

# #100 Development of Accident Consequence Assessment Scheme using Accident Cost and Consideration of Decontamination Model

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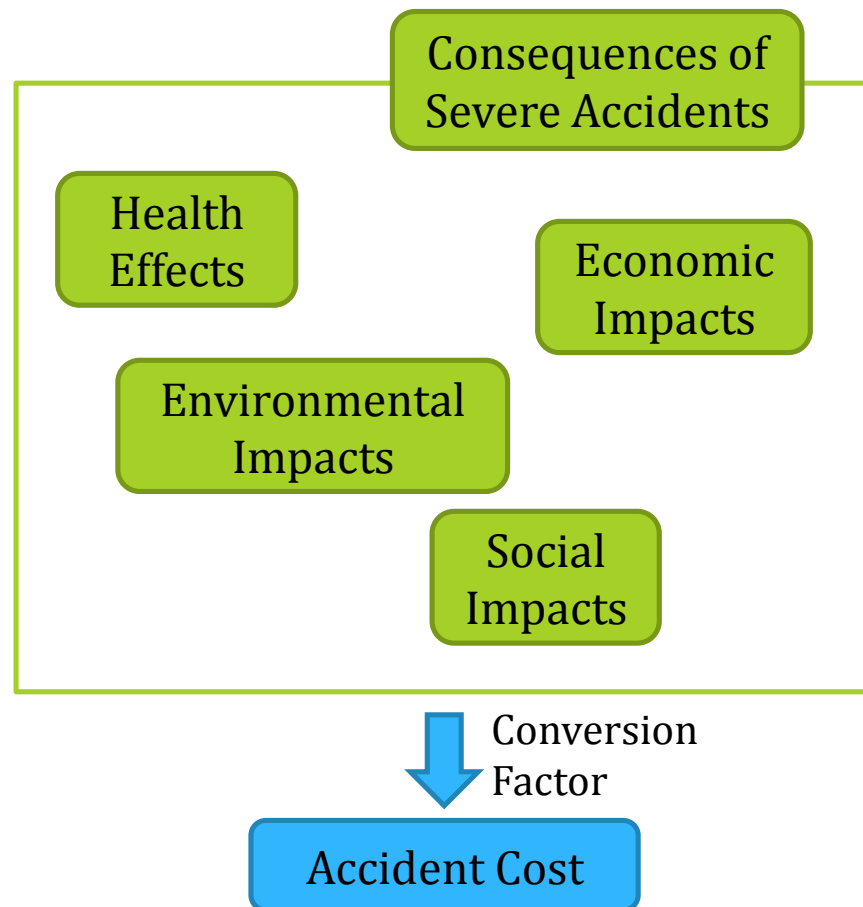
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# Motivation of research on accident cost calculation



Index for accident consequence assessment

# Components of accident cost

## Health effects

- Radiation effect cost
- Psychological effect cost

## Social impacts

- Harmful rumors

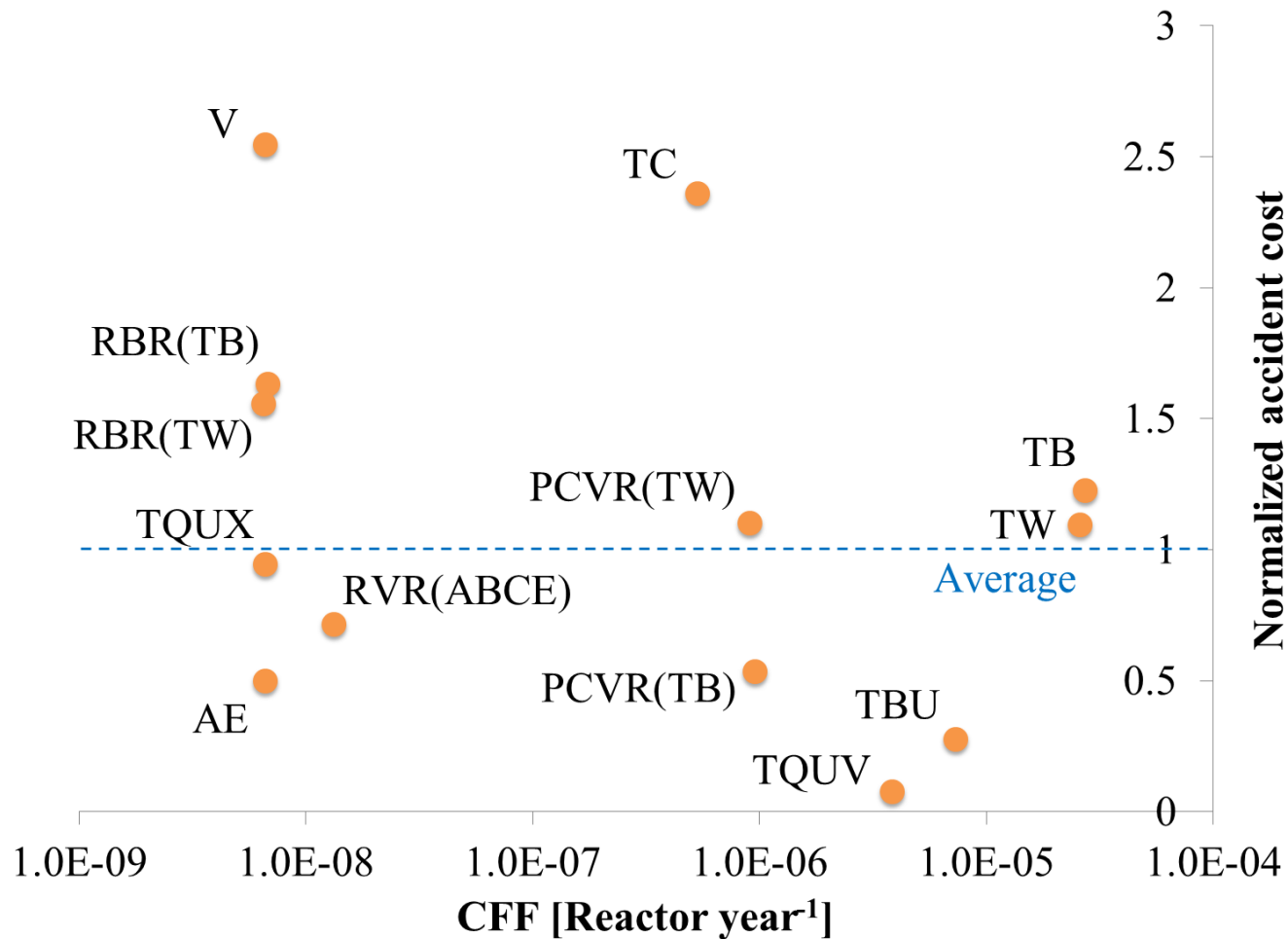
## Economic impacts

- Sheltering cost
- Evacuation cost
- Relocation cost
- Food intake restriction cost
  - Alternative source cost

## Environmental impacts

- Decommissioning cost
- Decontamination cost

# Results: Normalized accident cost

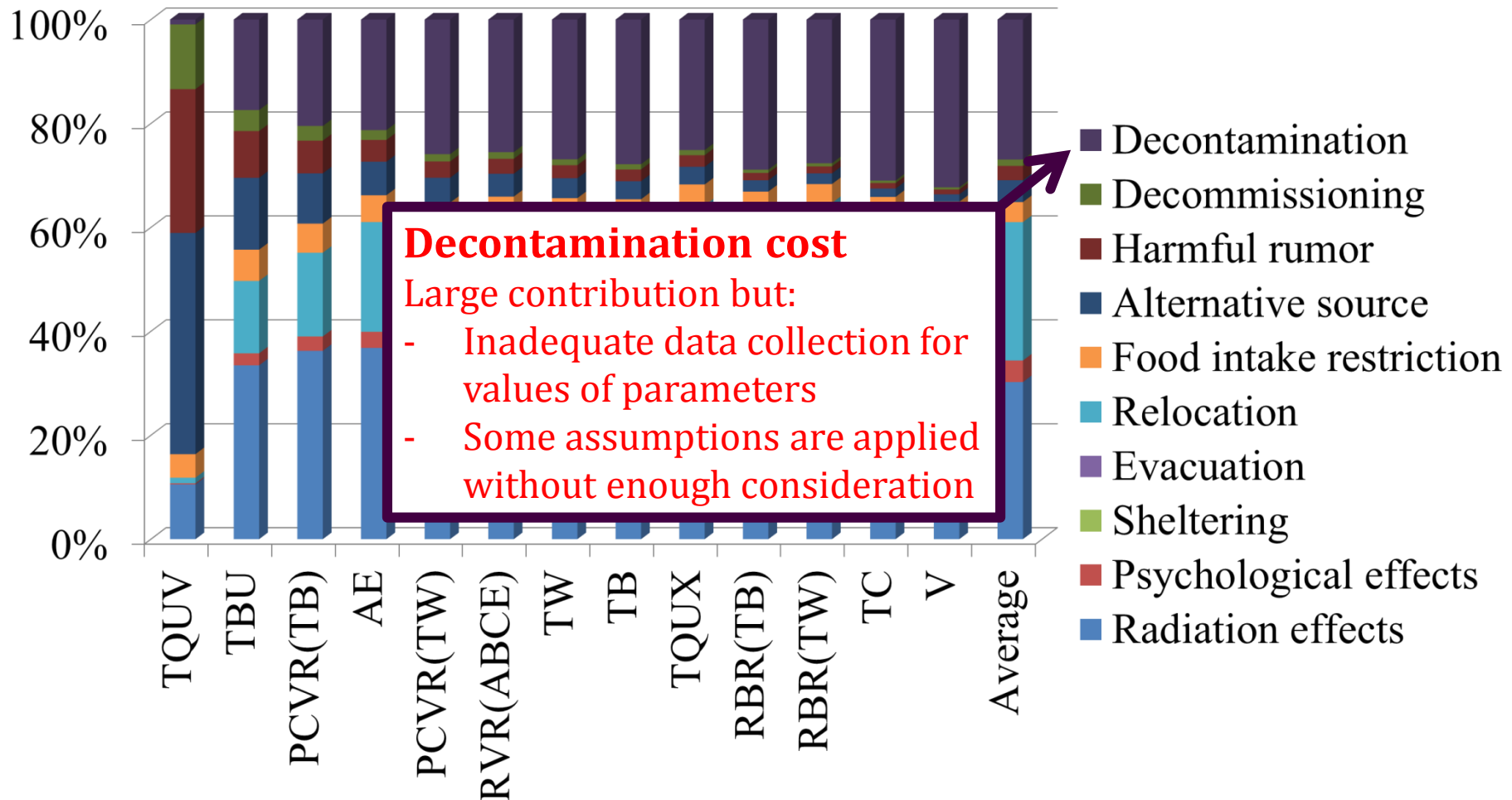


Silva K, Ishiwatari Y, Takahara S. Cost per severe accident as an index for severe accident consequence assessment and its applications. Reliab. Eng. Syst. Saf. 2014;123:110-22.



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# Results: Breakdowns of accident cost

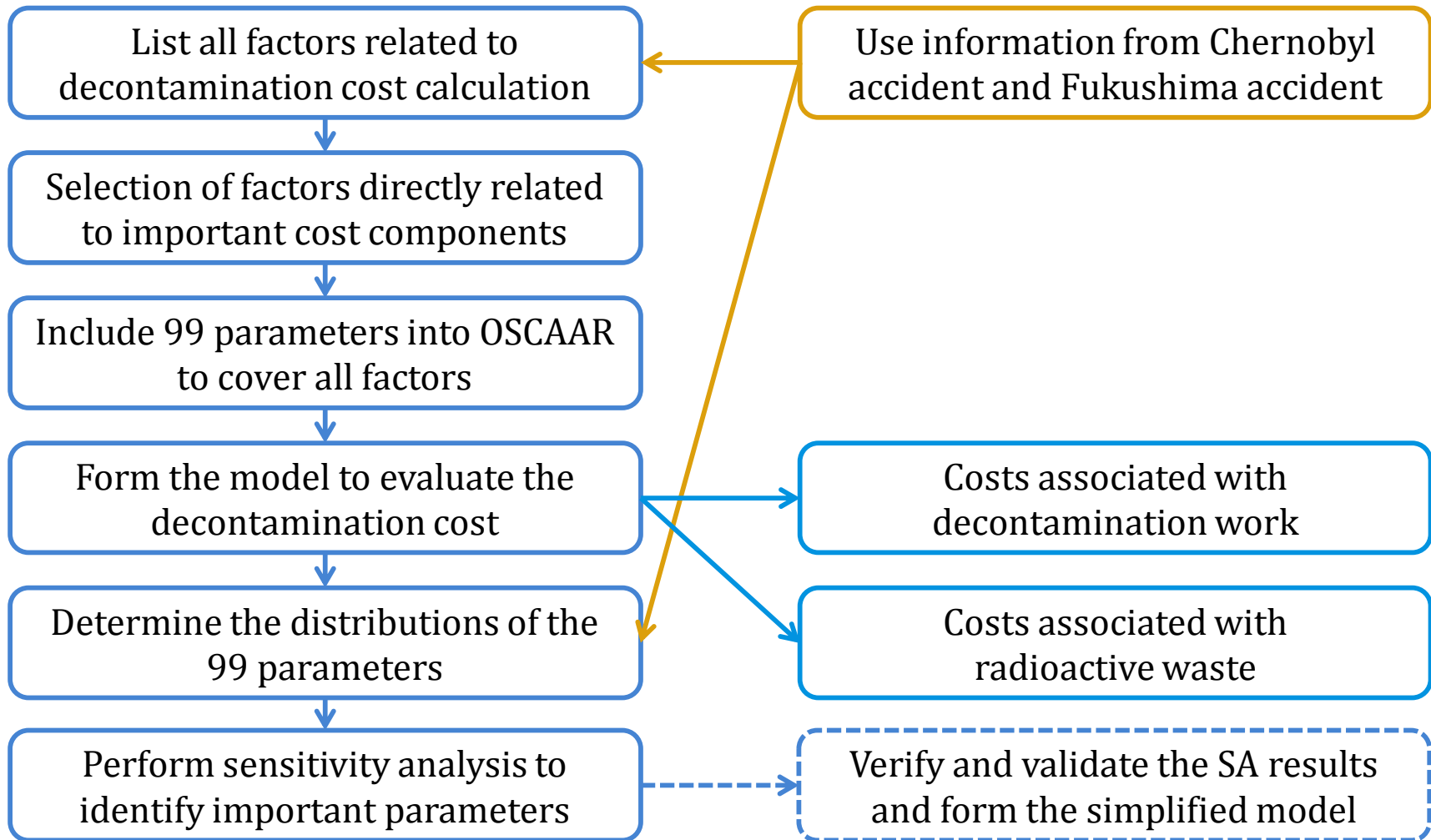


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# Objectives

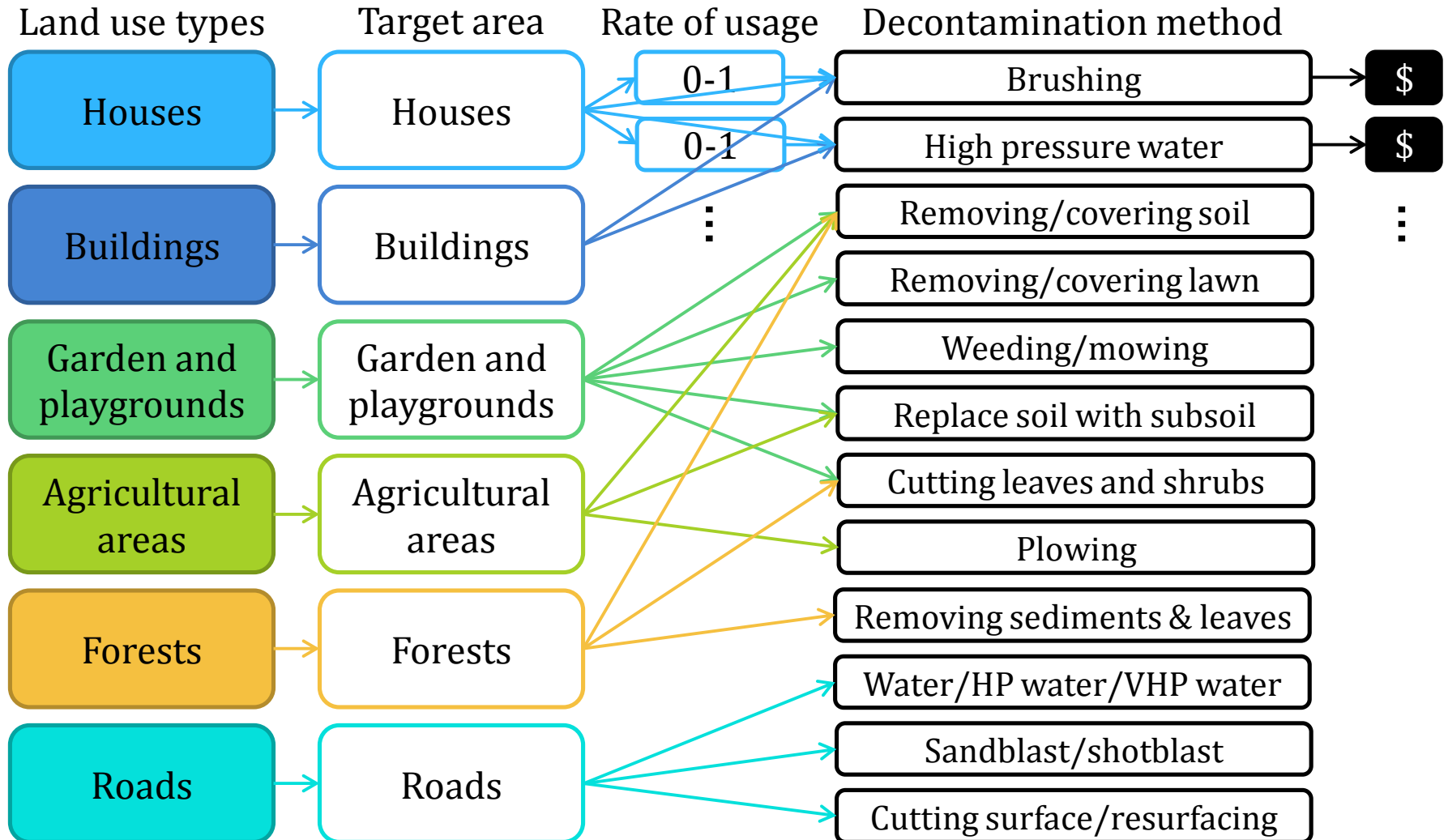
- ❑ To formulate the decontamination model for accident cost calculation.
  
- ❑ To perform a sensitivity analysis to identify:
  - ◆ Parameters with large influence on accident cost calculation and large extent of interactions with other parameters;
  - ◆ Parameters with negligible influence.

# Formation of decontamination cost calculation model





# Costs associated with decontamination work



# Costs associated with radioactive wastes

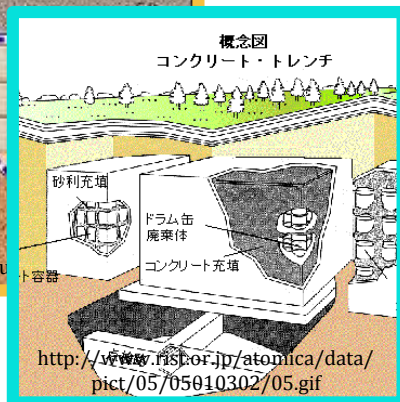
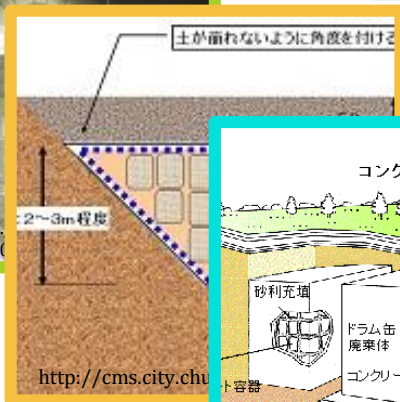
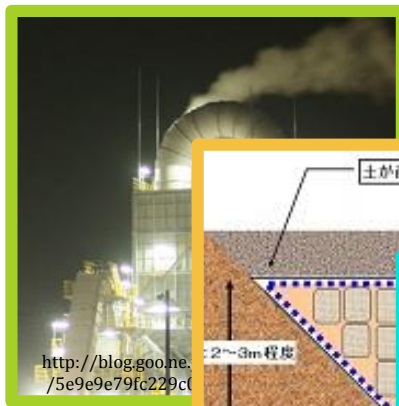
Keeping waste at site

Waste transportation

Waste treatment

Waste interim storage

Waste disposal



# Sensitivity analysis: Elementary effect method

## Why sensitivity analysis?

- ❑ To check the influence of each parameter to the model.
- ❑ To keep only important parameters distributed, fix other parameters to constants, in order to simplify the model.

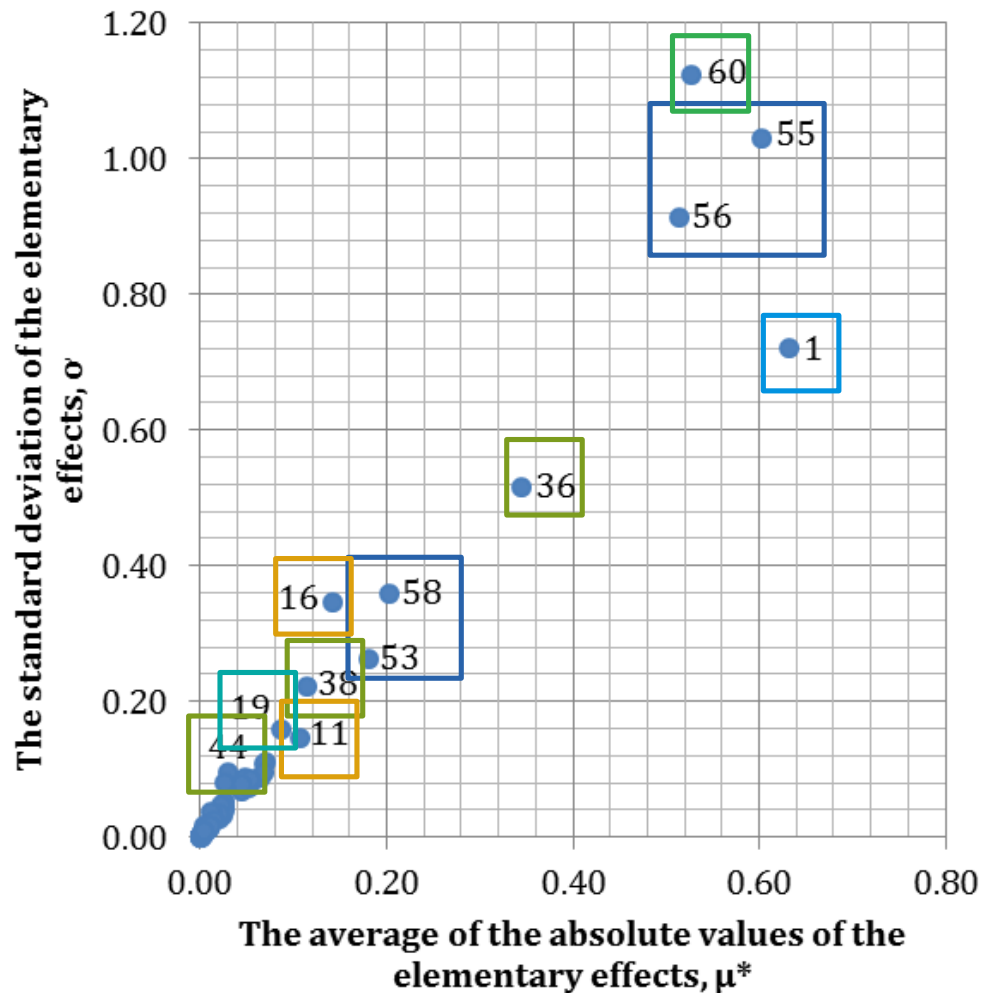
## Why elementary effects method (Morris method)?

- ❑ The method is simple.
- ❑ It is somewhere between local sensitivity analysis and global sensitivity analysis.
- ❑ The results are simple: only  $\mu^*$ s and  $\sigma$ s.
  - ◆  $\mu^*$ s help identify parameters with large contribution to accident cost
  - ◆  $\sigma$ s help identify parameters having large interactions with others

# Determination of parameter distributions

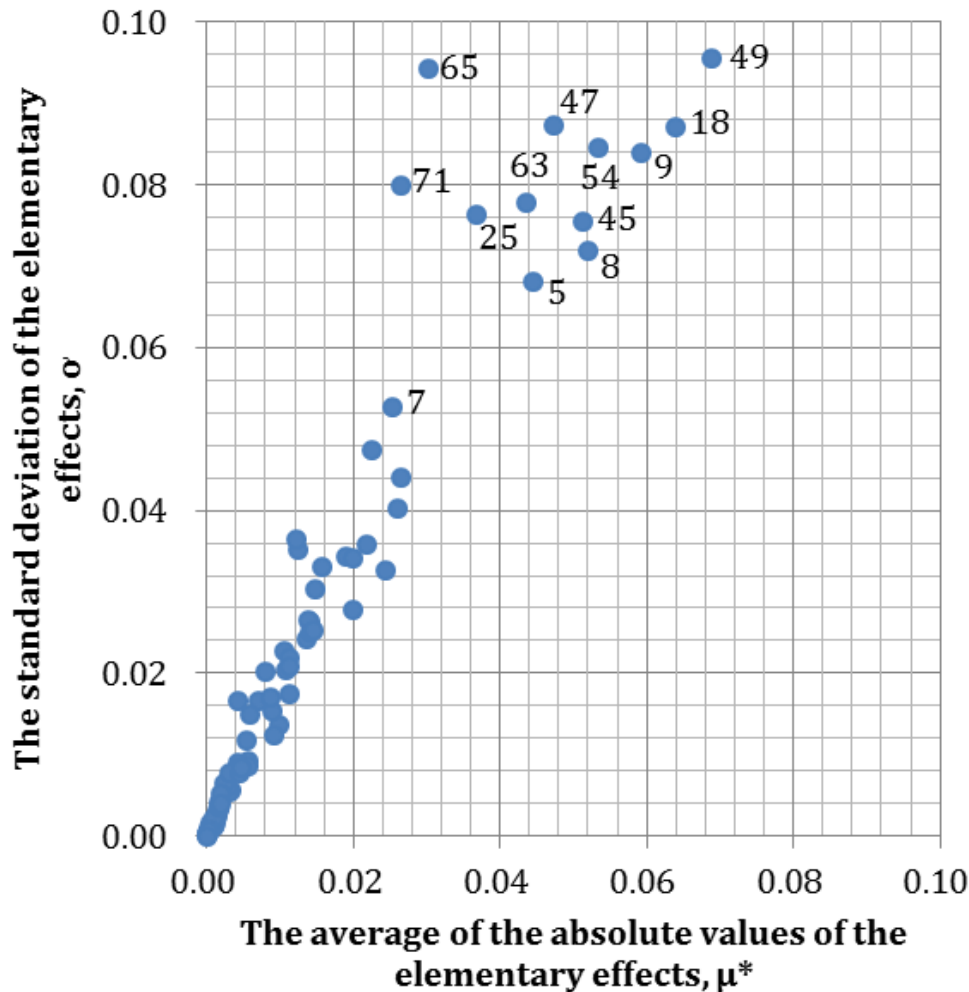
No.	Parameter	Type of Distribution	Min.	Max.	Remarks
1	Dose for decontamination target area setting [mSv/year]	Discrete	1	20	4 annual dose rates (1, 5, 10 and 20) with same probability density ( $P(x) = 0.25$ ).
55	Determination whether or not to include cost due to waste disposal	Discrete	0	1	[0, 0.5) = no/ [0.5, 1) = yes.
60	Number of workers that can be involved in the decontamination work [man-year/year]	Uniform	5000	50000	Determined by the evaluator.
56	Unit cost of waste disposal [JPY/m <sup>3</sup> ]	Uniform	650000	3018000	
36	Waste generated by removing soil or covering with soil [m <sup>3</sup> /m <sup>2</sup> ]	Uniform	0.000	0.079	

# $\mu^*$ s and $\sigma$ s of all parameters



- 1: Dose for decontamination target area setting
- 53, 55, 56, 58: Waste management related parameters
- 60: Number of workers involved in decontamination
- 36, 38, 44: Volumes of waste generated per unit area
- 11, 16: Rates of usage of decontamination techniques
- 19: Selection of the way to distribute the unit costs

# $\mu^*$ s and $\sigma$ s of all parameters (zoomed-up ver.)



- $\mu^*$ s and  $\sigma$ s over 0.05
  - ◆ Rates of usage of some decontamination techniques
  - ◆ Unit costs of some decontamination techniques
  - ◆ Other waste management-related parameters
  - ◆ Work speeds of some decontamination techniques
  
- None of parameters that affect radiation effect cost are influential
  - ⇒ Small interaction between decontamination cost and radiation effect cost

# Conclusions

- ❑ The calculation scheme of accident cost was introduced.
- ❑ The decontamination model was reconsidered to:
  - ◆ Collect enough data to appropriately determine the values of parameters;
  - ◆ Make sure that all assumptions are appropriate.
- ❑ A sensitivity analysis was performed to identify:
  - ◆ Parameters with large contribution to accident cost;
  - ◆ Parameters having large interactions with others.
- ❑ Parameters that are influential to the accident cost are:
  - ◆ the dose of setting decontamination target area;
  - ◆ a number of waste management-related parameters;
  - ◆ the number of workers involved in decontamination work etc.
- ❑ None of parameters that affect radiation effect cost are influential
  - ◆ Small interaction between decontamination cost and radiation effect cost

Thank you for you attention

