Parameter Sensitivity Analysis

A cookbook presentation regarding methods used to select sensitive parameters for more intensive investigation

Inputs to Dose/Risk Calculations

Recall: The calculation of dose or risk is preceded by development of a scenario, identification of pathways, and characterization of appropriate parameters.

Scenarios	Pathways	Parameters	Calculation
Wildlife Refuge Open Space Office Worker Rural Resident : Resident Rancher	Soil Ingestion Plant Ingestion External Radiation Inhalation Water	Exposure (physiological, institutional) Physical (natural)	Dose/Risk Calculation ⇕ RSAL

Role of Parameters

Parameters:

- are controlling inputs to the dose/risk model
- are assigned by the user/modeler to reflect a conservative reality (may differ for dose and risk)
- represent the physical conditions and exposure expectations that are appropriate to a particular land-use scenario

Types of Parameters

- Physical Parameters include measurable quantities such as:

  Air mass loading, plant uptake, annual average wind speed, external gamma shielding factor, depth of roots,

- Exposure Parameters include observable quantities such as:

  Indoor time fraction, home-grown produce ingestion (leafy, non-leafy), inhalation rate, outdoor time fraction, indoor dust shielding factor

Parameter Sensitivity

- Not all parameters are equal contributors to the final dose/risk result
- Sensitivity analysis is appropriate to discover the ones that are of greatest importance
- Sensitive parameters deserve more careful consideration if there is significant uncertainty in their assignment
- For this evaluation 108 parameters from 10 groups were potentially subject to evaluation

Determining Sensitive Parameters

- The model is exercised for each contributing pathway, using a range of parameter inputs, one at a time
  - The model's response (dose) is measured across a hypothesized realistic range of parameter input values
  - The relative change in response is tabulated
  - The steps are repeated for another parameter
- The steps are repeated for another pathway

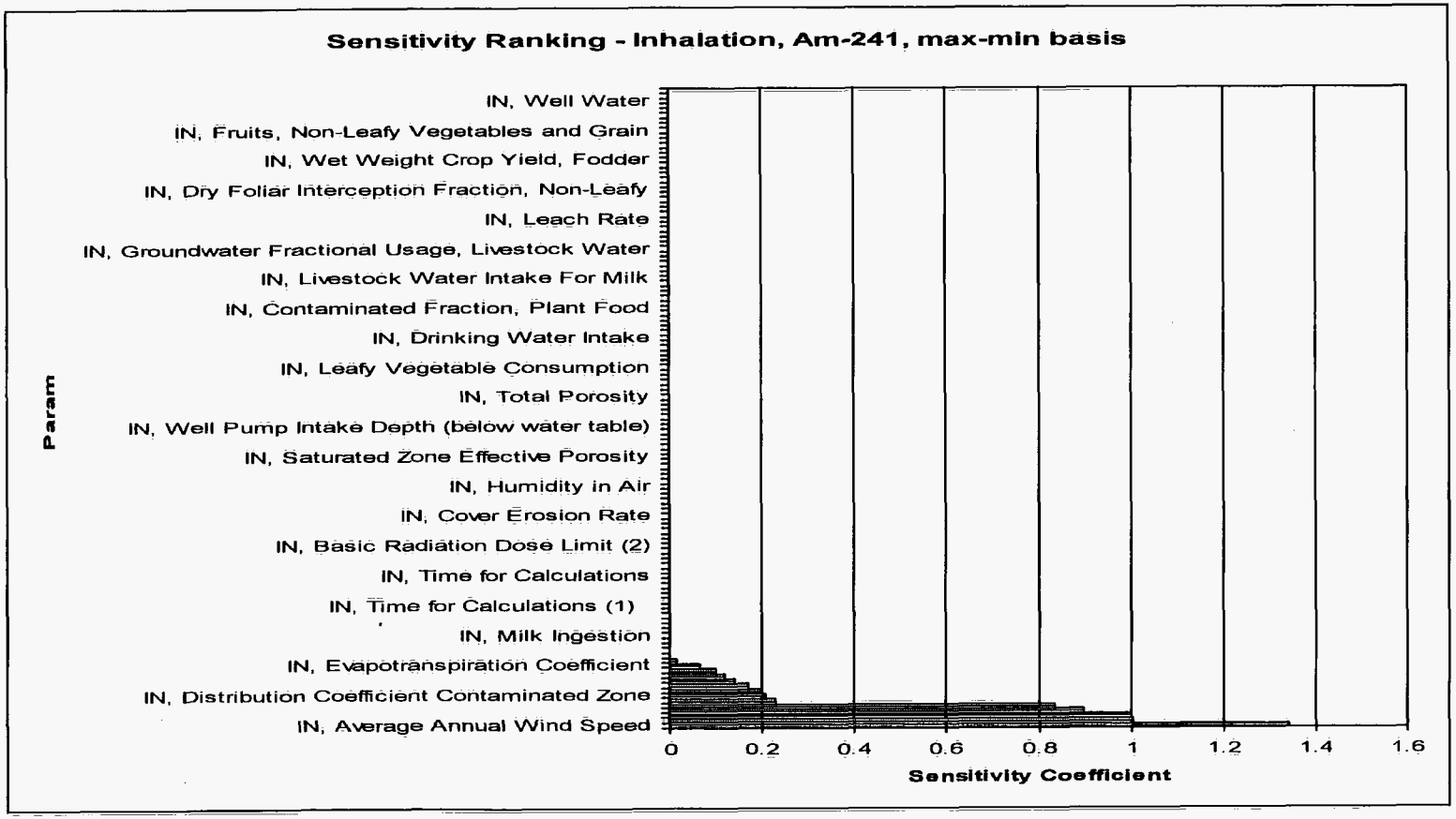
Sensitivity Calculations

- Sensitivity Coefficient is calculated as:

$$SC = \frac{(DR_{max} - Dr_{min})/Dose_{base}}{(Input_{max} - Input_{min})/Input_{base}}$$

- This formulation allows equal consideration for each input parameter by normalizing the comparison within any pathway and isotope selection
- Similar application across all pathways and isotopes combined allows further refinement of the sensitivity analysis

Example: Sensitivity Results for Inhalation Pathway and Am-241



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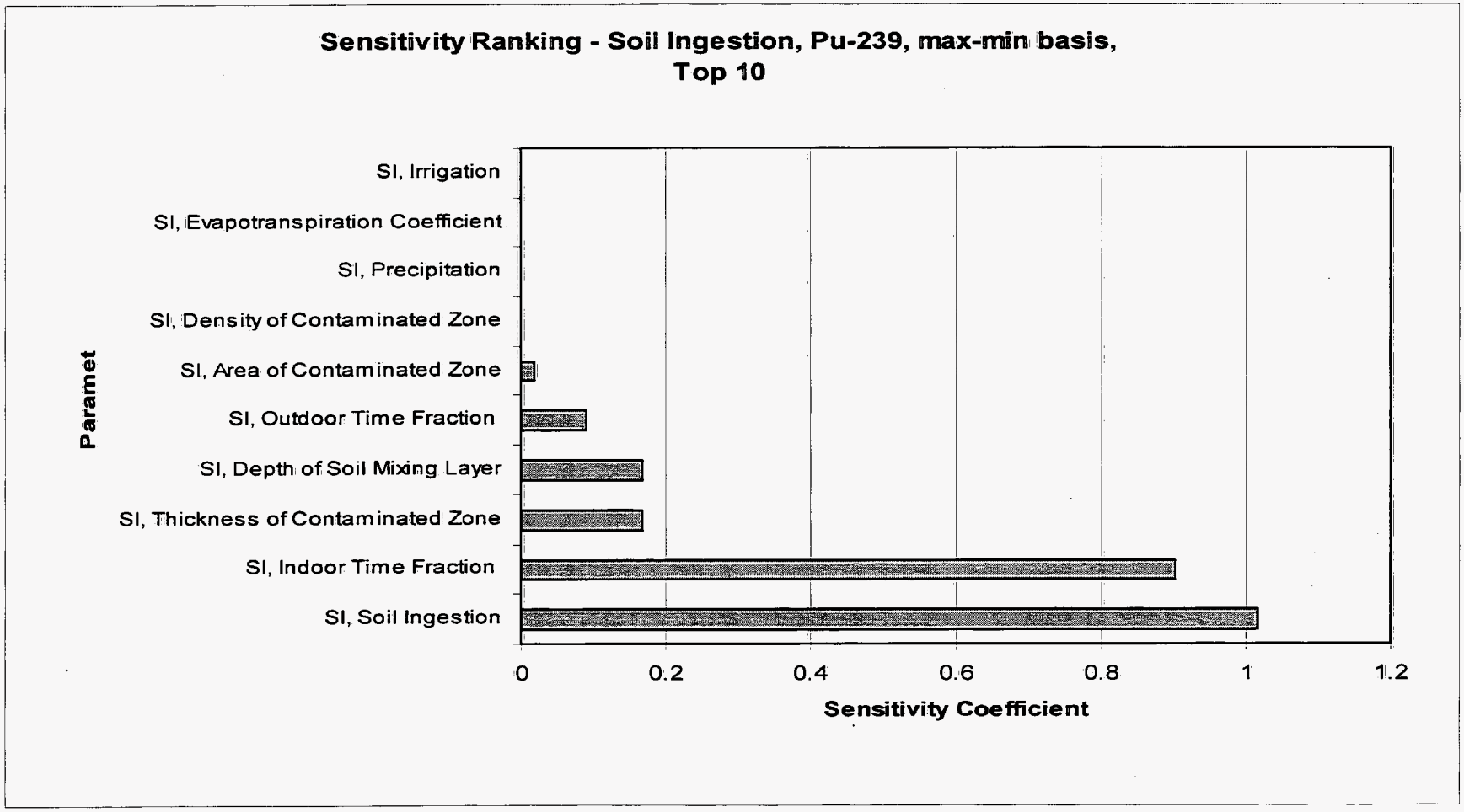
Evaluating Sensitive Parameters

- Lacking some absolute reference against which to compare sensitivities, the sensitivities can be ranked
- Ranked sensitivities may display some "natural" cutoff, above which the parameters show much lessened response to changes

Examples follow:

Soil Ingestion Pathway: Pu-239; Most Sensitive Parameters



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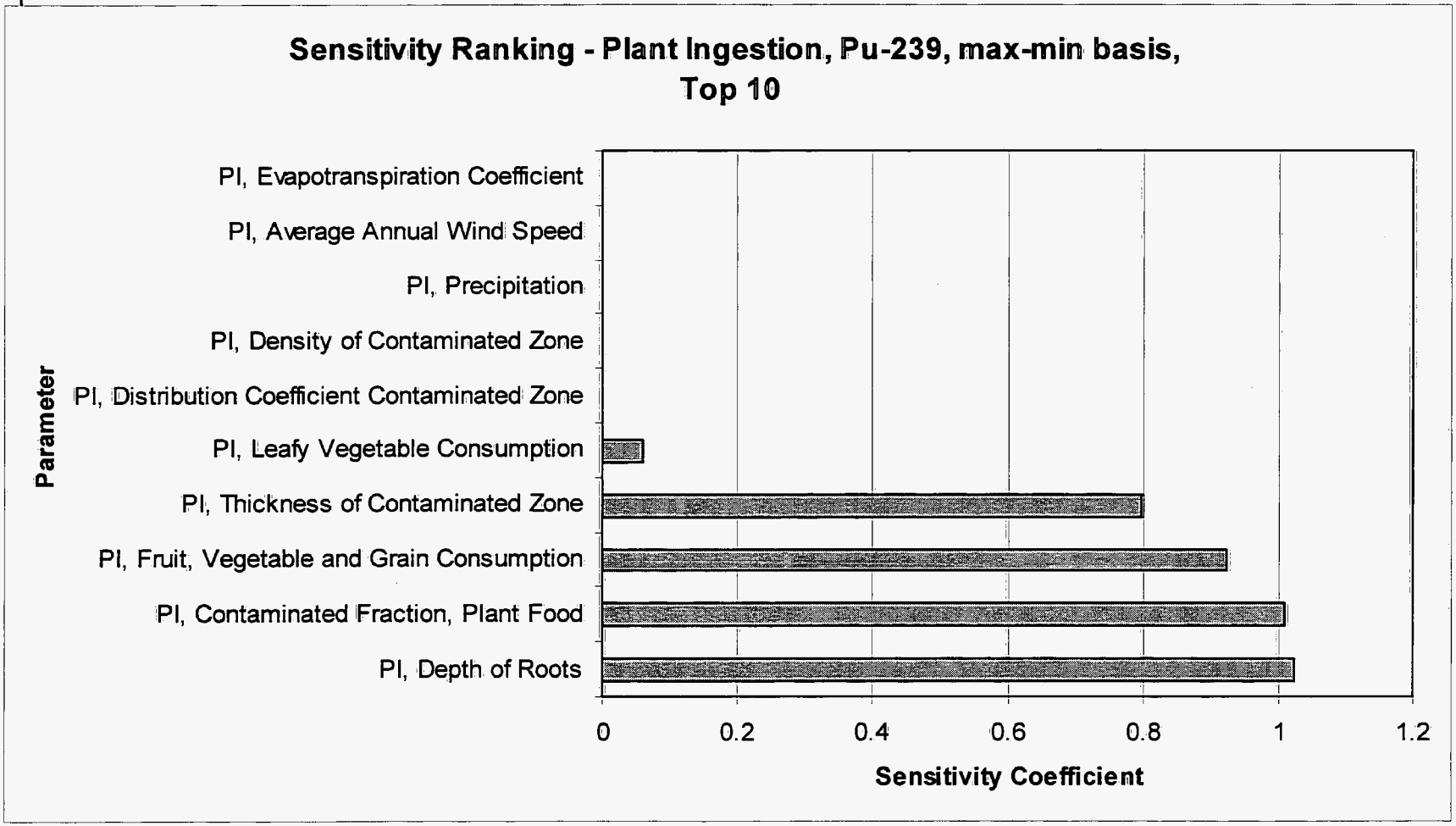
Plant Ingestion Pathway: Pu-239; Most Sensitive Parameters



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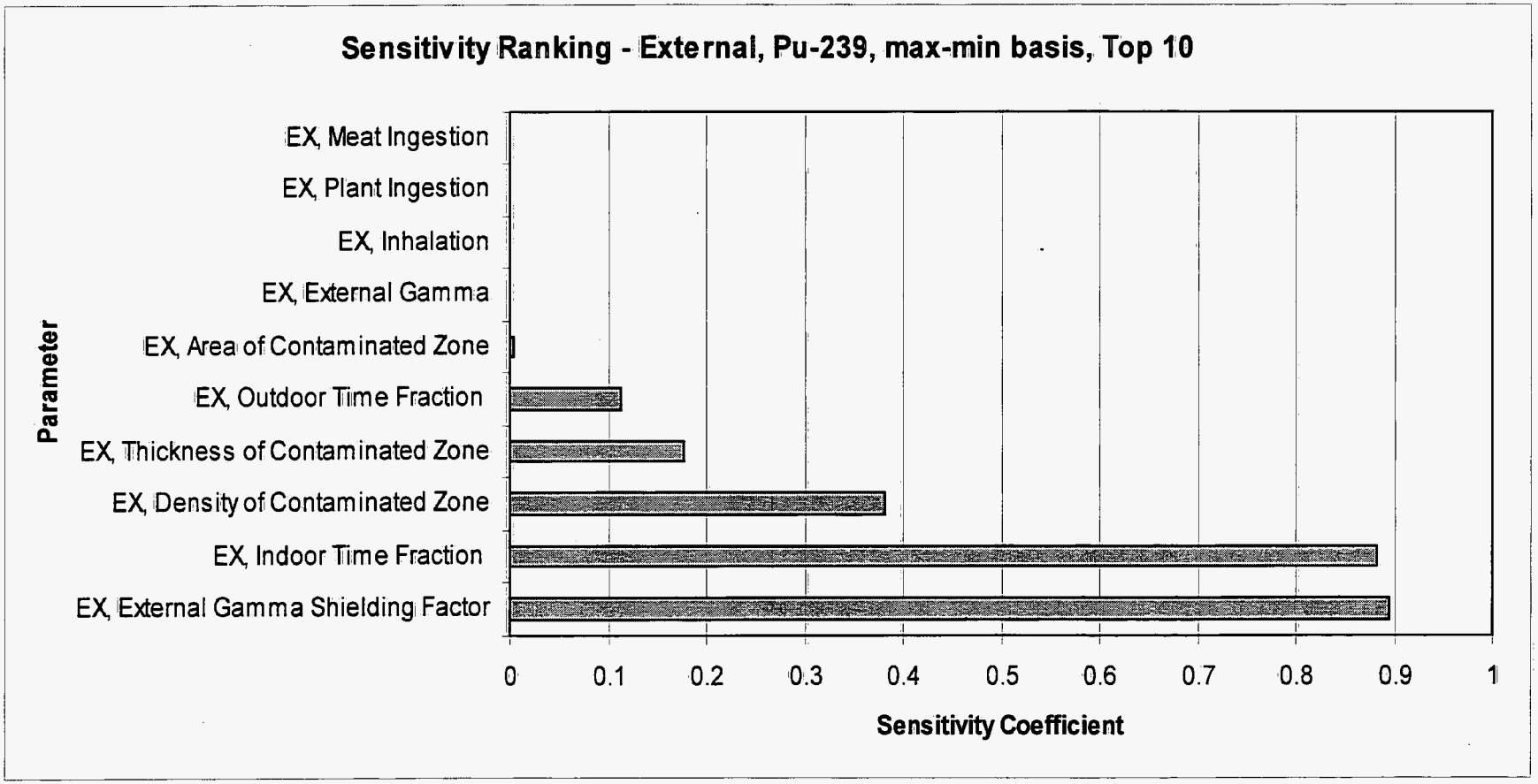
External Pathway: Pu-239; Most Sensitive Parameters



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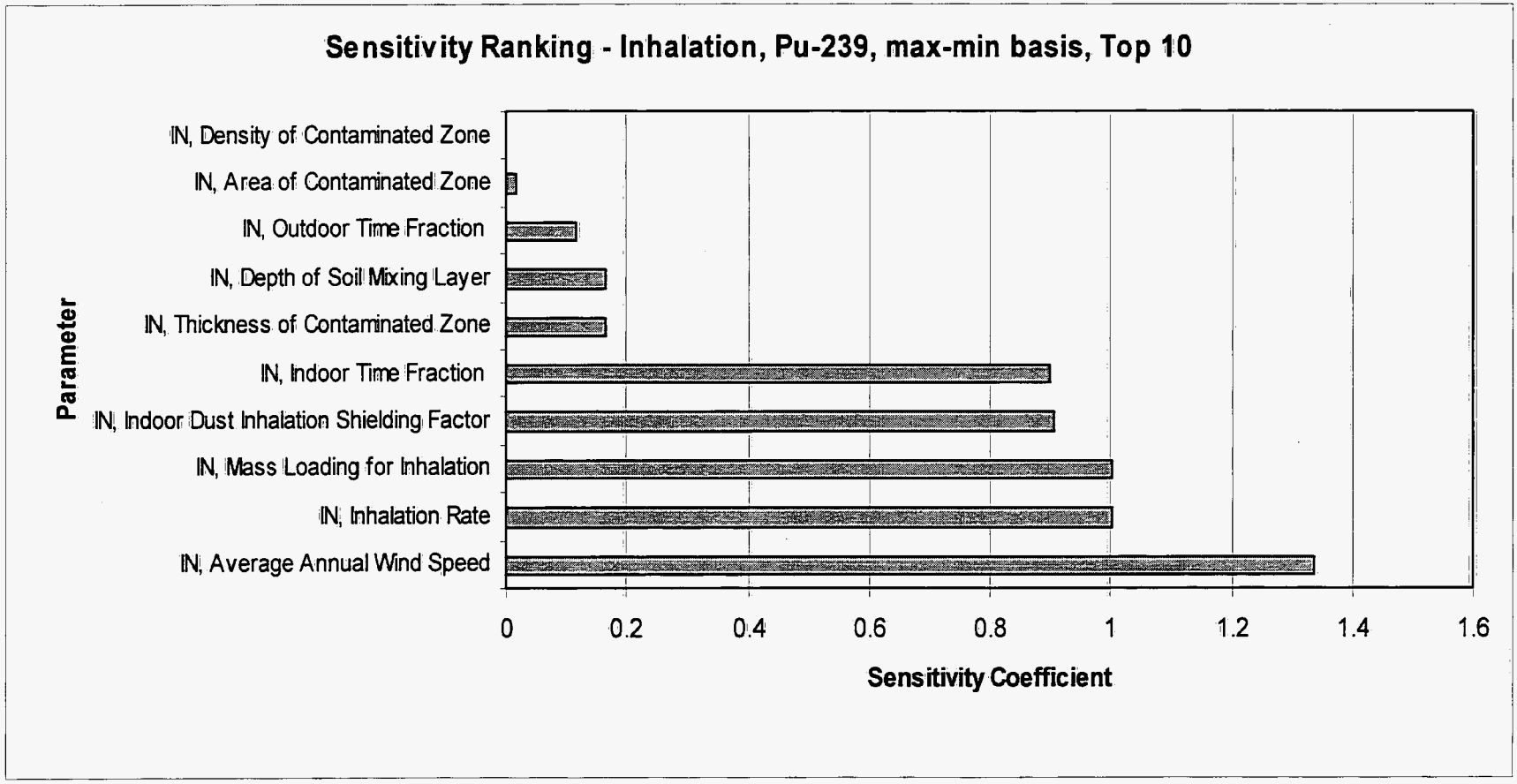
Inhalation Pathway: Pu239; Most Sensitive Parameters



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Parameter Investigation

- The sensitive pathways contributing the greatest change were subjected to further investigation
- Each parameter can be assigned a single value or a distribution (range of values)
- That assignment depends on how predictable the parameter may be, how well-characterized, or in some cases, how uncertain its basis

Example - Mass Loading

- Mass loading in the atmosphere is a sensitive parameter in RESRAD
- Site-specific data indicate a measured range of annual PM-10 mass loading (ML) values from 9.4 to 16.6 $\mu g/m^3$
- Though the site-specific baseline mass loading is reasonably well characterized, it may not represent the ML typical of a more developed environment, hence the baseline will be selected as the median value from all available PM-10 data from across the state.
- Site-specific precipitation data (35+ years) suggest the annual rainfall is not extremely variable; allows estimates of wet/dry effects
- Site-specific data indicate a post-fire resuspension rate that is expected to increase the annual ML by a factor of 2.51 to 4.74, depending on growing conditions

Example (continued)

Result: Because the ML parameter is moderately sensitive, its overall range is potentially large, and its value not predictable, ML will be input into RESRAD as a distribution.

Mass Loading Distribution

(Result subject to further refinement)