Some of the) Human food chain modelling within the CONFIDENCE project

https://portal.iket.kit.edu/CONFIDENCE/

...then a bit about source-sink for non-rads

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COping with uNcertainties For Improved modelling and DEcision making in Nuclear emergenCiEs

• Funded under 1st CONCERT call [EURATOM]
  • Co-ordinator Wolfgang Raskob (KIT)

• Research focussed on uncertainties in the area of emergency management and long-term rehabilitation
  • Focus on early and transition phases of an emergency
  • WP3 Human food chain
Can process based models reduce uncertainties?

- Transfer to foodstuffs generally estimated using empirical ratio [maybe classified by soil group]
- Do process based models represent a useful alternative [give ‘added value’]?

Wright et al. 2003 Rad. Environ. Biophys.
Can process based models reduce uncertainties?

- Transfer to foodstuffs generally estimated using empirical ratio [maybe classified by soil group]

- *Do process based models represent a useful alternative [‘added value’]?*

- Applicability to European soils

- How can process based models be incorporated into DSS?

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Wright et al. 2003 Rad. Environ. Biophys.
Chernobyl accident 1986
Monitoring and de-restriction
Restricted areas in west Cumbria

- 1986
  - 1,670 farms and 867,000 sheep
- 1990
  - 167 farms and 152,000 sheep
- 1992
  - 138 farms and 120,000 sheep
- 2002
  - 9 farms and 11,500 sheep
Inputs
Predicted restricted areas

Monte-Carlo prediction of changes in areas of west Cumbria requiring restrictions on sheep following the Chernobyl accident
Also applied probabilistically
‘Absalom’ or ‘SAVE’ model

![Diagram](image_url)

- Total $^{137}$Cs (Bq kg\(^{-1}\) soil)
- Clay (%) Exchangeable K (cmol, kg\(^{-1}\)) Organic Matter (%) pH

- Inorganic CEC (cmcol, kg\(^{-1}\))
- Organic CEC (cmcol, kg\(^{-1}\)) Solution Ca (mol dm\(^{-3}\))

- Exchangeable K on OM (mol dm\(^{-3}\))
- Solution K (mol dm\(^{-3}\))
- $k_d$ (dm\(^3\) kg\(^{-1}\))

- Solution $^{137}$Cs (time=t) (Bq dm\(^{-3}\))
- Concentration factor (Bq kg\(^{-1}\) plant/Bq dm\(^{-3}\) soil solution)

- Plant $^{137}$Cs (Bq kg\(^{-1}\))
Absalom or SAVE model

- Total $^{137}$Cs (Bq kg$^{-1}$ soil)
- Clay (%)
- Exchangeable K (cmol, kg$^{-1}$)
- Organic Matter (%) (cmol, kg$^{-1}$)
- pH

- Inorganic CEC (cmcol, kg$^{-1}$)
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- Plant $^{137}$Cs (Bq kg$^{-1}$)

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**Graphs:**

- Log(TF - grass) - organic and mineral soils
  - RSD = 0.69
  - Measured vs. Modeled

- $^{137}$Cs in wheat-inedible fraction (Bq kg$^{-1}$)
  - RSD = 0.508
  - Measured vs. Modeled
Lamb Concentrations in Clwyd
Absalom or SAVE model
Absalom or SAVE model
….and then
Can process based models reduce uncertainties?

Application of the Absalom model to Japanese soils RIP predictions

RIP\textsubscript{Japanese clay} \sim \frac{1}{3} \times \text{RIP}\textsubscript{European clay}

Absalom + European soils \rightarrow overestimation of RIP

![Graph](image)

**Fig. 2.** The relationship between RIP\textsubscript{soil} and soil clay content for (a) Japanese soils (this study, \(N = 51\)) and reported for Belgian soils (Waegeneers et al., 1999, \(N = 88\)).

Application of Absalom model would underestimate TF
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Experimental work
Soils

- Soils with a wide range of characteristics
- Different ecosystems (climate, landuse, crops, etc.)

 variation in pH between soils

 variation in LOI between soils

 variation in clay content between soils
Can process based models reduce uncertainties?

- How about for Sr-90?
Can process based models reduce uncertainties?

- How about for Sr-90?
Can process based models reduce uncertainties?

- How about for Sr-90?

**Parameter set**

<table>
<thead>
<tr>
<th>Parameter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soil solution pH</td>
</tr>
<tr>
<td>Barium chloride-extractable Na, Mg, K, Ca, NH₄, Sr</td>
</tr>
<tr>
<td>Copper chloride-extractable Al, Fe</td>
</tr>
<tr>
<td>Soil organic carbon/organic matter content</td>
</tr>
<tr>
<td>Clay content</td>
</tr>
<tr>
<td>Oxalate-extractable Mn, Al, Fe</td>
</tr>
</tbody>
</table>
Abstract

The pattern of radiostrontium and radionesium sorption–desorption was examined in 30 Spanish soils by the quantification of the distribution coefficients ($K_{d}$) with batch tests, the evaluation of sorption reversibility with a single extraction, the estimation of
Full WHAM model

Modelled $K_d$ vs. Observed $K_d$
Plant uptake?

Wasserman et al. in-prep

Maize

![Bar chart showing Fv for different soils (Ferralsol-Al, Ferralsol-Fe, Nitisol, Acrisol) with two different isotopes (Sr, 90Sr).]
Plant uptake
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....then a bit about source-sink for non-rads
CEH Source to Sea modelling

Soil

River

Centre for Ecology & Hydrology
NATURAL ENVIRONMENT RESEARCH COUNCIL
Thank you