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Office of Atoms for Peace

Establishment of the National Baseline Using Data from IDC

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Abstract

Radionuclide levels from selected IMS stations have been studied, in order to establish the national baselines. The study has focused on specific radionuclides including, nuclides from medical production, and fission products from research reactors and nuclear power plants, as well as existing particulate and gaseous nuclides from nuclear tests from the past. The data obtained from IDC products for the region of East Asia have been analyzed from year 2014. Then, geo-statistic analysis has been performed to study the probability distributions of the radiation from the nuclides of interest across the country. The radiation baselines will be used as a new measure supporting the decision making in case of nuclear incidents in the region.

Introduction and Source Terms

The nuclides of interest are Co-60, Tc-99m, I-131, Cs-134, Cs-136, and Cs-137. Those nuclides are from human activities including isotope production, mining, scrap metal industry, and nuclear power plants. Office of Atoms for Peace, OAP, has established monitoring program and considered that the nuclides listed above can be used as indicators for radiation and nuclear incidents or any other suspicious activities.

Tc-99m has been produced by reaction of Molybdenum Trioxide (MoO_3) and followed by Methyl Ethyl Ketone (MEK) extraction process. The production capacity was approximately 1–2 Ci per batch. The consumption of Tc-99m with the supply sources is summarized and illustrated in **Fig.1.1**.
The production of I-131 started from 1–2 Ci/week, then increased to 5–6 Ci/week, which was at the maximum capacity.

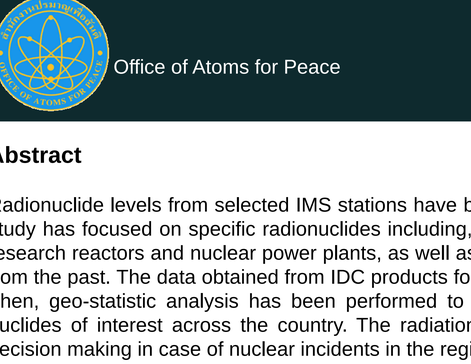


Fig 1.1. Summary of Tc-99m consumption in Thailand.

Scrap metals have been imported to use as raw material for casting industry. The import increases every year as shown in Fig. 1.2.

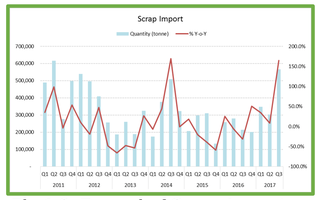


Fig 1.2. Record of Scrap Import in Thailand from year 2011-2017. Source: http://www.thanasarn.co.th

Tc-99m & I-131
- Isotope production & Radiotherapy

Co-60 & Cs-137
- Scrap metal, Cast iron industry

Cs-137, Cs-136, Cs-134, I-131
From Nuclear facilities
- Domestic: Research reactor
- Outside the country: NPPs

Interested Nuclides:
- Tc-99m
- I-131
- Co-60
- Cs-137
- Cs-136
- Cs-134

Fig 1.3. Research reactor in Thailand.

The research reactor in Thailand, TRIGA Mark III with the nominal operation of 1.2 MW, the program has developed in various aspects, including applications in medical, agriculture, industry as well as research and education.

NPP accident consequence assessment shows the possibility of environmental impact to Thailand and other ASEAN country.

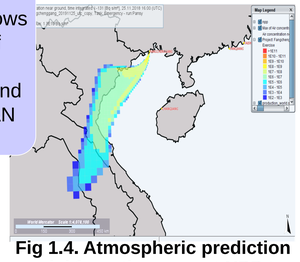


Fig 1.4. Atmospheric prediction model from the nearest NPP to Thailand during monsoon season.

References
[1] Thailand Institute of Nuclear Technology Record, Radioisotopes in Medicine, information updated as of 26 Jan 2011.
[2] S. Charoen, Current status of Tc-99m Production in Thailand JAERI -Conf 2003 -004.

Acknowledgements
•Thailand Institute of Nuclear Technology.

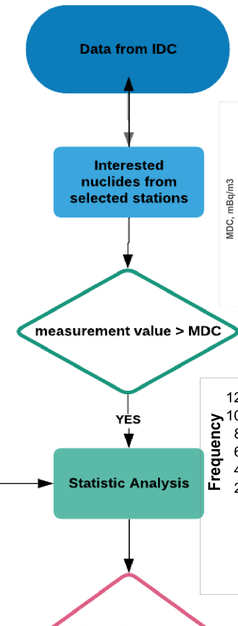
Data Processing

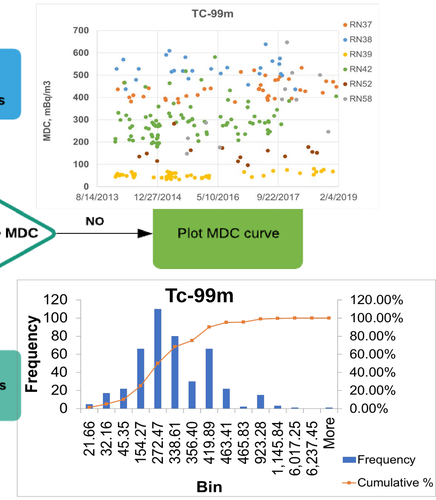
Data of interested nuclides from IMS stations within and nearby Asia have been used for analysis. The data with the value that is less than minimum detection concentration (MDC) were filtered out, then statistic analysis were performed. Histograms for each nuclide from all stations were plotted. The step of data processing is shown in **Fig.2.1** and the data are summarized in **Table** 1. Geo-statistical analysis was performed to estimate the level of the background for each nuclide. The result from analysis, however, contained high uncertainty because of few number of the stations compared to the coverage area.

Table 1. Summary of the data for each nuclide detected from selected IMS stations.

Nuclide	Station	China			Japan		Kiribati	Malasia	Mongolia	Philippines	Russia	Thailand
		Beijing	LanZhong	Guangzhou	Okinawa	Takasaki	Kiritimati	Kuala Lumpur	Ulaanbaatar	Quezon City	Ussuriysk	Bangkok
		RN20	RN21	RN22	RN37	RN38	RN39	RN42	RN45	RN52	RN58	RN65
	Latitude	40.0	36.0	23.1	26.5	36.3	2.0	4.5	47.9	14.6	44.2	14.0
	Longtitude	116.4	104.0	113.3	127.9	139.1	157.4	101.4	106.3	121.4	132.0	100.0
Co-60	Number of Detections	-	0 (out of 2)	-	3 (out of 20)	0 (out of 14)	3 (out of 6)	56 (out of 301)	0 (out of 2)	0 (out of 3)	5	-
	Average value (μBq/m^3)				2.36		1.66	3.79		0.864	2.388	
Cs-134	Number of Detections	-	-	-	0(out of 4)	941 (out of 1070)	0 (out of 2)	1 (out of 3)	0 (out of 1)	0 (out of 3)	1	-
	Average value (μBq/m^3)				2.36	26.73	1.66	3.79		0.864	2.388	
Cs-136	Number of Detections	-	0 (out of 1)	-	0 (out of 5)	0 (out of 2)	0 (out of 5)	0 (out of 1)	-	0 (out of 3)	0 (out of 5)	-
	Average value (μBq/m^3)											
Cs-137	Number of Detections	3 (out of 4)	4 (out of 8)	-	19 (out of 35)	1265	24 (out of 174)	0 (out of 1)	23 (out of61)	-	108 (out of 122)	0 (out of 6)
	Average value (μBq/m3)	3.8833	6.27		727	182	3.78		10.23		9.8	
I-131	Number of Detections	7 (out of 16)	0 (out of 1)	30 (out of 48)	2 (out of 8)	0 (out of 1)	0 (out of 4)	0 (out of 2)	0 (out of 1)	19 (out of 64)	4 (out of 13)	0 (out of 1)
	Average value (μBq/m^3)	7.25		15.54	5.54					3.27	3.28	
Tc-99m	Number of Detections	4 (out of 7)	-	0 (out of 1)	1 (out of 41)	0 (out of 28)	1 (out of 53)	2 (out of 95)	10 (out of 187	0 (out of 14)	1 (out of 13)	0 (out of 1)
	Average value (μBq/m^3)	993			363.66		55.92	186.9	434		725.1	
	Total of detections	27	12	49	113	2380	244	403	252	87	154	8

a - numbers used in calculation (out of all no.reported by IDC)





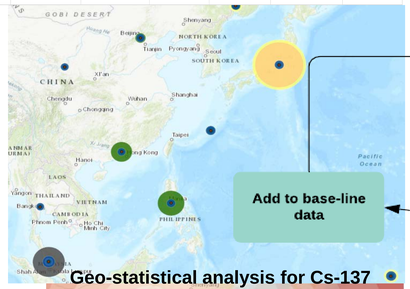


Fig.2. Steps for data processing.

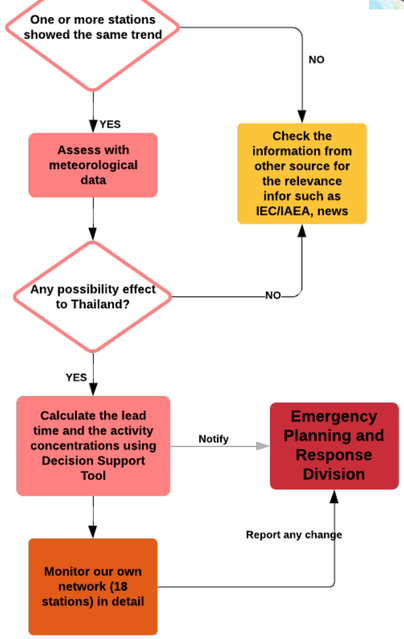


Fig.3. Investigation flow of the warning data for further action.

Decision Making Support

This study aims to use the available international resources, to enhance the performance of the existing early waring system. The warning level is set at 2σ for analyst to do further investigation of the root cause, and then assess for the impact. As a preliminary study, the warning is currently set at 2σ to understand the nature of the detection and stations in the region, and not to miss any suspicious fact that possibly cause the elevated radiation. The results integrated with other information such as metrological data can be used for decision making as the information support. Routinely, calculated dose rates at the border of Thailand during first 24 hours will be compared to the background dose rate measured at monitoring stations network. With the more available and reliable information monitoring data from IDC, the dose rate value to trigger the level 1 alarm (for investigation) of the radiation monitoring system, taking into account the potential dose rate attributed to any detection of release, may be reconsidered. Therefor, the result can also be used for developing national and regional "Emergency Preparedness and Response (EPR)" strategy for transboundary atmospheric dispersion from a radiation/nuclear accident outside the region or any other incidents.