# Measurement of Radiation on Soil and Water Samples at War-Tee Villages

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## Abstract

Soil and water samples were collected at War-Tee villages near Sittaung river, at Taungoo Township and Oktwin Township, Bago Region. After sample preparation, they were measured by Geiger Muller counter to detect radiation on soil and water samples. Measurements were made before cultivation, after cultivation and after harvesting. The analysis showed that both soil and water samples at War-Tee villages contained very little amount of radiation, and were suitable for cultivation and drinking for human and animals.

## Introduction

Myanmar is an agricultural country so soil and water for cultivation needs to be free hazard elements and radiation for public health. To do research for radiation measurement *Shan-War-Tee* (pronounced *Shan-Waddy*) and *Bamar-War-Tee* (pronounced *Bamar-Waddy*) villages near Sittaung river in Bago Region were selected. The former was located at Taungoo Township and the latter was situated at Oktwin Township in Bago Region.

**Bago Region** (formerly **Pegu Division** and **Bago Division**) is an administrative region of Myanmar, located in the southern central part of the country. It is bordered by Magway Region and Mandalay Region to the north; Kayin State, Mon State and the Gulf of Martaban to the east; Yangon Region to the south and Ayeyarwady Region and Rakhine State to the west. It is located between 46°45'N and 19°20'N and 94°35'E and 97°10'E.

Bago Region occupies an area of 39,400 square kilometres (15,214 sq mi) divided into the four districts of Bago, Pyay, Tharrawaddy and Taungoo. Bago, the divisional capital, is the fourth largest town of Burma. Other major cities include Taungoo and Pyay. Bago Region's symbol is a couple of *hintha* (mythical ducks), due to historic Mon influences in the area.

The total population of Bago Region is 4,863,455 according to 2014 Burma Census with Bamar, Karen, Mon, Chin, Rakhine, Shan, South Asians, Chinese, and Pa-O ethnic groups represented. The majority of the people are Buddhists. Burmese language is the lingua franca.

The region's economy is strongly dependent on the timber trade. Taungoo, in the northern end of the Bago Region, is bordered by mountain ranges, home to teak and other hardwoods. Another natural resource is petroleum. The major crop is rice, which occupies over two-thirds of the available agricultural land. Other major crops include betel nut, sugarcane, maize, groundnut, sesamum, sunflower, beans and pulses, cotton, jute, rubber, tobacco, tapioca, banana, Nipa palm and toddy. Industry includes fisheries, salt, ceramics, sugar, paper, plywood, distilleries, and monosodium glutamate.

The Region has a small livestock breeding and fisheries sector, and a small industrial sector. In 2005, it had over 4 million farm animals; nearly 1,200 hectares (3,000 acres) of fish and prawn farms; and about 3000 private factories and about 100 state owned factories. The major tourist sites of the Bago Region can be reached as a day trip from Yangon.

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**Taungoo (Toungoo)** is a District level city in the Bago Region of Myanmar, 220 km from Yangon, towards the north-eastern end of the division, with mountain ranges to the east and west. The main industry is in forestry products, with teak and other hardwoods extracted from the mountains. The city is known for its areca palms, to the extent that a Burmese proverb for unexpected good fortune is equated to a "betel lover winning a trip to Taungoo".

The city is famous in Burmese history for the Taungoo Dynasty which ruled the country for over 200 years between the 16th and 18th centuries. Taungoo was the capital of Burma in 1510–1539 and 1551–1552.

**Sittaung river** lies in east-central Myanmar, rising northeast of Yamethin on the edge of the Shan Plateau and flowing south for 260 miles (420 km) to empty into the Gulf of Martaban of the Andaman Sea. The broad Sittaung River valley lies between the forested Bago Mountains on the west and the steep Shan Plateau on the east and holds the main road and railway from Yangon (Rangoon) to Mandalay as well as the major towns of Bago, Taungoo, Yamethin, and Pyinmana. The river is navigable for 25 miles (40 km) year-round and for 55 miles (90 km) during three months of the year. The Sittaung is used to float timber, particularly teak south for export. Its lower course is linked by canal to Bago River. This canal, built to bypass the tidal bore that afflicted the mouth of the Sittaung, once provided the only route from Yangon to Taungoo.

Soil and water samples were collected from War-Tee villages, at Taungoo and Oktwin Townships, near Sittaung river in Bago Region to detect radiation on soil and water samples. Measurements were made before cultivation, after cultivation and after harvesting.

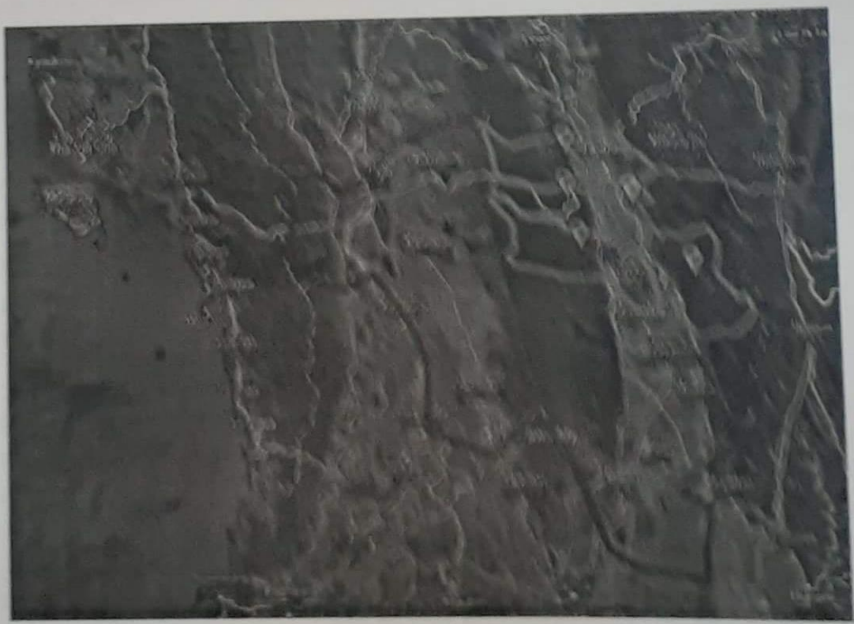

Figure 1 Bago Region map

(a) (b)

Figure 2 Sample collection at (a) *Shan-War-Tee village* and (b) *Bamar-War-Tee village* in Bago Region

## Materials and Methods

### Study Site and Study Period

The present study research work was carried out at the Department of Physics, Taungoo University (18° 57' N, 96° 22' E), Bago Region. Samples were taken from *Shan-War-Tee* and *Bamar-War-Tee* villages near Sittaung river in Bago Region. The study period was from April 2016 to April 2017.

### Experimental Geiger Muller Counter

Geiger-Müller (GM) counters were invented by H. Geiger and E.W. Müller in 1928, and are used to detect radioactive particles (α and β) and rays (γ and X). A GM tube usually consists of an airtight metal cylinder closed at both ends and filled with a gas that is easily ionized (usually neon, argon, and halogen). One end consists of a "window" which is a thin material, mica, allowing the entrance of alpha particles. (These particles can be shielded easily.) A wire, which runs lengthwise down the center of the tube, is positively charged with a relatively high voltage and acts as an anode. The tube acts as the cathode. The anode and cathode are connected to an electric circuit that maintains the high voltage between them.

When the radiation enters the GM tube, it will ionize some of the atoms of the gas. Due to the large electric field created between the anode and cathode, the resulting positive ions and negative electrons accelerate toward the cathode and anode, respectively. Electrons move or drift through the gas at a speed of about $10^4$ m/s, which is about $10^4$ times faster than the positive ions move. The electrons are collected a few microseconds after they are created, while the positive ions would take a few milliseconds to travel to the cathode. As the electrons travel toward the anode they ionize other atoms, which produces a cascade of electrons called gas multiplication or a (Townsend) avalanche. The multiplication factor is typically $10^6$ to $10^8$. The resulting discharge current causes the voltage between the anode and cathode to drop. The counter (electric circuit) detects this voltage drop and recognizes it as a signal of a particle's presence. There are additional discharges triggered by UV photons liberated in the ionization process that start avalanches away from the original ionization site. These discharges are called Geiger-Müller discharges. These do not affect the performance as they are short-lived.

The positive ions may still have enough energy to start a new cascade. One (early) method was 'external quenching' which was done electronically by quickly ramping down the voltage in the GM tube after a particle was detected. This means any more electrons or positive ions created will not be accelerated towards the anode or cathode, respectively. The electrons and ions would recombine and no more signals would be produced.

The modern method is called internal quenching. A small concentration of a polyatomic gas (organic or halogen) is added to the gas in the GM tube. The quenching gas is selected to have a lower ionization potential (~10 eV) than the fill gas (26.4 eV). When the positive ions collide with the quenching gas's molecules, they are slowed or absorbed by giving its energy to the quenching molecule. They break down the gas molecules in the process (dissociation) instead of ionizing the molecule. Any quenching molecule that may be accelerated to the cathode dissociates upon impact producing no signal. If organic molecules are used, GM tubes must be replaced as they loss they permanently break down over time (about one billion counts). However, the GM tubes included in Spectrum Techniques® set-ups use a halogen molecule, which naturally recombines after breaking apart.

For any more specific details, the reader will be advised to refer to literature such as G.F. Knoll's *Radiation Detection and Measurement* (John Wiley & Sons) or to this lab manual.

**Procedures for GM counter**

Firstly, GM counter was setup as shown in Figure 3. Then, the plateau curve of the counter was investigated by changing voltage steps and the obtained data were plotted to get operating voltage or working voltage for measurement. And, the background radiation was made. Secondly, the sample holder containing sample was put into stand of GM counter and the total counts were measured. The net count was obtained by subtracting background counts from the total counts. The results for each stage (during cultivation, after cultivation and after harvesting) were recorded and analysed.

**Sample Preparation**

The soil and water samples from Shan-War-Tee and Bamar-War-Tee villages (located at Taungoo Township and Oktwin Township) near Sittaung river in Bago Region were collected to detect radiation on these samples. The soil samples were dried and ground for measurement. After that the samples were placed into sample holders of GM counter. Water samples were also put into sample holders to make radiation measurement. Then, GM counter detected radiation from samples.

**Data Analysis**

The measured data were shown as Tables using Microsoft Excel Program.

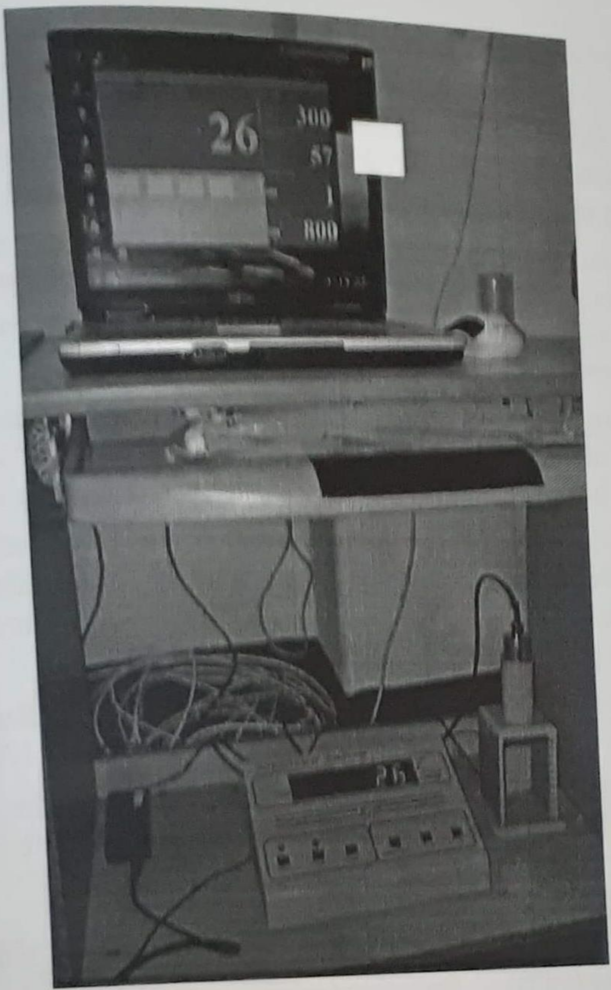


Figure 3  Experimental set-up of GM counter

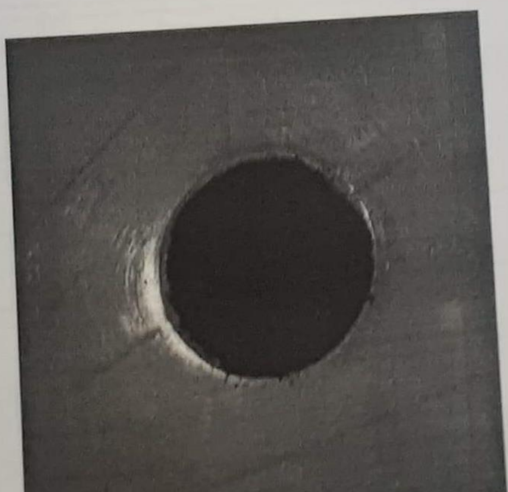

Figure 4  Sample and sample holder for radiation measurement

## Results

Soil sample at Bamar-War-Tee village before cultivation showed that the net count for radiation was 7 counts/min. The net count of soil radiation was 6 counts/min for Shan-War-Tee village. The results were shown in Tables 1, 2 and 3.

Water sample at Bamar-War-Tee village before cultivation was found to be 3 counts/min. The net count of water radiation was also 3 counts/min for Shan-War-Tee village. The results were shown in Tables 1, 4 and 5. From these results, the radiation on soil and water samples was present but that amount was only a little for public health.

After cultivation, soil sample at Bamar-War-Tee village showed that the net count was found to be 2 counts/min. The net count of soil radiation was not present for Shan-War-Tee village. The results were shown in Tables 6, 7 and 8.

Water sample at Bamar-War-Tee village after cultivation was observed 1 count/min. For water sample at Shan-War-Tee village, radiation was not present. The results were shown in Tables 6, 9 and 10. From these results, the radiation on soil and water samples was very little compared to those before cultivation.

After harvesting, it was found that soil samples at Bamar-War-Tee village and Shan-War-Tee village had no radiation. The results were shown in Tables 11, 12 and 13.

Both villages had no radiation on water samples after harvesting. The results were shown in Tables 11, 14 and 15. From these results the radiation on soil and water samples was not remained after harvesting.

Table 1 Background radiation measurement before cultivation

| Sr. No. | Operating voltage (volts) | Duration (min) | Counts |
|---|---|---|---|
| 1 | 820 | 1 | 38 |
| 2 | 820 | 1 | 26 |
| 3 | 820 | 1 | 42 |
| 4 | 820 | 1 | 36 |
| 5 | 820 | 1 | 33 |
| 6 | 820 | 1 | 38 |
| 7 | 820 | 1 | 28 |
| 8 | 820 | 1 | 43 |
| 9 | 820 | 1 | 34 |
| 10 | 820 | 1 | 36 |
| | | Average (counts/ min) | 35.4 |

Table 2 Radiation measurement for soil sample at Bamar-War-Tee village before cultivation

| Sr. No. | Operating voltage (volts) | Duration (min) | Counts |
|---|---|---|---|
| 1 | 820 | 5 | 219 |
| 2 | 820 | 5 | 205 |
| 3 | 820 | 5 | 200 |
| 4 | 820 | 5 | 202 |
| 5 | 820 | 5 | 214 |
| 6 | 820 | 5 | 219 |
| 7 | 820 | 5 | 206 |
| 8 | 820 | 5 | 210 |
| | | Average (counts/ min) | 42.125 |

Table 3 Radiation measurement for soil sample at Shan-War-Tee village before cultivation

| Sr. No. | Operating voltage (volts) | Duration (min) | Counts |
|---|---|---|---|
| 1 | 820 | 5 | 186 |
| 2 | 820 | 5 | 213 |
| 3 | 820 | 5 | 215 |
| 4 | 820 | 5 | 182 |
| 5 | 820 | 5 | 198 |
| 6 | 820 | 5 | 209 |
| 7 | 820 | 5 | 246 |
| 8 | 820 | 5 | 196 |
| | | Average (counts/ min) | 41.125 |

Table 4 Radiation measurement for water sample at Bamar-War-Tee village before cultivation

| Sr. No. | Operating voltage (volts) | Duration (min) | Counts |
|---|---|---|---|
| 1 | 820 | 5 | 192 |
| 2 | 820 | 5 | 180 |
| 3 | 820 | 5 | 192 |
| 4 | 820 | 5 | 204 |
| 5 | 820 | 5 | 184 |
| 6 | 820 | 5 | 187 |
| 7 | 820 | 5 | 191 |
| 8 | 820 | 5 | 196 |
| | | Average (counts/ min) | 38.15 |

Table 5 Radiation measurement for water sample at Shan-War-Tee village before cultivation

| Sr. No. | Operating voltage (volts) | Duration (min) | Counts |
|---|---|---|---|
| 1 | 820 | 5 | 189 |
| 2 | 820 | 5 | 187 |
| 3 | 820 | 5 | 203 |
| 4 | 820 | 5 | 189 |
| 5 | 820 | 5 | 186 |
| 6 | 820 | 5 | 173 |
| 7 | 820 | 5 | 187 |
| 8 | 820 | 5 | 198 |
| | | Average (counts/ min) | 37.8 |

Table 6 Background radiation measurement after cultivation

| Sr. No. | Operating voltage (volts) | Duration (min) | Counts |
|---|---|---|---|
| 1 | 840 | 1 | 45 |
| 2 | 840 | 1 | 42 |
| 3 | 840 | 1 | 38 |
| 4 | 840 | 1 | 48 |
| 5 | 840 | 1 | 43 |
| 6 | 840 | 1 | 37 |
| 7 | 840 | 1 | 24 |
| 8 | 840 | 1 | 45 |
| 9 | 840 | 1 | 39 |
| 10 | 840 | 1 | 38 |
| | | Average (counts/ min) | 39.9 |

Table 7 Radiation measurement for soil sample at Bamar-War-Tee village after cultivation

| Sr. No. | Operating voltage (volts) | Duration (min) | Counts |
|---|---|---|---|
| 1 | 840 | 5 | 229 |
| 2 | 840 | 5 | 206 |
| 3 | 840 | 5 | 213 |
| 4 | 840 | 5 | 198 |
| 5 | 840 | 5 | 211 |
| | | Average (counts/ min) | 42.28 |

Table 8 Radiation measurement for soil sample at Shan-War-Tee village after cultivation

| Sr. No. | Operating voltage (volts) | Duration (min) | Counts |
|---|---|---|---|
| 1 | 840 | 5 | 214 |
| 2 | 840 | 5 | 176 |
| 3 | 840 | 5 | 217 |
| 4 | 840 | 5 | 207 |
| 5 | 840 | 5 | 190 |
| | | Average (counts/ min) | 40.16 |

Table 9 Radiation measurement for water sample at Bamar-War-Tee village after cultivation

| Sr. No. | Operating voltage (volts) | Duration (min) | Counts |
|---|---|---|---|
| 1 | 840 | 5 | 210 |
| 2 | 840 | 5 | 205 |
| 3 | 840 | 5 | 212 |
| 4 | 840 | 5 | 200 |
| 5 | 840 | 5 | 206 |
| | | Average (counts/ min) | 41.32 |

Table 10 Radiation measurement for water sample at Shan-War-Tee village after cultivation

| Sr. No. | Operating voltage (volts) | Duration (min) | Counts |
|---|---|---|---|
| 1 | 840 | 5 | 210 |
| 2 | 840 | 5 | 180 |
| 3 | 840 | 5 | 183 |
| 4 | 840 | 5 | 211 |
| 5 | 840 | 5 | 188 |
| | | Average (counts/ min) | 38.88 |

Table 11 Background radiation measurement after harvesting

| Sr. No. | Operating voltage (volts) | Duration (min) | Counts |
|---|---|---|---|
| 1 | 800 | 1 | 41 |
| 2 | 800 | 1 | 42 |
| 3 | 800 | 1 | 42 |
| 4 | 800 | 1 | 39 |
| 5 | 800 | 1 | 36 |
| 6 | 800 | 1 | 43 |
| 7 | 800 | 1 | 41 |
| 8 | 800 | 1 | 46 |
| 9 | 800 | 1 | 40 |
| 10 | 800 | 1 | 33 |
| | | Average (counts/ min) | 40.3 |

Table 12 Radiation measurement for soil sample at Bamar-War-Tee village after harvesting

| Sr. No. | Operating voltage (volts) | Duration (min) | Counts |
|---|---|---|---|
| 1 | 800 | 5 | 178 |
| 2 | 800 | 5 | 205 |
| 3 | 800 | 5 | 228 |
| 4 | 800 | 5 | 214 |
| 5 | 800 | 5 | 169 |
| | | Average (counts/ min) | 39.76 |

Table 13 Radiation measurement for soil sample at Shan-War-Tee village after harvesting

| Sr. No. | Operating voltage (volts) | Duration (min) | Counts |
|---|---|---|---|
| 1 | 800 | 5 | 191 |
| 2 | 800 | 5 | 210 |
| 3 | 800 | 5 | 202 |
| 4 | 800 | 5 | 186 |
| 5 | 800 | 5 | 194 |
| Average (counts/ min) | | | 39.32 |

Table 14 Radiation measurement for water sample at Bamar-War-Tee village after harvesting

| Sr. No. | Operating voltage (volts) | Duration (min) | Counts |
|---|---|---|---|
| 1 | 800 | 5 | 206 |
| 2 | 800 | 5 | 184 |
| 3 | 800 | 5 | 189 |
| 4 | 800 | 5 | 175 |
| 5 | 800 | 5 | 174 |
| Average (counts/ min) | | | 37.12 |

Table 15 Radiation measurement for water sample at Shan-War-Tee village after harvesting

| Sr. No. | Operating voltage (volts) | Duration (min) | Counts |
|---|---|---|---|
| 1 | 800 | 5 | 170 |
| 2 | 800 | 5 | 152 |
| 3 | 800 | 5 | 205 |
| 4 | 800 | 5 | 186 |
| 5 | 800 | 5 | 173 |
| Average (counts/ min) | | | 35.44 |

## Discussion

Radiation measurement on soil and water samples at Shan-War-Tee and Bamar-War-Tee villages was found to be very little amount compared to hazard levels. Though only a little amount of radiation was found before cultivation, no radiation was observed after cultivation and after harvesting as the cultivation period was the raining season and other factors may also affect the radiation residues such as weather, sun and wind.

As for the whole experiment, the radiation was contained very little amount on soil and water samples at War-Tee villages in Bago Region. So, people on those areas can apply soil and water for their cultivation and drinking water.

## Conclusion

Although the radiations on soil and water samples of War-Tee villages before cultivation was present only a little amount, it was not hazardous to public health. The radiation on soil and water samples after cultivation and after harvesting was reduced. This may be the effect of rain water as the cultivation period was during the raining season. So, people from both villages can utilize soil and water for their cultivation and drinking water safely.

The person who deals with radiation measurement should wear appropriate safety protective clothing, mask and hand gloves to reduce radiation hazard elements to the body.

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