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ARTICLE

Inter-comparison of parameters and exposure scenarios in risk-assessment methodologies for radiological and chemical soil contamination

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Abstract – Various guidelines and models exist to assess the dose resulting from a radiological soil contamination. Analogous methodologies have been published to assess the chemical risk from non-radioactive pollutants present in soil. Although most of these methodologies insist on the need to use as much as possible site-specific parameters in the assessment-process, they also suggest a set of default or example parameters. In this study, we compare the suggested parameter values of four different national guidelines for risk-assessment of contaminated soil from France, Germany, Britain and Belgium. The Belgian methodology had been developed for the assessment of chemical risk while the three others are specifically dedicated to radiological risk. Significant discrepancies are found between the parameters of different national guidelines, which stresses the need for carefulness and sound expert judgment in the choice of the parameters of a risk-assessment process.

Keywords: risk-assessment / contaminated site / mixed contamination

1 Introduction

Decisions on remediation of sites contaminated with radionuclides generally require a dose-assessment and a comparison of the assessed dose with a reference level. How to perform this dose-assessment is described in various national and international guidelines or methodologies. It is generally a stepwise approach starting with a screening assessment. When the screening assessment concludes that the reference level may possibly be exceeded, a more detailed assessment requiring a more detailed knowledge of the characteristics of the contaminated site, of the exposure pathways and of the receptors is performed. How dose-assessment fits into the overall decision-making process for remediation of a contaminated site has been described *e.g.* in IAEA guides (IAEA, 2007) and in various IAEA working programs, such as EMRAS (Liland *et al.*, 2011) or MODARIA (IAEA, 2016).

Many countries have developed national guidelines to assess the exposure resulting from radioactively contaminated land, for instance France (MEDTL, 2011), United Kingdom (EA, 2011), Germany (BfS, 2010) or the USA (EPA, 1989). Next to these national guidelines, some models or calculation codes, such as RESRAD (Yu *et al.*, 2007), or NORMALYSA (Avila *et al.*, 2018), are freely available to calculate the dose from a contaminated soil. These guidelines and models suggest standard exposure scenarios, *e.g.* residential or agricultural scenario, and describe the relevant exposure pathways for each scenario as well as the parameters used in the assessment.

While these guidelines are specifically dedicated to exposure to radioactivity, analogous methodologies exist to assess the risks resulting from exposure to non-radioactive contaminants in soil, for instance the S-Risk model in Belgium (Cornelis *et al.*, 2017), the MODUL'ERS software in France (Bonnard, 2017) or the CLEA in Great Britain (EA, 2009). The principles are essentially the same as for exposure to radioactive substances; one defines the exposure scenarios, selects the relevant exposure pathways and calculates the exposure by picking adequate values for the parameters.

All these methodologies insist on the need to choose as much as possible site-specific values for all parameters. However, they also suggest default values or example values for some or all of these parameters. Indeed, site-specific values may not always been known or it would not be time- and cost-efficient to look for specific values in the context of a simple screening assessment.

When not directly derived from measurement, the choice of parameters is generally based on expert judgment. The

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Table 1. Standard soil use and corresponding exposure scenario in S-Risk.

Type of soil use		S-Risk default scenario
Type I	Nature area	REC-dayout (day recreation – incl. sport)
Type II	Agriculture	AGR (residence with vegetable garden in agricultural area)
Type III	Residential	RES-veg (residential with vegetable garden) RES (residential with garden) RES-ng (residential without garden)
Type IV	Recreational	REC-dayout (day recreation – incl. sport) REC-dayin (day recreation indoor sport scenario)
Type V	Industrial	IND-l (light industry) IND-h (heavy industry with outside activity)

default values proposed in the different national guidelines or models are not necessarily the same and the goal of this paper is to compare these default values for a selected set of parameters of different European guides from France, Germany and UK. We have added to the comparison the default parameters of the reference model used for risk-assessment of soil contaminated with chemicals in Belgium, S-Risk (Cornelis *et al.*, 2017).

The present study essentially complements a similar inter-comparison exercise performed in (Shubayr, 2017) where default parameters and assumptions of, *e.g.* EPA PRG calculator (EPA, 2017), RCLEA (EA, 2011) and RESRAD-ONSITE (Yu *et al.*, 2007) had been compared. That study already underlined that default values of a specific model should only be used in the assessment context for which this model had been developed. Site-specific values, when available, should be preferred to generic assumptions.

2 Approaches of chemical and radiological contamination in soil: similarities and differences

2.1 Coexistence of chemical and radiological risks: the necessity of consistency

Most sites contaminated with radionuclides are also contaminated with non-radioactive pollutants, such as heavy metals. This is particularly true for NORM contaminated sites where in many cases the non-radioactive part of the contamination constitutes the main health risk and impacting factor on the environment. Some substances, such as uranium, present both as radiological and non-radiological hazard. This coexistence of radiological and non-radiological hazards appeals for a consistent approach in the risk-assessment methodology for a contaminated site. In this context, it is especially important to use consistent exposure scenario and parameters in the assessment of both chemical and radiological risk.

Such a consistent approach has already been derived and applied in some countries: in particular the US EPA has made the policy decision that risks from radionuclides exposures at remedial site should be estimated in the same manner as chemical contaminants; in the context of its Superfund program, EPA has defined slope-factors for radionuclides allowing to sum the excess cancer risk of both radioactive and non-radioactive contaminants so as to provide an estimate of the combined risks (ISCORS, 2002; EPA, 2014). In the UK as well, the Radioactively Contaminated Land Exposure Assessment Methodology (RCLEA) (EA, 2011) is based on the original Contaminated Land Exposure Assessment (CLEA) approach that was developed for the assessment of non-radioactive contamination (EA, 2009). Other studies – *e.g.* (Gellermann *et al.*, 2012) in Germany – have used the assumptions of non-radiological soil protection regulations to derive reference values for radionuclides in soil.

2.2 An example of model used for chemical risk assessment: the Belgian S-Risk model

In Belgium, the model S-Risk (Cornelis *et al.*, 2017) has been developed to assess exposure to contaminants and human health risks from a contaminated site. It may be used to derive generic as well as site-specific clean-up levels. S-Risk is promoted by the Belgian competent authorities for soil remediation as the standard model for assessing exposure and human health risks from (non-radioactive) contaminants present in soil. This model has been developed by the Flemish environmental institute VITO and incorporates state-of-the-art values for assessment parameters taking into account specific circumstances for Belgium or its different regions (regarding *e.g.* diet or standard soil profile).

S-Risk does not address the issue of radioactive substances in soil. In Belgium, as in many other countries, chemical and radiological contaminations are not dealt with by the same regulator, radioactivity being regulated at a federal level by the Belgian radiation protection and nuclear safety authority (FANC, the Federal Agency for Nuclear Control) while chemical contamination are regulated by the regional environmental authorities.

Belgian soil protection regulations define 5 standard soil uses and S-Risk has implemented different standard scenarios corresponding to these standard uses. They are summarized in Table 1.

S-Risk incorporates following exposure pathways:

- oral:
  - **ingestion of soil and indoor settled dust**,
  - **intake of vegetables from local production (home-grown)**,
  - **intake of meat and milk from local production**,
  - **intake of water (drinking-water or groundwater)**;
- dermal:
  - absorption from soil and indoor settled dust,
  - absorption from water during showering and bathing;
- inhalation:
  - **inhalation of outdoor air (gas-phase + particles)**,
  - **inhalation of indoor air (gas-phase + particles)**,
  - inhalation during showering (gas-phase).

In bold, we have marked the pathways which are also generally considered for radiological impact. External exposure pathway is obviously a missing exposure pathway for non-radioactive contaminants but needs to be taken properly into account in radiological impact assessment.

S-Risk incorporates also the Volasoil model (Bakker *et al.*, 2008) which allows calculating indoor air concentration of volatile compound due to vapour intrusion from soil or groundwater into the building. The model considers three different building types: with basement, with crawl space and with slab-on-grade; it takes into account both diffusive and convective transport. It also allows two options for the floor of the building: intact or with gaps and holes. Further work will focus on the applicability of this model to estimate indoor radon concentration from radon in soil-gas concentration or radium activity concentration in soil.

S-Risk also proposes a set of default values for the parameters used in the assessment. In Section 4, we will compare these default parameters with the ones of the national guidelines used for radiological assessment.

3 Overview of the guides used in the inter-comparison

In this paper, we focus on the following guides developed in Western European countries:

- the *Radioactively Contaminated Land Exposure Assessment Methodology* (RCLEA) (United Kingdom); this methodology has been developed on basis of the Contaminated Land Exposure Assessment Methodology (CLEA); thus, it incorporates consistent parameters for radiological and chemical assessment. The equations of RCLEA have been coded in an Excel file which can be freely downloaded from the website of the English Environment Agency (EA, 2011);
- *calculations principles for the assessment of radiation exposure consecutive to environmental radioactivity due to mining activities* (Germany); this guide has been published by the Bundesamt für Strahlenschutz (BfS), the Federal Office for Radiation Protection and was initially developed in the context of the remediation of former uranium mining areas in Germany (BfS, 2010);
- *management of sites potentially polluted by radioactive substances – methodological guide* (France); the guide is the outcome of an inter-agency collaboration between the French Nuclear Safety Authority, ASN, the radiation protection and nuclear safety institute, IRSN and the French ministry of environment (MEDTL, 2011). This guide has been published in 2011 and replaces a former version published by IRSN;
- S-Risk (Belgium), described in Section 2.

In this work, we will not address all exposure pathways and parameters used in these references. We only focus on some selected exposure pathways and parameters: exposure time, dust inhalation, inadvertent ingestion of contaminated soil, ingestion of food grown on a contaminated land.

4 Comparison of default values for parameters of the exposure assessment

4.1 Exposure scenarios and age classes

The models described in the present study proposed conservative scenarios. In S-Risk, these conservative scenarios are standardized and correspond to the standard soil uses defined in the soil protection regulations (Tab. 1).

The German guide considers the following scenarios: residential (where consumption of home-grown foodstuff is considered as a distinct scenario), stay in open space, stay in underground workplaces.

The RCLEA guide proposes 3 reference land uses suitable for generic assessments: residential (where consumption of home grown products may or may not be considered), allotment use where the contaminated land is assumed to be a largely open space with individual plots for growing fruits and vegetables consumed by the allotment user and his/her family. Finally, the commercial or industrial land use reflects individual shops or offices or light industrial park.

The French guide does not consider reference land use but proposes a description of 11 generic scenarios, which may serve as starting point to develop site-specific scenarios: two of these scenarios are only relevant in the context of contaminated buildings, the 9 others are relevant for activities on contaminated soil: parking lot, allotment, professional activity, residential, school, sport complex, leisure park.

Regarding age classes, both German and French guides consider the 6 ages categories of (ICRP, 1994), while RCLEA only considers three categories: infant (= one-year old), child (= 10-year old) and adult (> 17-year old). S-Risk distinguishes between 10 age categories as the "adult" category is split into decades (*e.g.* 21–31 years old, 31–41, etc.). However, the differences in the parameters of these different "adult" subcategories are generally quite small.

4.2 Exposure time

The exposure time depends obviously on the exposure scenario considered and we focus in this section on the scenario "residential with vegetable garden". Table 2 shows the suggested

Table 2. Exposure time (in hour per day) for different age categories (in years) referenced in the guides.

S-Risk				FR				RCLEA			BfS	
Age category	Sleeping	Awake inside	Outside	Age category	Sleeping	Awake inside	Outside	Age category	Indoor	Outdoor	Indoor	Outdoor
1–2	12	11.5	0.5	1–2	14	9	1	Infant	21	3	–	–
3–5	11	9.7	1.38	3–5	12	9	3					
6–9	10	8.7	1.57	8–12		11	3					
10–15	9	10.6	1.12	13–17	10	11 (boy) 12 (girl)	3 (boy) 2 (girl)	Child (10–11)	18	2		
15–21	8	8.5	0.8									
21–31	8	9	1									
31–41	8	11.5	1.3	≥ 17 (living at home)	8.5	14.5	1	Adult (59–70)	20	2.5	19	5
41–51	8	11.5	1.5									
51–61	8	11.5	1.8									
≥ 61	8	11.5	1.7									

Table 3. Shielding factors from external dose.

FR			BfS	RCLEA
U-238+ (10 cm concrete)	0.087	Heavy construction (concrete, bricks...)	0.1	0.1
U-238+ (15 cm concrete)	0.037			
		Light construction (wood...)	0.3	1

exposure time in the different guides considered. It must be noted that, while S-Risk and the French methodological guide distinguish between sleeping and awake time inside, RCLEA makes rather a distinction between "active" and "passive" activities. The German guide does not make such a distinction and rather gives global exposure time outside and inside. The values suggested as examples in the French guide are taken from (ICRP, 1994). The total sum of exposure times is not always equal to 24 hours as some of the guides consider that a fraction of the day is spent away from the contaminated site.

Although some details may vary and some guides such as S-Risk propose more age categories, there are no fundamental differences between the different guides. The French guide proposes a slightly higher exposure time inside for the sedentary inhabitant (23 hours/day) while for the three other examples the exposure time inside is rather around 20 hours a day.

4.3 External dose: shielding factor

In a residential scenario, the external dose from the gamma radiation emitted by the radionuclides present in the underlying soil is shielded by the building. The external dose calculated from soil contamination or taken from on-site (outdoor) dose-rate measurements needs thus to be multiplied by a shielding factor which depends on the density and structure of the building basement layer.

Obviously, S-Risk does not consider external exposure and the comparison only applies to the three other guides.

In the French guide, various shielding factors (or protection factors) have been calculated with the software MicroShield® for different nuclides and different kinds of building structure (*e.g.* concrete). The two other guides do not make a difference between radionuclides and only suggest two types of shielding: one shielding factor for heavy construction made of concrete or bricks and another value for light construction such as a cabin made of wood.

Table 3 summarizes the values for the shielding factors. For the sake of the comparison, we have picked in the French guide the protection factor for U-238 in secular equilibrium given by a 10 cm (resp. 15 cm) concrete layer.

There is good agreement in the shielding factors for a heavy construction where both German and British guides have selected a value close from the shielding of a 10 cm concrete layer from a soil contaminated with U-238 and its progenies – as calculated with MicroShield® in the French guide. On the other hand, the British and German guides suggest very different values in the case of a light construction.

4.4 Parameters for inhalation dose: respiratory debit and air concentration

4.4.1 Respiratory rate

Respiratory rate depends on the nature of the activity (and thus of the exposure scenario) as well as on the age group. While the French guide suggests the values of ICRP66 (ICRP, 1994) and considers 4 different sorts of activities (sleep, rest,

Table 4. Respiratory rate (in m^3/hour) for the different age categories and activities considered in the guides.

	FR				BfS	RCLEA		
	Sleep	Rest	Light exercise	Heavy exercise	Stay in open space or building		Active	Passive
< 1	0.09	–	–	–	0.12		–	
1–2	0.15	0.22	0.35	–	0.22	Infant (1–2)	0.339 (male) 0.32 (female)	0.124 (male) 0.117 (female)
3–7	0.24	0.32	0.57	–	0.36			
8–12	0.31	0.38	1.12	2.22 (male) 1.84 (female)	0.64	Child (10–11)	1.103 (male) 1.1 (female)	0.404 (male) 0.403 (female)
13–17	0.42 (male) 0.35 (female)	0.48 (male) 0.40 (female)	1.38 (male) 1.3 (female)	2.92 (male) 2.57 (female)	0.84		–	
≥18	0.45 (male) 0.32 (female)	0.54 (male) 0.39 (female)	1.5 (male) 1.25 (female)	3 (male) 2.7 (female)	0.93	Adult (16–59)	1.456 (male) 1.234 (female)	0.485 (male) 0.411 (female)
Worker					1.2			

Table 5. Typical values for dust concentration. The French guide distinguishes between very weak (1), weak (2), medium (3) and high (4) concentration. The German guide distinguishes between concentration during stay outside (5) and outdoor work activities (6). All values are in mg/m^3.

FR				BfS		RCLEA	S-Risk
(1)	(2)	(3)	(4)	(5)	(6)		
0.001–0.01	0.01–0.1	0.1–10	10–100	0.05	0.5	0.05	0.01

heavy and light work), the German guide only considers one type of activity (stay in building or in open space) and the UK guide two classes (active and passive). S-Risk proposes values of respiratory rate for each standard exposure scenario. As for the other parameters, S-Risk and the French guide refer to all age classes while the UK methodology only considers the three categories infant, child and adult. The values cited in the French, German and British guides are summarized in Table 4.

Comparison with S-Risk is not straightforward as S-Risk calculates inhalation rate on basis of a default inhalation rate for adults (70 kg) of 20 m^3/day (0.83 m^3/hour) and of weighting factors for different age categories and types of activities.

Obviously, respiratory rates vary a lot in function of age and activities. This makes a direct comparison between the values of the different guides difficult as they do not categorize the activities in the same way. For instance, the value given in RCLEA for an "active" adult is essentially the same as the respiratory rate referred to in the French guide for an adult with "light exercise" activity. For "passive" activity, the RCLEA respiratory rate lies between the "sleep" and "rest" values of ICRP66 for male but for female the RCLEA respiratory rate is higher than the one of the French guide.

The value referred to in the German guide is roughly the average of "active" and "passive" activity of RCLEA for a male individual.

4.4.2 Air concentration

For typical resuspended dust concentration in air, the various guides suggest different approaches. The French guide proposes 4 typical values depending on the type of activity: very weak, weak, medium and high dust concentration corresponding respectively to *e.g.* sleep activity, outside activities, gardening and infrastructure works; the German guide only distinguishes between a reference air concentration value from resuspension during a stay in open space and during work activities. Both RCLEA and S-Risk consider only one value from soil resuspension. The RCLEA value corresponds to a residential scenario. These values are summarized in Table 5.

There is a good agreement between the French (medium concentration), German and British guide regarding typical dust concentration for outside light activity. The value suggested by S-Risk is similar to the edge between weak and medium concentration of the French guide.

4.5 Ingestion dose

4.5.1 Soil ingestion rate

In the guides, inadvertent soil ingestion rate are expressed in different units (mg/day in France and Belgium, mg/h in Germany and kg/year in RCLEA). For the sake of comparison, they have been converted in mg/day taking into account the exposure time of the relevant scenario. For the German values, two time patterns have been considered: the time pattern corresponding to the exposure in a garden (1000 hours a year for all age classes) and the pattern corresponding to a stay on an outside contaminated area (100 or 250 hours per year depending on age). Table 6 gives an overview of the values considered in the different guides for the age classes and exposure scenario considered.

There is a significant variability of the inadvertent ingestion rate depending on the scenario and on the guide considered. RCLEA in particular suggests values which are significantly higher than the other references.

Table 6. Comparison of inadvertent soil ingestion rate (mg/day). For the BfS guide, two exposure patterns are considered: (1) Stay in a garden (1000 hours a year); (2) Stay on an outside area (100 or 250 hours a year). For S-Risk, the acronyms of exposure scenario are explained in Table 1.

Age category	FR	BfS		RCLEA	S-Risk				
		(1)	(2)		Age category	AGR/RES	RES-ng	IND-l	IND-h
1–2	100	13.7	137	150.7	1–2	68.4	40	0	0
3–7	100	20.5	82	–	3–5	54.9	32	0	0
8–12	50	4.1	16.4	101.4	6–9	41.85	18.25	0	0
13–17	40	4.1	16.4	–	10–14	40.05	15.64	0	0
					15–20	38.25	12.6	5.2	30.8
Adult	40	1.6	16.4	60.3 (residential) 71.2 (allotment)	> 20	34.65	10.6	5.2	30.8

Table 7. Various vegetables categories and their consumption rate (in kg/year) considered in the different guides.

	FR (average individual)	BfS	RCLEA		S-Risk
			Male	Female	
Potatoes	32	55	101	84	47.4
Root vegetables	9		–	–	–
Carrot	–	–	19	16	24.8
Onion (shallots and leeks)	–	–	13	11	7
Leafy vegetables	20	13	–	–	11.9
Leafy salads	–	–	14	12	–
Cabbage	–	–	20	17	6.8
Brussels sprouts	–	–	21	17	
Fruit vegetables	74	–	–	–	29
Fruit and derived products	–	35	–	–	–
Other vegetables	–	40	–	–	–
Grain and derived products	55	110	–	–	–

4.5.2 Dietary habits

Dietary habits are among the parameters for which most variability is expected (Durand *et al.*, 2018): they vary between and within countries, between urban and rural environment, among age groups and sex, may depend on local circumstances... In the present paper, we only focus on dietary habits of the Western European countries addressed in the guides. The dietary habits include not only the consumption of various foods (grains, vegetables, meat, dairy products, drinking water...) but also the proportion of consumed food coming from the contaminated site.

4.5.2.1 Consumption rates

For this inter-comparison, we only consider the dietary habits of adults. Table 7 shows the different categories of vegetables considered in the different guides. All data are expressed in kg per year. For S-Risk, we present values for the age category 21–31 years old as S-Risk provides slightly different values depending on the adult age.

The different guides do not categorize the vegetables in the same manner. RCLEA for instance only focuses on vegetables which will be grown in an allotment. However, all guides give values for the consumption rate of potatoes, which varies with a factor 3 between France and UK.

Table 8 shows a similar inter-comparison for animal products. RCLEA does not provide any value for animal products. The German guide does not distinguish between different categories of meat and S-Risk only provides value for beef.

Here also there are noticeable differences between countries. The meat consumption in Germany for instance is 25% higher than in France according to the Table 8 while the beef consumption in Belgium is 40% lower than in France.

Finally, we compare in Table 9 the values for water consumption per age category.

The values proposed by the German guide are significantly lower than the values proposed in the French guide. The Belgian S-Risk gives values close to the German ones for the child consumption rate but closer to the French value for the adult. For some age categories, the values may vary with a factor 4 between different guides.

4.5.2.2 Fraction of consumption from home-grown products

The fraction of food derived from home-grown production is very much dependent on the selected exposure scenario: in an agricultural scenario, this fraction is often chosen close to 1 and is significantly lower in a residential scenario with garden.

Table 8. Various animal products and their consumption rate (in kg/year).

	FR (average individual)	BfS	S-Risk
Beef	19		11.7
Mutton	7	90	
Pork	24		–
Poultry	20		
Eggs	8	–	15
Milk	66	130	78.5
Dairy	37		1.13 (butter)
Fish	11	7.5	–

Table 9. Water consumption (liter per day) per age category.

	FR	BfS	S-Risk	
Age category			Age category	
< 1	0.55	0.15	1–2	0.3
1–2	0.8	0.27	3–5	0.31
3–7	1.3	0.27	6–9	0.38
8–12	1.5	0.41	10–14	0.65
13–17	1.5	0.55	15–20	1
Adult	1.5	0.96	21–60	1.76–2.23

Table 10. Fraction of consumption from home-grown production for different vegetable categories. The French guide gives values both for the average individual and for a rural inhabitant. S-Risk also distinguishes between the residential with garden scenario (similar to the RCLEA scenario) and the agricultural scenario.

	FR (average individual)	FR (rural inhabitant)	BfS	RCLEA	S-Risk (RES-veg)	S-Risk (AGR)
Potatoes	0.237	0.767	0.5	0.66	0.39	0.5
Root vegetables	0.237	0.675	0.5	–	–	–
Carrot	–	–	–	0.7	0.36	1
Onion (shallots and leeks)	–	–	–	0.91	0.52	1
Leafy vegetables	0.267	0.707	0.5	–	0.36	1
Leafy salads	–	–	–	0.51	–	–
Cabbage	–	–	–	0.92	0.21	1
Brussels sprouts	–	–	–	0.87		
Fruit vegetables	0.135	0.306	0.5	–	0.39	1
Grain and derived products	0.001	0.001	0.5	–	–	–

Table 10 summarizes these values. Note that the German guide assumes that the fraction of food from local production is 0.5 for all categories.

RCLEA and the agricultural scenario of S-Risk suggest quite conservative values for the fraction of consumption from home-grown production – except for potatoes where the value for a French rural inhabitant is higher. However, variation between guides are logically not as important as variation within a national population, *e.g.* between urban and rural population.

5 Conclusions

In this paper, we have compared the default values for risk assessment parameters used in four different methodological guides for assessing the risk of exposure to a contaminated land. In addition to the French, German and British guides specifically dedicated to radioactive contaminated land, the Belgian model S-Risk, reference model used in Belgium for assessing the risk of chemical contaminants in soil, has also been included in the study. Models used to assess chemical and radiological risks show high similarities. With the exception of external exposure, the exposure pathways are the same and most of the parameters used for chemical risk-assessment may also been used to perform radiological assessment. In fact, consistent choices for the parameters of radiological and chemical risk-assessment should be recommended as both types of contamination are generally simultaneously present.

We have compared “default” or “example” values given in the different guides. Although the different guides apply to neighbouring Western European countries, the variability between some of the parameters may be important, especially for parameters related to food habits where differences may reach a factor 3. However, there are never more than a factor 10 of differences and using the suggested values in a qualitative, screening assessment should thus probably not lead to major misinterpretations.

The present study confirms the conclusion already stated in (Shubayr, 2017): default values of a specific model should only be used in the assessment context for which this model has been developed. Site-specific values, when available, should be preferred to generic assumptions. One must say that the different guides investigated also warn the reader about the need of selecting site-specific values for the parameters where they are available.

This underlines the need for carefulness and transparency in the choice of any parameter: it needs to take into account site-specific circumstances (*e.g.* the diet must correspond to the one of the affected population) and an appropriate degree of conservativeness. As shown in this study, the impact of the differences in parameters between different Western European countries is moderate. However, in a world-wide context, using default parameters blindly may lead to a dramatic underestimation of risk if *e.g.* Western style habits are used for assessing the dose to an indigenous population having specific dietary habits. Other way around, this could also lead to overestimate the risk and affect the cost-effectiveness of the remediation strategy. The degree of conservativeness in the choice of parameters should be left to expert judgment but what matters is the justification of this choice and the transparency of assumptions behind it (*e.g.* does the parameter correspond to the average, median or percentile 95 value). Sensitivity or probabilistic analysis is also recommended to identify the parameters which are critical for the results of the risk-assessment and for which further investigation and justification will be needed.

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