

PAPER • OPEN ACCESS

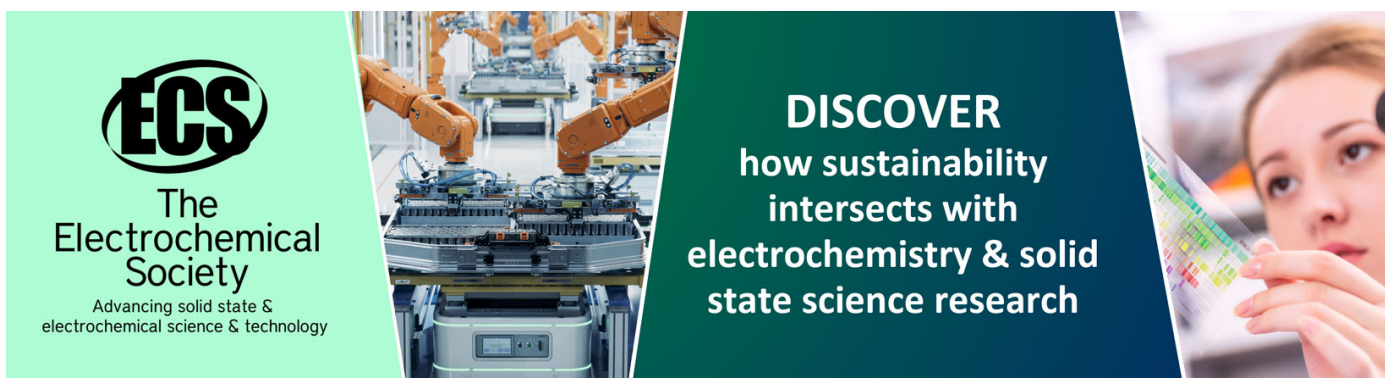
Ambient dose measurement from high natural background radiation (HNBR) in Botteng Utara Village, Mamuju-Indonesia

To cite this article: S N Shilfa *et al* 2020 *J. Phys.: Conf. Ser.* **1436** 012027

View the [article online](#) for updates and enhancements.

You may also like

- [Measuring individual external doses of Tokyo Electric Power Company Holdings employees living in Fukushima prefecture](#)
Keizo Uchiyama, Toshiaki Ishii, Ken Koyabu et al.
- [Measuring and assessing individual external doses during the rehabilitation phase in Iitate village after the Fukushima Daiichi nuclear power plant accident](#)
Wataru Naito, Motoki Uesaka, Tadahiro Kurosawa et al.
- [IRPA Consultation: is the system of protection 'fit for purpose' and can it be readily communicated? Views of the radiation protection professionals](#)
Roger Coates and Renate Czarwinski



ECS
The
Electrochemical
Society
Advancing solid state &
electrochemical science & technology

DISCOVER
how sustainability
intersects with
electrochemistry & solid
state science research

Ambient dose measurement from high natural background radiation (HNBR) in Botteng Utara Village, Mamuju - Indonesia

S N Shilfa¹, B Y E B Jumpeno², Nurokhim¹, Kusdiana¹

¹ Radioecology Department, Centre for Technology of Radiation Safety and Metrology National Nuclear Energy Agency, Indonesia

² Occupational Safety and Dosimetry Department, Centre for Technology of Radiation Safety and Metrology National Nuclear Energy Agency, Indonesia

E-mail: sharah-nataz@batan.go.id

Abstract. The terrestrial environment is one of the contributors to natural background radiation. Mamuju Regency, located in the Province of West Sulawesi Indonesia is known as the high natural background radiation (HNBR) area due to its high terrestrial exposure. Botteng Utara Village is one of the areas with dose rates up to 5 mSv/y in Mamuju district. For this reason, measurements were taken to determine the ambient dose received by society. In situ measurements were carried out in Botteng Utara Village using 70 OSL (Type EX - OSLD Environment) installed in 70 houses. The selection of houses is made with various types of building materials, randomly selected from 10 hamlets with each of 7 houses per sub-village. Measurements were done for $\pm$ two months from February 20, 2019 to April 12, 2019. The range of ambient dose achieved by measurement was from 51 up to 176 mRem/h. Further investigation using a larger sample number and longer time should be performed to validate this study's results. This result will serve as a baseline for further research regarding the possibility of radiation effects on the society in Botteng Utara Village in Mamuju district.

1. Introduction

Radiation is the transmission of energy through a material or space in the form of heat, particles or waves (photons) from a radiation source. Radiation consists of natural and artificial radiation: artificial radiation is created for the benefit of human life while natural radiation is cosmic rays and primordial radionuclides in the earth's crust. The International Atomic Energy Agency (IAEA) estimates that over 85% of background radiation received by man is derived from natural radio-nuclides, while the remaining 15% is from cosmic rays and nuclear processes [1].

Natural background radiation varies tremendously in different regions. This is influenced by the radioactive concentration on the surface of the earth's crust, such as potassium, uranium, thorium, and its radioactive decay products (eg Radium, radon) [2]. The area where total cosmic radiation and natural radioactivity in the soil, indoor and outdoor air, water and food leads to chronic external and internal exposure to the public is called a high natural background radiation area (HNBR). Annual effective doses in the HNBR region have been classified into four levels: low (around 5 mSv/y) or about twice the global average of 2.4 mSv/y reported by UNSCEAR; intermediate (5-20 mSv/y); high (20-50 mSv/y); and very high (> 50 mSv/y) [3].



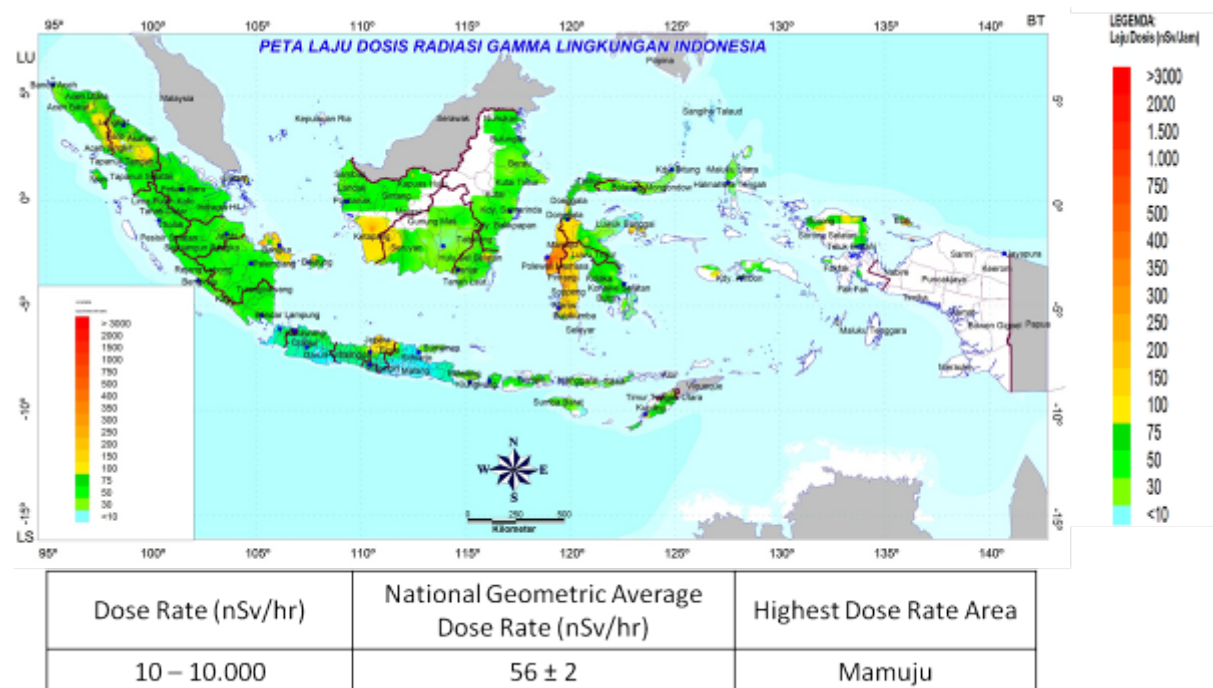


Figure 1. Gamma Dose Rate of Indonesia in a Map

Since 2005, the environmental radioactivity mapping throughout Indonesia began (Figure 1). This mapping is done by measuring the rate of terrestrial radiation dose. Based on the mapping results, it is known that Mamuju Regency, West Sulawesi is the area with the highest level of natural radiation in Indonesia [2]. One of the villages in Mamuju Regency, Botteng Utara Village, Simboro District, is estimated to have an average dose rate of more than 5 mSv per year with radiation dose rates at several points reaching nearly 200 times the national dose rate. Indonesia's average radiation dose rate is 56 ± 2 nSv/h while Mamuju ranges from 10-10,000 nSv/h [4]. Consider the high value of the dose rate and the possible risk of radiation effects received by the community, further research was carried out including measuring the ambient dose received by the community in the Botteng Utara Village. The result of this study will provide a baseline of data on environmental radioactivity that may be useful for some guiding information in regards to the possibility of hazardous health problems.

2. Materials and Methods

2.1. Description of Study Area

Mamuju is one of the regencies in Indonesia located in West Sulawesi province. The astronomical position is between Latitude $10^{\circ}38'11''$ - $20^{\circ}54'55''$ S and Longitude $110^{\circ}54'47''$ - $130^{\circ}5'35''$ E or are in the southern part of the equator. Mamuju Regency has an area of 5,064.19 km². Administratively, the Mamuju Regency is divided into 11 subdistricts [2]. Botteng Utara Village, Simboro district, is placed where the research was done which consists of 10 sub-village. Mamuju and surrounding areas are generally composed of volcanic rocks. The radioactivity anomaly in the Mamuju area is known to include a relatively large area with significant uranium and thorium levels. This is closely related to the distribution of volcanic rocks that are included in the Adang volcano rock [5]. Figure 2 showing the location of the study area in Mamuju – Indonesia.

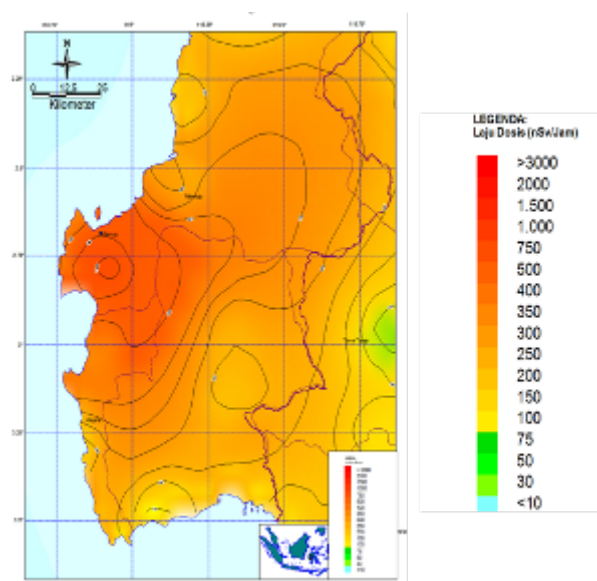


Figure 2. Location of the study area in Mamuju - Indonesia

2.2. Research Methods

Since 2011, the Center for Safety Technology and Radiation Metrology, the National Nuclear Energy Agency (PTKMR BATAN) has a dose evaluation facility using OSL (Optically Stimulated Luminescence) technology, known as the InLight Microstar System. InLight Microstar System consists of OSLD Microstar Reader (OSLD Reader), computer and barcode scanner. This device is an OSL InLight dosimeter type XA / AA (personnel dose), EX type (environmental dose), and pacifier type (patient / medical dose) [6].

Related to the research on effective dose data in the society due to high natural radiation exposure in Mamuju Regency, West Sulawesi, the InLight Microstar System facility is involved in evaluating ambient doses of the environment or $H^*(10)$ using OSL dosimeter type EX. This type of OSL dosimeter can be used to measure doses originating from environmental radiation exposure or occupational radiation exposure. The OSL dosimeter to be used for measurement must first be annealed [7]. Furthermore, OSL is packed with aluminum foil paper to prevent translucent light which can result in fading at the dose readings received. Each OSL is labeled a number for marking the installation location. Then the packed OSL dosimeter is put in a sealed plastic bag and ready to be used for measurement (Figure 3).



Figure 3. OSL Dosimeter ; unpack, packed, and InLight Microstar System

In situ measurements were done for $\pm$ two months from February 20, 2019 to April 12, 2019 installed in 70 houses. There are 7 sample houses for each sub-village chosen randomly varied from various building materials and architectures. OSL was installed at the main room by hanging it as far as 50 cm from the roof of the house and kept away from the direct light source. The results obtained are an ambient dose of $H^* 10$, which is reading on OSL is repeated three times to account for errors in the data.

3. Results

Table 1 is the result of ambient dose $H^*(10)$ in sampling houses at Botteng Utara village. The ambient dose results vary for each house in each sub-village. Figure 04 shows the distribution of ambient doses. Based on Figure 04, the dose distribution in each house is quite varied so that the average dose value for each sub-village is counted. The range of ambient dose achieved by measurement 51 up to 176 mRem/hr. The average ambient dose can be seen in Table 01. From the results of the interpretation of the graph, it is known that the Tande-Tande sub-village obtained the highest ambient dose H^*10 129.50 mRem or 1.295 mSv while the lowest is Salukalo which obtained 61.80 mRem or 0.680 mSv for about two months measurement.

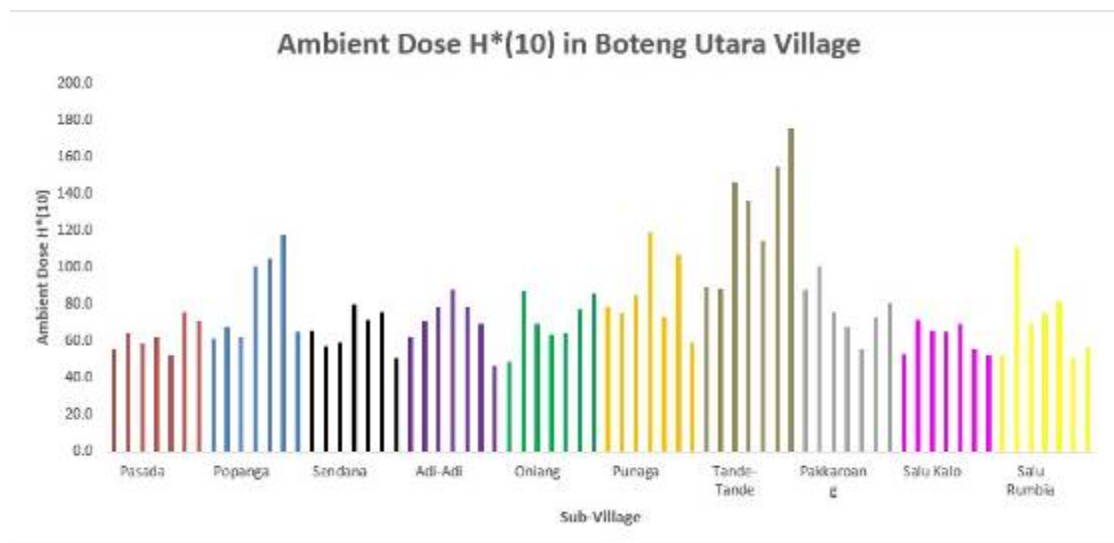


Figure 4. Distribution of ambient dose H^*10 in Botteng Utara Village obtained from sampling house

The varying amount of ambient dosage (H^*10) is influenced by the primordial condition of environmental radioactivity. Radioactive elements contained in the soil, such as uranium and radium will affect the photons captured in the OSL detector. The reading results will be directly proportional to the large level of radioactive elements. As is well known, Mamuju is an area of high natural radiation which is influenced by uranium and radium contained in the soil.

Apart from being influenced by terrestrial radiation, materials and architecture buildings also influence OSL reading results [8]. Building materials can trap radium inside the house, thereby affecting the dosage read on OSL. In addition, air ventilation also affects radium trapped inside the house. Healthy air circulation will reduce trapped radium thereby reducing the ambient dose in the house.

As Table 1 has shown the data, the ambient dose of OSL has exceeded the radiation level limit with the safe limit for areas of the normal background set by UNSCEAR (2.4 mSv/y). The high ambient dose has shown no significant health risk, but further studies related to epidemiology are needed to explore the possibility of health hazardous problems. For further research, a comparison of the results obtained with radon measurement data, measurement of indoor / outdoor dose rates, and the concentration of radioactive elements in the soil can be made.

Table 1. Highest vs Lowest Ambient Dose H*(10) in Botteng Utara Village

Sample No.	Ambient Dose (mRem)		
	Highest	Lowest	Average Data
Pasada	76,0	52,5	62,90
Popanga	117,7	61,3	82,90
Sendana	80,0	51,0	65,80
Adi-Adi	88,0	46,3	70,40
Oniang	87,3	48,7	70,90
Punaga	119,0	59,3	85,30
Tande-Tande	176	88,7	129,50
Pakkaroang	101	56	77,50
Salu Kalo	71,3	52	61,80
Salu Rumbia	111	51	71,00

4. Conclusions

The ambient dose H*10 in Botteng Utara Village has been studied using a radon passive detector. The range of ambient dose achieved is from 51 up to 176 mRem/hr with the highest is in Tande-Tande that is 129.50 mRem and the lowest is in Salu Kalo that is 61.80 mRem. The average values have exceeded the radiation level limit with the safe limit for areas of the normal background set by UNSCEAR (2.4 mSv/y). The data obtained will be used for further studies related to epidemiology is needed to explore the possibility of health hazardous problems.

Acknowledgments

We thank the residents in Botteng Utara Village. Mamuju regency, for their willingness and permission for installed dosimeters in their homes. Thanks to Mr. Eko Pujadi as the person in charge of environmental research in the high radiation area for the previous period, Eka Aulia Ardyanti from the radiation safety group as the officer who evaluated the results of OSL measurements, as well as Center of Radiation Safety and Metrology Technology, the National Nuclear Energy Agency of Indonesia who has financed this research project in 2019.

References

- [1] A. T. Ramli, A. S. Aliyu, E. H. Agba, and M. A. Saleh, "Effective dose from natural background radiation in Keffi and Akwanga towns, central Nigeria," *Int. J. Radiat. Res.*, vol. 12, no. 1, 2014.
- [2] M. Syaifudin, "Buletin ALARA - Pusat Teknologi Keselamatan dan Metrologi Radiasi," in *ISSN 1410 – 4652*, vol. 19 Nomor 1, 2017, pp. 17–25.
- [3] G. Assembly, *UNSCEAR 2017 Report: SOURCES, EFFECTS AND RISKS OF IONIZING RADIATION*. 2018.
- [4] N. Rahajeng, I. Kurnia, T. Rahardjo, V. A. Sufivan, and M. Syaifudin, "Health Status and Physical Condition of Community Living in Takandeang Village, an Area With High Natural Radiation in Mamuju," *2nd Int. Conf. Sources, Eff. Risks Ioniz. Radiat. 14th Bienn. Conf. South Pacific Environ. Radioact. Assoc.*, pp. 133–138, 2016.
- [5] H. Syaeful, I. G. Sukadana, and A. Sumaryanto, "Radiometric Mapping for Naturally Occurring Radioactive Materials (NORM) Assessment in Mamuju, West Sulawesi," *Atom Indones.*, vol. 40, no. 1, p. 35, 2014.
- [6] B. Y. E. B. Jumpeno, E. Ekaranti, and P. Batan, "Verifikasi Dosis H *(10) Pada Evaluasi Dosis Radiasi Lingkungan Menggunakan Dosimeter OSL Verification of H *(10) Dose on Environmental Dose Evaluation by Using OSL Dosimeter," *Widyanuklida*, vol. 16, no. 1, pp. 22–28, 2017.
- [7] I. KOBAYASHI, T. OKAZAKI, K. YAJIMA, and H. YASUDA, "Environmental Radiation

- Dosimetry by the Small OSL Reader,” *Prog. Nucl. Sci. Technol.*, vol. 3, pp. 79–81, 2012.
- [8] E. Pudjadi, Wahyudi, A. Warsona, and Syarbaini, “Measurement of Indoor Radon-Thoron Concentration in Dwellings of Bali Island, Indonesia,” *2nd Int. Conf. Sources, Eff. Risks Ioniz. Radiat. 14th Bienn. Conf. South Pacific Environ. Radioact. Assoc.*, no. September, pp. 186–192, 2016.