

Landscape and Lake-System Response to Late Quaternary Monsoon Dynamics on the Tibetan Plateau - Northern Transect

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Investigation on the Tibetan Plateau (TP) and adjacent regions over the last couple of years shows that major proxy data for climate and environmental reconstruction comprise information from lakes, glacial/periglacial development, aeolian mobility and vegetation history. Although external forcing of climate may have played a major role (e.g. insolation) for moisture transport over the plateau, locally derived internal processes of latent heat transport, topographic and geologic setting as well as human activity seem to be further important factors that influence moisture availability on a local to regional scale. Up to date, however, little is known, how strong the local setting of the landscape and interrelated processes at specific sites have been modulating the local climate system, thus affecting the interpretation of proxy data used for climate change reconstruction. With respect to the northern Tibetan Plateau and adjacent regions along the dryland belt, many of the sites investigated in the past decade show evidence for increasing aridity over the past 5000 calendar years.

Ongoing efforts towards a better understanding of climate and environmental change on the TP require a more systematic approach along the pathways of effective moisture transport. Our research project aims to fulfill this demand by choosing key sites and catchments crossing the northern TP from a strongly summer monsoon dominated site (Donggi Cona) via a transitional zone between monsoon and more westerlies influence (Heihai).

End-member modeling of sedimentological data from 912 terrestrial sediment samples along typical sediment cascades in the catchment provides information of the dominant modes in which sediments are transported. The end-member scores can be interpreted spatially and temporally, indicating the varying dominant transport processes in time and space. Currently, the most dominant transport process in the catchment is aeolian transport. Three types of sediment, being sand, sand-loess and loess, represent aeolian sediments. OSL dating of loess in the mountains around Donggi Cona reveals ages between 10 and 9 ka. Reworked loesses from lower elevations were dated to 8-6 ka. These ages point to favorable conditions for loess transport in the early Holocene.

The examination of ancient shore lines and terraces from higher-than-present lake indicate a minimum of four terrace generations around the lake. They were most likely were formed by the interplay of varying climatic conditions (warming leads to glacial and periglacial meltwater input). The onset of East Asian monsoon precipitation and low vegetation cover fostered higher runoff within the catchment at the end of the last Glacial, culmination of East Asian monsoon precipitation during the Holocene Optimum) and tectonic circumstances leading to or keeping the current outlet of the lake closed during most of the time at least till 4.6 cal. BP.

The sedimentological, geochemical and mineralogical analyses of the lake sediments from several core sites within Lake Donggi Cona suggest that the change of the hydraulic system and the water balance of the lake is coupled with many interacting factors, such as the existence of glaciers, the influence of varying catchment geology, sedimentation intensities from different sub-catchments, precipitation, temperature, humidity evaporation, and wind. All these factors were highly variable in time and/or space and interfered with each other. Past changes in the monsoon circulation undoubtedly influenced the precipitation to evaporation balance of the lake and its catchment, resulting in substantial changes in lake level and water chemistry.

Sediment input into the lake was characterized by two genetic phases during the last 19 kyr. From about 19 cal. kyr BP to about 13.5 cal. kyr BP the composition of the sediment consists of allochthonous material with a high amount of siliciclastic and detrital components, probably related to dry and cold climate. This suggests, that the lake mainly responded to melt periods and advances of glaciers in the catchment during the Late Glacial, whereas changes in the lake productivity and endogenic chemical precipitation of carbonates became a major process during the Holocene. The sediment records suggest that the Holocene Climate Optimum in the Donggi Cona catchment area

occurred during between 12.5 and 6.5 cal kyr BP. Because of the changing environmental conditions during the late Holocene, the lake system changed abruptly to an open lake system at about 4.6 cal. kyr BP., related to either cooler and dryer conditions on the north-eastern Tibetan Plateau and/or associated changes in geomorphological/tectonic processes within the catchment. Our study demonstrates the enormous influence of changing climate and interlinked geomorphological process ensembles on a hydrological system such as Lake Donggi Cona.

Key words: Holocene; paleoclimate, monsoon, Tibetan Plateau