Applying Optimal Decision-Making Techniques to Design the Best Counter Measures for a Large-Scale NPP Accident

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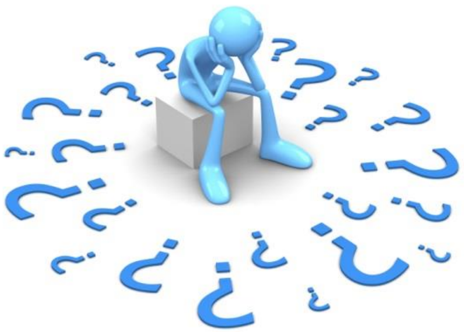
Making Decisions in the Aftermath of a Nuclear Accident

How can we make the best decisions today?



Weigh up the cost/benefit of every possible future scenario

Can we also take into account the decisions we might take in the future?

Optimising Long-Term Recovery Measures

Relocation

- High costs
- Permanent or temporary
- Safest option

Remediation

- Medium costs
- Partial or complete clean-up
- Requires time to implement

Food Bans

- Low costs
- Prevents contamination spread through food chains

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What is Optimal Control Theory?

- Once the objective is defined clearly, the framework allows an optimal strategy to be found
- We can evaluate whether Relocation, Remediation, or Food Bans should be implemented and find their optimal timing
- The algorithm gives the optimal strategy based on the best combination of these three Counter Measures
- Optimal strategies can be tailored to individual towns and villages based on local contamination level and local economic conditions

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How is it Applied?

- Consider a single district with known initial contamination levels
- Define an objective
  - Jointly minimise **total** cost (economic and health)
  - Keep health effects below a certain critical threshold
- Evaluate the effect of each decision
  - Direct costs – losses in production, cost of measures
  - Health costs – loss in life expectancy (J-value), associated healthcare costs
- Optimise over **all** possible future scenarios to obtain the optimal strategy

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Response to Medium Contamination

Food Ban: Immediately

No Relocation;

Remediate: Years 0 - 2

Lift Food Ban: Year 2

No population movement

Response to Large Contamination

Temporary Relocation & Food Ban:

Immediately

Remediate:
Years 0-2

Repopulate:
Year 1.5 onwards

Lift Food Ban:
Year 2

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Key Findings of Our Research

- The preferred strategies in most cases are:
  - immediate but temporary food ban,
  - with no relocation but immediate remediation,
  - or temporary relocation with delayed remediation.

- For temporary relocation it is best to delay remediation by several weeks or more to allow for the natural decay of volatile isotopes

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Conclusions

- We can suggest which strategies are optimal (safest and most cost-effective) across a wide range of possible nuclear accidents in locations with varying degrees of economic development
- Significant levels of spatial and temporal flexibility in the mitigation measures are desirable
- We can estimate expected costs and how long it will take before there is a full economic recovery
- The algorithm requires all economic costs to be weighted against the health cost which can be risk-adjusted
- We have found that relocation should be used sparingly for many big nuclear accidents

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