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Modelling geogenic fluoride contamination in groundwaters, a global perspective

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Consumption of groundwater with high fluoride concentrations poses a health threat to millions of people around the world. In this study we used a large database of measured fluoride concentration in groundwaters (around 60'000 data points) from around the world as well as global digital maps of physical characteristics such as soil, geology and climate to model probability maps of fluoride concentrations on a global scale. A knowledge-based statistical procedure was used to combine the physical data and expert knowledge to delineate regions with similar geochemical properties. Using this approach, the world delineated into 8 regions. Fluoride concentration was modeled in each region using regression analysis and adaptive neuro-fuzzy inferencing system followed by Latin hypercube sampling for uncertainty propagation to produce probability maps. Using some proxy surface information, the models explained between 30 to 70% of fluoride variation in different regions. The global fluoride models could benefit from more accurate geological information and further information regarding chemistry and physics of the aquifers. The probability maps based on the above models correspond well with the known contaminated regions around the world and delineate new, untested areas that have a high probability of fluoride contamination. Notable among them is a belt of high contamination stretching from North Africa to the Middle East and towards Pakistan, Afghanistan, Uzbekistan, Turkmenistan and Kazakhstan as well as densely populated areas in China and India, Argentina, Mexico USA, South Africa, East African countries and Australia. Although the probability map does not replace fluoride testing, it gives a first indication of a possible contamination and thus may support the planning process of new drinking water projects.