The concentration of trace elements such as Ni, Co, and Cu in a stalagmite is determined by (i) the amount of these elements present in so-called organic-metal complexes (OMCs) that trap the ionic forms of such elements in the dripwater, and (ii) the amount that is able to decay from the OMCs into the aqueous phase, from where the elements can adsorb to the growing stalagmite surface (and remain captured within the stalagmite crystal structure). A statistical treatment of the decay of a population of trace element ions from OMCs allow us to model the rates at which the dripwater dropped from the roof of the cave on to the stalagmite's surface. The problem is however made challenging due to: (i) the lack of reliable monitoring data that quantifies the relationship between OMC trace metal ion concentration and stalagmite trace metal ion concentration, and (ii) the presence of chronological uncertainties in our estimates of trace element concentrations at past time points from the depth-based measurements along the stalagmite. We present here a semi-heuristic, semi-theoretical approach that estimates dripwater rates using a theoretical model based on the population-level chemical kinetics of trace element decay from OMCs, and a heuristic choice of calibration data sets based on precipitation and temperature from nearby weather station data. Our approach is applied to trace metal data from the Heshang Cave in southeastern China, and we are able to reconstruct a driprate proxy time series — a first quantitative hydrological proxy record presented along with well-defined estimates of uncertainty.