (christophe.grenier@lsce.ipsl.fr), (2) LASG, Institute of Atmospheric Physics, No. 40 Huayanli, Chaoyang District, 1000029 Beijing, China, (3) Laboratoire de Glaciologie et Géophysique de l'Environnement. LGGE/CNRS. 54 rue Molière, BP 96. 38402 St Martin d'Hères Cedex, France, (4) Observatoire Aquitain des Sciences de l'Univers, UMR 5804 – LAB, 2 rue de l'Observatoire - BP 89, 33270 Floirac, France

Reconstructions from sedimentary records and climate modelling results show an overall drying in the African Sahara and Sahel during the Holocene. Was this change abrupt or gradual, and amplified or not through vegetation change and feedbacks to the atmosphere is still the subject of debate. For instance, while [deMenocal et al. 2000] show from oceanic sediments off the Mauritanian coast, that the end of the African Humid Period (AHP), recorded 5500 years ago, was abrupt. [Kroepelin et al., 2008] studied recently sediments from lake Yoa (Ounianga region, NE Chad) and derived a gradual climate change.

The present paper focusses on the Ounianga lake region (NE Chad) where the Kropelin et al. study was carried on. We investigate hydrological reconstructions based on climate scenarios and modelling of water dynamics of the catchment area of the lakes. Under modern conditions, Ounianga lakes are maintained in a hyper arid environment due to groundwater inputs from the Nubian Sandstone Aquifer System (NSAS), a very large aquifer covering parts of Chad, Libya, Egypt and Sudan. Moreover, these lakes are situated within 200 km of the Tibesti Mountains ranging over 3000 meters where rainfall is larger than in the plains. So the issue arises as to what extent distant water inputs from the Tibesti and local groundwater recharge could have maintained high lake levels during the climatic transition phase and/or could explain some features analysed from the sediments regarding the abruptness of the salinisation of lake Yoa roughly by 3900 BP. The topography of the region is analyzed from SRTM data to obtain paleo river networks and compared with satellite radar pictures (PALSAR) to identify key features in the Yoa catchement area [refer to Grenier et al. 2009]. A hydrological model is constructed including the river network and depressions interpreted as lakes and modeled dynamically as reservoirs. The groundwater input from the aquifer is modeled within the Cast3m finite element code (www-cast3m.cea.fr/cast3m) by a 2D approach focusing on the SW part of the NSAS.

The evolution of lake levels is computed with seasonal time step for several climatic scenarios issued from simulations with the IPSL coupled ocean-atmosphere model and from regional simulations with a zoomed version of the atmospheric component of the coupled model (LMDz). These simulations account for the changes in the Earth's orbital parameters, which is the dominant climate driver during the Holocene. The possible impact on lakes on precipitation is considered in the regional simulations. Several climate indices are developed to define possible climate thresholds that are critical for the local environment and characterize the major changes recorded at Ounianga. These indices account for wind directions and strengths, the length of the dry season or of dry spells, or the distribution of precipitation. Results show that during the mid-Holocene, the southwest winds are enhanced during the summer season, which indicate the enhancement of the African monsoon. The PDF of the daily rainfall also shows a shift to higher precipitation, especially in the summer time.

The ability to put quantitative constraints on some properties of the landscape or even reconstruct paleo environments at the Ounianga lakes will be discussed.

deMenocal P., J. Ortiz, T. Guilberson, J. Atkins, M. Sarnthein, L. Baker, M. Yarusinsky. Abrupt onset and termination of the African Humid Period: rapid climate responses to gradual insolation forcing. Quaternary Science Reviews 19, 347-361 (2000)

Grenier C., P. Paillou, P. Maugis. C. R. Geoscience (2009), doi:10.1016/j.crte.2009.03.004. Assessment of Holocene surface hydrological connections for the Ounianga lake catchment zone (Chad)

Kröpelin S., D. Verschuren, A.-M. Lézine, H. Eggermont, C. Cocquyt, P. Francus, J.-P. Cazet, M. Fagot, B. Rumes, J. M. Russell, F. Darius, D. J. Conley, M. Schuster, H. von Suchodoletz, and D. R. Engstrom. Climate-Driven Ecosystem Succession in the Sahara: The Past 6000 Years. Science 9 (2008) 320: 765-768