Decision processes in case of nuclear accident and decision support tools

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This project has received funding from the Euratom research and training programme 2014-2018 under grant agreement No 662287

Introduction

- The CONFIDENCE Project performs 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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Protection strategy: example Germany

goals of emergency response

Aim: Avoid severe deterministic effects and reduce and limit the risk of stochastic effects

↓

residual dose

Reference level of the residual dose (in the first year): 100 mSv

(Typical behaviour of representative persons and effect of protective actions considered)

2014

↓

projected dose

Generic intervention criteria for protective actions

(No effect of staying indoors nor effect of protective actions considered)

2014

↓

Operational intervention levels

(German catalogue of countermeasures)

2010/ 2018

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Basis for decisions on countermeasures: Intervention levels

Counter-measure	Intervention levels		
	Dose to thyroid	Effective Dose	Exposure Pathways and Time of Integration
Sheltering		10 mSv	Sum of external dose rate und inhalation dose integrated over 7 days
Intake of Iodine tablets	50 mSv Children until 18 years, pregnant woman, 250 mSv adults		Equivalent dose to inhalation of radioiodine inhaled within 7 days
Evacuation		100 mSv	External dose integrated over 7 days

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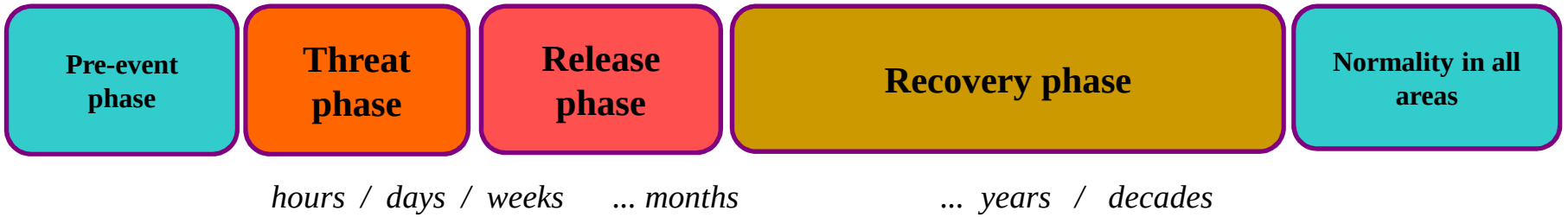
Means supporting decisions

- There exist tools such as Decision Support Systems to facility decision making in the various phases of an emergency



- Decisions and challenges differ in the various phases
- The following presents some ideas how a DSS can support decision making teams and what CONFIDENCE has contributed to this

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Possible tasks of a decision support system for off-site nuclear emergency management

- Provide consistent and comprehensive information at local, regional and national levels, for all accident phases
  - During real event (housing and displaying of relevant information about the release, the weather, the contamination; forecast of health, agricultural and economic impacts with and without the application of countermeasure)
  - When preparing for a possible future event (creating scenarios and background material for planning, exercises and training)
- Assist decision makers in evaluating different measures against a range of quantitative and qualitative criteria
- Promote a common emergency management frame aiming to move away from national solutions

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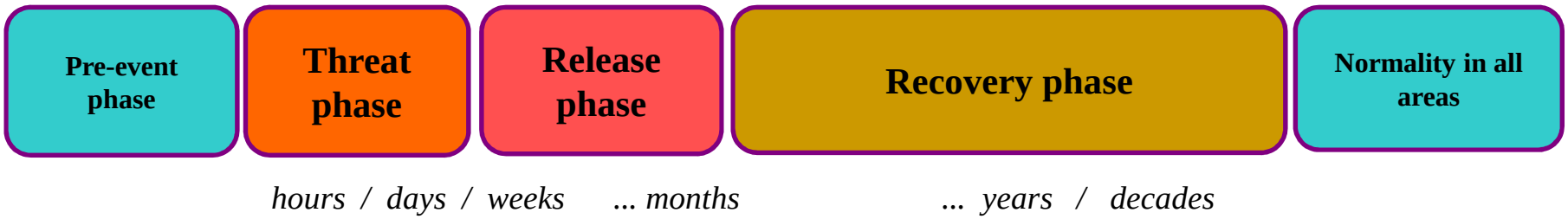
Key questions in off-site nuclear emergency management

(1) What is the current radiological situation, and how will it possibly develop with time?

(2) Is there a need for actions to protect the population?

(3) If yes, where; which actions are suitable, feasible, effective and acceptable; of more than one, which to select; if already implemented ones, which to maintain, which to withdraw?

(4) ------ Repeat (1) to (3) until situation is back to normal ------



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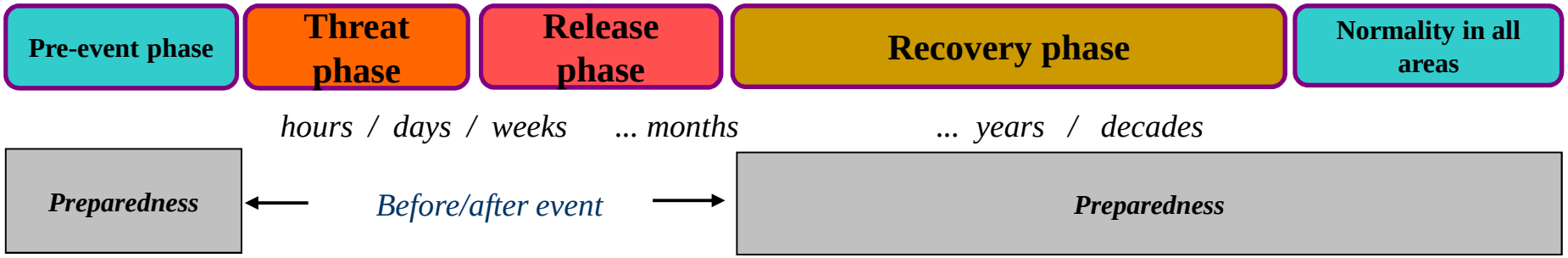
More relevant issues in nuclear off-site emergency management



(5) Improvement of emergency management processes in the preparedness phase (plans, rules, training)

(6) Moving away from national solutions by promotion of a common European emergency management frame

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Threat phase: objectives of decision making

- We need modelling to decide
  - Early phase countermeasures are most effective when implemented early before the release
    - Evacuation initiated and completed before cloud arrival; sheltering during whole cloud passage; prophylactic intake of stable iodine
  - Shall early phase countermeasures be issued, and, if yes, is it likely to complete them before a possible release is likely to start?
  - Shall other measures be issued, and where (limiting access to areas, closing down public services etc.)
- Uncertainties are huge in this phase and mainly caused by unknown source term and development of the weather

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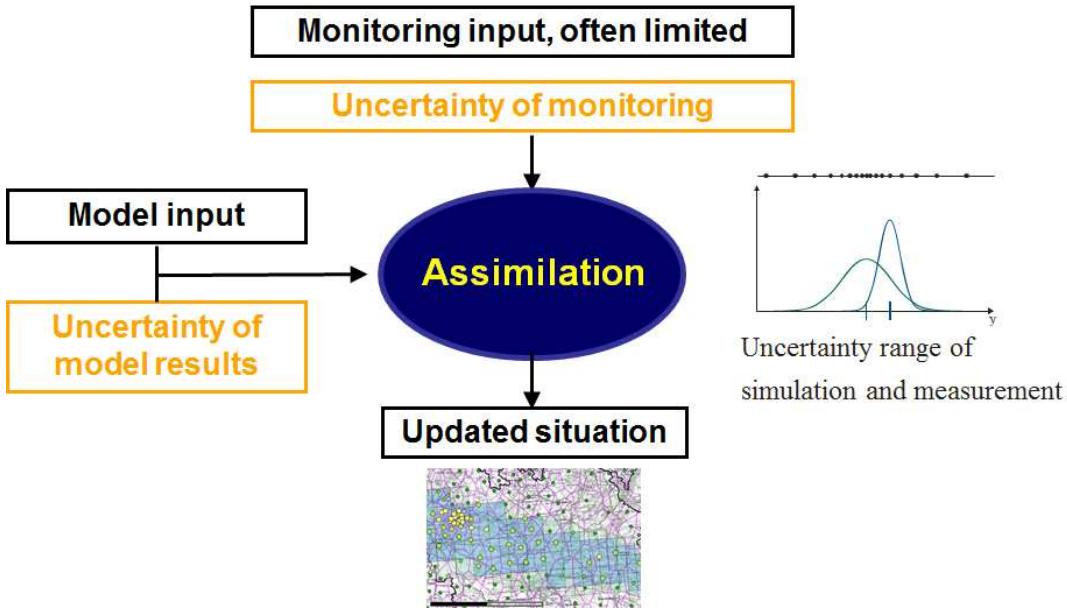
Release phase: Challenges

- Two different types of information: Measurements and predictions
- Bringing both together is important, because:
  - Measurements only represent a situation at one time at one given location ("on-site")
  - Required are data representing larger time periods and areas
- Data assimilation can combine both monitoring and modelling



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Post-release phase

- Development of monitoring strategies (in inhabited and agricultural areas), in contaminated and possibly not contaminated areas
- Simulation of recovery phase strategies
- Evaluation of actions to identify the most effective ones

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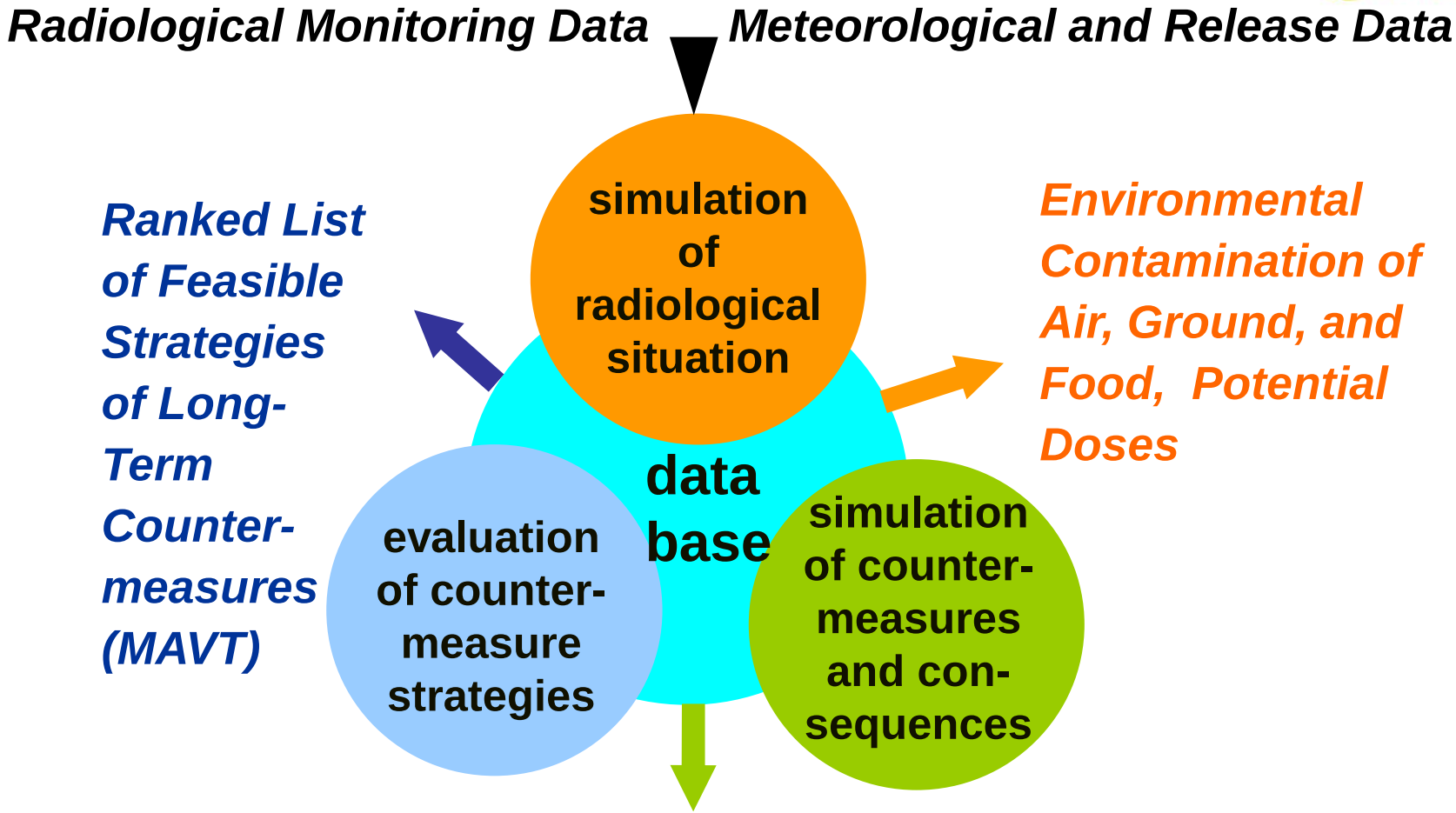
DSS: Tasks, input data, output



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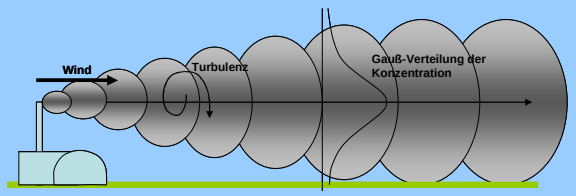
Example JRodos EMERGENCY chain models

Released activity (Measurement / User)

Meteorological data (Measured / Prognostic / User)

Further data (from JRodos Data bases)

LSMC: Atmospheric dispersion and deposition, local scale (up to several 100 km)

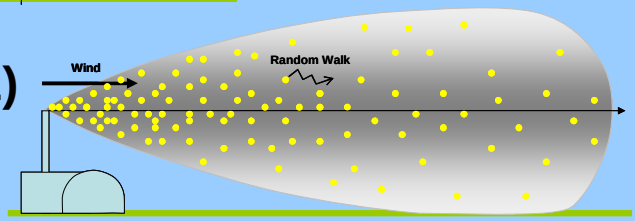


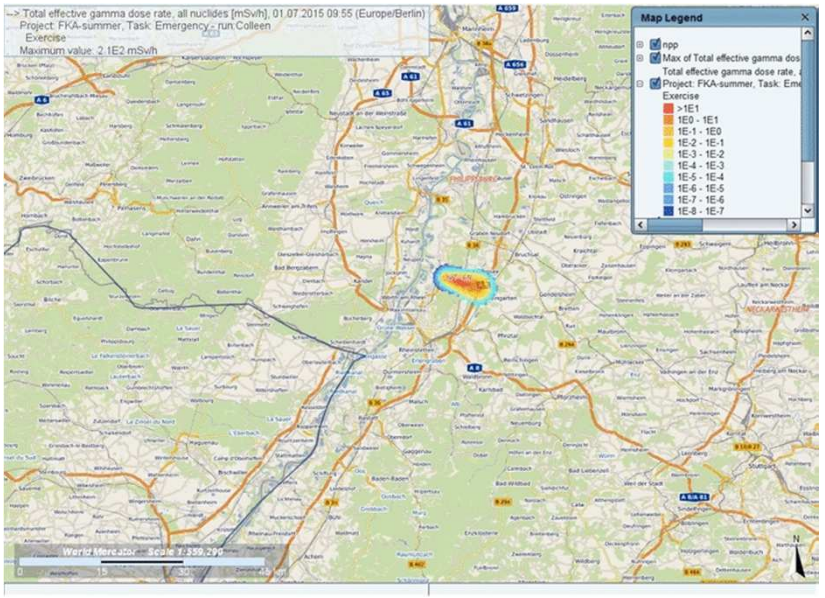
Rimpuff (DEN)

Atstep (IKET)

Dipcot (GRE)

Lasat (GER)



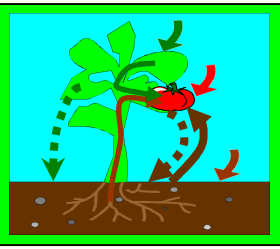


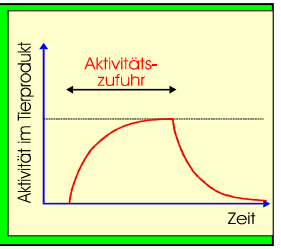
Current dose rate and dose calculation

Early countermeasure simulation

Health effects and costs

Food chain and dose model, terrestrial FDMT (GER)





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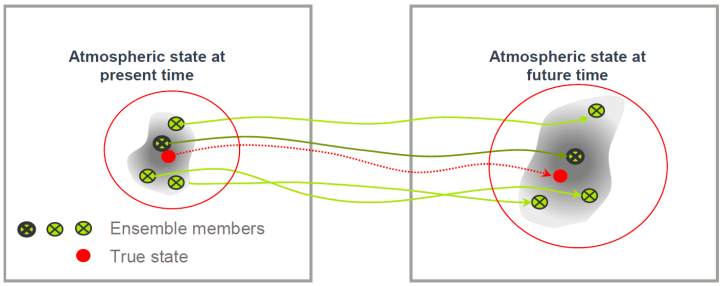
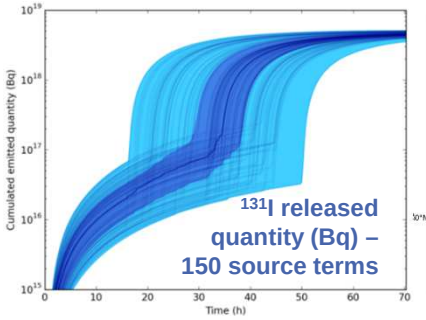
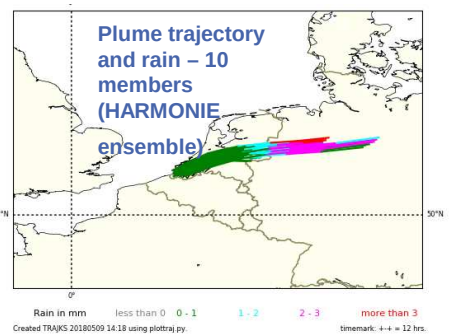
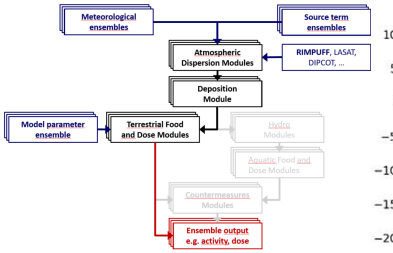
Ensembles early phase + results

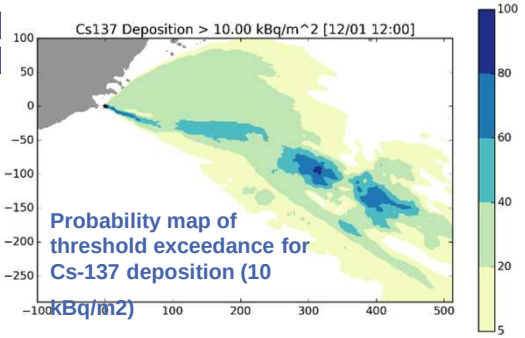
- Early phase modelling
  - Analysing and ranking sources of uncertainties
  - Performing scenario calculations to propagate the uncertainties through atmospheric dispersion models (ADMs)
- Key driver for uncertainties: wind direction, atmospheric stability, source term, start of release
- Ensemble approach was used to describe uncertainties from meteorology and source term and propagate them through ADMs to dose and food chain models











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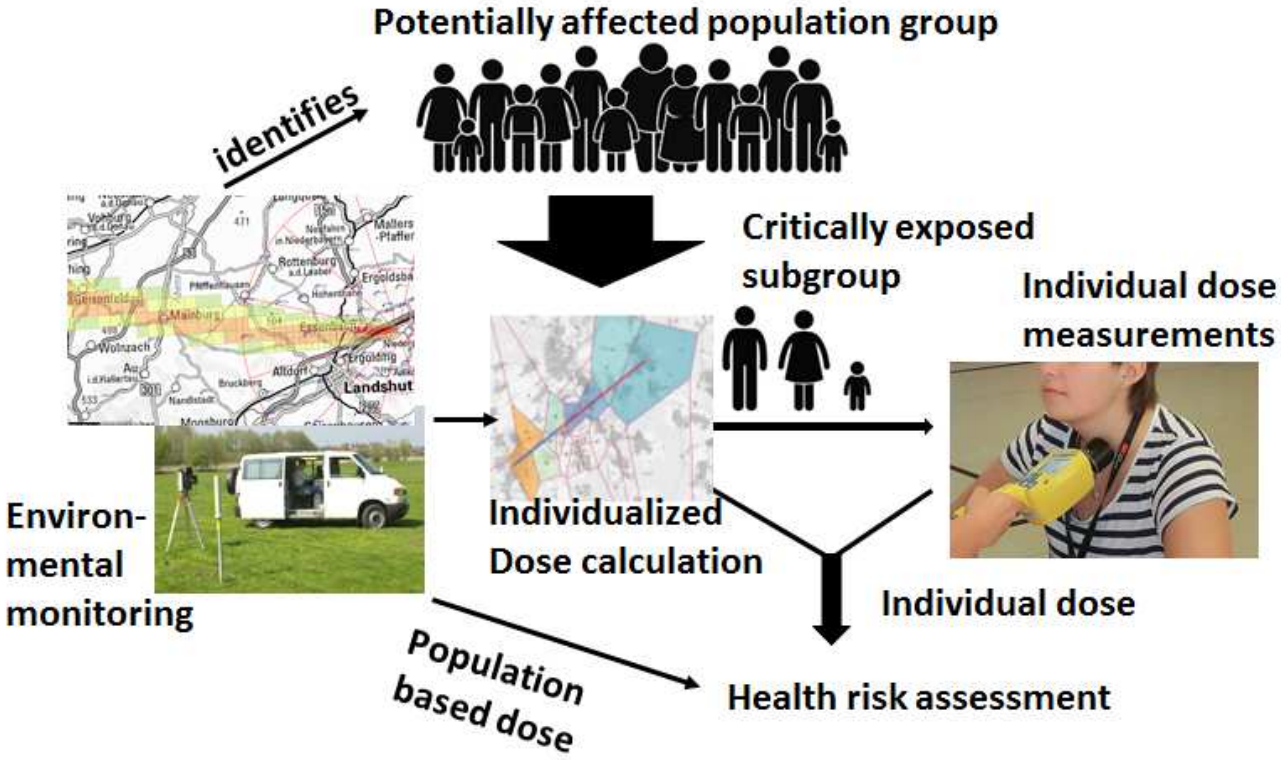
Combining simulations and measurements

- Operational picture
  - Combination of model results and monitoring information
  - Health risk assessments based on WHO methodology



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Radioecological models

- Improving model data bases including through experimentation
  - No root uptake of 131I after deposition demonstrated
  - Data for Mediterranean ecosystem collected
- Key parameters of operational radioecological models have been identified
- Investigate process based models for Sr and Cs
- Study the effect of “hot particles”

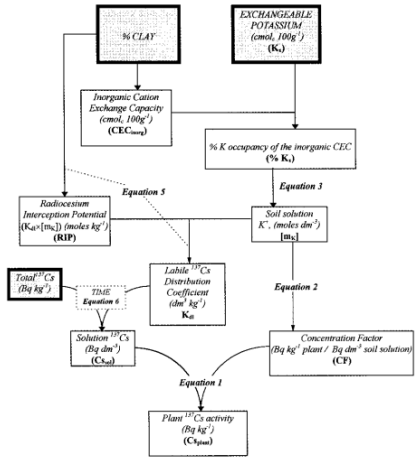

FIGURE 1. Relationship between conceptual pools of radiocesium. Shaded boxes indicate model input data. Equations describing the relationship between pools are referenced to those given in the text.

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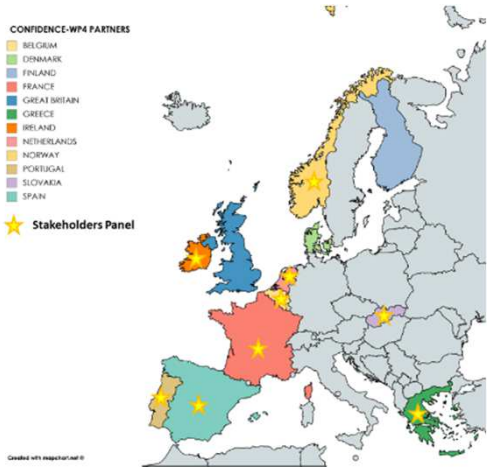
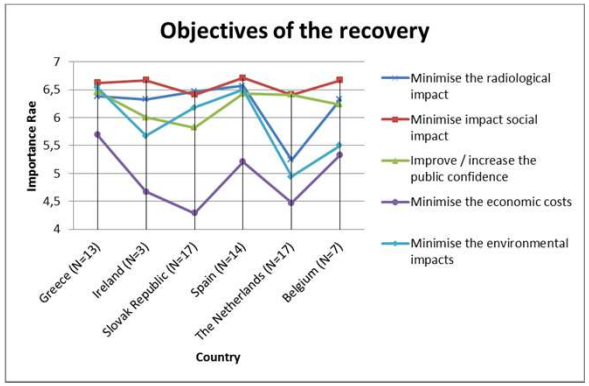
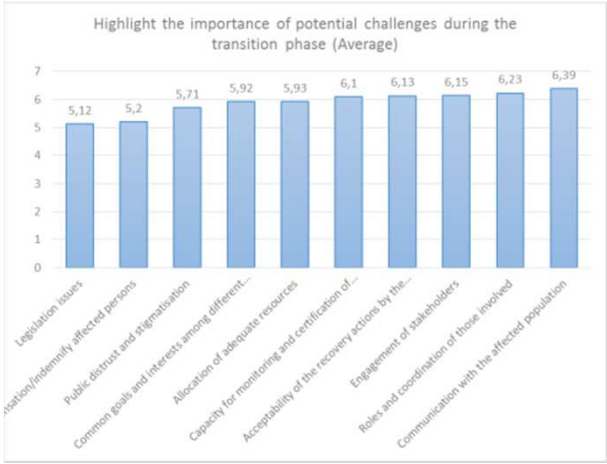
Stakeholder engagement and strategies

- Stakeholder preferences
  - Decision-oriented scenario-analysis allowed to identify, evaluate and optimise countermeasure strategies by involving stakeholders
  - Delphi studies were performed for preference elicitation
  - The workshops and the Delphi study resulted in a set of preference values that can be used by the MCDA and ABM







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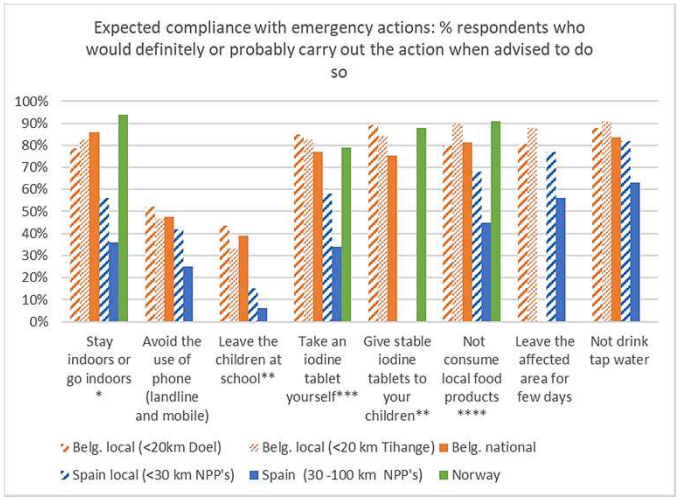
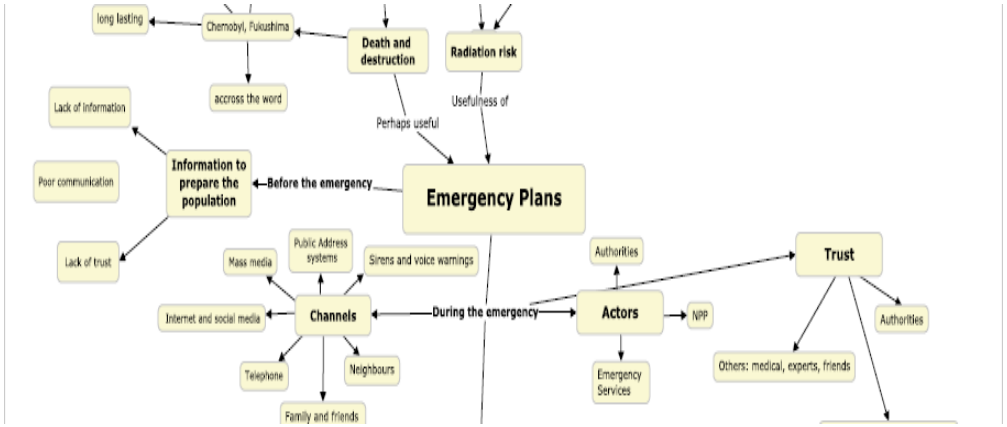
Social and ethical aspects

- Analysis of social uncertainties from past events
- Studies on expected behaviour and information needs
- Observation of emergency exercises
- Development of mental models to understand processing of uncertainties
- Communicate uncertainties





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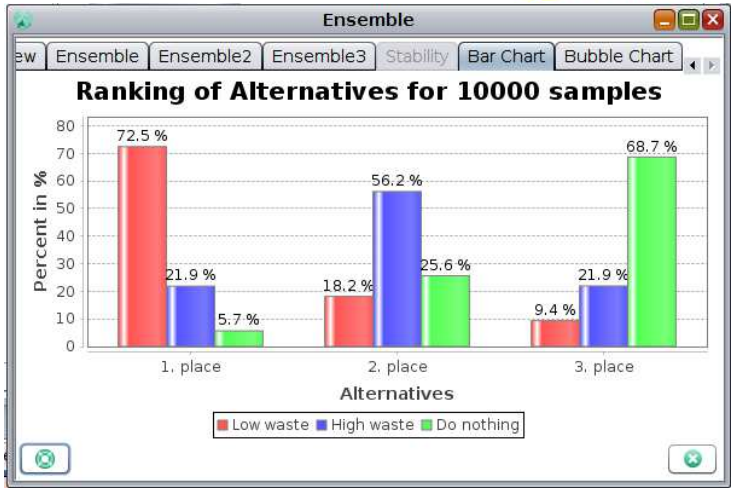
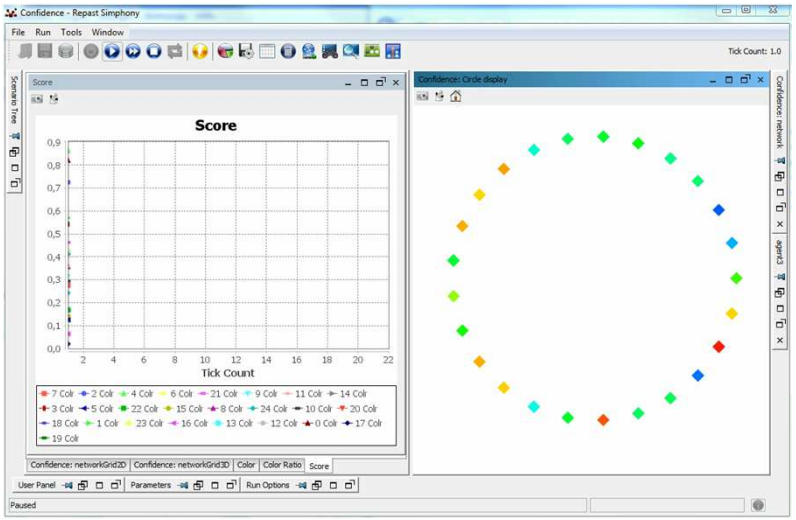
Formal decision aiding tools

- Use formal decision aiding tools such as MCDA
- Develop agent based models to investigate the decision making process in more detail
- Preferences and strategies, generated in other work packages were applied to the MCDA
- Agent Based Simulation model (ABM) have been developed to better understand the importance of the negotiation process





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Conclusion and how to combine all this

- The CONFIDENCE project was a first attempt to deal with uncertainty handling in nuclear and radiological emergency management
- The ensemble approach on source term and meteorology will be implemented in national operational simulation models as well as into the European DSS JRODOS with more than 20 users in Europe and worldwide
- Data assimilation methods will be also implemented into JRODOS as well as the risk model
- At the end of CONFIDENCE, we will decide how to proceed with the process based radioecological models
- The methodological results will be published as reports; communication aspects will be considered when resenting ensemble results to decision makers
- The MCDA tools will receive an interface to JRODOS
- When all this will become operational, decision making might change

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