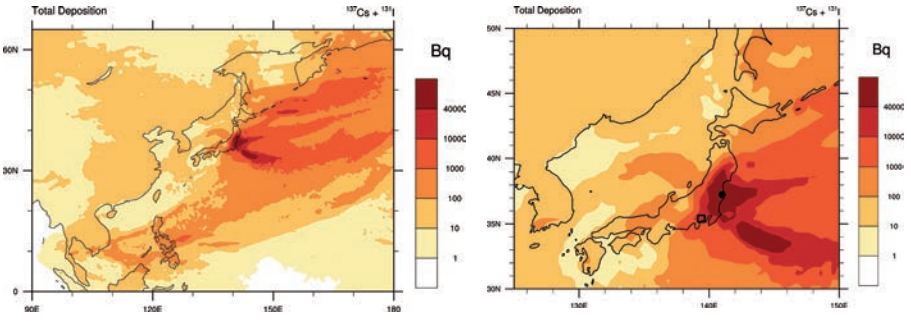
New insights on radioactivity from Fukushima

A recent study by the Cyprus Institute in Nicosia addressed the atmospheric dispersion of radioactive isotopes from Fukushima, Japan, during several months after the nuclear reactor accidents. The study was performed by Dr. Theo Christoudias and Prof. Jos Lelieveld in the frame of an ERC Advanced Researcher Grant. The results suggest that an area of more than 34,000 km^2 in Japan was radioactively contaminated, and that about 3% of the radioactive iodine reached Europe (publication doi: 10.5194/acp-13-1425-2013).



Model calculated deposition of radioactive iodine and caesium, showing the western Pacific region (left) and Japan (right), based on the low iodine source. The black point marks Fukushima and the square the Tokyo metropolitan area. The 40,000 Bq/m^2 contours (dark red) signify areas that received a total deposition greater than the contamination threshold defined by the IAEA.

The nuclear accident in Fukushima, which took place in March 2011, caused the release of large amounts of radionuclides (unstable atoms that produce radioactivity) to the atmosphere. Caesium and iodine radionuclides can affect human health through the contamination of air, water, soils and agricultural products. The study computed the spreading of radionuclides in the atmosphere and the deposition patterns until the end of May 2011, using a high-resolution atmospheric chemistry – general circulation model.

The prevailing winds transported most of the radionuclides away from Japan and over the Pacific Ocean where about 80% of the caesium (^{137}Cs) was deposited. This was different for iodine radionuclides (^{131}I). The model results suggest that about 13% of the iodine was deposited over the USA and Canada, nearly 5% over Russia and 3% over Europe. Approximately 50-60% deposited in Japan.

Contaminated ground

The International Atomic Energy Agency (IAEA) defines "contamination" as the presence of a radioactive substance in quantities of more than 40,000 Becquerel per m^2 (Bq is unit of radioactivity). The study estimated that the land area affected by radioactivity from both types of radionuclides exceeding this threshold in Japan is approximately 34,000 km^2, inhabited by around 10 million people.

However, this calculation was based on an iodine source that is considered to be a lower limit. An additional calculation, assuming five times larger emissions – indicated by limited observations – suggests that a larger and densely populated part of Japan, 56,000 km^2, including Tokyo, would have to be classified as contaminated. This underscores the need to perform representative measurements and improve the source estimates.

Dosage to population

Finally, the exposure of the population was investigated in terms of the inhaled dose of radioactivity, estimated to be between 10 and 20 milliSieverts (mS) – equivalent to a CT scan – over an area of about 2500 km^2. It should be emphasised that this includes only two radionuclides and is based on the lower source estimate of iodine. Further, this dose refers to the general public and not to workers at the accident site who received higher doses. The 50-year ground deposition dose in the same area was estimated to exceed 125 mS.

Despite the uncertainties, in particular of the radioactivity source estimates used in the model, the study provides valuable information about the geographic deposition patterns, the population that was affected and the timing of the most important contamination periods.

Further Information:
Cyprus Institute
Nicosia, Cyprus
www.cyi.ac.cy
E-mail: christoudias@cyi.ac.cy