

Streamlining the Process of Conducting Human Health Risk Assessments

with BREEZE AERMOD, Esri ArcGIS, and BREEZE Risk Analyst
Software

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Presented by
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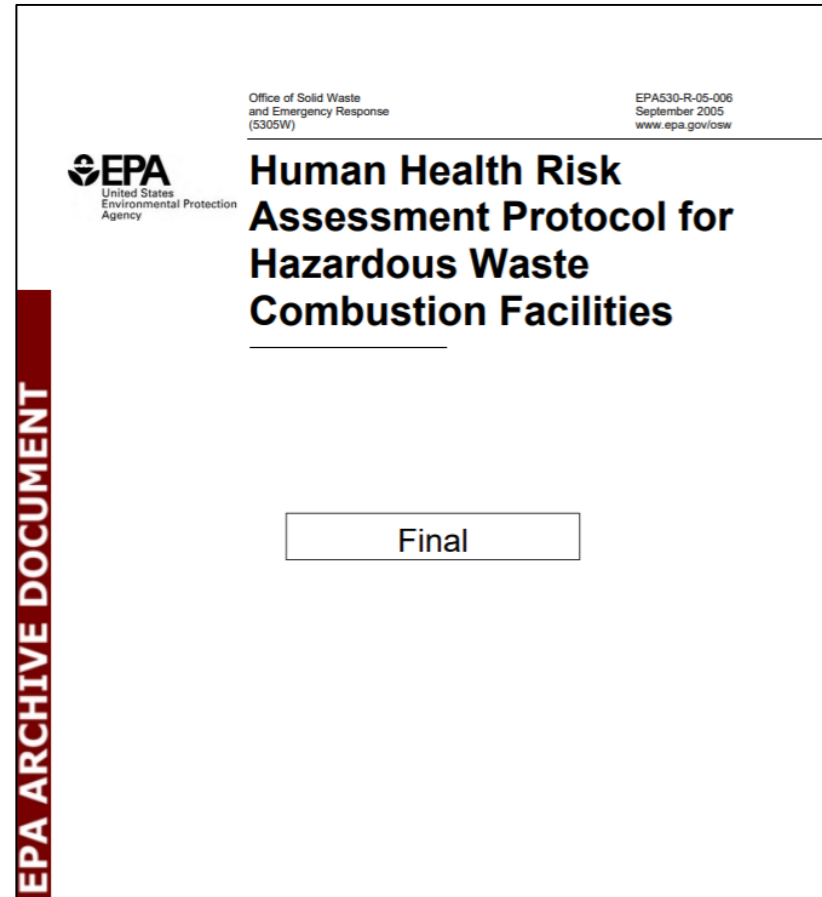
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Introduction

- Full scale Human Health Risk Assessments (HHRA) are useful for:
 - Evaluating the *potential health impacts* of exposure to specific release (emission) scenarios.
 - Assessing environmental compliance and strategizing mitigation actions.

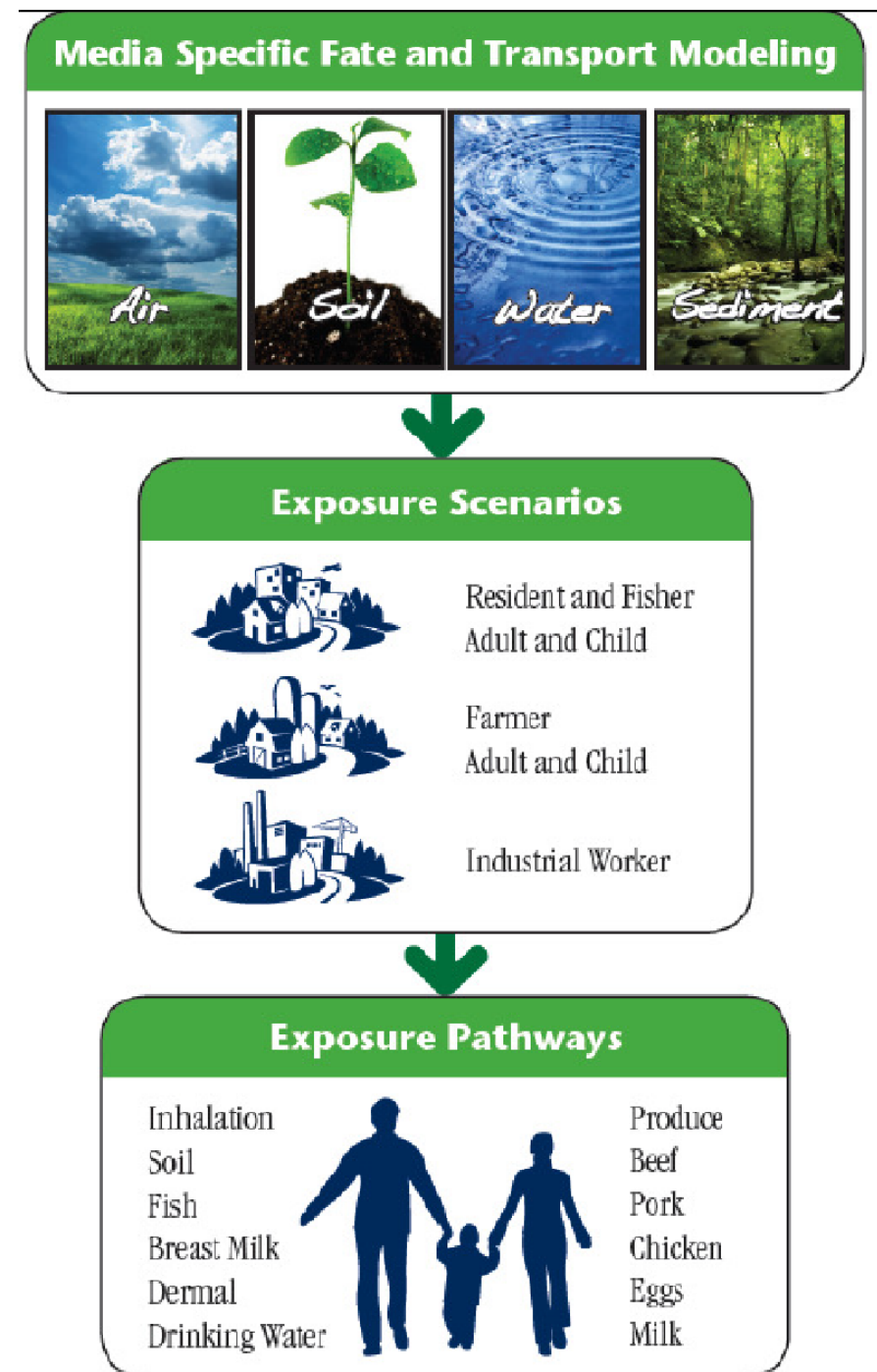
U.S. EPA Human Health Risk Assessment Protocol is a guidance for performing **site-specific, multi-media, and multi-pathway** HHRA.

- HHRAP covers:
 - Risk Assessment Methodologies
 - Chemical of Potential Concen (COPCs) selection process
 - Air Dispersion & Deposition Modeling
 - Exposure scenario and pathway selection
 - Fate, Transport, and Exposure Equations – quantifying exposure
 - Recommended Parameter Defaults (usually conservative)
 - Chemical Database (and the reference concentration)



Human Health Risk Assessment Protocol Module

- **Chemical database**
 - Over 400 chemicals
- **Exposure Scenarios**
 - Adult and Child Resident
 - Adult and Child Fisherman
 - Adult and Child Farmer
 - Custom
- **Exposure Pathways** include:
 - **Media** (Air, Soil, Surface Water, Sediment)
 - **Vegetation** (Forage, Silage, Above and Below Ground Produce)
 - **Animal Tissue** (Pork, Beef, Milk, Chickens, Eggs, Milk, Fish)
 - **Nursing Infant** (Breast milk)
 - **Other** – Dermal (not HHRAP default)



Software Tools

- **ArcGIS** is a geographic information system (GIS) for working with maps and geographic information, such as analyzing geographic data, creating maps, etc
- **BREEZE AERMOD** dispersion modeling system is a refined, steady-state, multiple source, Gaussian dispersion model*
- **BREEZE Risk Analyst** – built upon GIS-based analysis platform
 - Fully implements the U.S. EPA HHRAP
 - Chemical Database includes over 400 HHRAP chemicals
 - Chemical types include volatiles, semi-volatiles, and metals

* 40 CFR Part 51, Appendix W Guideline on Air Quality Models, Appendix A.1 - AERMOD is a U.S. EPA Regulatory Model

BREEZE Risk Analyst Software

Tool for complex modelling & assessment involving multiple pollutants, pathways, environmental media

Benefits

- Recognized by USEPA and widely used by industry
- Highly transparent - eliminate “black box” modeling
- Integrated with AERMOD results – saves study time
- Fully editable and comment-enabled *chemical database*
- Intuitive process flow – follow steps in HRA process
- Scenario analysis especially at EIA stage

HHRA Process

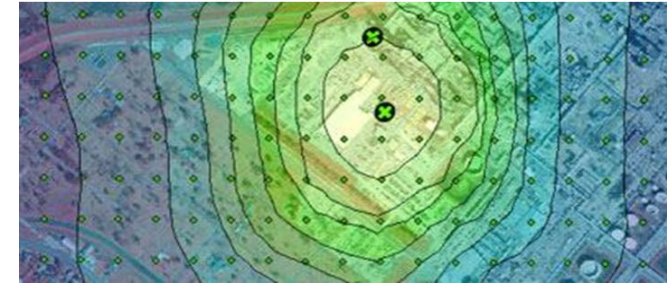


Step 1: HHRA Data Preparation

Facility Characterisation
Compiling facility info, Emission Sources & Rates, Identifying COPCs



Air Dispersion & Deposition Modelling
Modelling with *AERMOD*, including over watershed



Step 2: HHRA with BREEZE Risk Analyst

Exposure Scenario
Selecting scenarios & scenario Locations



Estimating Media Concentration
Concentration in Soil, Air, Drinking Water, Animals



Quantifying exposure
Inhalation, Dermal, Ingestion Pathways, Exposure Duration, Frequency



Risk and Hazard Characterisation
Calculation of Cancer Risk and Noncancer Hazard



Identifying and Interpreting Uncertainty
Qualitative and Quantitative

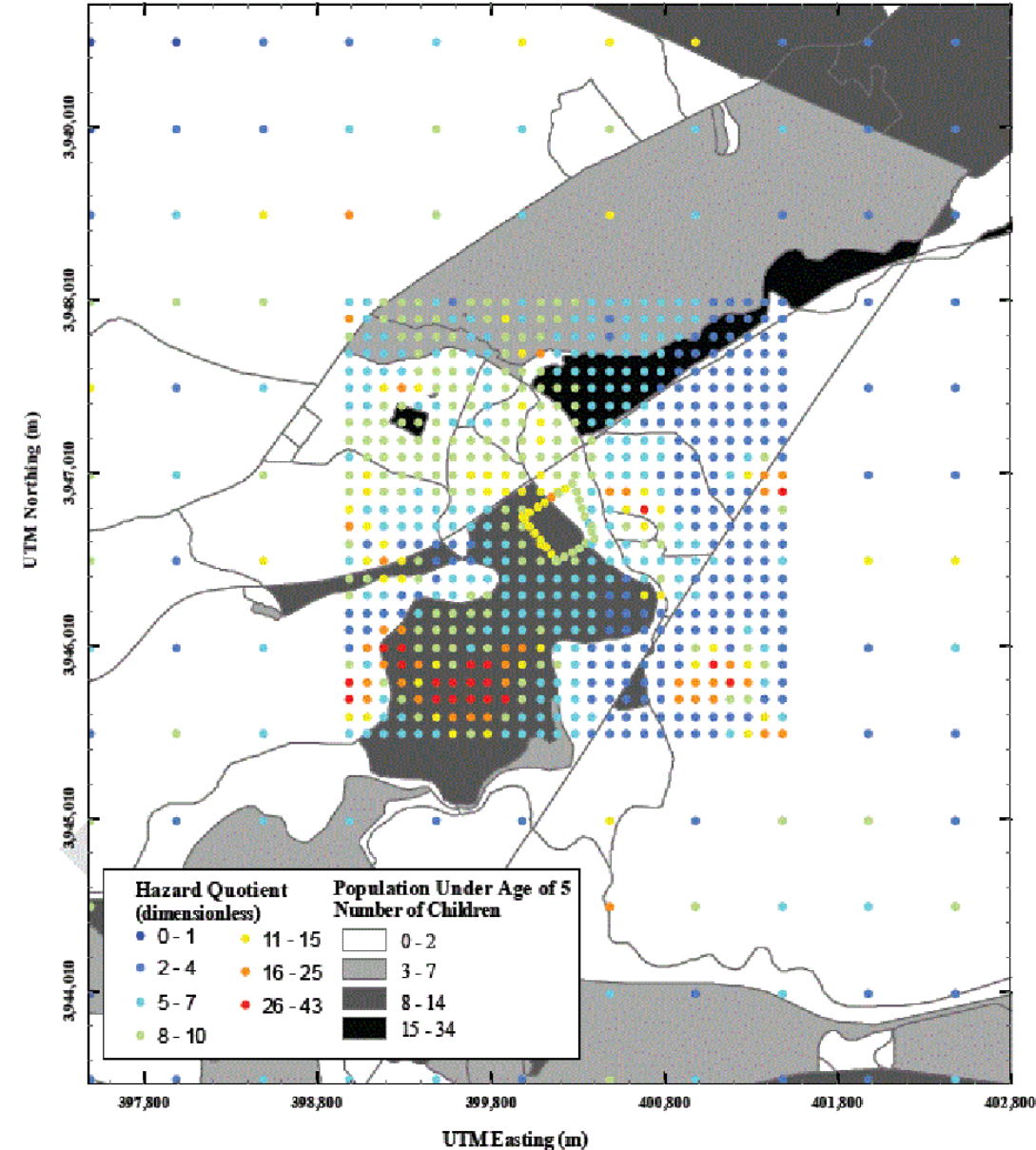
Results

- The results can be visualized in ArcGIS using Risk Analyst
- Case study
 - Prop-2-enal, a type of aldehyde regulated by US EPA's effect:
 - Acute Inhalation
 - Results in Children

Target Levels

- Total Hazard Index (Non-Carcinogens):
 - Target Hazard Index level of less than 1.0 (Health protective, Superfund Value)

Unacceptable HQ, Additional mitigation measures needed to control the emission sources



Summary

- BREEZE Risk Analyst Software – developed as a tool for **Human Health and Ecological Risk** assessment & modelling
 - Streamline multi-media **fate and transport** and **exposure modelling**
 - To estimate potential adverse impacts to human health
 - Cancer risks, non-cancer hazards, and short-term acute effects
 - Ecological receptors : food-web based ecological risk modelling



Case Study

Attachment

Examples of HRA applications

- Air emissions from **toxic & hazardous waste** incineration plant
- Air emissions from **municipal solid waste** incineration plant
- Air emissions from **coal power plant**
- Accidental release of toxic & hazardous waste

Case Study

- Site: A fictitious manufacturing facility located in the state of North Carolina
- Chemical of Potential Concern (COPC): Acrolein (Prop-2-enal, a type of aldehyde regulated by US EPA)
- Emission Sources: A boiler, several press vents and several dryers
- AERMOD results:
 - Maximum ambient concentration for 1-hour and annual averaging periods for one year
- Pathway: Inhalation (Vapor form emission only as a product of combustion)
- Scenarios: Acute inhalation
- Exposure frequency: 350 days/year
- Exposure duration: 1 year
- Reference Concentration (RfC) for acrolein: $2.00 \times 10^{-05} \text{ mg/m}^3$
- Air inhalation exposure criteria for acrolein: 0.069 mg/m^3

Case Study

- Results of the air dispersion modeling analysis with AERMOD completed for the 1-hour averaging period were used as input to Equation (C_acute) to calculate potential human health risks associated with acute inhalation of acrolein.
- The comparison of inhalation exposure estimates to the AIEC are known as Acute Hazard Quotients (AHQ).
 - AIEC is from EPA dose response table for screening risk assessments
- *C_acute is from AERMOD 1-hour results

$$AHQ_{inh(i)} = \frac{C_{acute} \times 0.001}{AIEC}$$

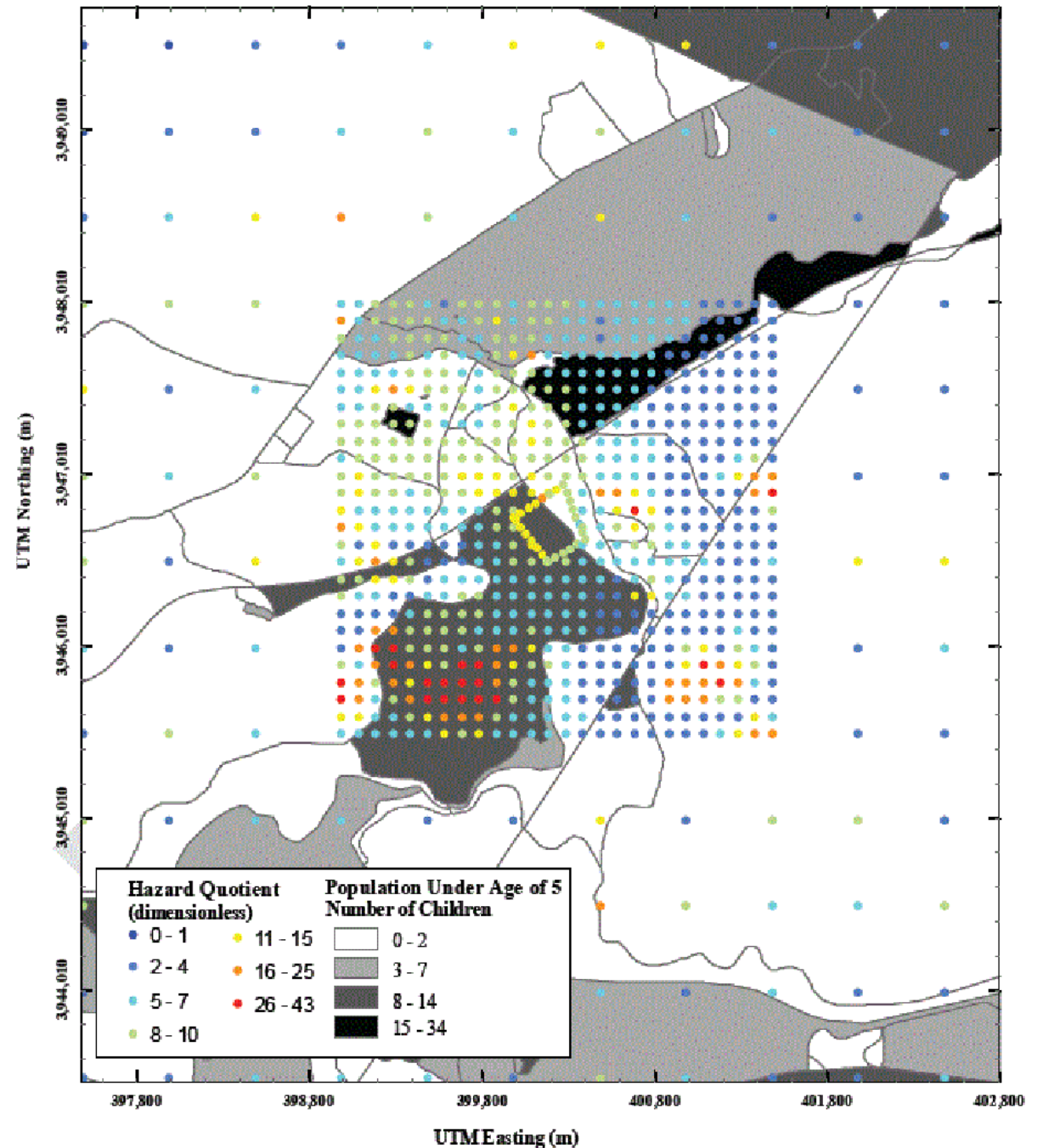
where:

C_{acute} = acute air concentration ($\mu\text{g}/\text{m}^3$)

AIEC = air inhalation exposure criteria (mg/m^3)

Case Study

- Results can be visualized in ArcGIS using Risk Analyst
- Conclusion:
 - Acute Inhalation
 - Results in Children
 - **Unacceptable HQ**
- Recommendation:
 - Additional mitigation measures needed to control the emission sources



- Exclusive distributor of BREEZE software
- Environmental Consultancy:
 - EIA & EMP
 - Air Quality Modelling & Assessment
 - EHS Audit
 - Environmental Due Diligence
 - Soil & Groundwater Contamination
- Training services

Website: www.riverstone-enviro.com

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- Provide global EHS services in over 50 locations
- **BREEZE** Trinity's for EHS modelling software, data & services division
 - Developer of the software

Website: www.breeze-software.com