# TropSOC Database

## 3.3. Cropland – $^{239+240}$Pu soil inventory

When using these data, please cite the database and the key publication in ESSD:

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Additionally more details are given in:

Wilken, F., Fiener, P., Ketterer, M., Meusburger, K., Muhindo, D. I., van Oost, K., Doetterl, S.: Assessing soil redistribution of forest and cropland in wet tropical Africa using $^{239+240}$Pu fallout radionuclides, SOIL 7, 399-414, 2021. https://doi.org/10.5194/soil-7-399-2021 .

### *Introduction*

The dataset comprises two plot and sample identifiers and a sampling data, followed 3 variables describing $^{239+240}$Pu characteristics and detection limits at the catchment level for TropSOC's cropland catchments. The last variable provide bulk densities of the mineral soil layer sampled specifically for the $^{239+240}$Pu assessment. Values below the detection limit or missing bulk density data are indicated by -9999.

### *Data structure*

| No. | Variable | Explanation | Unit |
|---|---|---|---|
| 1 | plotID | unique identifier of each plot and point where data were collected. | - |
| 2 | sampleID | unique identifier of any soil or vegetation sample taken in the field | - |
| 3 | sample_date | date of sampling | dd.mm.yyyy |
| 4 | mean_pu | mean $^{239+240}$Pu activity in one kg sample material reported on ashed mass basis, 1 Bq corresponds to one radioactive decay per second; if the $^{239+240}$Pu activity is below the detection limit of 0.01 Bq kg$^{-1}$ the value is set to -9999 | Bq kg$^{-1}$ |
| 5 | sd_pu | standard deviation of mean $^{239+240}$Pu activity | Bq kg$^{-1}$ |
| 6 | detec_limit | flag indicating if $^{239+240}$Pu activity is below (flag = 1) or above (flag = 0) the detection limit of 0.01 Bq kg$^{-1}$ | - |
| 7 | BD_m_soil | bulk density of mineral soil layer | g cm$^{-3}$ |

### *Methods*

To estimate effective soil redistribution since the 1960s, measurements of fallout radionuclides $^{239+240}$Pu were used following Calitri et al. (2019) and Ketterer et al. (2004). Mineral soil sampling for all sites was carried out using a manual soil corer (Ø 6.8 cm and 120 cm length). Before analyses, undisturbed soil cores of known sample volume were weighed for bulk density calculations after drying at 105°C. Sub-sampling of soil samples into smaller, representative portions was carried out on homogenised sample material using a sample splitter (Sample Splitter RT 6.5, Retsch, Germany). Then, 30 g of milled sample was dry-ashed for at least 8 hours at 600 °C to remove organic matter. Subsequently, the samples were spiked using 30 pg (c. 0.0044 Bq) of a $^{242}$Pu tracer solution (NIST 4334). Sample leaching was carried out by heating 16 M nitric acid ($HNO_3$) overnight at 80 °C, subsequently filtering the solution and adjusted the concentration of $HNO_3$ to 8 M. All present plutonium species were adjusted to the Pu (IV) oxidation state by first adding an acidified $FeSO_4 \cdot 7H_2O$ solution (2 mg ml$^{-1}$ of the leached solution) and subsequently adding a sodium nitrite ($NaNO_2$) solution (20 mg ml$^{-1}$ of the leached solution). Afterwards, samples were heated at 75 °C for two hours. Tetravalent Pu was separated from the leached solution using a Pu-selective TEVA resin (2 mg of TEVA per millilitre of leached solution). Following the occasional, two-hour long agitation, the resin was collected in a pipette tip equipped with a glass wool plug. This disposable column was first rinsed with 2 M aqueous $HNO_3$ to remove unretained matrix elements (i.e. uranium (U)), then it was rinsed with 8 M HCl to elute thorium (Th) and finally it was rinsed again with 2 M aqueous $HNO_3$ (rinse volume = 1 ml per 30 mg of TEVA). Plutonium was eluted using 0.05 M aqueous ammonium oxalate. Finally, activities of $^{239+240}$Pu were measured using mass spectrometry (Thermo X Series II quadrupole ICP-MS, located at Northern Arizona University). The ICP-MS instrument is equipped with an APEX HF high-efficiency sample introduction system. Upon analysis, masses of $^{239}$Pu and $^{240}$Pu present in the samples were converted into the summed activity of $^{239+240}$Pu, in Becquerel per kg. Data quality was evaluated through the analysis of blanks (soils or rocks devoid of Pu), duplicates and control samples of known $^{239+240}$Pu activities (Standard Reference material 4350b – River sediment for radioactivity measurements from NIST). Detection limit for $^{239+240}$Pu activity was assessed at 0.01 Bq kg$^{-1}$ corresponding to 5 Bq m$^{-2}$. For a scientific interpretation of these results see Wilken et al. (2021).

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### *References*

Calitri, F., Sommer, M., Norton, K., Temme, A., Brandova, D., Portes, R., Christl, M., Ketterer, M. E., and Egli, M.: Tracing the temporal evolution of soil redistribution rates in an agricultural landscape using Pu239+240 and Be-10, Earth Surf. Processes and Landforms, 44, 1783-1798, https://doi.org/10.1002/esp.4612, 2019.

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Wilken, F., Fiener, P., Ketterer, M., Meusburger, K., Muhindo, D. I., van Oost, K., Doetterl, S.: Assessing soil redistribution of forest and cropland in wet tropical Africa using $^{239+240}$Pu fallout radionuclides, SOIL 7, 399-414, 2021. https://doi.org/10.5194/soil-7-399-2021 .