

DEVELOPMENTS IN SOIL CONTAMINATION DECISION-MAKING PROCESS RESULT IN SPECIFIC HUMAN EXPOSURE MODELS

M. Strikwold¹ and P.J. Smit²

¹ Van Hall Instituut *Business Center*
Agora 1, P.O. Box 1754
8901 CB Leeuwarden, The Netherlands
Phone: +31 582846160, Fax: +31 582846199
Email: m.strikwold@pers.vhall.nl

² Van Hall Instituut
Expertise Centre Geo-information and Soil Management
Zernikeplein 11, P.O. Box 3037
9701 DA Groningen, The Netherlands
Phone: +31 505954550, Fax: +31 505954630
Email: pj.smit@pers.vhall.nl

Abstract

Risk assessment plays a role in the decision-making process of solving soil contamination problems. Exposure models are used to quantify the exposure of humans. Van Hall Instituut (VHI) developed a framework in which these models are converted into user-friendly programmes. This so-called RISC-framework (RISC = Risk Identification of Soil Contamination) provides users with tools to make risk assessment transparent and reproducible. In 1995 the first version of RISC-HUMAN, a generic human exposure model, was developed. It is an open system, in which all parameters can be changed. Developments in solving soil contamination problems resulted in integration of risk assessment in soil policy of different countries. As a consequence application of models is prescribed and generic models are not always suitable. Two models embedded in legislation have been developed by VHI so far. Remediation Urgency Method (RUM) is a model to support the urgency determination of soil contamination in the Netherlands. Vlier-Humaan is a model to support the human risk assessment of soil contamination in Flanders, Belgium. Where RUM should be used to derive the remediation urgency of contaminated sites, Vlier-Humaan can be used to make site-specific decisions. Developments in other countries in Europe show the need for comparable models in the near future.

1 Introduction

Throughout the years, the role of risk assessment (models) in the soil contamination decision-making process has changed. When the first major soil contaminations are discovered people become conscious about soil contamination problems. In this phase, experts often carry out risk assessments and they use generic risk assessment models. When the number of contaminated sites increases, policy to deal with these soil contaminations is often developed. Together with becoming conscious and policy developments with respect to soil contamination problems, the role of risk assessment becomes more and more important. Risk assessment models are used for several applications varying from deriving soil guideline values to site-specific risk assessment. In the first case, the models are often used by a few number of experts, while in the second case the models are often adapted for specific situations. If incorporated in a legal framework the number of users will increase, but these users are often less experienced and consequently the models will become less flexible. Nowadays risk assessment is more and

more implemented in the soil decision-making process in several countries. A study in which seven European risk assessment models are compared (1) showed that each of the models is used to derive soil quality standards, although not all are (legally) formalised. Examples of additional applications of these models are: calculating specific human exposure; ad hoc risk assessment and using risk assessment as a supporting tool to identify remediation solutions. Between several countries, differences exist between geographical, ethnological en policy elements (1). These differences and the abovementioned developments of risk assessment models in the soil contamination decision-making process resulted in the development of country specific risk assessment models. Generic risk assessment models are not applicable for every situation.

This paper describes the experience of the Van Hall Instituut concerning the development of three exposure models, one generic and two country specific exposure models. First, the general starting points of the three models are described. Then the influence of country specific elements on the development of the models is outlined. Finally, conclusions and discussions are presented.

2 General description risk assessment models

The Van Hall Instituut developed a framework that converts risk assessment models into user-friendly programmes. This so-called RISC-framework (RISC = Risk Identification of Soil Contamination) aims to develop risk assessment programmes to carry out reproducible and transparent risk assessment. In this paper three human exposure models, which are developed within in this RISC-framework, are compared: a generic exposure model, RISC-HUMAN and two country specific models, Remediation Urgency Method (RUM) and Vlier-Humaan.

RISC-HUMAN

RISC-HUMAN, developed in 1995, is a generic human exposure model, which is used for different applications of risk assessment of contaminated soils. These applications vary from gaining global insight in potential risks to site-specific risk assessment. Although model concepts are mainly based on the Dutch situation, RISC-HUMAN is a country independent model. The incorporated model concepts are CSOIL (2), VOLASOIL (3) and SEDISOIL (4). The flexible characteristics of RISC-HUMAN provide the user with the possibilities to model the contaminant situation and site characteristics as requested. Being an example of a generic model, RISC-HUMAN is used in the beginning of the soil contamination decision-making process. Hence, RISC-HUMAN is used as a starting point for the development of country specific exposure models developed within the RISC-framework, RUM and Vlier-Humaan.

RUM

RUM, developed in 1996, supports the decision on remediation urgency and remediation deadline as incorporated in the Dutch Soil Policy Law. RUM assesses the risks for human, ecology and transport. Model concepts to derive human risks are based on the CSOIL (2) and SEDISOIL (4) equations. RUM is a priority ranking system; for every serious contaminated site, the urgency of remediation has to be determined and based on that result the period in which remediation has to start. The required information level to carry out such an assessment with RUM is detailed investigation level 1.

Vlier-Humaan

Vlier-Humaan, developed 1997, is a human exposure model, especially developed for Flanders, Belgium and is embedded in the Flemish legislation. The following purposes are described in the legislation:

- derivation of clean up values within the Flemish legislation on soil remediation, in case of recent soil pollution (originated after 28 October 1995);

- give a first indication of the presence of a 'serious threat' in case of historical soil pollution;
- calculate minimal required clean-up goals, which should fit within the legal framework, (reaching background values in principle) (1).

The model equations of Vlier-Humaan are originally based on the ECETOC (5) publications.

3 From country specific elements to country specific models

Differences in country specific elements have led to the development of country specific exposure models. In this paper, a division of elements is made in order to provide a clear overview how country specific elements influence the development of the country specific models.

The elements are divided as follows:

- the goal of the risk assessment;
- policy decisions;
- ethnological differences;
- other country specific elements.

Interaction between abovementioned topics is possible; policy decisions may influence the goal of the risk assessment. For example, determining the remediation urgency of serious contaminated sites is a policy decision and the goal of RUM is therefore to support this policy decision in assessing the risks.

Goal risk assessment

The goal of the risk assessment results in differences in the risk assessment model. RUM for instance is used as a priority ranking system. On the contrary RISC-HUMAN is developed for several applications of risk assessment amongst others the derivation of site-specific Soil Use Values. These differences have consequences for both the number of parameters that can be modified and the model design.

RUM is developed to determine the remediation urgency and remediation deadline. For this purpose a site-specific risk assessment is not necessarily required and therefore not every parameter needs to be changed into a site-specific value. RISC-HUMAN is a country independent model to derive risks for several applications and consequently needs to provide the possibility to adapt parameters to country and site-specific situations. RISC-HUMAN therefore provides the possibility to change every parameter while in RUM only a limited number of parameters can be changed, the ones which have much influence on the outcome of the risk assessment and the ones of which values are well known.

Another difference between the models resulting from the goal of the risk assessment is the model design. RUM is embedded in legislation and consequently is more straightjacket. This is amongst others expressed in the step-by-step procedure of the derivation of risks; consecutive steps won't be accessible unless the former step is completed (6). RISC-HUMAN is a country independent model and is therefore an open system.

Policy decisions

Differences in policy decisions in different countries influence the outcome of the models. In the Netherlands and Flanders, Belgium the derivation of standards for carcinogenic substances is for instance different. In RUM and RISC-HUMAN, where model concepts are based on the Dutch situation, a probability level of 1 on 10.000 is used. In Vlier-Humaan a probability level of 1 on 100.000 is incorporated. Another example is the decision whether or not taking into account background doses and concentrations in assessing the risks. Background values are not incorporated in RUM because the policy is to assess risks only originating from soil contamination. Starting point in Flanders, Belgium is to include different sources of exposure and as a result background levels are incorporated in the calculation of the exposure. RISC-HUMAN is country independent, including background values in the derivation of risk is optional.

The use of predefined land use types is another difference resulting from country specific policy decisions. In RUM and Vlier-Humaan predefined land use types are incorporated. Exposure routes and parameter values are related to a specific land use type. RUM provides also the option to add a self-defined land use type. Exposure routes and input parameters have to be adapted by the users themselves to the site-specific situation. In Vlier-Humaan it is possible to adapt to a certain extend predefined land use types. The country independency of RISC-HUMAN results in the absence of predefined land use types. Figure 1 illustrates the differences more clearly by showing windows of the software RISC-HUMAN and RUM: in RUM predefined land use types can be selected, while in RISC-HUMAN it is necessary to define land use types.

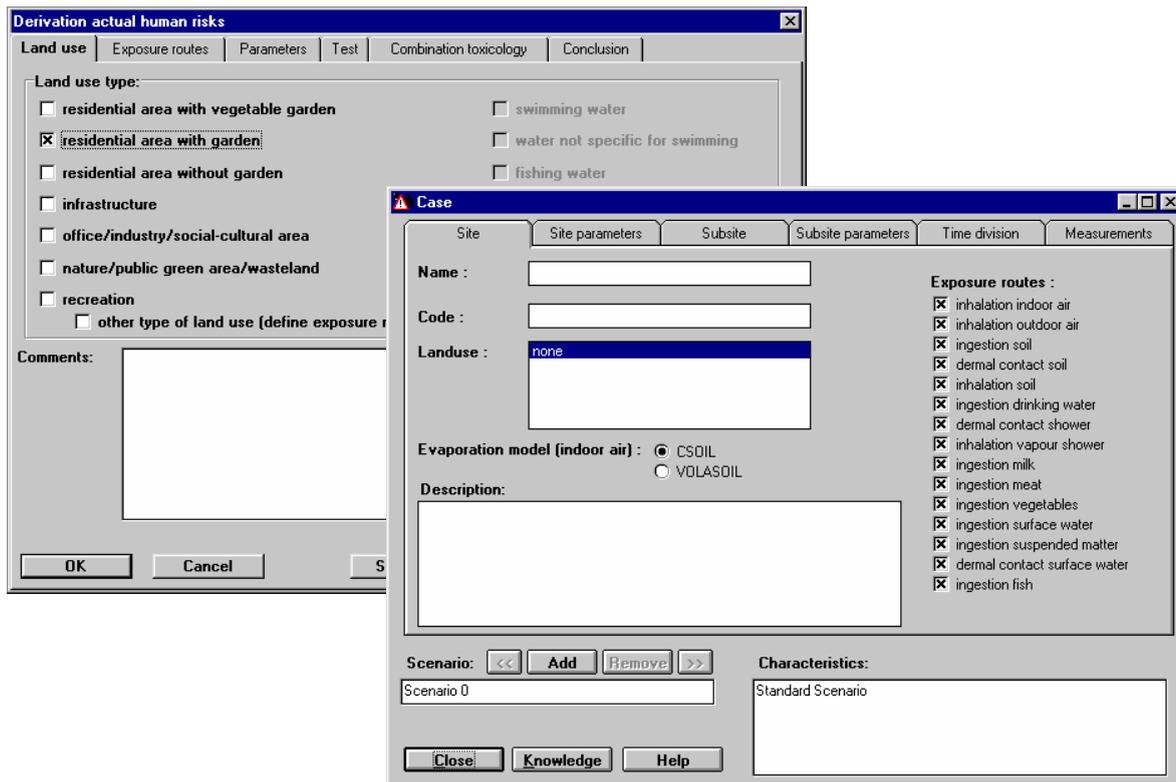


Figure 1: the screen in front shows the Case window of RISC-HUMAN 3.1 where users themselves have to define land use types by amongst others selecting exposure routes. The screen on the back shows predefined land use types in RUM, which need to be selected by the users.

Ethnological differences

Ethnological differences between countries can influence the value of the (input) parameters of the different models. For instance, the amount of home-grown vegetables, but also a parameter like the Bio Concentration Factor (BCF), which is used to calculate the exposure via crop consumption and amongst others depends on the type of crops which are consumed.

Other country specific elements

A lot of other elements, not necessarily ethnological originated, result in differences between the models. Differences in building constructions can for instance be found between houses with a crawl space, houses with a basement or houses with neither a crawl space nor a basement. These different building constructions ask for a different modeling of the concentration in indoor air. A house with a crawl space is a typical Dutch situation and this model concept as well as the model concept for a basement is present in RUM and RISC-

HUMAN. Additional to these model concepts the option to model a house without crawl space and basement is present in Vlier-Humaan. Depending on specific building constructions used in a country, options to model them are incorporated.

4 Conclusions and discussion

Due to developments in the soil contamination decision-making process the role of risk assessment (models) increases gradually. The current state of the soil contamination decision-making process differs per country and as a result also the role of risk assessment (models).

Differences in country specific elements show the need for country specific models. Otherwise this does not mean that part of model concepts or input values between country specific models do not or cannot correspond. It does not either mean that generic and country specific risk assessment models can't exist next of each other. RUM and RISC-HUMAN for example are applied next of each other in the Netherlands, but in a different phase of the soil contamination decision-making process. RUM is especially developed to determine the remediation urgency for serious contaminated soils and is therefore not suitable to derive risks for any other situation. Due to this generic models like RISC-HUMAN are still of importance in the Netherlands but also in countries in which the whole decision-making process still have to take a definite shape.

5 References

1. Swartjes, F.A. (2002)
Variation in calculated human exposure. Comparison of calculations with seven European human exposure models. RIVM report 711701030, Bilthoven, The Netherlands.
2. Van den Berg, R. (1991)
Blootstelling van de mens aan bodemverontreiniging. Een kwalitatieve en kwantitatieve analyse, leidend tot voorstellen voor humaan toxicologische C-toetsingswaarden (in Dutch). RIVM report 725201006, Bilthoven, The Netherlands.
3. Waitz, M.F.W., J.I. Freijer, P. Kreule and F.A. Swartjes (1996)
The Volasoil risk assessment model based on CSOIL for soil contaminated with volatile compounds. RIVM report 715810014, Bilthoven, The Netherlands.
4. Bockting, G.J.M, J.G.M. Koolenbrander and F.A. Swartjes (1996)
SEDISOIL; Model ter berekening van humane blootstelling ten gevolge van verontreinigde waterbodems (in Dutch). RIVM report 715810011, Bilthoven, The Netherlands.
5. Veerkamp, W. and W. ten Berge (1992)
Hazard assessment of Chemical Contaminants in Soil. Technical report no. 40. ECETOC Technical report 40 Revised Appendix III, ECETOC, Brussels.
6. Brochure Remediation Urgency Method. Joint Publication of Ministry of Housing, Spatial Planning and the Environment and the Van Hall Instituut *Business Center*.