E.D.E.N.: a software to calculate the dose rate of energy for the non-human biota, due to the presence of radionuclides in the environment

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Considering that, if this is well established for humans through the ICRP recommendations, radiological dose assessment tools are needed for non-human biota, we are working at the IRSN on an user-friendly software, EDEN for Elementary Dose evaluation for Natural Environment, dedicated to the calculation of dose rate for non human species.
Aim

- Energy delivered according to exposure conditions

- D.P.U.C. : ∀ org., ∀ rn, intern. & extern. exposure, α, β and γ radiations

Main hypothesis

H2 : homogeneity
- chemical composition
- density
- radionuclide concentration

For source and target

The dose calculation for such an organism is based on the estimation of the energy delivered to it, according to its exposure conditions.

Radiation dose may come from external sources surrounding the organism, like air, water and soil, as well as from internal sources, meaning radionuclides uptaken by the organism.

This deposited energy, normalised by one Bq per unit of mass or volume of the exposure source, constitutes an operational parameter, called DPUC for Dose rate Per Unit of Concentration, and expressed in Gy per unit of time per Bq per unit of mass or volume. The dose then results from the multiplication of the source concentration by the DPUC considered.

EDEN aims to provide these DPUCs for any organism, any radionuclide, both for internal and external exposure, for any radiations.

To simplify the physical problem to solve, two main hypotheses were made. First, any organism can be represented by an ellipsoid, characterised by its three axes. Second, any source is homogeneous in terms of elementary composition, density and radionuclide concentration.
The calculation aims to determine mono energetic DPUCs for given rays of energy, and then to extrapolate between them for any other energy. The combination of these mono-energetic DPUCs for the energies of a radionuclide spectrum gives the corresponding operational DPUC.

This is done with a Monte Carlo calculation, creating and tracking particles to determine their interaction with the target organism and the corresponding energy deposit.

The low penetration power of alpha and beta radiations leads to adopting different solutions according to the size of the target and the nature of its exposure. The dose is then considered negligible for macroscopic organisms externally exposed. Considering the same organisms in internal exposure, the hypothesis of local deposit is adopted. Finally, specific calculations are made only for microscopic organisms.
All these calculations have been implemented in EDEN, characterised by a screen organization common to all its screens. At the top is a title's heapiece. On the left is the menu's column. The rest of the screen is an active window that allows dialog with the user.

The main menu gives access to the theoretical documentation of the tool, to some common utilities and to the heart of the system, the calculation box.

This part is based on three elementary bricks that allow the whole description of a case, through interactive forms, one devoted to the definition of the shapes, the second concerning source characterisation, and the third, on the same model as the previous one, allowing the definition of the chemical compositions. The combination of these three fundamental elements makes up the calculation scenario. The final screen includes an area summarizing the scenario, a button that runs the code and a window informing the user on the final status of the calculation.
To illustrate my purpose, I have defined an exposure scenario that includes a 20 cm soil layer under a 5 cm grass layer. 5 meters of air are also considered, partially surrounding a rabbit, that is exposed internally as well as externally to cobalt, cesium and iodine radiations.

Running EDEN, for each radionuclide and its progeny we determined their DPUC for internal as well as external exposure. The code can also estimate the dose associated to an exposure duration.
friendly calculation for any user defined configuration

validation stage: tests and intercomparisons

(FASSET, UK EA, US DOE...)

A step in the development of a whole ERA tool

This project provides a tool simply allowing the calculation of DPUCs for any user defined configuration.

We are now testing the tool through intercomparisons with other methods aiming to determine radiological dose for non-human species.

Lastly, this tool will be integrated in the future in a whole ERA code, that would provide complete calculation from release dispersion to risk assessment.