



## **The transfer of critical elements from soils to rice grains in the Mekong River delta area, Vietnam**

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### Abstract

Mekong River Delta is the largest rice-grown area in Vietnam. Due to its high consumption, rice is one of the main contributors to the uptake of some harmful elements such as Cd and As into the human body (Chaney 2016). Understanding the impacts of soil parameters on the transfer of harmful elements into rice grain may help to restrict their human uptake.

The alluvial paddy soils along Mekong River soils have enrichments of As, Bi, Cd, Pb, S, Sb, Sn, and U in comparison with the background of shale and upper Earth crust. However, the concentrations of critical elements are below the allowable limits for Vietnam's agricultural soil, except As. More than a half of the investigated samples surpass the Vietnamese limit of 12 mg kg<sup>-1</sup>, in which two samples are more than two times. This presumably caused by natural processes. In addition, they also exceed European threshold values in As, Cr, and Sb with 100, 25 and 50% of the investigated samples respectively. The concentrations of Bi, Cd, Co, Cu, Ni, Pb, Sb, and Zn in the investigated acidic to neutral paddy soils show highly significant positive intercorrelations.

The elements Cd, Co, Cr, Mn, Ni, and Zn show a higher transfer into the rice grains in acidic soils, while Mo is enriched in grains at higher soil pH. Increasing concentrations of Fe and Mn in soil reduce the transfer of Bi, Cd, Co, Cu, Mn, and Zn into the rice grains, presumably because of the high sorption of these elements by freshly precipitated Mn and Fe oxide-hydroxides. Increasing concentrations of LOI (loss on ignition, a proxy of organic material) lead to an increase of Mn content in rice grains, while Mo follows the opposite trend. We conclude that the transfer of critical elements from soils to rice grains is only partially reflected by their concentrations in the corresponding soil, but more by the pH, Mn, Fe, LOI, and other soil parameters.

Unpolished rice grains from the Mekong River Delta area surpass partially the permissible level of the European Food Safety Authority (EFSA) and the Food and Agriculture Organization of the United Nations (FAO) for As and Pb in approximately one fourth of total samples studied.