



ASSESSMENT OF ENVIRONMENTAL GAMMA DOSE RATE IN HO CHI MINH CITY, VIETNAM

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Introduction



Introduction

- Ho Chi Minh city is located on the South of Vietnam. The area of the city is about 2095 km², and the population is about 9.0 millions. The altitude of the city is within 1–32 m above the sea level.
- Ho Chi Minh city, consisting of 24 districts, is the biggest city of the country, contributing significantly in the transportation and economic development in the southern region of Vietnam and Southeast Asian countries. Therefore, further comprehensive assessment of natural radioactivity in the city for the purpose of baseline data establishment and environmental protection is considerably beneficial

Introduction

- Two main sources of exposure of humans to environmental radiation are terrestrial gamma rays and cosmic rays. Terrestrial gamma rays are mainly from the primordial radioactive nuclides occurring naturally in soils, rocks existing in the earth's crust and building materials, such as ^{238}U , ^{232}Th series and ^{40}K .
- The terrestrial gamma radiation level and associated external exposure due to the natural radioactivity, in particular outdoor gamma dose, depend on the geological structure and the activity concentration in the soil.

Instruments and Methods

➤ Measurements of activity concentrations in the soil samples were carried out using a low background gamma spectrometer with an HPGe detector, the measured gamma spectra were processed using MAESTRO-32 software, In the present work, each sample was measured during a time period of 90,000 s to obtain good statistics. Background measurement was also conducted during a period of 100,000 s.

Instruments and Methods

➤ Collection of surface soils was carried out at 120 locations distributed evenly in 24 districts of Ho Chi Minh city as shown in Fig. 1. At a sampling location, a triangle with the sides of 3 m was determined. Four topsoils at the center and three corners of the triangle at the depth level of 0–30 cm were collected using a stainless steel core having the diameter of 10 cm. It is because the soil layer upper 30 cm contributes predominantly to the natural terrestrial radiation exposure.

Instruments and Methods

➤ The soils were mixed up and packed in a polyethylene bag. At the laboratory, the soils were dried in air for 24–48 hrs, and in an oven at 110 °C for 10 hrs to attain unchanged mass. The soils were crushed and split using a mesh with 0.2-mm diameter holes, and put in a cylindrical polyethylene box with 60-mm diameter and 40-mm height. The soil samples were stored for four weeks for obtaining secular equilibrium between ^{226}Ra with ^{214}Bi and ^{214}Pb before performing the measurements.

Instruments and Methods

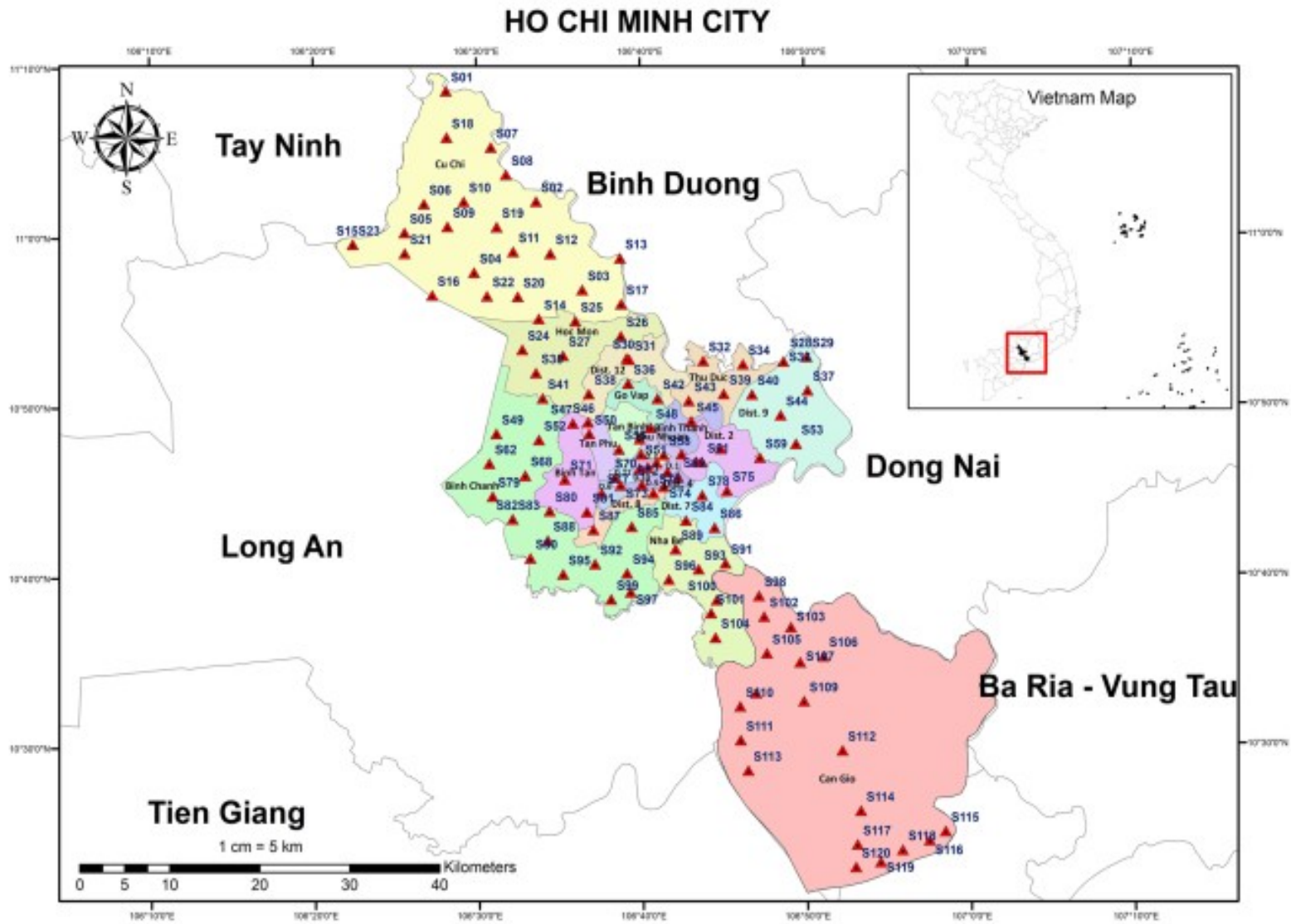


Fig. 1 Map of Ho Chi Minh city and the locations of soil samples

Instruments and Methods

- Measurement of the gamma dose rates in air at 2245 locations distributed evenly in the 24 districts of the city was performed using the portable dose survey FAG FH 40 dosimeter. This measurement was conducted by installing the FAG FH 40 dosimeter on a motobike and driving on the main roads of the city.
- The FAG FH 40 dosimeter, a Geiger Mueller (GM) counter, is a battery-operated low-level dose rate meter used to measure gamma radiation in the range of 0.01 $\mu\text{Sv/h}$ – 10 mSv/h , with the energy range from 45 keV to 3.0 MeV

Instruments and Methods

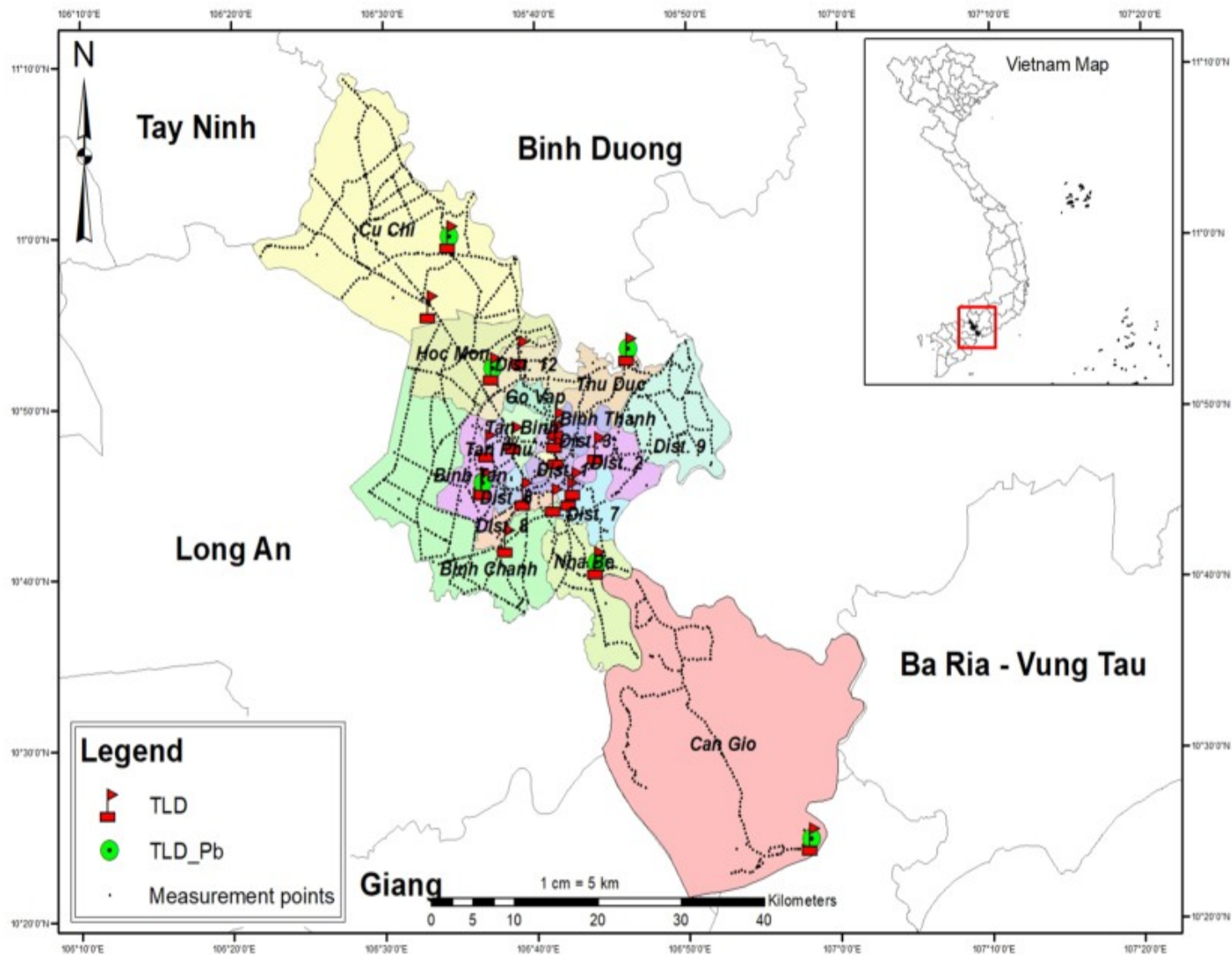


Fig 2. Map of Ho Chi Minh city and the locations of gamma dose measurement

Instruments and Methods

➤ To ensure the reliability of the FAG FH 40 dosimeter, the detector was calibrated to a standard gamma radiation field of a ^{137}Cs source, which has the reference standard dosimeters traceable to the primary standard dosimetry laboratory (PSDL). Figure 3 displays the total ambient dose equivalent rate in the standard gamma radiation field of ^{137}Cs source.

Instruments and Methods

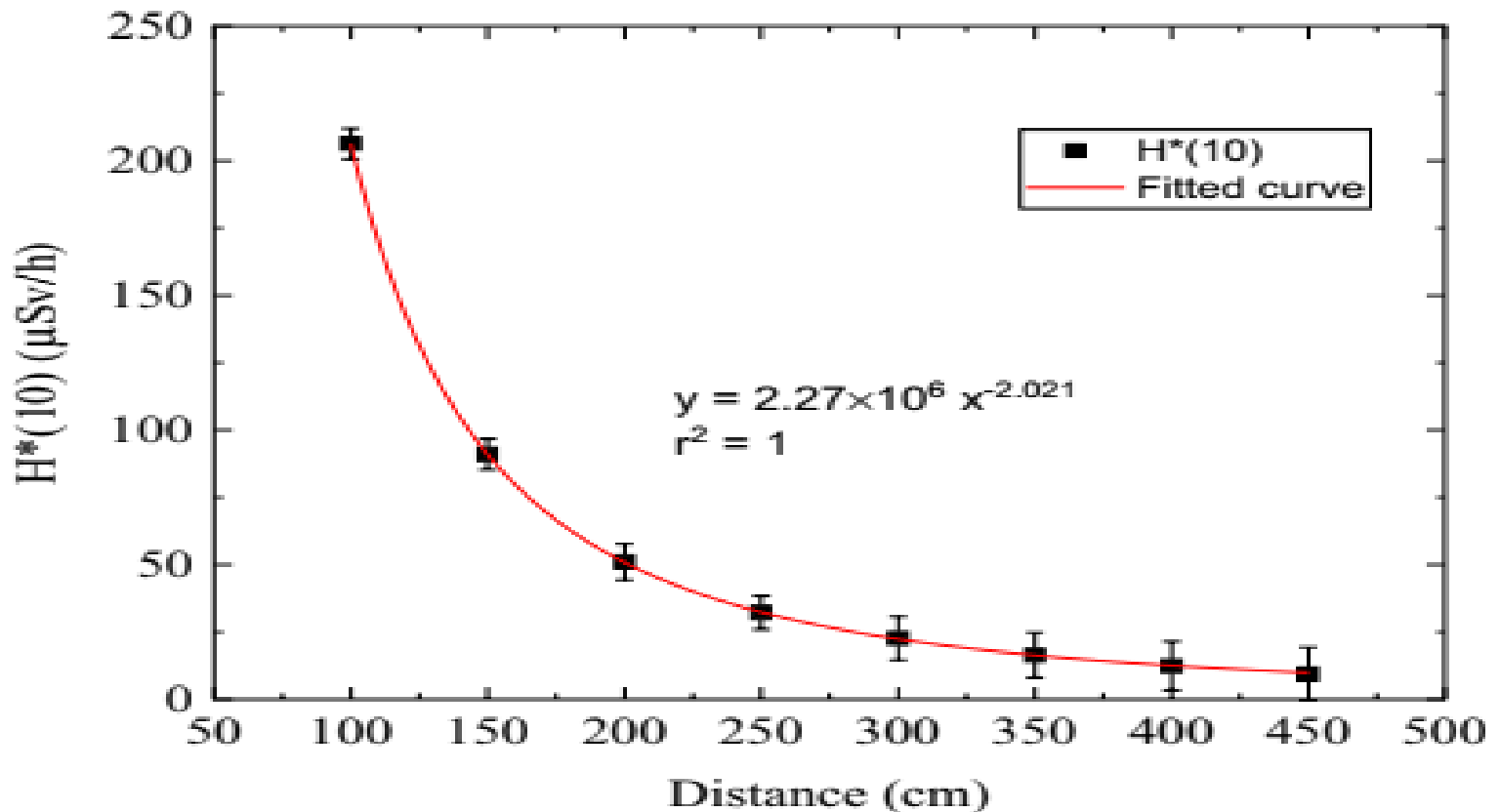


Fig. 3 The ambient dose equivalent rate of the standard gamma radiation field of a ^{137}Cs source calibrated using the FAG FH 40 dosimeter. The error bars indicate the 95% confident interval of the data

Instruments and Methods

➤ To measure the total cumulative gamma dose in air and evaluate the contribution of cosmic rays, the in-house Thermoluminescent dosimeters (TLDs) with CaSO₄:Dy powder were used.

➤ The dosimetric parameters of the TLDs such as glow curve with temperature, homogeneity of the batch, reproducibility of measurement, linearity of dose response, limit of detection, fading, and energy dependent response function were determined by radiating with the gamma rays of ¹³⁷Cs source (662 keV) within dose interval of 0.05–24.24 mSv, and filtered X-rays (Pantak standard X-ray generator) with energies of 33 keV, 48 keV and 65 keV for dose interval of 0.3– mSv at the Secondary Standards Dosimetry Laboratory (SSDL) of Institute for Nuclear Science and Technology (Hanoi, Vietnam).

Instruments and Methods

➤ Then, the irradiated TLDs were measured by REXON-UL320 Reader System which has the consecutive heating cycle of 30 s with four nodes: node 1 for increasing from room temperature to 135 °C in 6 s, node 2 for keeping the temperature at 135 °C in 4 s, node 3 for increasing the temperature from 135 to 280 °C in 12 s, and node 4 for keeping the temperature at 280 °C in 8 s. Figure 2 shows the energy dependent response function of the TLD dosimeter

Instruments and Methods

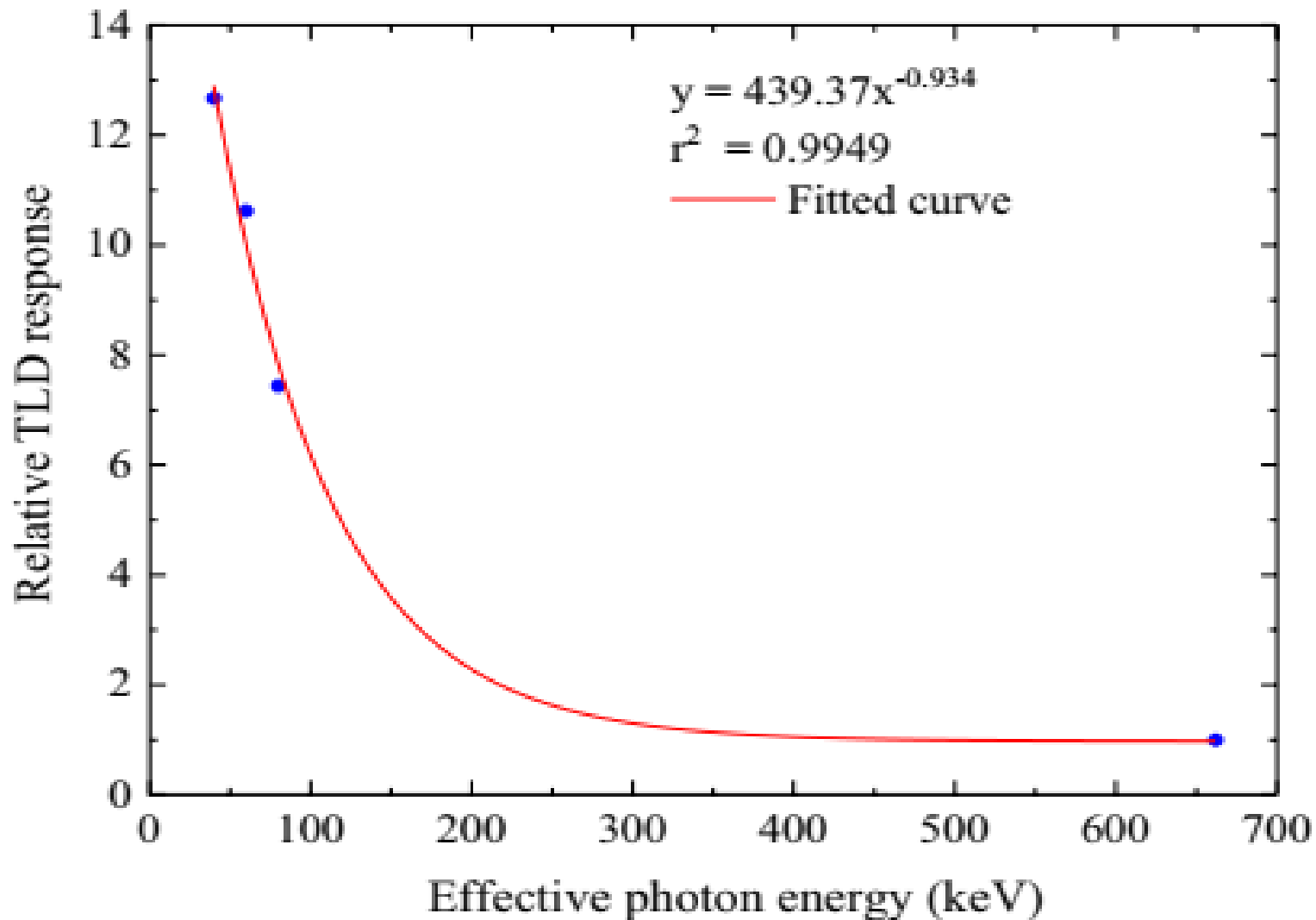


Fig. 2 Energy dependent response function of the TLD dosimeter

Instruments and Methods

➤ The TLD dosimeters were installed at 20 positions distributed evenly in the city for measuring the cumulative gamma doses in air. In which, at six positions in Cu Chi, Hoc Mon, Thu Duc, District 1, Nha Be and Can Gio were located double TLD dosimeters. One of the two TLD dosimeters was included with a lead shielding layer (TLD_Pb) to prevent the gamma rays coming from surface soils for measuring only the cumulative gamma dose from the cosmic rays.

Instruments and Methods

- The other TLD dosimeter was used without the lead shielding layer for measuring the total cumulative gamma dose in air, i.e., including the components of gamma doses from cosmic rays and surface soils.
- The use of TLDs to measure the lower environmental dose rate from surface soil or building material with shielding layers to eliminate the effect of cosmic rays is quite common.

Results and Discussion

1. About activity concentration in surface soils

- Table 1 presents the average values and the range of activity concentrations in 24 districts.
- The ^{226}Ra activity concentrations ranges from 9.6 to 48.5 Bq kg⁻¹ with the average value of 21.1 ± 1.3 Bq kg⁻¹. This value is smaller than the world average value (35 Bq kg⁻¹) by a factor of 0.6 [1].
- One can see that the ^{232}Th activity concentrations vary from 11.1 to 93.2 Bq kg⁻¹. The smallest value is 11.1 ± 1.0 Bq kg⁻¹ obtained in District 2. Whereas, the greatest value of 59.6 ± 3.5 Bq kg⁻¹ is obtained in District 4

Results and Discussion

1. About activity concentration in surface soils

➤ The average radioactivity concentration of ^{232}Th in Ho Chi Minh city is $36.6 \pm 1.3 \text{ Bq kg}^{-1}$. This value is about 1.2 times greater than the world average value. The highest value obtained in the city is 2.0 times the world average value.

➤ The ^{40}K activity concentrations in the city vary from 10.9 to 637 Bq kg^{-1} . The lowest value of $37.5 \pm 2.7 \text{ Bq kg}^{-1}$ is obtained in Cu Chi, whereas the highest value of 637 Bq kg^{-1} is found in Can Gio. The average value in the city is $279 \pm 29 \text{ Bq kg}^{-1}$, which is about 30% smaller than than the world average value

Table 1 Activity concentrations in soil samples in Ho Chi Minh city

District name	Samples	Activity concentration (Bq kg ⁻¹)							
		²²⁶ Ra		²³² Th		⁴⁰ K		<i>Ra_{eq}</i>	
		Average	Range	Average	Range	Average	Range	Average	Range
Cu Chi	23	19.9 ± 6.5	10.5–48.5	37.1 ± 4.8	28.1–48.2	111 ± 15	10.9–406	81.7	62.1–113
Hoc Mon	6	16.6 ± 3.1	9.9–23.5	36.1 ± 4.2	29.8–45.8	195 ± 15	28.2–358	83.3	66.1–104
Go Vap	2	21.7 ± 1.8	19.2–24.3	33.8 ± 2.8	33.6–34.1	298 ± 12	279–318	93.1	92.4–93.9
Binh Tan	2	24.0 ± 1.8	20.5–27.5	43.8 ± 5.1	40.2–47.4	185 ± 9	153–216	101	89.7–112
Tan Phu	1	19.0 ± 0.9	–	32.4 ± 0.8	–	43.8 ± 0.5	–	68.7	–
Tan Binh	3	24.8 ± 2.0	21.7–28.9	36.7 ± 3.7	34.5–41.1	271 ± 20	106–423	98.2	86.5–104
Binh Thanh	1	19.7 ± 1.2	–	31.4 ± 2.2	–	296 ± 8	–	87.4	–
Phu Nhuan	1	21.0 ± 1.3	–	35.4 ± 2.4	–	311 ± 9	–	95.5	–
Thu Duc	4	17.6 ± 2.4	13.9–23.0	34.9 ± 3.9	32.1–37.0	290 ± 17	132–360	90.0	74.9–99.8
District 1	2	19.7 ± 1.4	16.1–23.3	41.6 ± 2.1	40.7–42.5	80.7 ± 3.5	70.1–91.3	85.4	83.9–86.9
District 2	5	17.5 ± 2.1	12.1–23.3	28.4 ± 4.2	14.8–36.3	289 ± 21	143–388	80.6	48.1–102
District 3	2	22.3 ± 1.1	19.7–25.0	34.7 ± 1.7	33.6–35.9	118 ± 3	81.7–155	81.2	77.3–85.9
District 4	2	26.6 ± 1.7	25.2–28.0	47.0 ± 2.9	34.5–59.6	354 ± 8	245–463	121	112–129
District 5	1	16.0 ± 1.3	–	35.4 ± 1.6	–	105 ± 4	–	74.7	–
District 6	2	17.7 ± 1.6	17.5–17.9	35.3 ± 3.0	29.9–40.8	333 ± 14	253–413	93.9	92.4–95.3
District 7	2	20.9 ± 1.7	20.8–21.0	48.1 ± 3.6	39.4–56.8	434 ± 20	376–492	123	106–140
District 8	2	23.3 ± 1.9	19.4–27.3	32.8 ± 3.4	26.2–39.4	316 ± 15	312–319	94.6	88.8–100
District 9	7	20.6 ± 3.4	12.9–30.4	40.2 ± 6.7	27.0–55.1	259 ± 28	150–386	98.2	71.5–122
District 10	4	16.7 ± 2.3	13.9–20.1	42.8 ± 2.7	39.2–52.5	126 ± 5	88.6–225	87.8	77.5–107
District 11	2	17.0 ± 1.5	16.0–18.1	29.7 ± 2.9	26.6–32.9	251 ± 13	127–375	78.9	74.9–82.9
District 12	2	18.9 ± 2.0	18.6–19.3	32.6 ± 2.9	32.2–33.1	315 ± 12	299–332	89.9	87.6–92.2
Binh Chanh	17	26.3 ± 6.2	14.1–40.4	36.7 ± 6.0	24.8–45.5	394 ± 46	42.8–554	109	78.1–140
Nha Be	19	17.8 ± 3.4	9.6–24.3	33.9 ± 3.1	28.3–37.9	336 ± 36	24.3–418	92.2	65.2–109
Can Gio	8	23.0 ± 5.8	12.7–40.1	35.9 ± 8.2	17.7–52.8	448 ± 47	244–637	109	72.8–142
Average		21.1 ± 1.3	9.6–48.5	36.6 ± 1.3	14.8–59.6	279 ± 29	10.9–637	94.9 ± 4.7	48.1–142
World average		35	–	30	–	400	–	89	

Results and Discussion

- Table 2 displays the activity concentrations in surface soils in Ho Chi Minh city in comparison with that in neighboring regions.
- The radioactivity concentrations are in a good agreement with that obtained in the present work as presented in Table 2. The activity concentrations obtained in Ho Chi Minh city are approximate that in some neighboring regions, e.g., Southern Vietnam, Southern Thailand and Savannakhet, Laos.

Table 2. Comparison of the activity concentrations in Ho Chi Minh city and other regions in neighboring countries

Region	Activity concentration (Bq kg ⁻¹)			References
	²²⁶ Ra	²³² Th	⁴⁰ K	
Ho Chi Minh city, Vietnam	21 ^a (10–49) ^b	37 (15–60)	279 (11–637)	This work
Ho Chi Minh city, Vietnam*	23	31	41	[15]
Central of Ho Chi Minh city, Vietnam	23 (15–47)	29 (17–65)	208 (21–486)	[16]
Southern Vietnam	29 (6–54)	51 (12–99)	293 (6–756)	[14]
Savannakhet, Laos	22 (7–74)	31 (4–114)	212 (14–906)	[10]
Bolikhamxay, Laos	44 (13–90)	63 (11–93)	523 (38–999)	[31]
Southern Thailand	29 (4–122)	44 (6–170)	344 (5–1422)	[29]
Thailand	48 (11–78)	51 (7–120)	230 (7–712)	[1]
Penang, Malaysia	396 (64–799)	165 (16–667)	835 (87–1827)	[5]
Johor, Malaysia	162 (12–968)	261 (11–1210)	300 (12–2450)	[28]
Perak, Malaysia	112 (12–426)	246 (19–1377)	277 (19–2204)	[30]
Malaysia	67 (38–94)	82 (63–110)	310 (170–430)	[1]
Xi'an, China	36 (28–49)	51 (44–61)	733 (640–992)	[32]
China	32 (2–440)	41 (1–360)	440 (9–1800)	[1]
World average	35	30	400	[1]

*The values obtained from 16 soil samples [15]

^aAverage activity concentration

^bRange of activity concentration.

Results and Discussion

Absorbed gamma dose:

➤ Outdoor absorbed gamma dose, D_{out} , at about 1 m above the ground is calculated as:

$$D_{out}(nGy h^{-1}) = 0.46A_{Ra} + 0.62A_{Th} + 0.042A_K \quad (1)$$

where the activity-to-outdoor dose conversion factors for ^{226}Ra , ^{232}Th and ^{40}K are 0.46, 0.62 and 0.042, respectively. The formula to calculate indoor absorbed gamma dose rate, D_{in} , is written as

$$D_{in}(nGy h^{-1}) = 0.92A_{Ra} + 1.1A_{Th} + 0.084A_K \quad (2)$$

where the conversion factors of activity-to-indoor dose rate for ^{226}Ra , ^{232}Th and ^{40}K are 0.92, 1.1 and 0.084, respectively. The population-weighted average values of D_{out} and D_{in} are 59 and 84 $nGy h^{-1}$, respectively

Results and Discussion

Annual effective dose equivalent:

➤ The outdoor and indoor annual effective dose equivalent rates, $AEDE_{out}$ and $AEDE_{in}$, are expressed as follows:

$$AEDE_{out}(mSv y^{-1}) = D_{out}(nGy h^{-1}) \times 0.7(Sv.Gy^{-1}) \times 0.2 \times 8760(h) \quad (3)$$

And

$$AEDE_{in}(mSv y^{-1}) = D_{in}(nGy h^{-1}) \times 0.7(Sv Gy^{-1}) \times 0.8 \times 8760(h) \quad (4)$$

In the above equations, D_{out} and D_{in} are calculated from Eqs. (1) and (2), respectively. A dose conversion factor of $0.7 Sv Gy^{-1}$ is used in Eq. (3). The occupancy factors of 0.2 and 0.8 used in the calculations of $AEDE_{out}$ and $AEDE_{in}$ are based on an estimation of time spent outdoors and indoors of 20% and 80%, respectively

Results and Discussion

- Table 3 depict the average outdoor, indoor absorbed gamma doses and the outdoor , indoor annual effective dose equivalent rates in 24 districts of the city.
- The values of D_{out} vary in the range of 22.6–67.8 nGy h⁻¹ with the average value of 44.1 ± 2.1 nGy h⁻¹. This value is lower than the world average value by about 25%
- The D_{in} is obtained within the range of 43.0–130 nGy h⁻¹, The average D_{in} is 82.6 nGy h⁻¹. This value is approximate the world average value

Results and Discussion

➤ From the Table 3, we can see that the $AEDE_{out}$ values in Ho Chi Minh city vary in the range of 0.03–0.08 mSv h⁻¹ with the average $AEDE_{out}$ is 0.05 mSv h⁻¹, which is much smaller than the safety limit of 1.0 mSv h⁻¹. Whereas, the $AEDE_{in}$ varies in the range of 0.21–0.63 mSv h⁻¹ with the average value of 0.40 mSv h⁻¹. The values are also smaller than the safety limits.

Table 3 Calculated radiological hazard indices in soil samples in Ho Chi Minh city

District name	Samples	D_{out} (nGy h ⁻¹)		D_{in} (nGy h ⁻¹)		$AEDE_{out}$ (mSv h ⁻¹)		$AEDE_{in}$ (mSv h ⁻¹)	
		Average	Range	Average	Range	Average	Range	Average	Range
Cu Chi	23	36.9	27.7–52.6	68.6	51.6–101	0.04	0.03–0.06	0.34	0.25–0.49
Hoc Mon	6	38.2	30.2–48.4	71.4	56.3–91.3	0.05	0.04–0.06	0.35	0.28–0.45
Go Vap	2	43.5	43.3–43.7	82.3	81.8–82.8	0.05	0.05–0.05	0.40	0.40–0.41
Binh Tan	2	45.9	40.7–51.1	85.8	75.9–95.6	0.06	0.05–0.06	0.42	0.37–0.47
Tan Phu	1	30.7	–	56.8	–	0.04	–	0.28	–
Tan Binh	3	45.6	39.2–49.1	86.0	73.6–93.4	0.06	0.05–0.06	0.42	0.36–0.46
Binh Thanh	1	41.0	–	77.6	–	0.05	–	0.38	–
Phu Nhuan	1	44.7	–	84.4	–	0.05	–	0.41	–
Thu Duc	4	42.0	40.5–47.0	79.0	76.7–89.2	0.05	0.05–0.06	0.39	0.37–0.44
District 1	2	38.2	37.5–38.9	70.7	69.2–72.1	0.05	0.05–0.05	0.35	0.34–0.35
District 2	5	37.9	22.5–47.7	71.9	43.0–90.3	0.05	0.03–0.06	0.35	0.21–0.44
District 3	2	36.8	34.7–38.8	68.7	64.5–73.0	0.04	0.04–0.05	0.34	0.32–0.36
District 4	2	56.3	53.6–58.8	105.9	103–109	0.07	0.07–0.07	0.52	0.50–0.54
District 5	1	33.7	–	62.5	–	0.04	–	0.31	–
District 6	2	44.1	43.9–44.1	83.2	82.2–84.1	0.05	0.05–0.05	0.41	0.40–0.41
District 7	2	57.7	49.8–65.4	108.6	94.3–123	0.07	0.06–0.08	0.53	0.46–0.60
District 8	2	44.3	41.9–46.8	84.1	80.2–88.0	0.05	0.05–0.06	0.41	0.39–0.43
District 9	7	45.4	33.1–56.3	85.1	62.4–105	0.05	0.04–0.07	0.42	0.31–0.51
District 10	4	39.6	34.8–48.9	73.2	64.2–90.4	0.05	0.04–0.06	0.36	0.31–0.44
District 11	2	36.8	34.0–39.6	69.5	63.5–75.4	0.04	0.04–0.05	0.34	0.31–0.37
District 12	2	42.2	41.0–43.3	79.8	77.6–82.0	0.05	0.05–0.05	0.39	0.38–0.40
Binh Chanh	17	51.4	36.2–66.3	97.7	66.8–126	0.06	0.04–0.08	0.48	0.33–0.62
Nha Be	19	43.4	28.7–51.5	82.0	52.2–97.7	0.05	0.03–0.06	0.40	0.26–0.48
Can Gio	8	51.8	35.1–67.8	98.5	67.8–130	0.06	0.04–0.08	0.48	0.33–0.64
Average		44.1	22.5–67.8	82.6	43.0–130	0.05	0.03–0.08	0.40	0.21–0.63
World average		59	–	84	–	0.07	–	0.41	–
Limit		–	–	–	–	1	–	1	–

Results and Discussion

2. About gamma dose rate in air

➤ Table 3 shows the average and the range of the equivalent gamma dose rates in air measured in 24 districts of Ho Chi Minh city. Figure 3 displays the distribution of the gamma dose rates in the city plotted from 2245 measured points

Table 3. Measured gamma dose rate in air in Ho Chi Minh city

District name	Average dose rate ($\mu\text{Sv/h}$)	Range of dose rates ($\mu\text{Sv/h}$)
Cu Chi	0.10	0.05–0.17
Hoc Mon	0.10	0.05–0.18
Go Vap	0.10	0.08–0.15
Binh Tan	0.10	0.07–0.17
Tan Phu	0.10	0.07–0.13
Tan Binh	0.10	0.07–0.15
Binh Thanh	0.10	0.08–0.14
Phu Nhuan	0.10	0.08–0.15
Thu Duc	0.10	0.08–0.15
District 1	0.10	0.06–0.14
District 2	0.10	0.06–0.16
District 3	0.10	0.07–0.16
District 4	0.11	0.08–0.15
District 5	0.11	0.09–0.18
District 6	0.10	0.07–0.15
District 7	0.10	0.08–0.18
District 8	0.10	0.07–0.15
District 9	0.10	0.07–0.16
District 10	0.11	0.09–0.17
District 11	0.10	0.08–0.17
District 12	0.11	0.05–0.17
Binh Chanh	0.10	0.05–0.18
Nha Be	0.10	0.07–0.18
Can Gio	0.10	0.05–0.18
Average	0.10	0.05–0.18

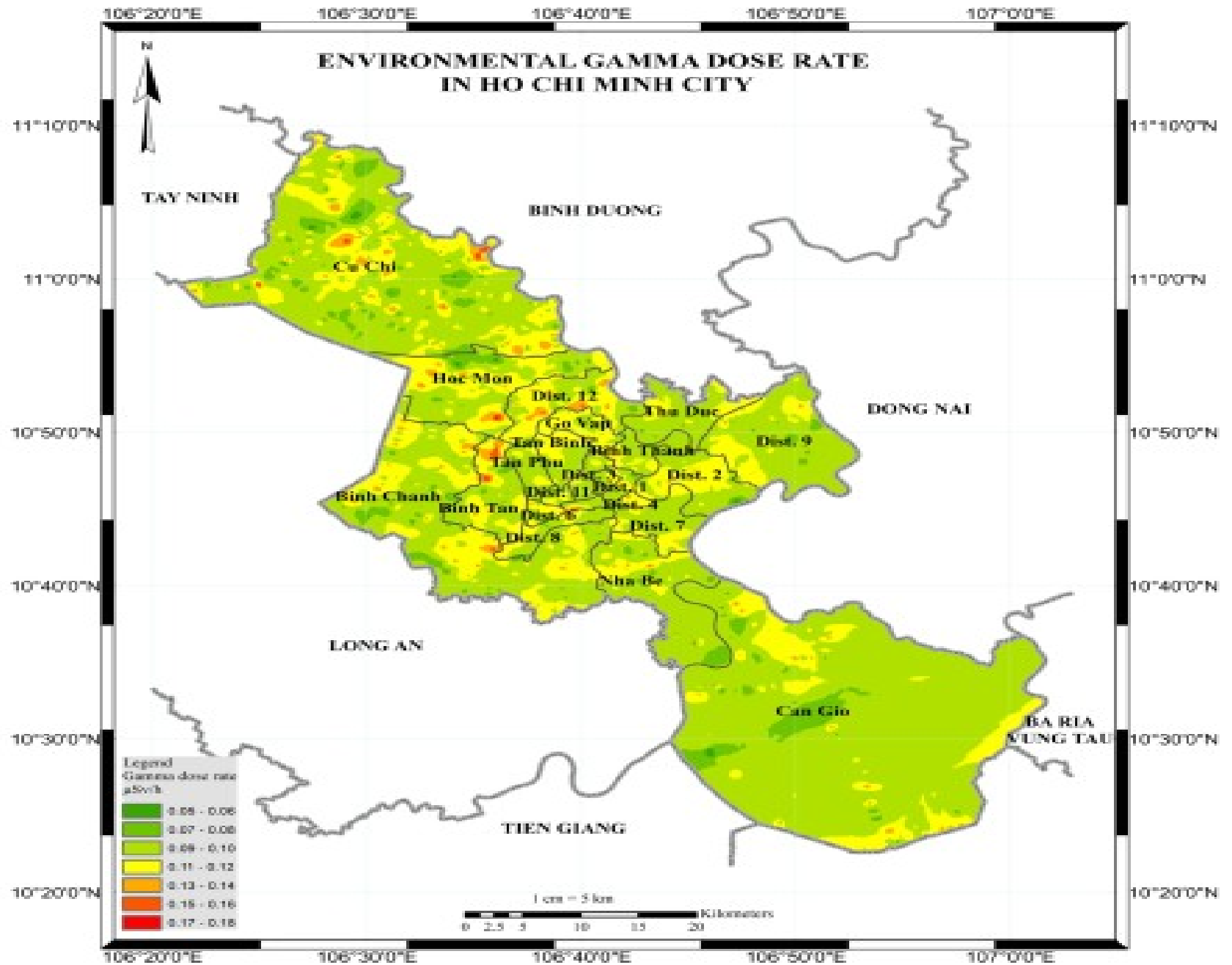


Fig. 3 Distribution of environmental gamma dose rate in Ho Chi Minh city

Results and Discussion

➤ It can be seen that the equivalent gamma dose rates in air in the city vary from 0.05 to 0.18 $\mu\text{Sv/h}$ with the average value of 0.10 $\mu\text{Sv/h}$. The lowest values of the gamma dose rates in 24 districts are about 0.05–0.09 $\mu\text{Sv/h}$, whereas the highest values are about 0.13–0.18 $\mu\text{Sv/h}$. The average gamma dose rates in all districts are approximate, within the values from 0.10 to 0.11 $\mu\text{Sv/h}$. This means that the difference of the average gamma dose rates from district to district, as well as compared to the average value of the whole city, is within 10%.

Results and Discussion

➤ Fig. 4 displays the frequency distribution of the gamma dose rates measured at 2245 locations in the city. One can see that the gamma doses rates in air in Ho Chi Minh city follow the symmetrical distribution around the mean value.

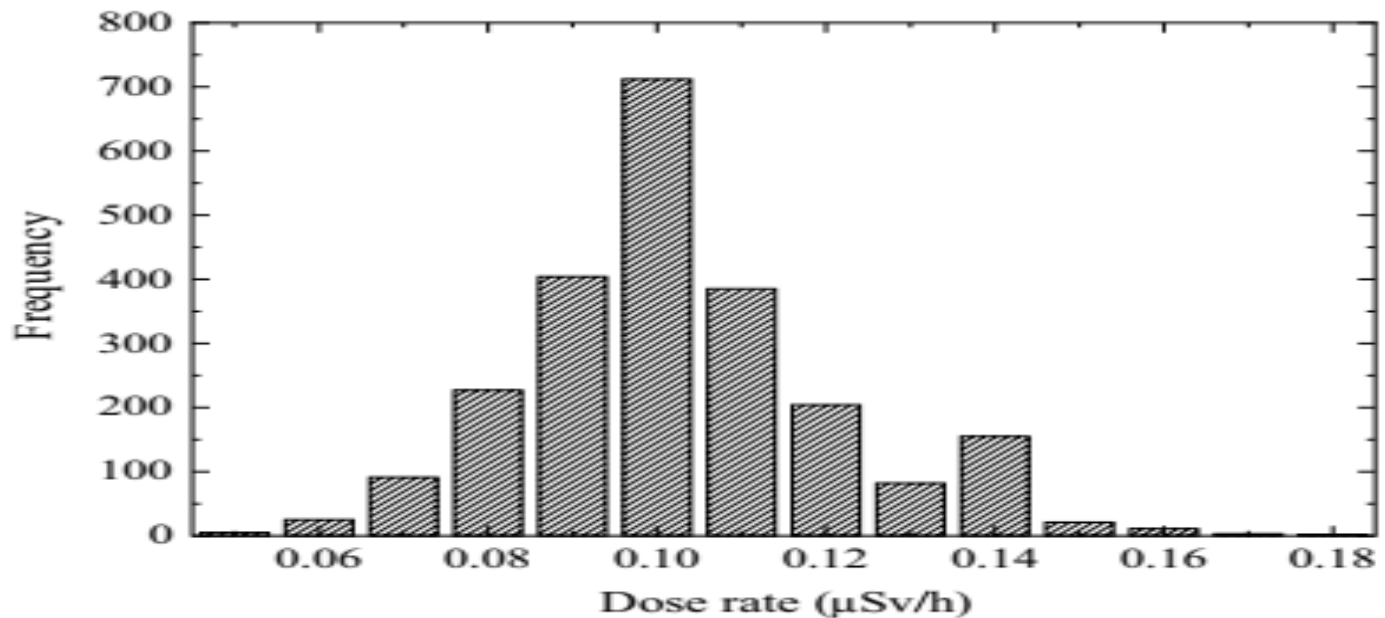


Fig. 4 Frequency distribution of total gamma dose rates in air at 2245 locations in Ho Chi Minh city measured by the FAG FH 40 dosimeter

Results and Discussion

➤ Table 4 shows the total cumulative gamma dose rates and the components due to the surface soils and the cosmic rays measured by the TLD dosimeters in the rainy and dry seasons, respectively. The average equivalent gamma dose rate calculated from the cumulative doses is about $0.98 \mu\text{Sv/h}$. This value agrees with that measured directly in air ($0.10 \mu\text{Sv/h}$).

➤ The cumulative gamma doses due to the cosmic rays in the rainy season vary from 0.044 to $0.051 \mu\text{Sv/h}$ with the average value of $0.048 \mu\text{Sv/h}$. Whereas, in the dry season, that values vary in the range of 0.046 – $0.068 \mu\text{Sv/h}$ with the average value of $0.055 \mu\text{Sv/h}$.

Results and Discussion

Table 4. Cumulative gamma doses due to cosmic rays and total gamma doses in air in Ho Chi Minh city measured by the TLD dosimeters

Time period	Period 1 (rainy season)		Period 2 (dry season)		Period 3 (dry season)		Period 4 (rainy season)	
	D_{cos}^*	D_{total}^{**}	D_{cos}	D_{total}	D_{cos}	D_{total}	D_{cos}	D_{total}
Parameters	($\mu\text{Sv/h}$)	($\mu\text{Sv/h}$)	($\mu\text{Sv/h}$)	($\mu\text{Sv/h}$)	($\mu\text{Sv/h}$)	($\mu\text{Sv/h}$)	($\mu\text{Sv/h}$)	($\mu\text{Sv/h}$)
Minimum value	0.044	0.082	0.049	0.085	0.046	0.084	0.046	0.084
Maximum value	0.050	0.100	0.068	0.153	0.055	0.116	0.051	0.103
Mean value	0.048	0.091	0.060	0.111	0.051	0.096	0.048	0.094
Standard deviation	0.002	0.004	0.006	0.016	0.004	0.007	0.002	0.004
Contribution of cosmic	0.048		0.060		0.051		0.048	
Contribution of soil	0.044		0.051		0.045		0.045	

* D_{cos} : cumulative gamma dose rate due to cosmic rays

** D_{total} : total cumulative gamma dose rate in air

Results and Discussion

➤ Figure 5 displays the cumulative dose rates in the rainy and dry seasons measured by the TLD dosimeters at 20 locations distributed evenly in the city. It can be seen that the cumulative doses measured in the dry season are greater than that in the rainy season by about 15%.

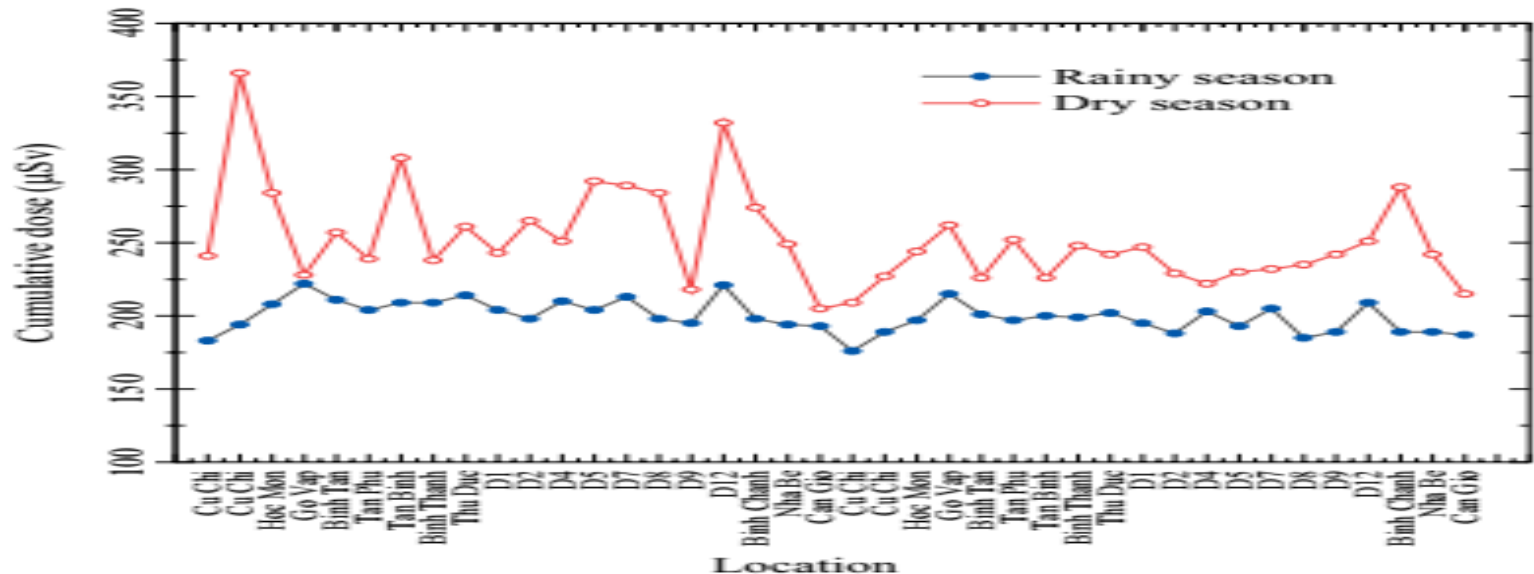


Fig. 5 Cumulative gamma doses in the rainy and dry seasons measured by the TLD dosimeters at 20 locations in Ho Chi Minh city

Conclutions

➤ Assessment of gamma doses in air at in Ho Chi Minh city, Vietnam has been conducted using the FAG FH 40 dosimeter installed on a motobike driven around the city. Soil samples were collected at 120 locations distributed widely in the city to evaluate absorbed gamma dose the possible impact to human health. Measurement of the cumulative gamma dose rates in rainy and dry seasons and the contribution of cosmic rays has also been conducted using 20 TLD dosimeters at fixed locations.

Conclutions

➤ It was found that the gamma dose rates measured in air in the city vary in the range of 0.05–0.18 $\mu\text{Sv/h}$ with the average value of about 0.10 $\mu\text{Sv/h}$. The lowest gamma dose rates in each district are about 0.05–0.09 $\mu\text{Sv/h}$, while the highest values are about 0.13–0.18 $\mu\text{Sv/h}$. The contribution of cosmic rays in the total gamma dose rates is about 53%. The measurement of cumulative gamma dose rates shows that the average dose rate in the dry season is greater than that in the rainy season by about 15%

Thank you !