Radioactivity and the Environment

TREE

TRANSFER → EXPOSURE → EFFECTS
Transfer - Exposure – Effects (TREE): integrating the science needed to underpin radioactivity assessments for humans and wildlife

PI: Dr. Brenda Howard (NERC-CEH)
WP1: Biogeochemical processes and radionuclide behaviour in soil-plant systems

Objectives: Improve understanding of the biogeochemical behaviour $^{129}$I, $^{79}$Se, $^{99}$Tc, and U isotopes in soils; Critically assess the validity of models parameterised from short-term laboratory experiments.

Approach:
Controlled incubation of different soils ‘spiked’ with radionuclides. Determine solubility and isotopic exchangeability over 2-3 years
Develop/parameterise kinetic models describing changes in isotope speciation with time based on incubation experiments
Validate models using samples from Chernobyl exclusion zone
WP2: Novel approaches to estimate the radionuclide activity concentrations in the human foodchain and terrestrial and aquatic wildlife

Objective: to develop a new scientifically robust approach to predicting radionuclide activity concentrations in human foodstuffs and wildlife, which is independent of site variables and generically applicable across species

Approach:
Adapt methodologies (phylogeny & ionomics) from plant science to improve models of radionuclide transfer to crop species and wildlife

- Plant uptake studies
- Field sampling (wildlife – ICRP Reference Animals & Plants)
- Use international databases (held by TREE consortium and Project Partners)

Output of REML model

Beresford et al 2013
Sci. Total Environ. 463/464

Willey in press
J. Environ. Radioactivity
WP3: Exposure of wildlife under field conditions

Objective: to evaluate uncertainties in wildlife exposure estimation by assessing how animals utilize contaminated environments.

Approach:
Evaluate pathways of exposure in the Chernobyl Exclusion Zone
Compare field measurements with predictions using different modelling approaches

Wildlife cameras - Image-based analysis of habitat utilisation
GPS collars linked to base station - Digital tracking of habitat utilisation
TLDs - External dose rates
Faeces sampling – DNA metabarcoding (to determine diet composition)
Live-monitor

Source: S. Gashchak
WP4: Mechanisms of biological effect and trans-generational impacts of exposure to ionising radiation

**Objective:** Determine whether low level chronic exposure to radiation has significant effects on exposed populations in contaminated sites.

**Approach:**
- Compare effects from radiation exposure in laboratory and field studies
- Measure exposure and effects in contaminated sites
- Test whether transgenerational effects are occurring at Chernobyl zone

Trans-generational studies on worms and bees
- Develop biomarkers for terrestrial and aquatic spp. in the lab
- Field studies in aquatic and terrestrial Chernobyl systems taking account of confounding factors
- Expand to marine systems with Japanese partners

Moller and Mousseau 2009
Biology Letters 5, 356-359
Capacity Building

- Extensive national & international network, including industry & regulators
- key skills development using our diverse expertise – 4 PDRAs, 7 PhDs
- multidisciplinary summer school at Chernobyl
- working with COGER to provide training opportunities
- Interaction with European student cohorts (& access to facilities)
- training for regulators and industry
Wider Impact

TREET consortium
- Radioecologists
- Soil scientists
- Plant scientists
- Ecotoxicologists
- Environmental chemists
- Modellers
- Specialised analysts

Subcontractors

Project Partners

Wider networking
- International organisations (IAEA, ICRP IUR)
- European networks and platforms (STAR, COMET, ALLIANCE, OPERRA)
- Radioactive waste group (Bioprotea)
- Scientific media
- Gov-associated bodies (UK: SEPA, NE, FSA, Japan: NIRS)

Annals of the ICRP
- ICRP PUBLICATION 114
- Environmental Protection: Transfer Parameters for Reference Animals and Plants
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