**137Cs contamination in one river valley in Taiwan**

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**INTRODUCTION**
In early 1990, local people in Tau-Yuan County, Taiwan, noted surface radioactivity in Ta-han River valley. The contaminated area was said to be within 1 km from an outlet drainage from the government-owned Institute of Nuclear Energy Researches (INER). It was reported that accidents with spent nuclear fuel had occurred in the Institute in late 80’s (1). About 6 years after the accident, the contamination in the valley was contained and part of the soil from contaminated area replaced.

In order to make a more comprehensive evaluation of the contaminated area, we conducted a systematic sampling and tried to characterize 137Cs distribution in 1999.

**SAMPLES PREPARATION AND MEASUREMENT**
At each sampling site, a soil sample was taken from the surface down to 10-15 cm in depth. All soil samples were taken from randomly selected microplots (20x20 cm) to cover sites of cultivated and uncultivated soils. Each sample weighted about 2.0-2.5 kg. Samples were oven dried at 110°C for about 48 hours. Clods were crushed with a mortar and pestle. Rocks and plant roots were removed. In order to obtain homogeneous structure, all the samples were ground in a ball mill to particle size less than 0.1 mm in diameter and thoroughly mixed.

Radioactivity measurement of 137Cs and gamma-emitting natural radionuclides was performed by the HPGe (High-Purity Germanium Coaxial Detector System, 30 % efficiency at 1.33 MeV of 60Co, GEM Series), coupled with Nomad™ Plus Portable Spectroscopy System (EG&G ORTEC) and PC with Gamma-Vision™ spectroscopy software for germanium detector gamma-spectrum analysis (EG&G ORTEC). The Gamma-spectroscopy system was supplied with a lead shield with a uniform 10 cm wall thickness. A Standard Radionuclide Sources, soil equivalent (ANALYTICS, USA) was employed for efficiency calibration of the spectroscopy system.

Each soil and rice sample after treatment was placed in the similar container as that for the Standard Source and measured for 80,000 s. The counting uncertainty did not exceed 20%. The Currie method was employed to estimate lower limit of detection (2). The gamma transitions of 208Tl (583.14 keV) and 228Ac (911.07 keV) were employed to determine activity of 232Th series radionuclides (3, 4). Radionuclides of 232Th series and 40K in the same sample were measured simultaneously to characterize concentrations of natural radionuclides.

**RESULTS AND DISCUSSION**
The scheme of the 137Cs distribution study is shown on Fig.1.

Figure 1. Scheme of 137Cs distribution study in Ta-han River valley
In order to characterize the distribution of $^{137}$Cs contamination in Ta-han River valley, soil samples were taken toward different directions from the possible source of contamination – outlet of the INER underground drainage:

Direction A. Directly from the outlet toward Ta-han river bank.
Direction B. From the outlet and along the valley.

Concentrations of $^{137}$Cs on each direction is shown on Fig. 2 and 3.

As could be seen from the Fig. 2, concentrations of $^{137}$Cs sharply decrease toward the Ta-han River bank. Therefore, no significant contamination had been occurred in this direction. In contrast, spatial distribution of radionuclide’s concentrations in Direction B is characterized by strong non-uniformity (Fig.3). As was mentioned above, some comprehensive post accidental clean-up was reported to have been conducted in the studied area (1). The remaining soil was treated and stirred by bulldozers and tractors by the farmers. Because of that, it was very difficult to identify pathways of $^{137}$Cs inflow to this area. The highest amounts of radionuclide were found concentrated in soil of some rice field (the third bar on Fig. 3). This site is located far downstream from the outlet. It was assumed that soil from this site functioned as the original trap for $^{137}$Cs dispersion because it was the lowest level in the studied area. Apparently, as contaminated material was washed down from the outlet drainage and further downstream along the valley, $^{137}$Cs was primary absorbed by soil from this site. We also suspect that extensive soil cleaning was not conducted there.

It can be seen clearly from the Fig. 2 and 3 that concentrations of $^{137}$Cs in deposits from the outlet also still remain on relatively high levels. High radionuclide’s concentrations in the drainage reservoir pond could have originated from continuous inflow in recent years. It could be due to wash-off from hill top and slopes.
covered by forest and inaccessible for previous clean-up.

The same might occur on the site located about 4 km downstream from the outlet drainage (the last bar on the Fig.3). It also was a rice field and maximal $^{137}$Cs concentration in soil unexpectedly reached about 280 Bq/kg. We assume that a local stream from hill may have served as a separate water drainage source for this field. It was probable that water flow washed off soil from the uphill catchment area nearby the INER and proved this contamination. Meanwhile, concentartions of naturally occurring radionuclides in soil from studied area were comparable with levels typical for soils in Taiwan (5,6).

In conclusion it should be noted, that $^{137}$Cs distribution in soils from studied area is an important example of radionuclides dispersion in extremely disturbed landscape. Combination of natural factors such as wet climate and high amount of precipitation with human activity complicates the understanding of radionuclides inflow pathways and migration.

REFERENCES