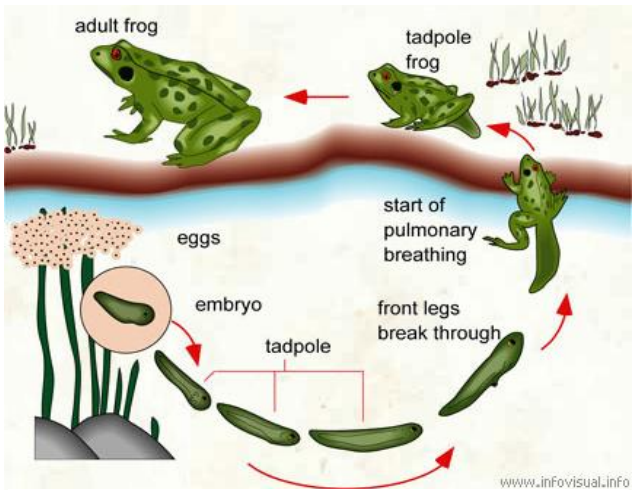
RADIATION DOSES TO FROGS DURING DIFFERENT LIFE STAGES

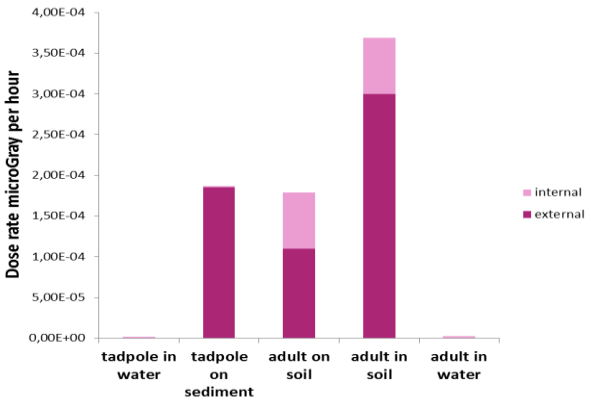
Exposure pathways of radiation and the resulting doses may differ for different life stages in an animals life cycle. A frog's life cycle is complex and encompasses several habitats and physiological changes. The first egg life stages are aquatic and laid in shallow freshwater. After hatching the tadpole is a free swimming herbivore breathing through gills. During metamorphosis the tadpole changes into a lung respiring juvenile carnivorus frog and migrate to terrestrial habitat. The adult frog will live in terrestrial or wetland habitat and return to freshwaters to breed. In temperate climates it will hibernate during the winter months in soil under logs or stones and in stream sediment.

In this radiation dose calculation example seven radionuclides (^{137}Cs, ^{241}Am, ^{14}C, ^{60}Co, ^{3}H, ^{90}Sr, ^{238}U) and five scenarios for different life stages of a frog were chosen:

- Egg/tadpole in water
- Tadpole on sediment surface
- Adult frog on soil surface
- Adult frog in soil
- Adult frog in water

^{137}Cesium. The ERICA tool was used and activity concentrations of ^{137}Cesium in soil or sediment was assumed to be 1 Bq kg^{-1}. In the freshwater habitat the concentration ratio for tadpole (ERICA insect larvae geometry) and adult frog (ERICA amphibian geometry) was 1987.5 and 2265.3 Bq kg^{-1} per Bq L^{-1}, respectively, and in terrestrial habitat 0.457 Bq kg^{-1} per Bq kg^{-1}. The freshwater K_d value was 1.40 x 10^5.





The results show that the radiation dose rates from ^{137}Cesium to a egg/tadpole will be higher the closer to the sediment they are. For the adult life stages the highest dose rates will occur during hibernation when the frog is in soil.

When the tadpole is in water the internal dose will be dominating over external dose while the external dose will dominate when it is close to the sediment.

For the adult frog the external dose will dominate over internal dose when it is in soil. When the frog is situated on the soil surface the dose will be about equal from external and internal radiation.

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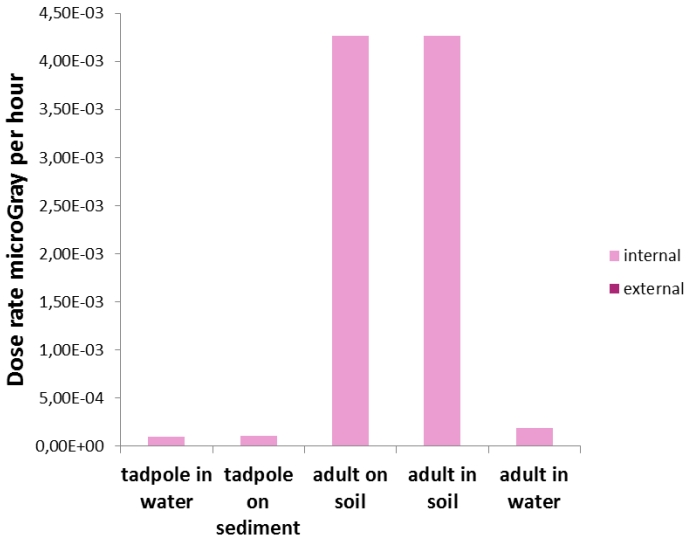
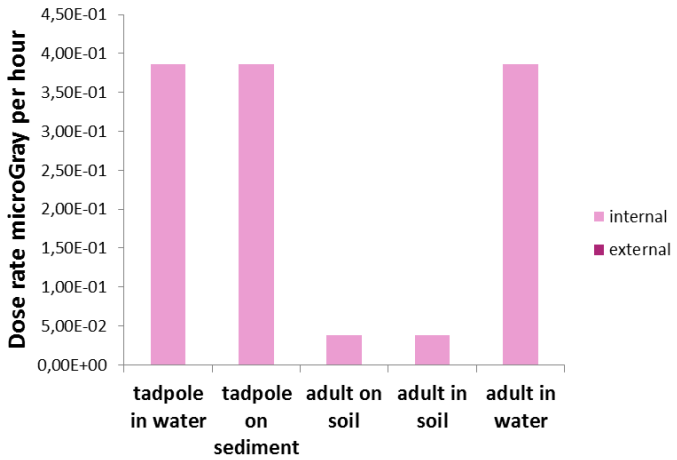
^{241}Americium. In this example radiation doses to different life stages of a frog was calculated from a hypothetical release of ^{241}Americium. The ERICA tool was used and activity concentrations of ^{241}Americium in soil or sediment was assumed to be 1 Bq kg^{-1}. In the freshwater habitat the concentration ratio for tadpole (ERICA insect larvae geometry) and adult frog (ERICA amphibian geometry) was 1750 and 3220 Bq kg^{-1} per Bq L^{-1}, respectively, and in terrestrial habitat 0.134 Bq kg^{-1} per Bq kg^{-1}. The freshwater K_d value was 5.46 x 10^5.



The results show that the dose rate from ^{241}Americium will be higher in the terrestrial ecosystem when the adult is on or in soil. The exposure will be dominated by internal doses for both tadpole and adult frog.

^{14}Carbon. Here, the ERICA tool was used and activity concentrations of ^{14}Carbon in soil or sediment was assumed to be 1 Bq kg^{-1}. In the freshwater habitat the concentration ratio for tadpole (ERICA insect larvae geometry) and adult frog (ERICA amphibian geometry) was 1.80 x 10^5 Bq kg^{-1} per Bq L^{-1} and in terrestrial habitat 1340 Bq kg^{-1} per Bq m^{-3}. The freshwater K_d value was 1.33 x 10^1.



The results show that the dose rate from ^{14}Carbon will be higher in the freshwater ecosystem when the tadpole or adult is in water. The exposure will be dominated by internal doses for both tadpole and adult frog.

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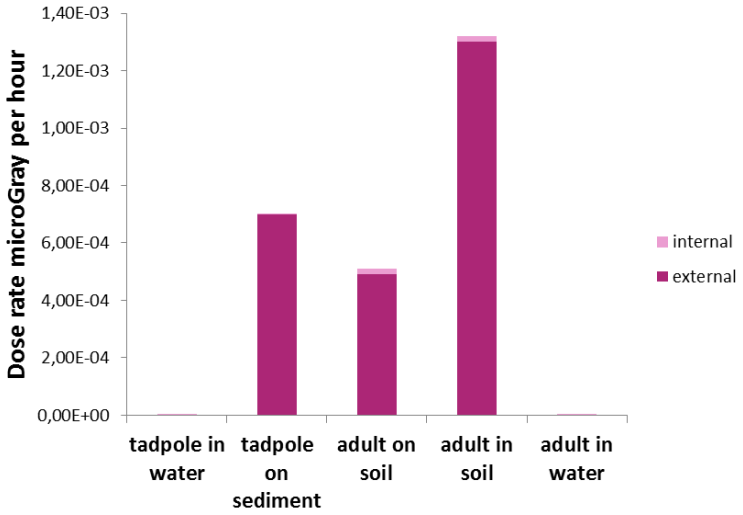
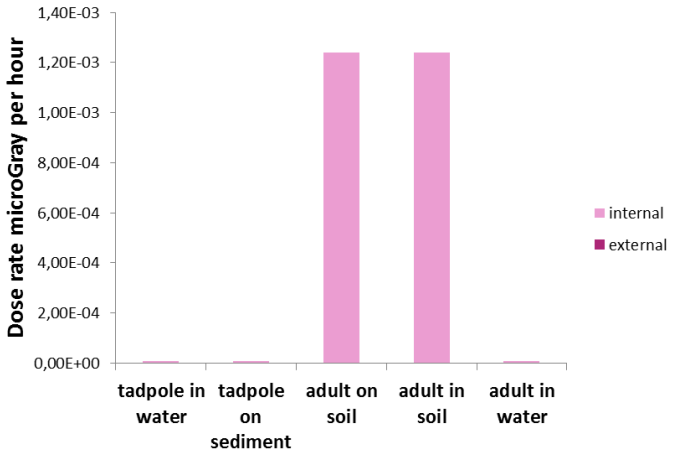
^{60}Cobalt. In this calculation with the ERICA tool activity concentrations of ^{60}Cobalt in soil or sediment was assumed to be 1 Bq kg^{-1}. In the freshwater habitat the concentration ratio for tadpole (ERICA insect larvae geometry) and adult frog (ERICA amphibian geometry) was 1850 and 231 Bq kg^{-1} per Bq L^{-1}, respectively, and in terrestrial habitat 0.191 Bq kg^{-1} per Bq kg^{-1}. The freshwater K_d value was 1.11 x 10^5.



The results show that the dose rates will be dominated by the external dose and higher to the adult situated in soil and to the tadpole on the sediment surface. Dose rates from water will be lower to both tadpoles and an adult frog.

^{3}H, Tritium. In this calculation with the ERICA tool activity concentrations of ^{3}H (tritium) in soil or sediment was assumed to be 1 Bq kg^{-1}. In the freshwater habitat the concentration ratio for tadpole (ERICA insect larvae geometry) and adult frog (ERICA amphibian geometry) was 1 Bq kg^{-1} per Bq L^{-1} and in terrestrial habitat 150 Bq kg^{-1} per Bq m^{-3}. The freshwater K_d value was 1.



The results show that the dose rates will be dominated by the internal dose and higher to the adult situated in or on soil. Dose rates from water will be lower to both tadpoles and an adult frog.

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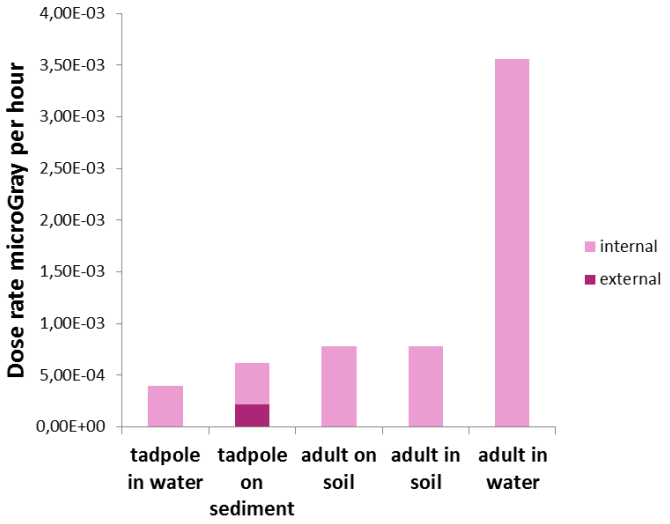
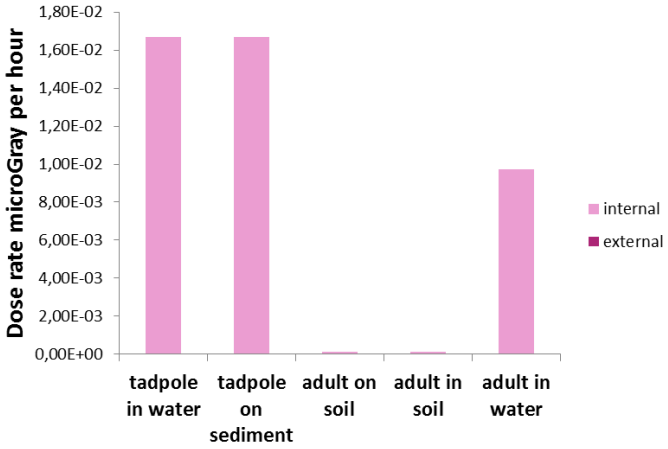
^{90}Strontium. In this example with the ERICA tool activity concentrations of ^{90}Strontium in soil or sediment was assumed to be 1 Bq kg^{-1}. In the freshwater habitat the concentration ratio for tadpole (ERICA insect larvae geometry) and adult frog (ERICA amphibian geometry) was 3700 and 11800 Bq kg^{-1} per Bq L^{-1} and in terrestrial habitat 1.32 Bq kg^{-1} per Bq kg^{-1}. The freshwater K_d value was 1.97×10^3.



The results show that the dose rates from ^{90}Strontium will be dominated by the internal dose and higher to the adult situated in water than a tadpole. Dose rates from soil will be lower to an adult frog.

^{238}Uranium. In this calculation with the ERICA tool activity concentrations of ^{238}Uranium in soil or sediment was assumed to be 1 Bq kg^{-1}. In the freshwater habitat the concentration ratio for tadpole (ERICA insect larvae geometry) and adult frog (ERICA amphibian geometry) was 200 and 116 Bq kg^{-1} per Bq L^{-1} and in terrestrial habitat 5.47×10^{-3} Bq kg^{-1} per Bq kg^{-1}. The freshwater K_d value was 2.87×10^2.



The results show that the dose rates from ^{238}Uranium will be dominated by the internal dose and higher to the tadpole situated in water and on the sediment surface. Dose rates from soil will be lower to an adult frog.