Short-term assessment of the dynamics of elements in wastewater irrigated Mediterranean soil and tomato fruits through sequential dissolution and lead isotopic signatures

Abstract

To fight against sanitary risks due to the use of raw or insufficiently treated wastewaters, an irrigation system combining a farm-scale decentralized wastewater treatment and an improved drip irrigation management was developed. The whole soil-water-plant system was monitored on an experimental tomato field in Crete to assess the potential element accumulation due to drip irrigation with secondary treated wastewaters during 3 years. Although a decrease of the majority of element average concentrations (Mn, As, Cr, Cu, Pb, Zn and B) was observed in irrigated soils possibly due to crop export, increasing amounts of elements, especially for As, Cd, Zn, Cu, Ni and Na were measured in the bio-accessible and mobilizable fractions of the soil. Moreover, we show that surface drip irrigation can lead to very localized accumulation of trace metals driven by geochemical processes as pointed out by soil mapping. Transient but significant Na and B contents can also develop under the emitter in the soil fractions during secondary treated wastewater irrigation. Pb displayed no spatial relation with the drip emitter and its main sources were petrol-Pb aerosols and Saharan dusts. The trace metal contents and salinity indicators in crops stayed below the regulatory thresholds. Sequential dissolutions combined with the Pb isotopic tool traced element mobility and dynamics in an irrigated soil at short term, and were useful to distinguish between medium-term experiment at bulk soil scale and short-term impacts of secondary treated wastewaters irrigation at the drip emitter scale.