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Baseline data of radioactivity and radon mass exhalation rate in soils and phosphate rocks of a prospective phosphate mining area in Hinda district, Republic of Congo

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1. Introduction

- All human beings living on earth planet are daily exposed to ionizing radiations, principally from cosmic and terrestrial origin and remain the greatest sources of radiations.

- Because of their long half-life, 238U, 232Th and 40K are responsible for natural radioactivity on the earth and exist since its genesis.

- Artificial radioactivity comes from human creation (137Cs).

- The Republic of Congo is one of subsoil richest country in the world. Unfortunately, the mining of these resources is accompanying by a glary absence of accompanying measurement in terms of radioprotection of the population. This lack of information by local authorities could lead to the development of different diseases in the country, like allergies, cancer, etc.

- These data are important because they stem from the first study carried out on one of the mining sites in the Republic of Congo, despite the importance of the country's mining history.

- The objectives of this study were:
  - to establish the background level of radioactivity in soils and phosphate rocks present in the region before exploitation of phosphate ores;
  - to determined the type of phosphate;
  - to determine radiological health parameters associated in order to know the level of exposure of the public in the region.

2. Material and Methods

1. Study area
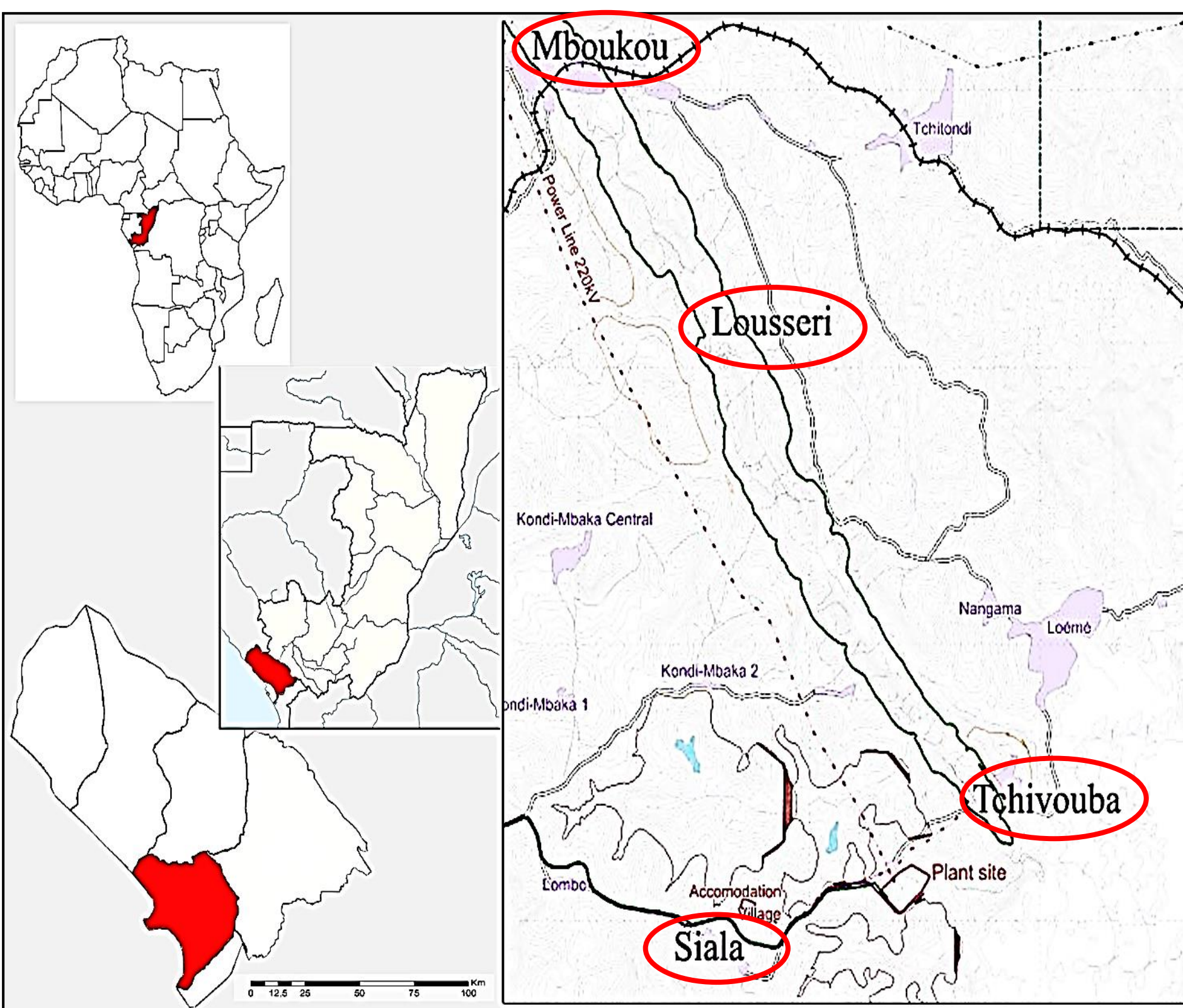
❖ Hinda district is located in Kouilou department;

❖ Kouilou department is one of the 12 departments in the Republic of Congo.

❖ Population of 32.995

❖ Wet season:
From March-April-May (MAM) and September-October-November (SON)

❖ Dry season:
From June-July-August (JJA) and December-January-February (DJF)

2. Sample collection, preparation and analysis

- A total of 24 soil and phosphate rock samples were collected in the study area.
- Sampling points were recorded using Garmin GPS.
- Samples were oven-dried at 105°C for 24h, then ground and sieved.
- Each sample was weighed, homogenized and conditioned in 500 ml Marinelli beakers.
- Samples were analyzed using a coaxial P-type High Purity Germanium (HPGe) detector from Ortec having its relative efficiency of 30%

The activity concentration A (Bq/kg) of each radionuclide in any given sample was determined from the following equation:

$$A\ (^{238}U, ^{235}U, ^{226}Ra, ^{232}Th, ^{40}K, ^{137}Cs)\ (Bq\ kg^{-1}) = \left\{ \frac{\frac{N}{Tc} - \frac{Nb}{Tb}}{m \times I\gamma \times \varepsilon(E) \times C1 \times C2} \right\}$$

3. Results

1. Activity concentrations determination

(a) Soil
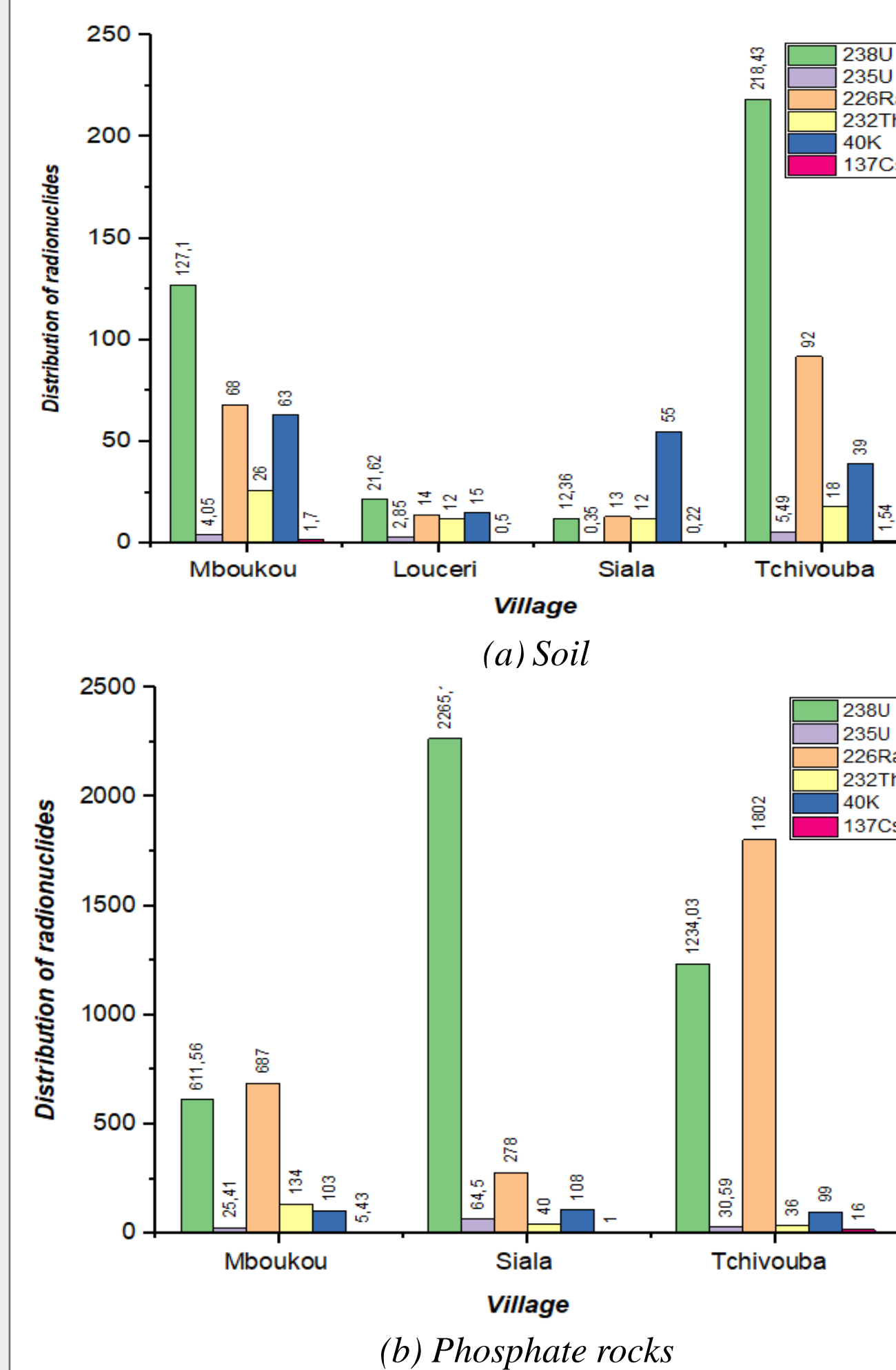
- 238U mean value is of 94.87 Bq/kg > 35 Bq/kg
- 235U mean value is of 12.29 Bq/kg < 35 Bq/kg 226Ra mean value is of 47 Bq/kg > 35 Bq/kg
- 232Th mean value is of 17 Bq/kg < 30 Bq/kg
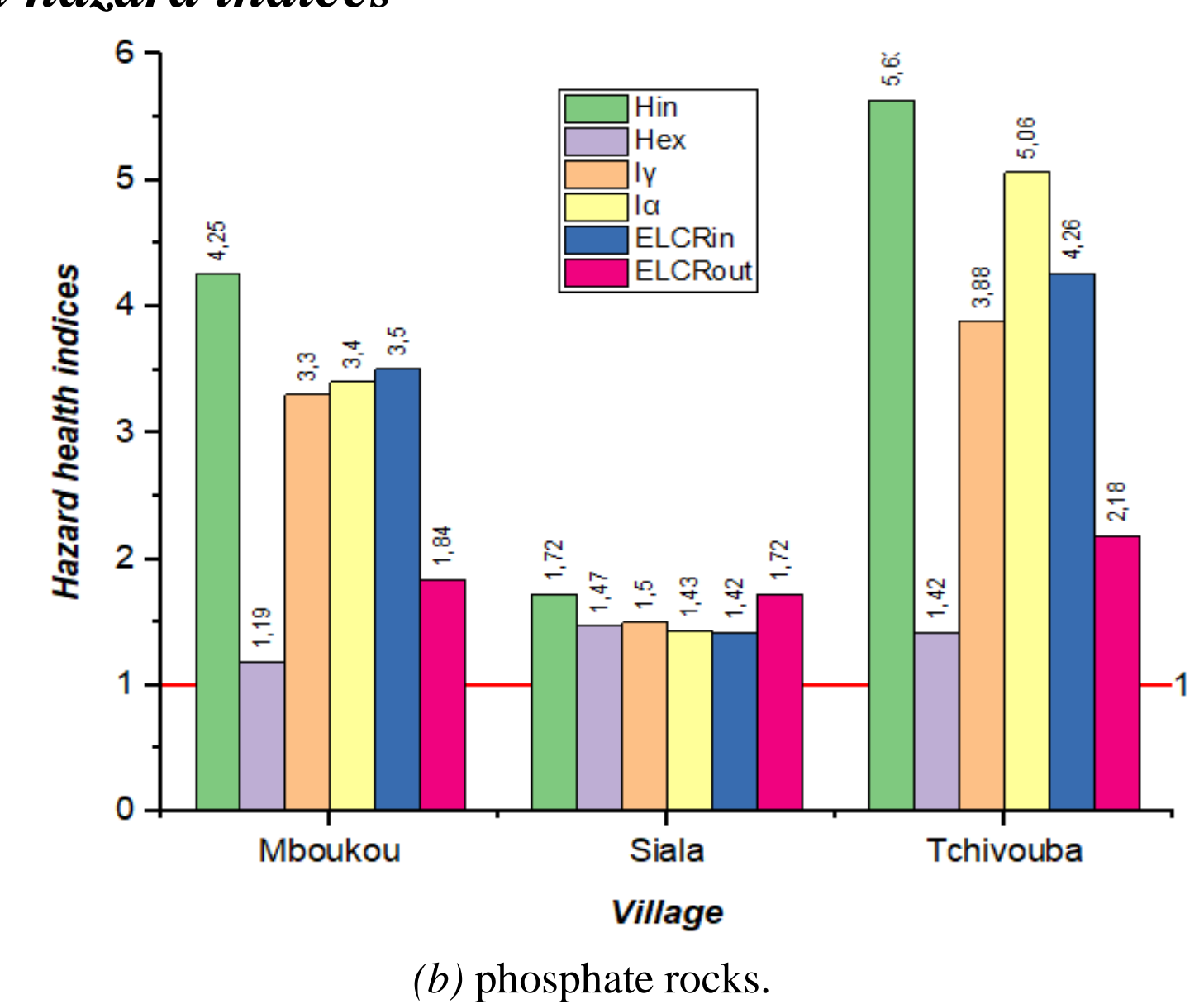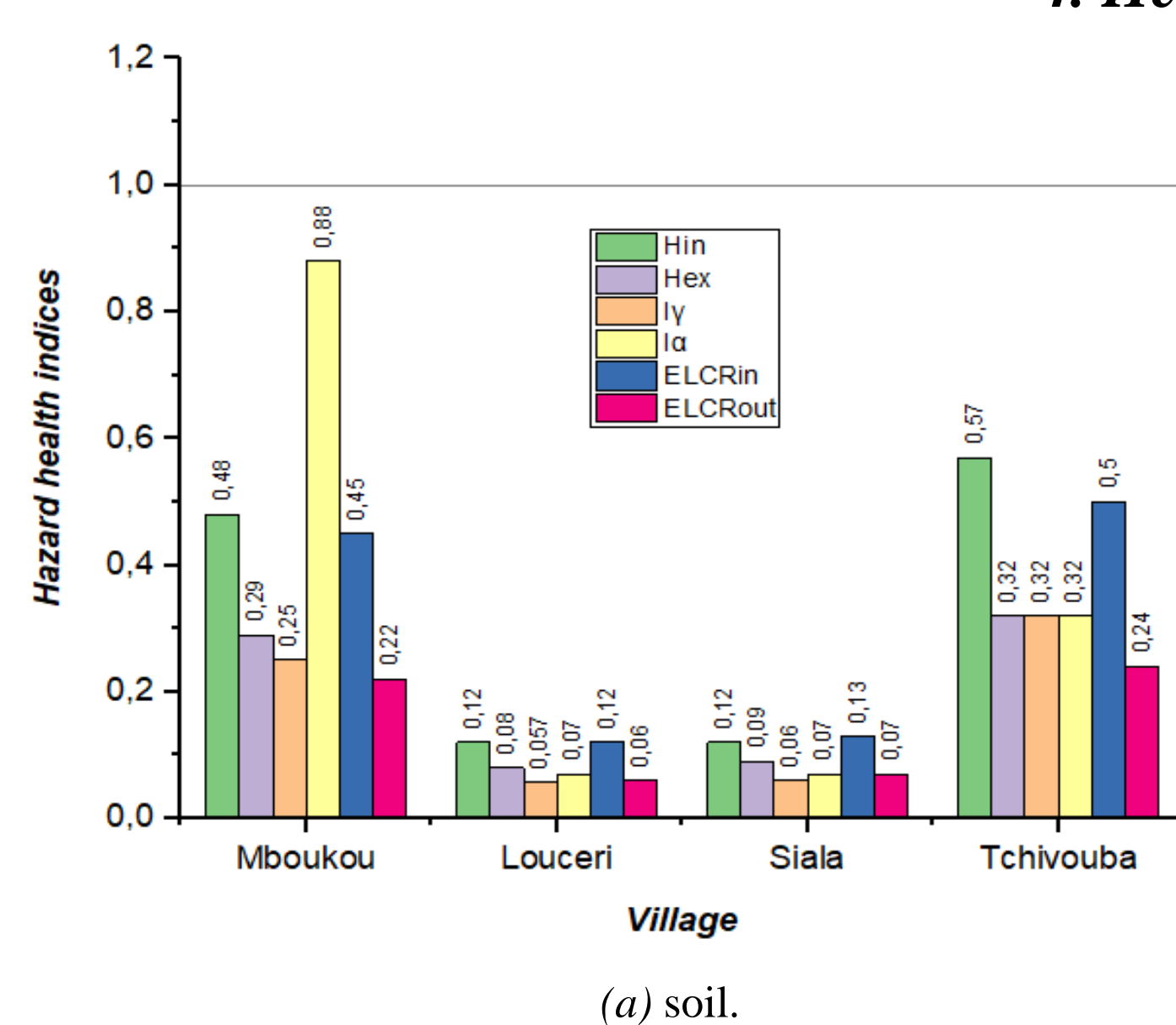- 40K mean value is of 43 Bq/kg < 400 Bq/kg 137Cs mean value is of 1 Bq/kg < 51 Bq/kg.

(UNSCEAR 2000)

(b) Phosphate rocks

- 238U and 235U mean values are 1370 and 40 Bq/kg, respectively belongs in a range of 37–4900 Bq/kg reported by Rossler et al. (1979) and IAEA (1979) for sedimentary phosphate.
- 226Ra mean value is of 922 Bq/kg, belongs in a range of 100-10,000 Bq/kg reported by Rossler et al. (1979) and IAEA (1979) for sedimentary phosphate.
- 232Th and 40K mean values are of 70 and 103 Bq/kg, respectively lower than 226Ra mean value .
- 137Cs mean value is of 7 Bq/kg < 51 Bq/kg (UNSCEAR 2000)

2. Origin of contamination

Activity ratio
- 238U / 235U = 7.71 for soil
- 238U / 235U = 34.11 for phosphate rocks. This value is higher than 21.7 proposed by Ivanovich et al. 1992.

3. Radon mass exhalation rate and radon activity

$y = 0.0923x + 1.3298$
$R^2 = 0.9938$

(a) soil.

$y = 15.59x + 16.236$
$R^2 = 0.9953$

(b) phosphate rocks.
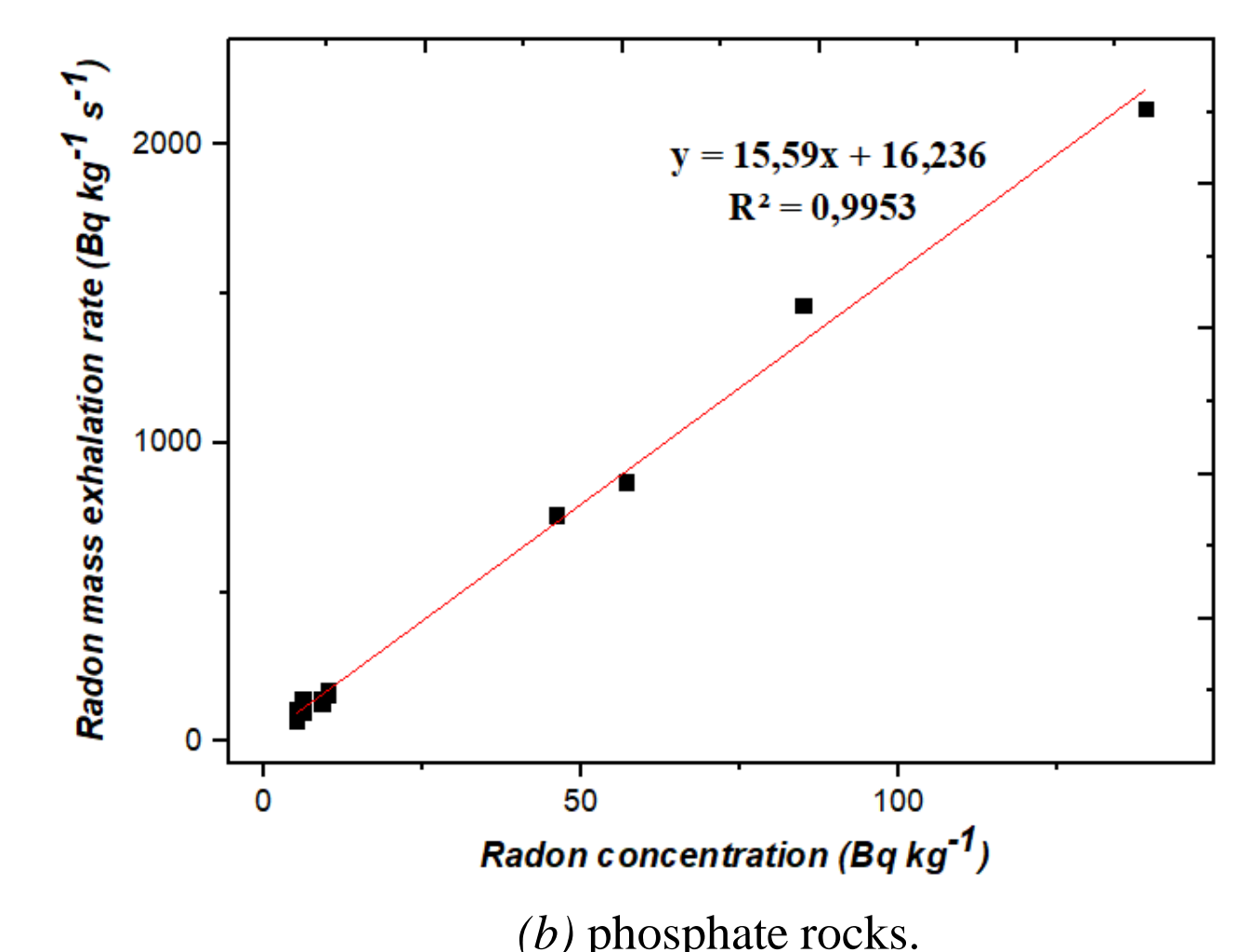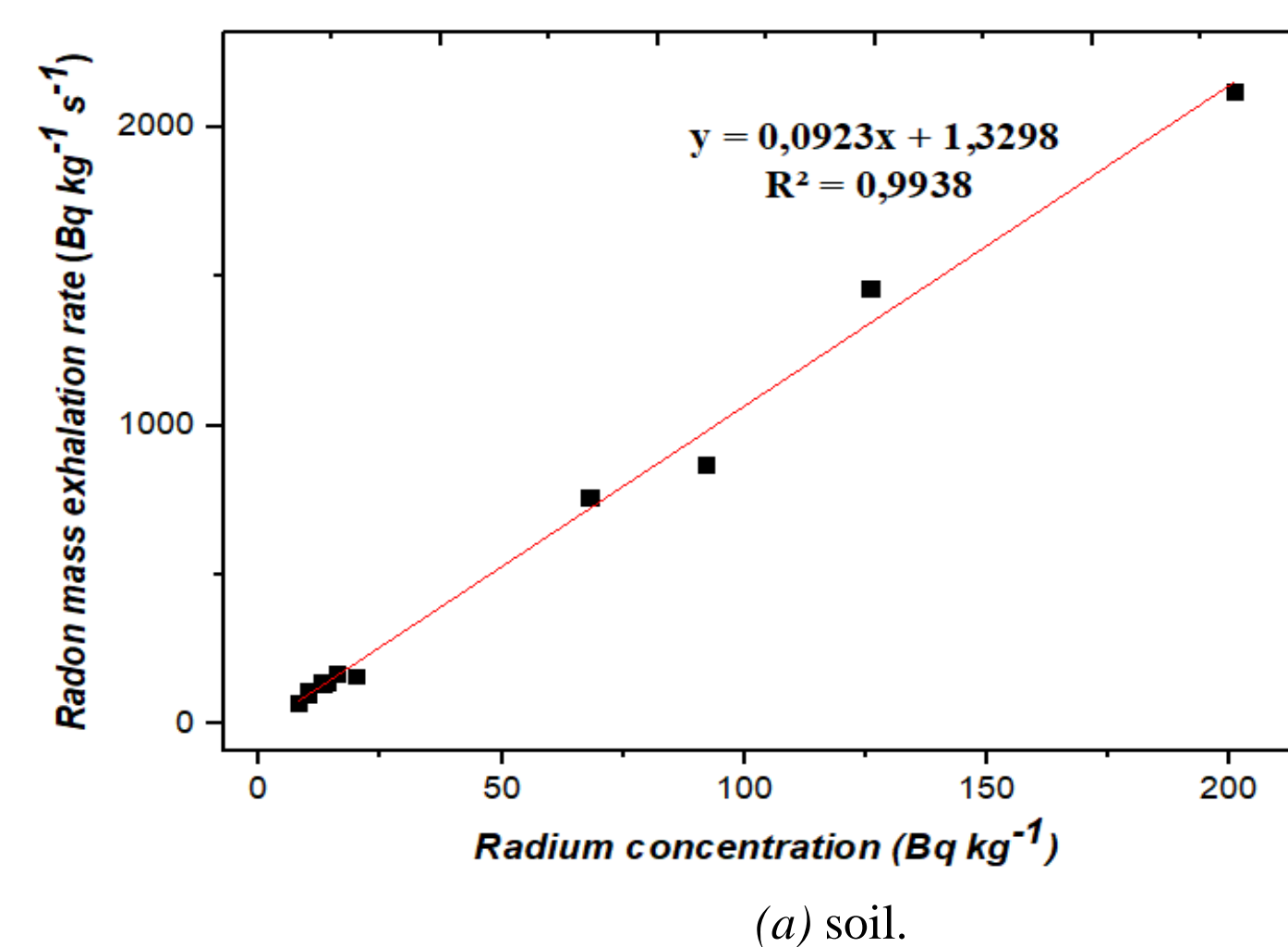
4. Health hazard indices

(a) soil.

(b) phosphate rocks.

4. Conclusions

- The results showed the mean activity concentrations of 238U and 226Ra higher than the recommended limits. While, those of 232Th, 40K and 137Cs were found to be lower the limits.
- Health hazard indices for the soil were found to be under the recommended limits.
- Soils from the study area should not be recommended for brick making, because it contains phosphate rocks in certain sites.
- On the other hand, high activity concentrations have been found in phosphate rock samples, showing risky level of contamination considered hazardous to population in Hinda district.

5. Acknowledgements

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