# Transfer times in the CZ in Sahelian catchment from extensive $^{36}Cl$ data

C. BOUCHEZ [1]*, P. DESCHAMPS[1], J. GONCALVES[1], B. HAMELIN[1], C. VALLET-COULOMB[1], A. MAHAMAT NOUR[1,2], J.C. DOUMNANG[2], F. SYLVESTRE[1]

[1]CEREGE-CNRS/IRD/Aix-Marseille Universite, Aix en Provence, France (*correspondence : bouchez@cerege.fr)
[2]Universite de Ndjamena, Ndjamena, Chad

The severe vulnerability of Africa to climatic variability contrasts with the most sparse data coverage in the world and appeals for new in situ data. The $2.5x10^6$ $km^2$ Lake Chad Basin (LCB) is located at the centre of Africa and spans contrasted ecoclimatic zones, from the southern humid Soudanese areas to the northern arid Saharian areas. The South-North-oriented Chari-Logone River drains the hydrologically active part of the basin ($6.1x10^4$ $km^2$) into the terminal Lake Chad. LCB exemplifies the redistribution of water and carried elements at a large scale, which is vital for Sahelian populations and ecosystems. Here we show that $^{36}Cl$ is a powerful, innovative tool to constrain water transit times at a regional scale and to provide insights into the critical zone functioning in Sahel.

Based on a careful Cl mass balance, we estimate that only 18% of the atmospheric Cl fallout over the entire Chari-Logone catchment is exported through the Chari-Logone River and only 7% of rainfall. Moreover, 90% of Cl reaching Lake Chad originates from the upper catchment, which suggests a major role of the restricted upstream regolith area.

The investigation of $^{36}Cl$ contents in the water cycle (>150 samples from rainfall, rivers, upstream and downstream groundwaters) reveals bomb-produced $^{36}Cl$ persisting in present-day rivers and groundwaters. Water gets enriched in bomb-produced $^{36}Cl$, after its fallout and before reaching the upstream River, during its transfer in the CZ. Based on baseflow separation methods and lumped-parameter models applied to the anthropogenic fallout of $^{36}Cl$, a water transit time of upstream groundwaters of about 10 years is estimated. Together with an estimation of recharge of 185mm/y, this yields a saturated thickness of the upstream aquifer of ~ 10m.

A closer inspection reveals that high streamflows are slightly more $^{36}Cl$-enriched than low streamflows. It suggests the washout of old-trapped Cl at high stages reinforcing the assumption of diffuse stocks of chlorine in the catchment.

This study brings key constraints on the hydrology of a large and contrasted Sahelian basin and raises questions on the Cl- balance at the regional scale. This study points to the strong dependance of the whole Chari-Logone hydrology to the upstream catchment, highlighting the high vulnerability of surface waters in Sahel.