CONFIDENCE: Dealing with uncertainties in multi-criteria decision analysis tools

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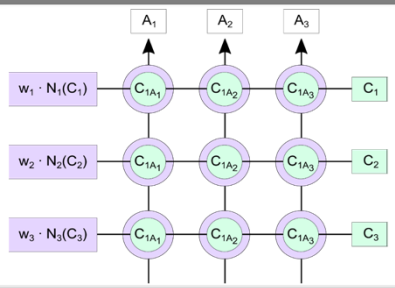
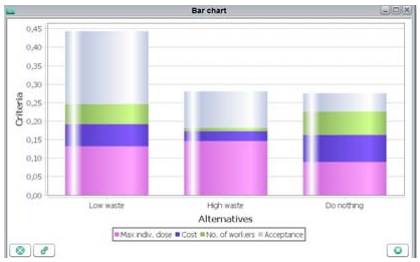
RICOMET workshop 13.06 and 15.06.2018, Antwerp, The Netherlands





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Introduction

- The CONFIDENCE Project will perform research focussed on uncertainties in the area of emergency management and long-term rehabilitation. It concentrates on the early and transition phases of an emergency, but considers also longer-term decisions made during these phases.
- Duration: 1.1.2017 – 31.12.2019
- 31 partners from 17 countries
- Budget: 6.201.026 €, request to EC: 3.252.487 €
- Part of CONCERT

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Which uncertainties

- 'Uncertainty' is interpreted differently by different people and disciplines
- It can include ***stochastic uncertainties*** (i.e. physical randomness), ***epistemological uncertainties*** (lack of scientific knowledge), ambiguities (ill-defined meaning), value uncertainties (when the required endpoint is ill-defined), *judgemental uncertainties* (e.g. setting of parameter values in codes), computational uncertainties (i.e. inaccurate calculations), *modelling errors* (i.e. however good the model is, it will not fit the real world perfectly)
- We should also address ***social and ethical uncertainties***, in the analysis of risk and in decision making

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Uncertainties in CONFIDENCE

- The following lists all work packages of CONFIDENCE
  - WP1: Pre- and release phases
  - WP2: Improve the common operational picture
  - WP3: Improve radioecological models
  - WP4 Transition to long term recovery
  - WP5: Stakeholder, social and ethical aspects
  - ***WP6: Facilitate decision making***
  - WP7: Education and training
- Uncertainties in the early phase mainly due to weather and source term
- Uncertainties in the transition phase are more difficult to grasp; societal and ethical issues may be more important
- Uncertainties in the later phase might even be more dominated by other factors than uncertainties of radiological modelling and monitoring

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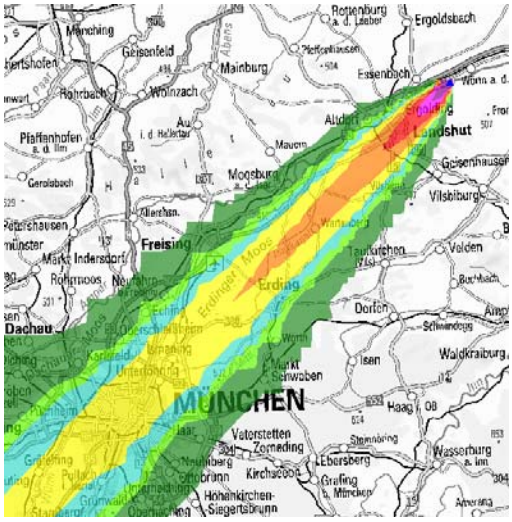
Typical result of dose model - deterministic



- Dose for action: "sheltering" is 10 mSv

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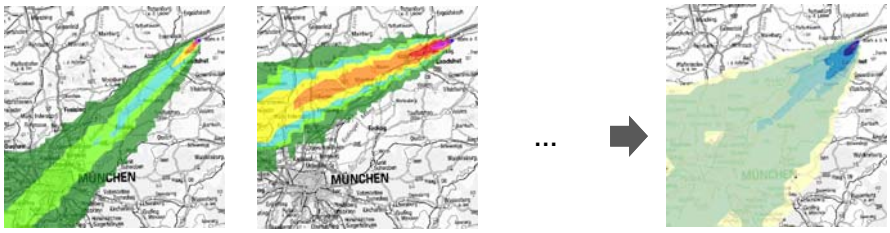
Main source of uncertainty & current research

- Input data (two key variables):
  - **Source term** → variations of several orders of magnitude
  - **Weather**
- Approach: Use **ensembles** to demonstrate uncertainty
  - Set of deterministic results based on slightly changed input and model parameters
  - Possible visualization: Areas indicating the probabilities for exceeding the dose threshold for certain countermeasure



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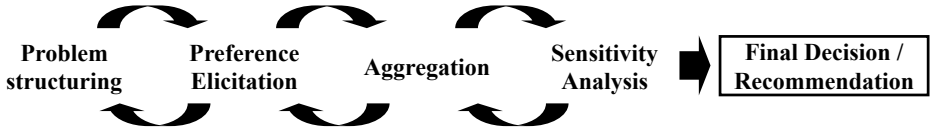
Multi-Criteria decision making (MCDM)

- Decision support for emergency management involves resolving conflicting objectives, setting priorities and building consensus for the various perspectives of the many stakeholder groups
- MAVT (Multi-Attribute Value Theory) is a MCDM framework that provides methods to structure and analyse problems by means of attribute trees and to elicit the relative importance of the criteria in such a tree
- Several key phases of MCDM (resp. of MAVT) can be distinguished



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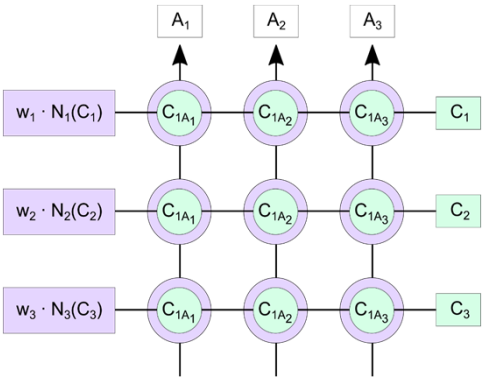
MCDA basics

- A set of alternatives $A_1, \cdots, A_n$ describing the possibilities for decision making for a given scenario
- The criteria $C_1, \cdots, C_m$ important for the decision making in that scenario have to be defined as value for each criterion-alternative pair
- The importance of the criteria is taken into account by weights $w_1, \cdots, w_m$ defined for each criterion



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MCDA uncertainties

- Criterion and weights can be defined as single values: deterministic approach
- How to deal with uncertainties
  - Applying a distribution
  - Providing boundary conditions (e.g. 5% and 95%)
- Proposed realisation
  - Providing direct results from ensemble calculations for attributes
  - Providing a distribution for the weights

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Example

- Urban decontamination (from HARMONE handbook)
- Three options
  - Low waste
  - High waste
  - Do nothing
- Attributes
  - Max. individual dose
  - Costs
  - Number of workers
  - Acceptance
- For all examples: 2001 ensembles used with a statistical distribution of values
- In future, direct input from JRodos foreseen

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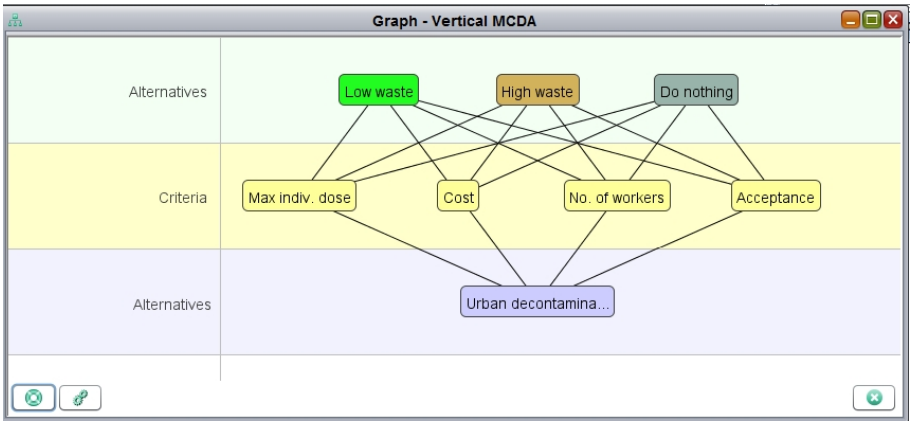
MCDA problem definition



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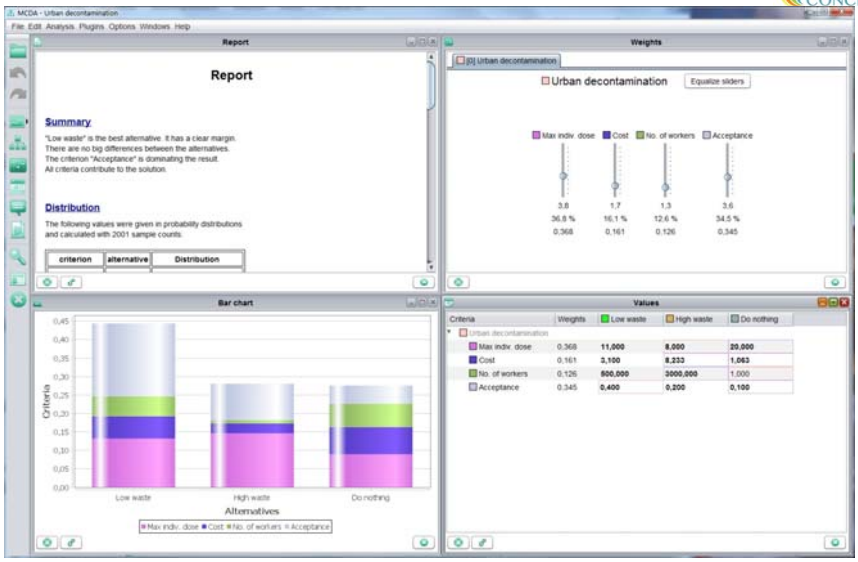
Main window



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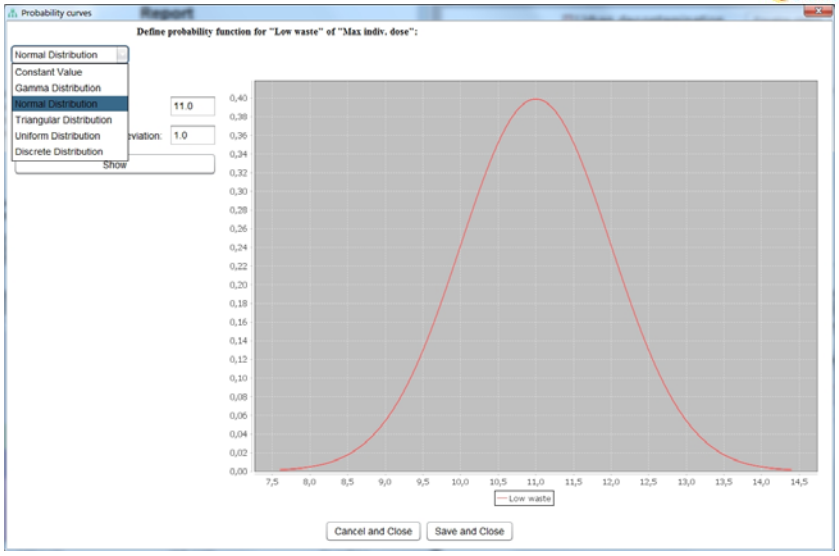
Distribution example for “maximum ind. dose”



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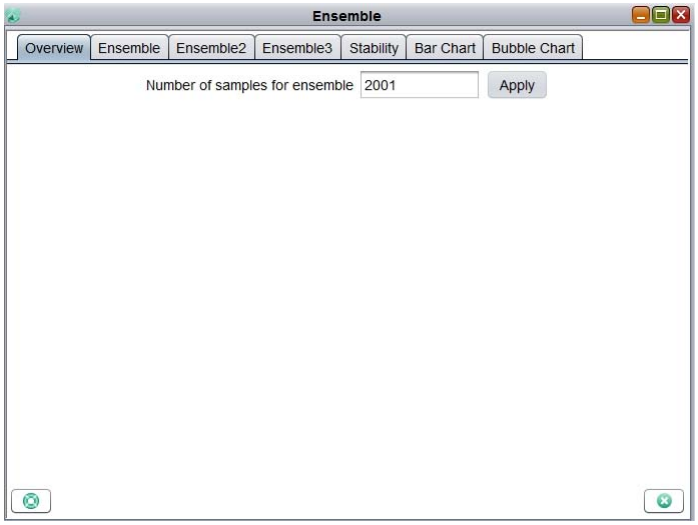
Ensemble window



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Result visualisation

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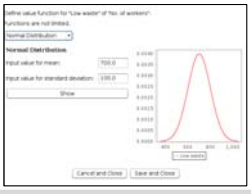
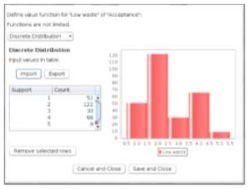
The way forward

- Within CONFIDENCE the ensemble approach will be implemented in JRodos (weather and source term) and all simulation models up to the late phase will use this information.
- Direct link with the MCDA will be established, for example:
  - Ensemble of 30 weather realisations with equal probabilities times 3 source terms with different probabilities = 90 realisations, each with a particular probability
  - Strategies with a given preference setting can be tested against these ensembles by repeated MCDA
  - The MCDA is applied to each of the realisations and the results are weighted with their probabilities
- In this way, simulated uncertainties or estimated uncertainties can be used as input for the MCDA





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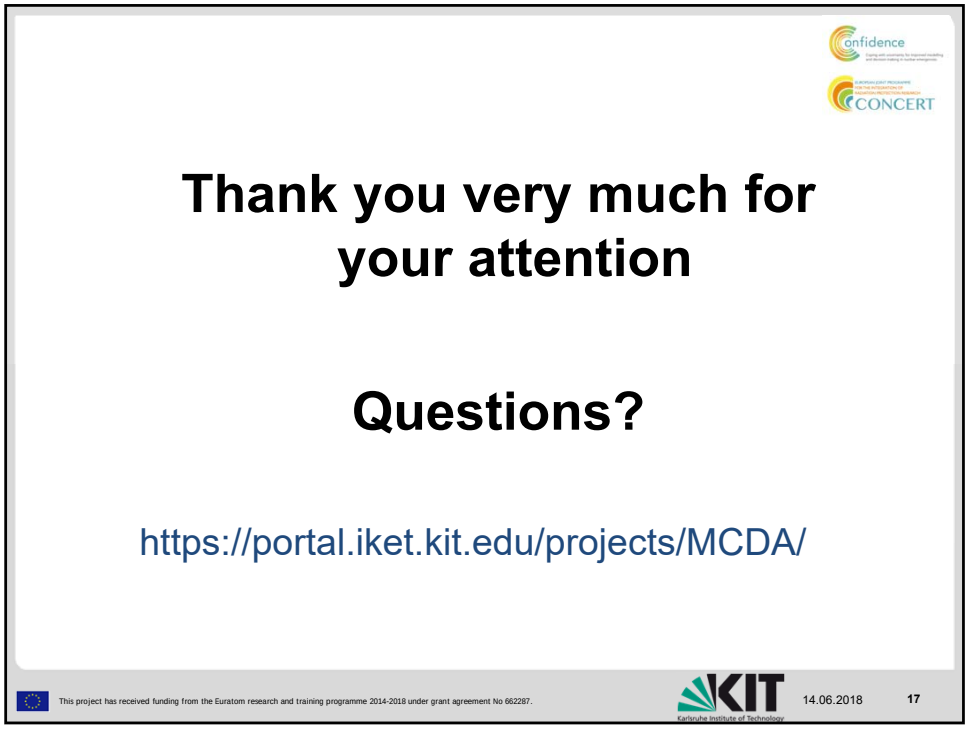
Thank you very much for your attention
Questions?
https://portal.iket.kit.edu/projects/MCDA/
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14.06.2018
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