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Environmental Radiation Surveillance Results from over the Last Decade of Operational Experience at the Regional Radiation Monitoring Stations (RRMS)

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1. Introduction

Environmental radiation surveillance program in Korea started in 1961 to measure the radioactivity of radioactive fallouts originated from the open-air nuclear weapon tests conducted in other countries [1]. Since then the program has experienced many changes and numerous expansions in scale, and at this point in time it is operated under the guidance of Korea Institute of Nuclear Safety (KINS) according to the Act of nuclear safety (Article 105).

The objectives of the current program are to monitor environmental radiation/radioactivity level in Korea and to provide the base-line data on environmental radiation/radioactivity which will be useful in the case of radiological emergency situations. This program plays an important role in the view of protecting the public health against the potential hazards of radiation and maintaining a clean environment [2].

This paper describes an introduction to the Regional Radiation Monitoring Stations (RRMS), and also presents some results of recent years (2001-2014).

2. Methods and Results

2.1 The Regional Radiation Monitoring Station (RRMS)

Nationwide monitoring is provided by the Regional Radiation Monitoring Stations located nationwide and there is one central station operated by KINS. The first RRMS were installed in Seoul, Incheon, Daejeon, Daegu, Busan and Jeju in 1967. New stations were setup at Ulsan and Incheon (in 2012 and 2013), and another new station at Jinju was installed recently. As a result the RRMS system is established and operated in 15 highly populated regions now. Monitoring targets include radioactivity concentrations in samples of airborne dust, precipitation, fallout, tap water. And the gamma exposure rates which would be very useful due to their fast responses for the purpose of early detection of a radiological emergency, are usually measured using ion chambers. Measurement periods are set to scopes for the accomplishment of monitoring purpose according to targets. Table I shows RRMS operational program [3].

Table I: The operational program of RRMS

List	Radionuclides		Period	Pretreatment method
Airborne Dust	Gross Beta		Weekly	Low Volume Air Sampler
	Gamma	Particle	Weekly	High Volume Air Sampler
		Particle /Ash	Monthly	High Volume Air Sampler
		Gas	Weekly	Low Volume Air Sampler
Fallout	Gamma		Monthly	Evaporation
Precipitation	Gross Beta		Every rain	Evaporation
	Gamma		Monthly	Evaporation
Tap water	Gamma		Monthly	Evaporation
TLD (Collective dose rate of a region)	Dose		Quarterly	TLD

2.2 Measurement of gamma exposure rates

The outdoor gamma radiation level was measured at 15 regional stations using a high pressurized ion chamber filled with Argon gas compressed to 25 bar (Model: RSS-131, GE). At each spot, a reading was taken in air, every 15 minutes, at 1 ~ 1.2 m above the ground. The averages of gamma exposure rates are given in Table II and Fig. 1. The range of the values is from 8.1 to 15.9 μR/h for the last 14 years. The Suwon station shows the highest in regional average, while the Jeju station located in southern volcanic island of Korea provides the lowest due to its parent rock material. This trend is similar to the trends from other studies.

Table II: The comparison of gamma exposure rates

	Period	Average (μR/h)	Range (μR/h)
This study	2001-2014	12.3	8.1~15.9
Literature 2 (J. W. Park et al, 2003)	1991-2000	11.4	7.6~16.3
Literature 1 (K. H. Kim et al, 1995)	1992-1993	9.5	2.3~17.1

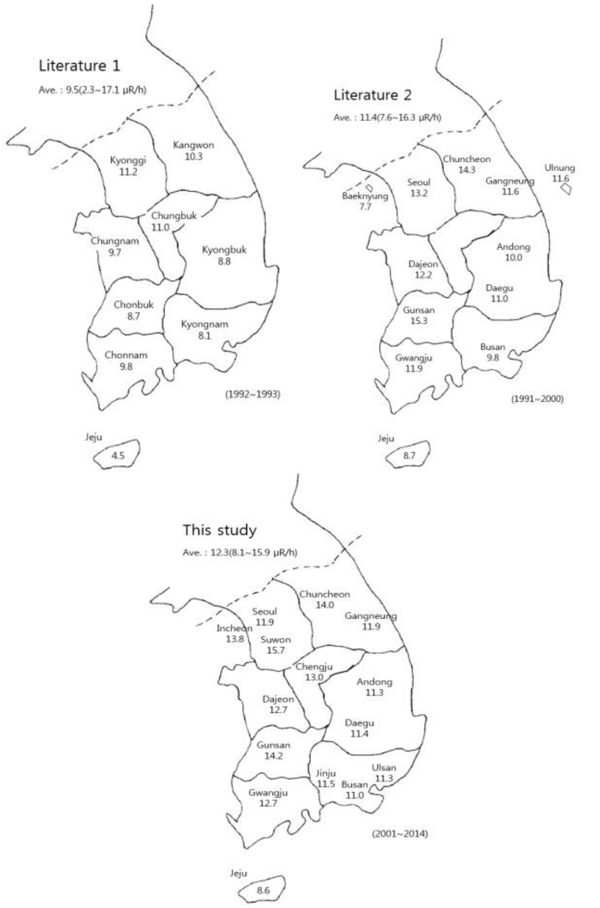

Fig. 1. Regional average distribution of the gamma exposure rates from three studies

2.3 Measurement of gross beta

Gross beta activities in the airborne dust and precipitation were measured to find information about rough fluctuations of environmental radioactivity or status of environmental emissions of radioactive materials quickly. For the airborne dust, the sample was collected by the low volume air sampler once a week. After passing the air through a filter paper (micro-fine borosilicate glass fiber filter paper, pore size 0.3μm, collection efficiency of 99.9%) for 24 hours, then the filter was detected using gas-flow proportional counters with a 2π geometric efficiency and P-10 (Ar 90% + CH_4 10%) gas. The detector efficiency was determined by the following equation.

$$\text{Eff.}_k = (n_k - n_b)/N_k \times 100$$

Where,
Eff._k : The counting efficiency of the standard sample
n_k : gross counting rate of the standard sample (cpm)
n_b : background count rate (cpm)
N_k : Standard samples(KCl) of radioactive (dpm)

A precipitation sample was made by collecting more than 100 mL water whenever it was raining (or snowing) and was reduced in volume to 5 ~ 10mL by evaporation. After then the sample was moved to a planchet where it was completely dried for measurement.

The gross beta radioactivity of airborne dust was measured after 5 hours and re-measured after 48 hours from the collection. Rainwater measurement was made 48 hours after, too [1][4]. The annual variation of gross beta radioactivity in airborne and precipitation is shown in Fig. 2. The monthly average range of airborne is 0.805 ~ 18.9 mBq/m^3 and 17.5 ~ 2610 mBq/L in precipitation, respectively.

Fig. 2. Gross beta radioactivity in airborne and precipitation

3. Conclusions

The environmental radiation surveillance results of years 2001-2014 have been described. It indicates normal levels of radiation in the past years. These kinds of studies are very important in providing references in understanding the environmental radioactivity level in a particular region.

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