http://www.epa.gov/heasd/products/sheds_multimedia/sheds_mm.html
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Human Exposure and Atmospheric Sciences

SHEDS-Multimedia

Details of SHEDS-Multimedia version 3: ORD/NERL's Model to Estimate Aggregate and Cumulative Exposures to Chemicals

You will need Adobe Acrobat Reader, available as a free download, to view some of the files on this page. See EPA's PDF page to learn more about PDF, and for a link to the free Acrobat Reader.

Background

On a daily basis people contact a variety of chemicals that enter the body through multiple routes and pathways. The Food Quality Protection Act of 1996 (FQPA) mandates the EPA to consider aggregate (single-chemical, multi-route/pathway) and cumulative (multi-chemical, multi-route/pathway) human exposure, particularly for infants and children, when making pesticide regulatory decisions. Implementation of FQPA necessitated developing new methodologies to assess residential exposures as well as refined dietary estimates. Probabilistic models have been recommended by the National Research Council and the EPA because they allow quantification at different percentiles of a population of interest, as well as the uncertainty associated with those percentiles. ORD/NERL developed SHEDS-Multimedia as a user-friendly, state-of-the-science human exposure assessment model to address these needs. SHEDS-Multimedia is a physically-based, probabilistic model that predicts, for user-specified population cohorts, exposures incurred via inhaling contaminated air, touching contaminated surface residues, and ingesting residues from hand- or object- to-mouth activities.

The general approach of SHEDS-Multimedia consists of simulating an individual using NERL's Consolidated Human Activity Database (CHAD), probabilistically simulating that individual's contact with environmental concentrations, estimating the individual's exposure time profile for multiple pathways, and applying Monte Carlo sampling to simulate the population exposure. While the core of SHEDS-Multimedia is the concentration-to-exposure module, there are several options (built-in source-to-concentration module; user-entered time series from other models or field study measurements) for obtaining concentration inputs, and SHEDS-Multimedia exposure outputs can be used as inputs to physically-based pharmacokinetic (PBPK) models. SHEDS estimates exposures at the national scale for sub-populations of interest (e.g., children). It is intended for use by the Agency (ORD, Program Offices) and exposure assessors outside the Agency. Inputs include chemical usage (optional), environmental concentration data, and exposure factors. Outputs include population and individual outputs for various exposure or dose metrics, and key factors and pathways.

Goal

The goal of this research is to provide a peer-reviewed state-of-the-science probabilistic model for improving estimates of human exposure and dose to multimedia, multipathway pollutants. Objectives to meet this goal include developing, testing, refining, applying, evaluating, and disseminating the model.

Description of the research program and results

SHEDS-Multimedia version 3 is ORD's state-of-the-science probabilistic aggregate residential exposure model. Other SHEDS models, with similar approaches but addressing different chemical classes and exposure scenarios, have been developed by EPA/ORD's exposure modeling research program to address exposures to particulate matter (SHEDS-PM), air toxics (SHEDS-ATOX), and

wood (SHEDS-Wood) This modeling tool can help predict ranges of exposure in a population, enhance dose model estimates, identify critical pathways and factors, quantify uncertainties, and compare model predictions against real-world data. It has a number of unique features that advance the science of human exposure assessment, and has been peer reviewed and applied for research and regulatory support. SHEDS can link with measurements, source models, and PBPK models to quantify and reduce uncertainty in risk assessments.

Model development included consideration of other exposure algorithms in conceptual formulation; SHEDS-Multimedia researchers participated in several model-to-model comparison workshops and requested external peer consultation in the model formulation stages. Model testing and refinement was based on code verification, quality assurance procedures, prediction evaluation using measurements data, external beta testing, and internal and external scientific peer reviews. Model evaluation was performed via model-to-model comparisons and comparisons of model predictions against measurement data. In general, SHEDS-Multimedia results are reasonable compared to biomonitoring data and other similar models, especially the dietary module. Additional SHEDS-PBPK evaluation using National Health and Nutrition Examination Survey (NHANES) and NERL measurement study data is currently underway for metals and pyrethroids. More research is needed to obtain data for critical inputs and conduct model evaluation for different chemical classes. SHEDS-Multimedia has been applied to support ORD chlorpyrifos research to prioritize data needs, and to support OPP's risk assessments for carbamates and pyrethroids (ongoing)

Impact

Computer models that simulate realistic distributions of human exposure to different chemicals through daily activities can improve our understanding of human health risks and fill the need for more realistic exposure prediction tools beyond screening level methods. The Stochastic Human Exposure and Dose Simulation model for multimedia, multipathway pollutants (SHEDS-Multimedia) is the EPA/ORD's principal model for simulating human exposures to a variety of multimedia, multipathway environmental chemicals such as pesticides, metals, and persistent bioaccumulative toxins. The model enhances estimates of aggregate and cumulative residential exposure, and can improve human health risk assessment and risk management decisions. To date, SHEDS-Multimedia has been used successfully by EPA to improve pesticide-related risk assessments (e.g., n-methyl carbamates, pyrethroids) and to prioritize data needs (e.g., chlorpyrifos, arsenic). SHEDS algorithms are being incorporated into the EPA Office of Pesticide Programs (OPP)'s revised standard operating procedures (SOPs) for residential exposure assessment. Non-EPA users in academia, government, and industry are also using SHEDS-Multimedia for a variety of regulatory and research purposes, and the model is gaining international attention. The model's use is expected to expand within the Agency and internationally to inform human health risk assessments for environmental regulatory decision-making, and for helping to address emerging issues.

Status

The aggregate residential version of SHEDS-Multimedia (version 3), the SHEDS dietary module, and methodologies to extend aggregate version 3 to cumulative version 4, were externally peer reviewed by the EPA OPP's Scientific Advisory Panel (SAP) August 14-15, 2007. An SAP review of the cumulative version with a pyrethroid pesticide case study (including linkage to NERL's PBPK model) is planned for 2010. Several publications are available and technical presentations have been made at various national and international conferences and workshops. The peer reviewed version 3 is available through this website (see below).

Development of SHEDS-Multimedia version 4 is ongoing; it will allow for cumulative (multi-chemical) or aggregate (single chemical) assessments and combine the residential and dietary modules. An SAP review of SHEDS-Multimedia version 4 is planned for 2010. This research will be useful to human exposure modelers conducting aggregate and cumulative exposure modeling assessments involving pesticides and other multimedia, multipathway chemicals, to enhance human exposure and risk assessments.

Download SHEDS-Multimedia Model v.3
Links to download the two modules and their technical manuals and user guides are provided below. The annotated SHEDS SAS code, technical manual, graphical user interface, and user guide provide a thorough perspective and understanding of the SHEDS technical and usability aspects. SAS version 9.1 or higher is required to run SHEDS-Multimedia version 3. The SHEDS-Multimedia technical manual describes the algorithms, methodologies, and input and output capabilities of SHEDS-Multimedia version 3, an aggregate residential model focused on single chemical exposures from inhalation, dermal contact, and non-dietary ingestion. The technical manual also includes some detail of the SHEDS-Multimedia code itself (written in the SAS programming language). The SHEDS-Multimedia version 3 user guide describes the graphical user interface and the how to use the model.

IMPORTANT: PLEASE REGISTER FIRST (link below) *before* performing the download.

Registration Form **for Download of Executable File (requires SAS software) & Comment Form.**

Comments or questions on EPA SHEDS Multimedia version 3 or problems with the download should be sent to zartarian.valerie@epa.gov. We welcome comments that can be considered for future development.

Product available for download:
EPA sheds Multimedia 3.15 Software (12.9 MB)

Technical Documentation and User Guide for SHEDS-Multimedia Model:
EPA SHEDS-Multimedia Model 3.0 User Guide (PDF, 103 pp, 3.6 MB)
EPA SHEDS-Multimedia3 TechManual (PDF, 150 pp, 1.42 MB)

Download Drafts of SHEDS-Multimedia (Residential Module) version 4 and Dietary Module version 1.0

Links to download the two modules and their technical manuals and user guides are provided below. The two modules are undergoing external scientific peer review by the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) Scientific Advisory Panel (SAP) on July 20-22, 2010. All documents for this meeting are available in the Office of Pesticide Programs public docket, EPA-HQ-OPP-2010-0383, and all, excluding the Residential and Dietary Modules executable files, are available online in the FDMS Docket System located at http://www.regulations.gov.

The annotated SHEDS SAS code, technical manual, graphical user interface, and user guide provide a thorough perspective and understanding of the SHEDS technical and usability aspects.

SAS version 9.1 or higher is required to run SHEDS-Multimedia version 4 and SHEDS-Dietary version 1.0.

- **SHEDS_Installation.pdf** (PDF, 1 pp, 48 KB)

EPA's SHEDS-Residential version 4 model
EPA's SHEDS-Residential version 4 model is a physically-based, probabilistic model that can simulate for a population of interest cumulative (multiple chemicals) or aggregate (single chemical) residential exposures over time via multiple routes of exposure for different types of chemicals and scenarios. The United States Environmental Protection Agency, through its Office of Research and Development, developed and funded SHEDS-Residential version 4 with assistance from contractor Alion Science and Technology, Inc.

SHEDS-Residential version 4 is one module (along with the separate SHEDS-Dietary module) of EPA's more comprehensive human exposure model, the Stochastic Human Exposure and Dose Simulation model for multimedia, multipathway chemicals (SHEDS-Multimedia), which can simulate aggregate or cumulative exposures over time via multiple routes of exposure (dietary & non-dietary) for different types of chemicals and scenarios. SHEDS-Residential and SHEDS-Dietary will be merged together in a future version of SHEDS-Multimedia.

SHEDS-Residential version 4 includes a case study example for illustrative purposes, as well as a default file for non-chemical specific inputs, as described in the Technical Manual and User Guide. All input values used in the SHEDS-Residential model for a given application should be entered or reviewed by the researcher so that the model results are based on appropriate data sources for the given application.

Version 4 of SHEDS-Residential reflects comments from EPA's August 2007 FIFRA SAP that reviewed SHEDS-Multimedia version 3 (the aggregate residential version)[http://www.epa.gov/scipoly/sap/meetings/2007/081407_mtg.htm].

Through its Office of Research and Development, the United States Environmental Protection Agency developed and funded the SHEDS-Residential module with assistance from contractor Alion Science and Technology. SHEDS-Residential Version 4 will undergo external peer review by EPA's FIFRA SAP July 20-22, 2010, and should be considered draft at this time.

- **SHEDS_Residentialv4_Techmanual_06-16-2010.Final.pdf** (PDF, 194 pp, 1.36 MB)
- **SHEDS_Residential_UsersGuide_6_16_2010.pdf** (PDF, 144 pp, 2.29 MB)
- **SHEDS_Residentialv4_Setup_4.00.exe** (EXE, 27.03 MB)
- **SHEDS Multimedia QAPP-Rev1-Final.pdf** (pdf, 28 pp, 9.06 MB)

EPA's SHEDS-Dietary model version 1

EPA's SHEDS-Dietary model is a probabilistic, population-based dietary exposure assessment model that simulates individual exposures to chemicals in food and drinking water over different time periods (e.g., daily, yearly). SHEDS-Dietary is one module (along with the separate SHEDS-Residential module) of EPA's more comprehensive human exposure model, the Stochastic Human Exposure and Dose Simulation model for multimedia, multipathway chemicals (SHEDS-Multimedia), which can simulate aggregate or cumulative exposures over time via multiple routes of exposure (dietary & non-dietary) for different types of chemicals and scenarios. SHEDS-Residential and SHEDS-Dietary will be merged together in a future version of SHEDS-Multimedia.

SHEDS-Dietary version 1 includes case study examples for illustrative purposes, as described in the Technical Manual and User Guide. All input values used in the SHEDS-Dietary model for a given application should be entered or reviewed by the researcher so that the model results are based on appropriate data sources for the given application.

Through its Office of Research and Development, the United States Environmental Protection Agency developed and funded the SHEDS-Dietary module with assistance from contractor Alion Science and Technology. SHEDS-Dietary Version 1 will undergo external peer review by EPA's FIFRA SAP July 20-22, 2010, and should be considered draft at this time.

- **SHEDS_Dietary_Setup_1.0.exe** (EXE, 126.15 MB)
- **SHEDS_Dietary_Techmanual_06-16-2010.FINAL.pdf** (PDF, 73 pp, 1.70 MB)
- **SHEDS_Dietary_TechManual_APPENDICES_06-16-2010_FINAL.pdf** (PDF, 163 pp, 0.96 MB)
- **SHEDS_Dietary_UsersGuide_6-16-2010.pdf** (PDF, 151 pp, 10.20 MB)

EPA SHEDS Summary and Review material presented to FIFRA Science Advisory Panel July 20-22, 2010

- **Introduction to and Overview of ORD's Stochastic Human Exposure and Dose Simulation model for multimedia, multiroute/pathway chemicals** (PDF, 27 pp, 288 KB)
- **SHEDS-Dietary overview and illustration with a permethrin case study** (PDF, 41 pp, 349 KB)
- **SHEDS-Multimedia Residential Module and Case Study Results** (PDF, 47 pp, 473 KB)
- **SHEDS-Multimedia Model Evaluation Efforts** (PDF, 36 pp, 368 KB)
- **Permethrin SHEDS-PBPK Linked Model Case Study** (PDF, 19 pp, 539 KB)

Publications

- **SHEDS-related publications as of September 2010** (PDF, 2 pp, 28.5 KB)

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