Comment on "Distribution of dissolved ^{137}Cs, ^{131}I and ^{238}Pu at Eastern Mediterranean Sea in case of hypothetical accident at the Akkuyu nuclear power plant", by Tsabaris et al. Journal of Environmental Radioactivity 251–252 (2022) 106964

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In Tsabaris et al. (2022) paper a numerical model for the eastern Mediterranean Sea is described, which is able to simulate the transport of radionuclides released to the sea from a hypothetical accident in a nuclear power plant. Three radionuclides, mentioned in the title, are considered. As mentioned in page 3 of the paper the same source is considered: instantaneous deposition on the sea surface consisting of circles with given radius for dissolved radionuclides and radionuclides fixed to particles; being activity the same for the three radionuclides. Thus, the release is exactly the same for the three radionuclides in magnitude, timing and initial geometry.

It is surprising that results for Cs and Pu are virtually the same (compare Figs. 2 and 4 in the paper). Even after 4 months, both the extension of the radionuclide patch and the color maps of concentrations are essentially the same. This is surprising since the geochemical behaviour of both radionuclides is very different. The explanation is given by the authors in page 6: *"The distribution of the dissolved* ^{238}Pu *has similar behavior as* ^{137}Cs *due to the long term lives of the radionuclides."* This is not correct. For both radionuclides half life is long compared with the simulated time and thus decay could even be neglected. This is not the case with ^{131}I and most of it disappears during the simulation. Long lives of both radionuclides is a required condition in order that their final distributions are the same; but this is not enough. In addition, it is required that their geochemistry is the same, and this is what the model is (incorrectly) doing.

It is well known that the mobility of Pu in the marine environment is much lower than that of Cs, due to the high affinity of plutonium to be fixed to sediments. Thus, Pu tends to be confined to a region close to the release point. As a few examples:

- Salomon et al. (1995) calculated a three month transit time of Cs from La Hague (English Channel) to Dover Strait (about 300 km). In contrast, Boust et al. (1997) estimated a transit time of Pu from La Hague to the east of Cotenin (about 100 km) of some 7 years. Simulation results in Periáñez (2003) are in agreement with such earlier estimations. The mobility of both radionuclides is extremely different.
- The transport of Pu directly released to the Pacific Ocean from Fukushima after the 2011 accident was simulated in Periáñez et al. (2013). It was found that Pu flushing time from the coastal waters off Fukushima was 243 days, in contrast with the 43 ± 16 days found for Cs (Dietze and Kriest, 2012). This difference was of course attributed to the low mobility of Pu in the marine environment. In addition, the impact of the released Pu was confined to a close area around Fukushima (less than 30 km radius).
- Exactly the same hypothetical accident was simulated for Cs and Pu in the Persian Gulf (Periáñez, 2021), i.e., same magnitude, timing and geometry of releases. The extremely different distributions of both radionuclides after 3 months can be seen in the paper (Figures 7 and 12 for Cs and Pu respectively). Differences are due to the different geochemistry of both radionuclides.

Of course the Mediterranean Sea is deeper than the English Channel and Persian Gulf. But Akkuyu nuclear power plant is located in the coast and thus the release occurs in shallow water. Also the main transport path is along the coast, as can be seen in the paper.

Thus, it seems that the model in Tsabaris et al. (2022) is not capturing the geochemistry of the different elements in a adequate form; which leads to distributions of Pu and Cs which are essentially identical. It is required to include radionuclide adsorption by bed sediments if an accidental Pu release from a coastal location is to be simulated.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

No data was used for the research described in the article.

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