

PERCENT- An open access tool to predict environmental Pb concentrations and their possible impacts on soils.

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Although a possible environmental risk (i.e. probability $\times$ impact) of lead (Pb) leaching from perovskite solar cells (PSCs) is frequently highlighted, it is seldomly quantified. The possible negative environmental impact on protected entities will depend on the concentration of Pb, as well as its speciation¹ and the transfer within the exposure pathway considered². Obviously, there is a physical limit to thickness of the perovskite layer in photovoltaics and thus a limit to the amount of Pb that can leach and enter surface waters, sediments soils, and ultimately biota. We have come across several studies that use unrealistic assumptions about leaching, which end up misrepresenting the actual Pb concentrations and impacts.

To realistically assess potential environmental risks, we have developed an open-access web tool called "PERCENT" (PERovskite leaChing assEssmeNt Tool). This tool allows both professionals and the public to interactively estimate the predicted environmental concentrations (PECs) of Pb in soils. The tool allows the user to set factors such as PSC composition, Pb layer thickness, module area and soil volume affected. Based on the PECs calculated, the user is provided with a context menu to explain possible impacts to be expected at such Pb soil concentrations. These are based on regulations of Swiss soil protection, which are well detailed, documented and publicly available. All assumptions and calculations are documented, which offers a transparent approach to address potential concerns of the public as well as to verify and modify own assumptions by the perovskite community.

We demonstrate the tool using different scenarios on perovskite composition and extent of leaching. We then put the calculated PECs as well as indicated impacts into perspective in terms of soil fertility as well as food and fodder production (again, following Swiss regulations). Our findings indicate that Pb leaching from typical PSCs under most assumptions presents no to minimal impacts on soils themselves as well as through soil usage.

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[1] Schmidt, F. et al., *J. Haz. Mat.* **2022**, 436, 128995.

[2] Huang, H. et al., *Soil Security*, **2024**, 15, 100150.