

AN INTRODUCTION TO DOSE RATE MODELLING IN NON-HUMAN BIOTA WITH

The ERICA tool

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The ERICA tool



Environmental
Risk from
Ionising
Contaminants:
Assessment and Management

The ERICA consortium



Developed by a number of European Radioecology ALLIANCE members



Project partners: SSM, SKB, SUC, AFRY, GSF, CIEMAT, IRSN, EDF, EA, WSC, UniLiv, CEH, UMB, STUK & DSA

The ERICA tool timeline



First release – 2007

Version 1.2 – 2014

Version 1.3 – 2019

Version 2.0 – 2021

Current: v.2.0.221

Use of the ERICA tool



Modelling of radiological risk to non-human biota

Simple concept: Uses activity concentrations in media/tissues to calculate dose rate

Application/situation entirely depends on your input data and/or conceptual design

Tiered approach options

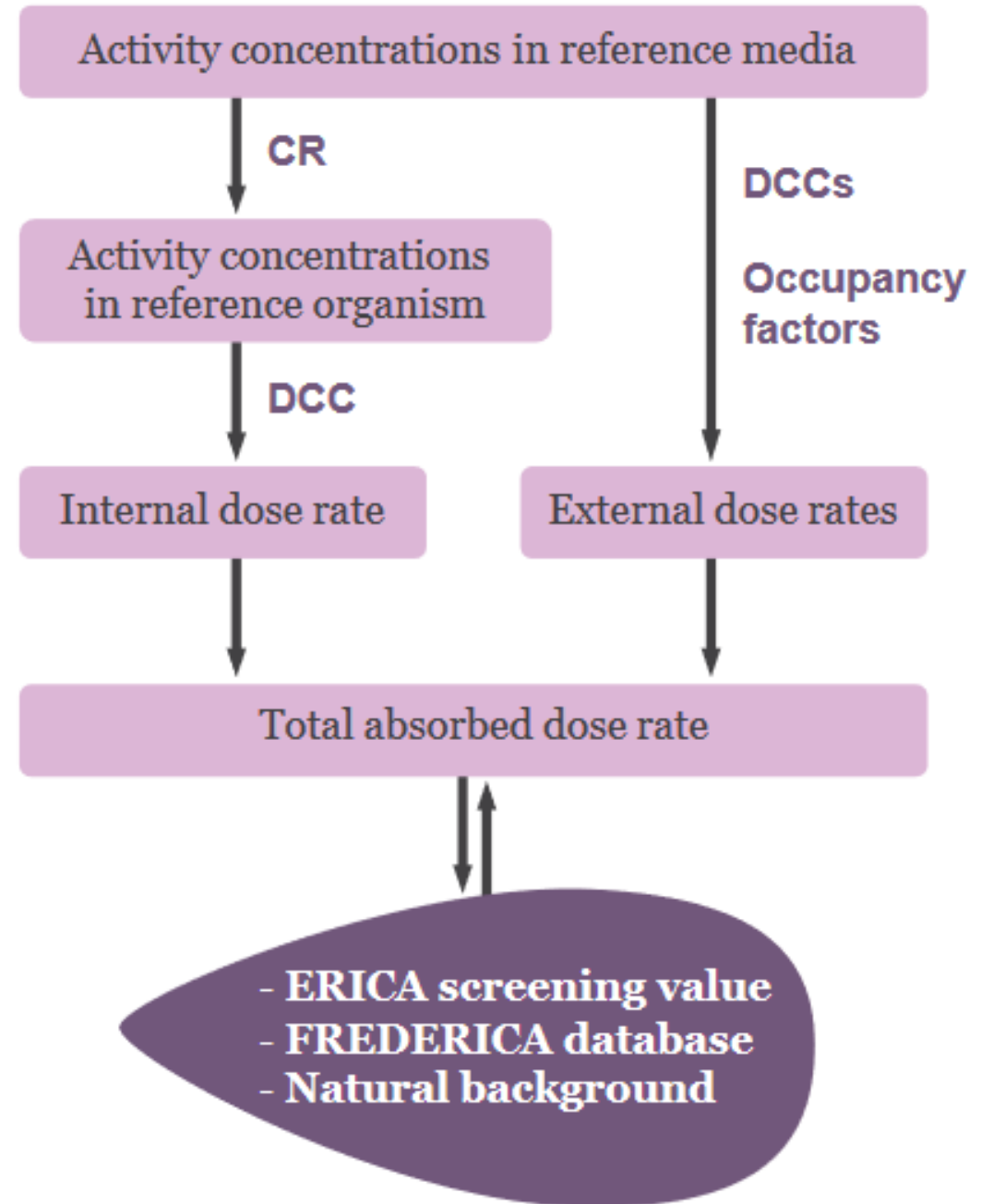
Spatial and temporal data supported

Calculations

CR – Concentration ratio

DCC – Dose conversion coefficient

Reference organism (similar concept to RAPs)



Reference organisms

13 different **Reference organism** types in each of three ecosystems

Terrestrial, freshwater and marine

Represent the **diversity** of organisms likely to exist at a typical site*

*Focus on European environments

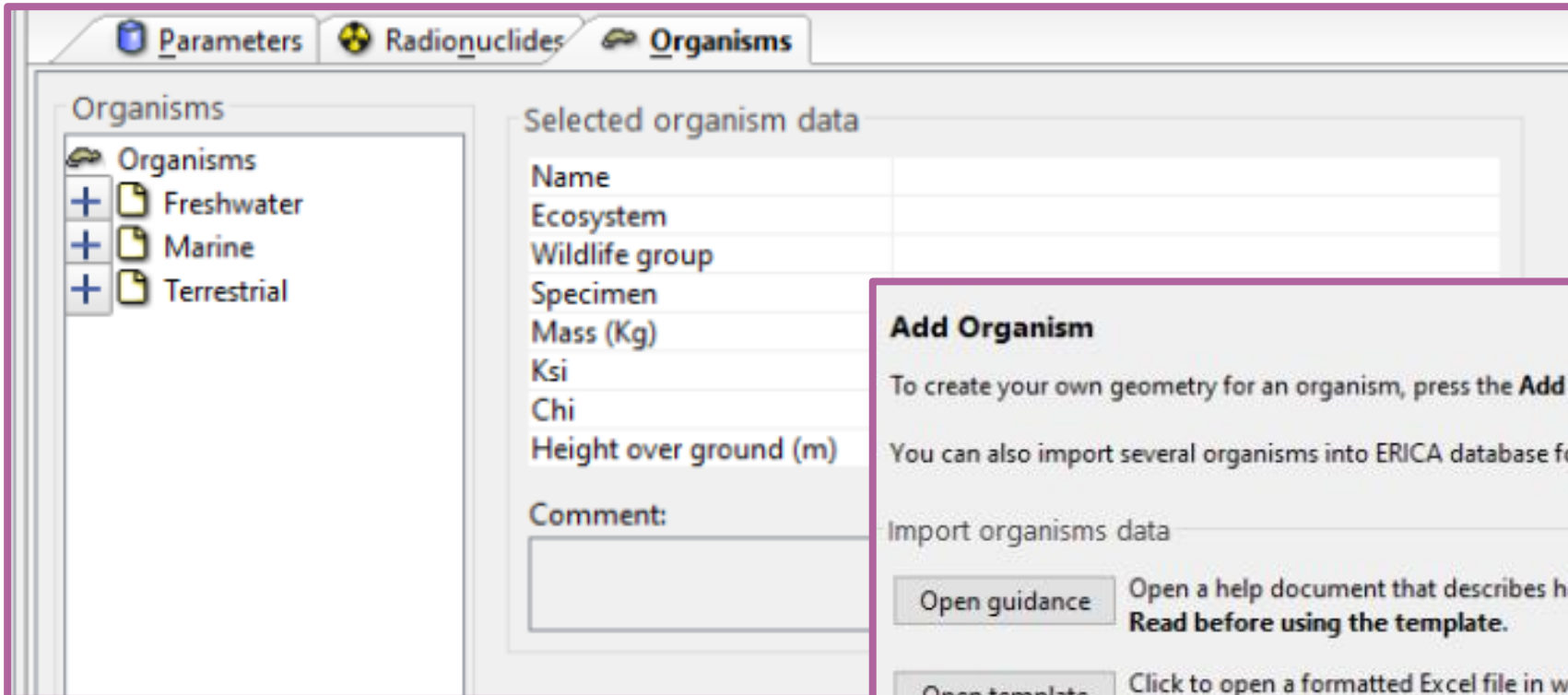
Reference organisms

- Terrestrial
 - Amphibian
 - Annelid
 - Arthropod - detritivorous
 - Bird
 - Flying insects
 - Grasses & Herbs
 - Lichen & Bryophytes
 - Mammal - large
 - Mammal - small-burrowing
 - Mollusc - gastropod
 - Reptile
 - Shrub
 - Tree

- Freshwater
 - Amphibian
 - Benthic fish
 - Bird
 - Crustacean
 - Insect larvae
 - Mammal
 - Mollusc - bivalve
 - Mollusc - gastropod
 - Pelagic fish
 - Phytoplankton
 - Reptile
 - Vascular plant
 - Zooplankton

- Marine
 - Benthic fish
 - Bird
 - Crustacean
 - Macroalgae
 - Mammal
 - Mollusc - bivalve
 - Pelagic fish
 - Phytoplankton
 - Polychaete worm
 - Reptile
 - Sea anemones & True coral
 - Vascular plant
 - Zooplankton

Add custom organisms



Add Organism

To create your own geometry for an organism, press the **Add** button located underneath the list of organisms tree box.

You can also import several organisms into ERICA database following these instructions:

Import organisms data

Open guidance Open a help document that describes how to fill in template file with your organism data.
Read before using the template.

Open template Click to open a formatted Excel file in which you can fill in your organism data. You will first be prompted to select a convenient folder to save the Excel file (.xls); review the file name and click on Save. ERICA will automatically open the template after you have clicked on Save.

Import organisms Click to import the organisms data from a convenient formatted Excel file.

Integrated DCC calculation

Integration of **BiotaDC**
(ICRP-136 methodology)

Collaboration between AFRY and
ICRP BiotaDC developer
(Alexander Ulanovsky)

The screenshot shows a web-based form titled "Input parameters" for the BiotaDC tool. The form is organized into several sections with labels and input fields:

- Ecosystem:** Radio buttons for "aquatic" and "terrestrial", with "terrestrial" selected.
- Type of terrestrial organism:** Radio buttons for "fauna" and "flora", with "fauna" selected.
- Exposure:** A dropdown menu labeled "Pathway" with "internal" selected.
- Mass of organism:** A text input field for "Mass [kg]" containing "1.0", with a range indicator "[10⁻⁶ ... 10³]" to the right.
- Shape of organism:** A text input field for "Shape" containing "1 : 1.0 : 1.0", with a range indicator "[0 ... 1]" to the right.
- Radionuclide:** Two dropdown menus for "Element" and "Mass number".
- Effect of radioactive progeny:** A dropdown menu for "Method" with "time-integral activities ratio" selected, and a text input field for "Time [d]" containing "365.2425".

At the bottom of the form is a green "Start" button.

ICRP, 2017. Dose coefficients for nonhuman biota environmentally exposed to radiation. ICRP Publication 136. Ann. ICRP 46(2).

Radionuclides

Starts pre-loaded with **101 radionuclides**

- '**Add radioisotope**' feature to include and parameterise an additional 711
- Includes noble gases

Radionuclide progeny is automatically generated and included in the calculations

- Includes branching ratio

Next update will include the **automatic** generation and inclusion of **radon/thoron** from radium

Integrated transport models

IAEA SRS-19 dispersion models

Can be used if activity concentration data in environmental media are unavailable

Terrestrial

- Air

Freshwater

- Small lake
- Large lake
- Estuary
- River

Marine

- Coastal
- Estuary

Databases of parameters

Concentration ratios – collaboration with the UK CEH **Wildlife Transfer Database**

- **CR gap-filling tool** helps give the next-best solution for where data is absent

DCCs included and generated within the tool (from BiotaDC)

All databases can be user-edited for **site-specific data**

FREDERICA **effects-database** integration

Concentration ratio gap-filling

Nuclide	Amphibian	Benthic fish	Bird	Crustacean	Insect larvae	Mammal	Mollusc - bivalve
Ac	4.79E3	1.13E3	2.91E3	3.35E4	3.35E4	4.79E3	3.35E4
Ag	3.00E2	2.00E3	3.50E2	2.07E4	2.07E4	3.50E2	6.36E3
Am	4.79E3	1.49E3	2.91E3	3.35E4	3.35E4	4.79E3	3.35E4
Ar	0	0	0	0	0	0	0
At	3.10E2	3.10E2	3.10E2	8.00E1	8.00E1	3.10E2	8.00E1
Ba	1.70E2	4.28E3	1.85E3	1.07E3	3.86E4	1.85E3	3.86E4
Bi	1.30E2	1.30E2	8.70E1	1.52E2	8.21E1	1.30E2	6.83E2
C	1.80E5	1.80E5	1.80E5	1.80E5	1.80E5	1.80E5	1.80E5
Ca	8.97E2	2.97E4	1.37E3	6.60E2	4.29E1	3.93E2	2.11E5
Cd	2.00E3	1.76E3	1.89E3	3.00E4	3.00E4	2.00E3	1.67E4
Ce	9.30E0	1.58E2	8.35E2	4.39E3	4.39E3	8.35E2	4.39E3
Cf	4.79E3	1.13E3	2.91E3	3.35E4	3.35E4	4.79E3	3.35E4
Cl	1.02E3	1.02E3	1.02E3	1.02E3	1.02E3	1.02E3	1.02E3
Cm	4.79E3	1.13E3	2.91E3	3.35E4	3.35E4	4.79E3	3.35E4

Select a cell to edit

Edit Value | Edit Distribution

Edit value and comment for selected cell(s)

Value: Comment:

Select ERICA default CR values

Method used to derive ERICA default CR value when no empirical data:

- A Bayesian approach or methods to derive a missing SD value applied to empirical datasets
- 1 Similar reference organism
- 2 From published review
- 3 Modelling approaches
- 4 Element of similar biogeochemistry for reference organism
- 5 Element of similar biogeochemistry for similar reference organism
- 6 Highest transition metal for reference organism
- 7 Estuarine data
- 8 Highest animal value
- 9 Highest plant/algae value
- 10 Combined methods*
- Select/Unselect all check boxes

*Using a combination of the above approaches.

FREDERICA effects database

Risk Background **Effects** Tables Plots Rules Record decision

This tab contains summarise radiobiological effects data to provide guidance on the types of effects that may be seen at given dose rates.

Organism
Mammal

Effects

Dose rate range [μGy h ⁻¹]	Dose rate [μGy h ⁻¹]	Species	Endpoint	Effect
0-50	10.0	Otter	MB	Minor decrease of body weight (10% reduction). No statistically significant effect on hair density
	16.0	Mice	MB	No statistically significant effect on body weight
	42.0	Vole	MB	Minor decrease of peripheral blood cells (15-50% reversible reduction)
	10.0	Otter	MT	Moderate decrease of otter population density (33% reduction)
	16.0	Mice	MT	Significant increase of life span (1.3 times the control value)
50-100	71.0	Dog	MT	Moderate decrease of life-span (30% decrease)
	80.0	Vole	MB	Major effect in percentage of voles infected with ectoparasites and low-fatness voles in population (3- fold increase)
	100.0	Mice	RC	Moderate decrease in fecundity (35% reduction in number of offspring sired and weaned; LOEDR)
	100.0	Mice	RC	Major decrease of male fertility (50% reduction of fertile pairs after male irradiation; LOEDR)
100-200	150.0	Mice	MT	No statistically significant effect on life span
	104.0	Pigs	RC	Major effect in male reproductive organs (59% reduction in number of primitive stem germ cells and sperm production; LOEDR)
	190.0	Mice	RC	No statistically significant effect on fertility and fecundity of F1 and F2
	190.0	Mice	RC	Major decrease of fecundity (60% reduction in litter size) and severe decrease in fertility (85% reduction in fertile females) in F3 and F4
	195.0	Mice	RC	Major decrease in fecundity of F1 and F2 (50% reduction in early survival)
200-400	291.0	Squirrel	MB	No pathological changes in liver, kidney, lungs or spleen
	240.0	Rats	MT	Major decrease of life span (45% decrease)
	400.0	Vole	MUT	Severe increase in the frequency of unstable chromosomal aberrations in bone marrow cells (3-fold increase)
	202.0	Rats	RC	Moderate effect in female reproductive organs (30% reduction in number of oocytes)
	230.0	Pigs	RC	Major effect in female reproductive organs (57% reduction in number of germ cells) and severe effect in male reproductive organs (89
	333.0	Mice	RC	Major effect in female reproductive organs (48% reduction in number of primary oocytes)

Thank you