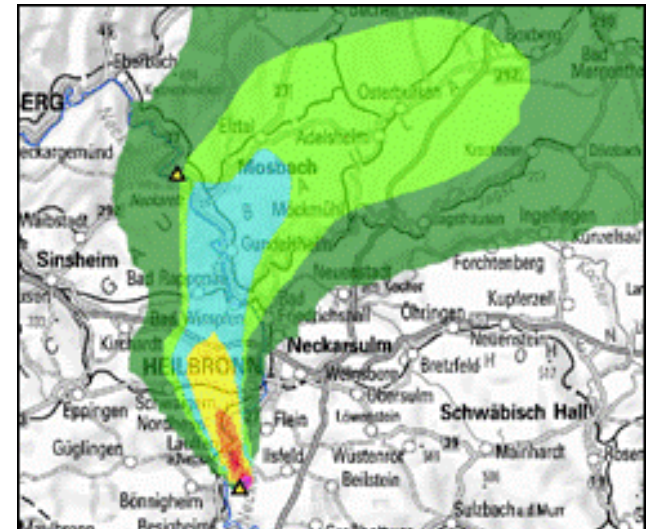
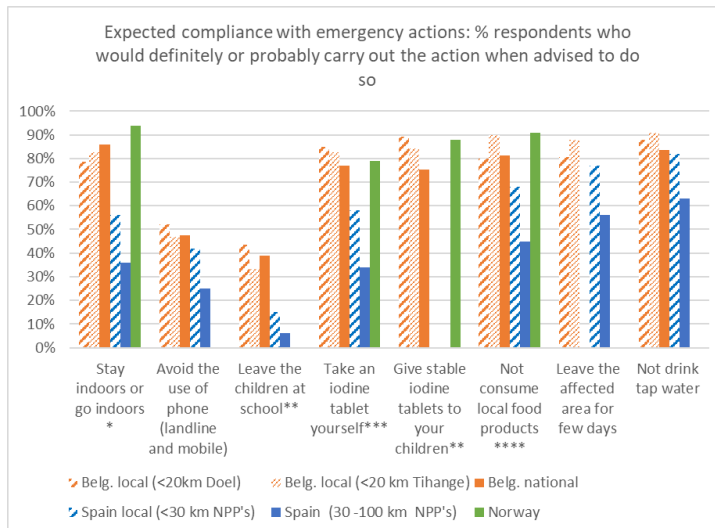


# Emergency preparedness: advancement and still open gaps in Europe

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# Content

- Short history of European research activities in Radiation Protection
- Research Platforms in particular NERIS
- Results of the CONFIDENCE project
- Possible interaction with SNETP
- Lessons learned from past emergencies/events
- Conclusions on advancement and still open gaps in Europe

# European Research project in RP

- **EURANOS Project** (2004-2009): European approach to nuclear and radiological emergency management and rehabilitation strategies
- **PREPARE Project** (2013-2016): Innovative integrated tools and platforms for radiological emergency preparedness and post-accident response in Europe
- **OPERRA Projects** (2013-2017): Open Project for the European Radiation Research Area
- **COMET Project** (2013-2017): Coordination and implementation of a pan-European instrument for radioecology
- **CONCERT Project** (2015-2020): European Joint Programme for the Integration of Radiation Protection Research Projects – some:
  - **CONFIDENCE**: Coping with uncertainties for improved modelling and decision making in case of nuclear emergency
  - **ENGAGE**: Enhancing stakeholder participation in the governance of radiological risks for improved radiation protection and informed decision-making

# Change in European research

- Before CONCERT, the European Commission defined topics for Radiation Protection calls based on feedback from the EURATOM members states, large research organisations and results from former Framework Programmes
- Calls were typically tailored to one or several well defined topics
- Consortia could emerge based on competences needed to answer the call
- With CONCERT – as it is the case also in other European Programmes, European Joint Programming started in Radiation Protection research
  - Only program owners or managers together with their linked third parties could form a consortium
  - Universities became third parties that could only participate when funded by consortium member by 100%
  - Research is performed by “open calls” and no longer by the project itself
- Radiation Protection Platforms “define” research topics

# Radiation protection platforms

- Up to now 6 Radiation Protection Platforms emerged and are organised under one umbrella organisation named **MEENAS**
- MELODI on **low dose** research
- EURADOS on **dosimetry**
- EURAMED on **medical**
- NERIS on **preparedness** for **response** and **recovery**
- ALLIANCE on **radioecology**
- SHARE on **social science** and **humanity**
  
- Important to note: **Research needs** are defined within the **platforms**



# NERIS Platform

- **NERIS**: European Platform on Preparedness for Nuclear and Radiological Emergency Response and Recovery
- Objectives:
  - Improving the **effectiveness and coherency** of current approaches to preparedness
  - Identifying further **development needs** and **prioritise them**
  - Improving know-how and technical expertise
  - Establish a **forum for dialogue and methodological development**
- **Created in 2010** and adoption of **legal statutes** in May, 15, 2012 in Glasgow
- **Legal registration** under the French Law: August, 28, 2012 and **self-sustainable** since 2014
- Currently:
  - **64 organisations** from 28 different countries
  - **26 supporting** organisations

# 64 NERIS supporting organisations and members

APA - Agencia Portuguesa do Ambiente (Portugal)  
BfS - Federal Office for Radiation Protection (Germany)  
CEPN - Nuclear Evaluation Protection Centre (France)  
CIEMAT - Research Centre for Energy, Environment and Technology (Spain)  
DSA - Norwegian Radiation and Nuclear Safety Authority (Norway)  
DTU - Technical University of Denmark (Denmark)  
EPA - Environmental Protection Agency (Ireland)  
FANC - Federal Agency of Nuclear Control (Belgium)  
FOPH - Federal Office of Public Health, Radiological Protection (Switzerland)  
GAEC - Greek Atomic Energy Commission (Greece)  
IRSN - French Institute for Radiological Protection and Nuclear Safety (France)  
IST - Instituto Superior Técnico, the Lisbon School of Engineering, Science and Technology (Portugal)  
KIT - Karlsruhe Institute of Technology (Germany)  
MUTADIS (France)  
NCSR - National Centre for Scientific Research "Demokritos" (Greece)  
NCBJ - National Centre for Nuclear Research (Poland)  
NMBU - Norwegian University of Life Sciences (Norway)  
PHE - Public Health England (United Kingdom)  
PDC - Prolog Development Center (Denmark)  
SCK.CEN - Belgian Nuclear Research Centre (Belgium)  
SSM - Swedish Radiation Safety Authority (Sweden)  
STUK - Finnish Radiation and Nuclear Safety Authority (Finland)  
SURO - National Radiation Protection Institute (Czech Republic)  
Tecnatom (Spain)  
UNIMI - University of Milan (Italy)  
UPM - Universidad Politécnica de Madrid (Spain)

AgroParisTech - Paris Institute of Technology for Life, Food and Environmental Sciences (France)  
AIT - Austrian Institute of Technology (Austria)  
ANCCLI - National Association of Liaison Committee (France)  
ASN - French Safety Authority (France)  
BIR - Bundeswehr Institute of Radiobiology (Germany)  
CNL - Canadian Nuclear Laboratories (Canada)  
DEMA - Danish Emergency Management Agency (Denmark)  
DZZZ - Office for Radiological and Nuclear Safety (Croatia)  
ENEA - Italian National Agency for New Technologies, Energy and Sustainable Economic Development (Italy)  
EVIRA - Finnish Food Safety Authority (Finland)  
GRS - Gesellschaft für Anlagen und Reaktorsicherheit (Germany)  
Hungarian Academy of Sciences Centre for Energy Research (Hungary)  
Institute of Environmental Geochemistry under NAS (Ukraine)  
IFIN HH - National Institute of Physics and Nuclear Engineering (Romania)  
IRB - Ruđer Bošković Institute (Croatia)  
ISGlobal - Barcelona Institute for Global Health - (Spain)  
JSI - Jozeph Stefan Institute (Slovenia)  
ISP NPP - Institute for Safety Problems of Nuclear Power Plants (Ukraine)  
ISS - Istituto Superiore di Sanità (Italy)  
KWR - Watercycle Research Institute (Netherlands)  
MBS - University of Manchester (United Kingdom)  
NAEA - National Atomic Energy Agency (Poland)  
NPP-OSI - NPP Operation Support Institute (Ukraine)  
NRG - Nuclear Research and Consultancy Group (Netherlands)  
PMA - Pays de Montbéliard Agglomération (France)  
Regional Environmental Center (Slovenia)  
RIKILT - Institute of Food Safety (Netherlands)  
RIVM - National Institute for Public Health and the Environment (Netherlands)  
SCN - Institute for Nuclear Research (Romania)  
SNSA - Slovenian Nuclear Safety Administration (Slovenia)  
SSTC NRS - State Scientific and Technical Center for Nuclear and Radiation Safety (Ukraine)  
TRPA - Taiwan Radiation Protection Association (Taiwan)  
UBB - University Babeş-Bolyai (Romania)  
UCEWP - Ukrainian Center of Environmental and Water Projects (Ukraine)  
UJV Rez, as - Nuclear Research Institute Rez (Czech Republic)  
UOI - University of Ioannina (Greece)  
UV - University of Valencia (Spain)  
UVM.BWL - Ministerium für Umwelt, Naturschutz und Verkehr Baden-Württemberg (Germany)

# NERIS Strategic Research Agenda

3 challenge areas, 10 key topics with 27 research areas

- Challenges in radiological impact assessment during all phases of nuclear and radiological events
- Challenges in countermeasures and countermeasure strategies in emergency & recovery, decision support and disaster informatics
- Challenges in setting-up a trans-disciplinary and inclusive framework for preparedness for emergency response and recovery



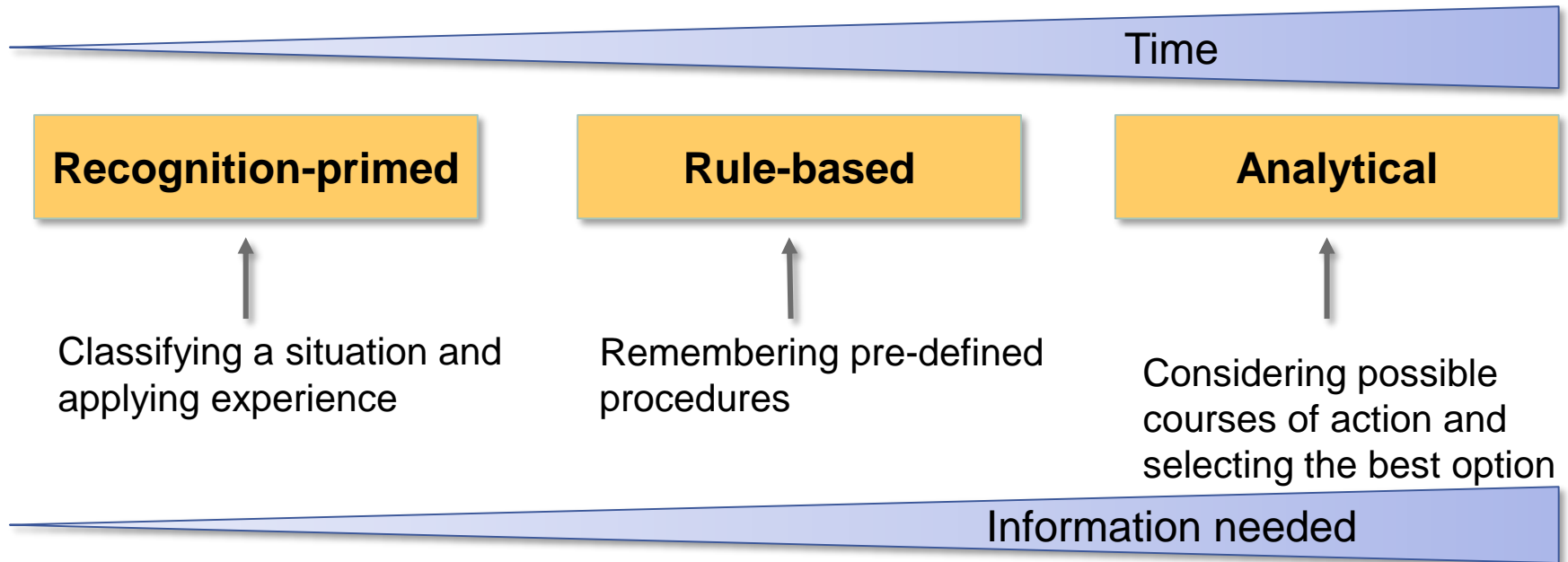
# 10 key topic areas

- Key topic 1. Improved **modelling**
- Key topic 2. Improved **monitoring**
- Key topic 3. **Data** assimilation - Data science - **Artificial Intelligence**
- Key topic 4. Countermeasures and **countermeasures strategy**
- Key topic 5. Formal **decision support**
- Key topic 6. Disaster **informatics**
- Key topic 7. Emergency response and recovery **framework** including reference level
- Key topic 8. **Stakeholder engagement**, involvement of public and **communication**
- Key topic 9. **Integrated** emergency management – non-radiological aspects
- Key topic 10. **Uncertainty** and incomplete information handling

# CONCERT gap analysis 2018 – NERIS perspective Karlsruhe Institute of Technology

- Gap analysis of all European research platforms: MELODI (low dose), ALLIANCE (radioecology), EURADOS (dosimetry), NERIS (emergency response and recovery), EURAMED (medical) and SSH (society) was performed beginning of 2018
- Individual and common gaps of two or more platforms were identified
- Overlapping gaps were identified with ALLIANCE on among others improved modelling, methods and guidance for optimisation and decision making under uncertainties
- Overlapping gaps were identified with EURADOS focus on improved strategies for monitoring including information from non-professional community and drones
- One gap was identified for EURADOS, NERIS, MELODI, and ALLIANCE: Improved modelling for internal doses after accidental situations based on environmental monitoring data and personal monitoring data

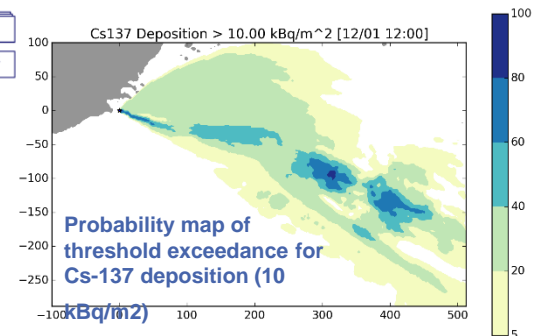
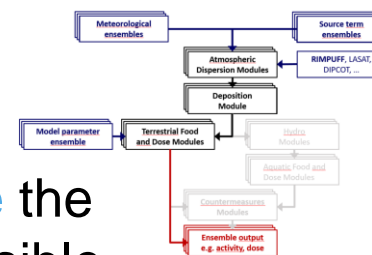
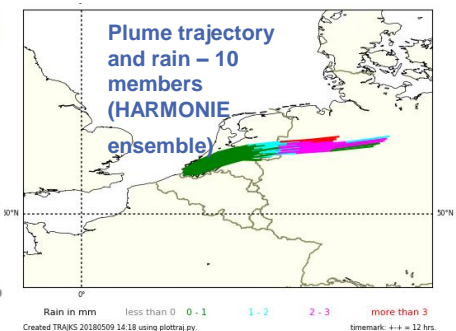
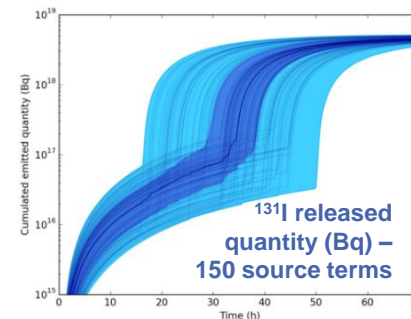
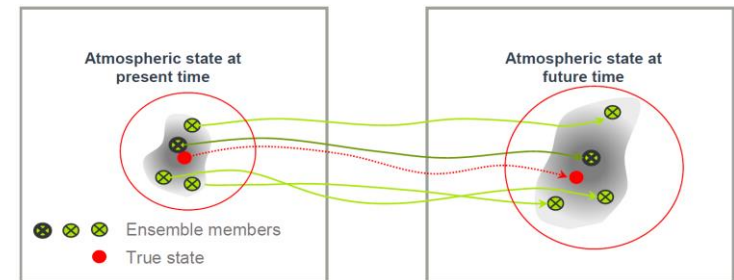
# CONFIDENCE: decision making under *high* uncertainties



- The CONFIDENCE Project will perform **research on uncertainties** in the area of emergency management and post-accident recovery – a further project named TERRITORIES deals with the late phase
- One aspect of CONFIDENCE is to **improve decision making under high uncertainties** by applying formal decision aiding techniques such as multi-criteria decision aiding tools and mental models

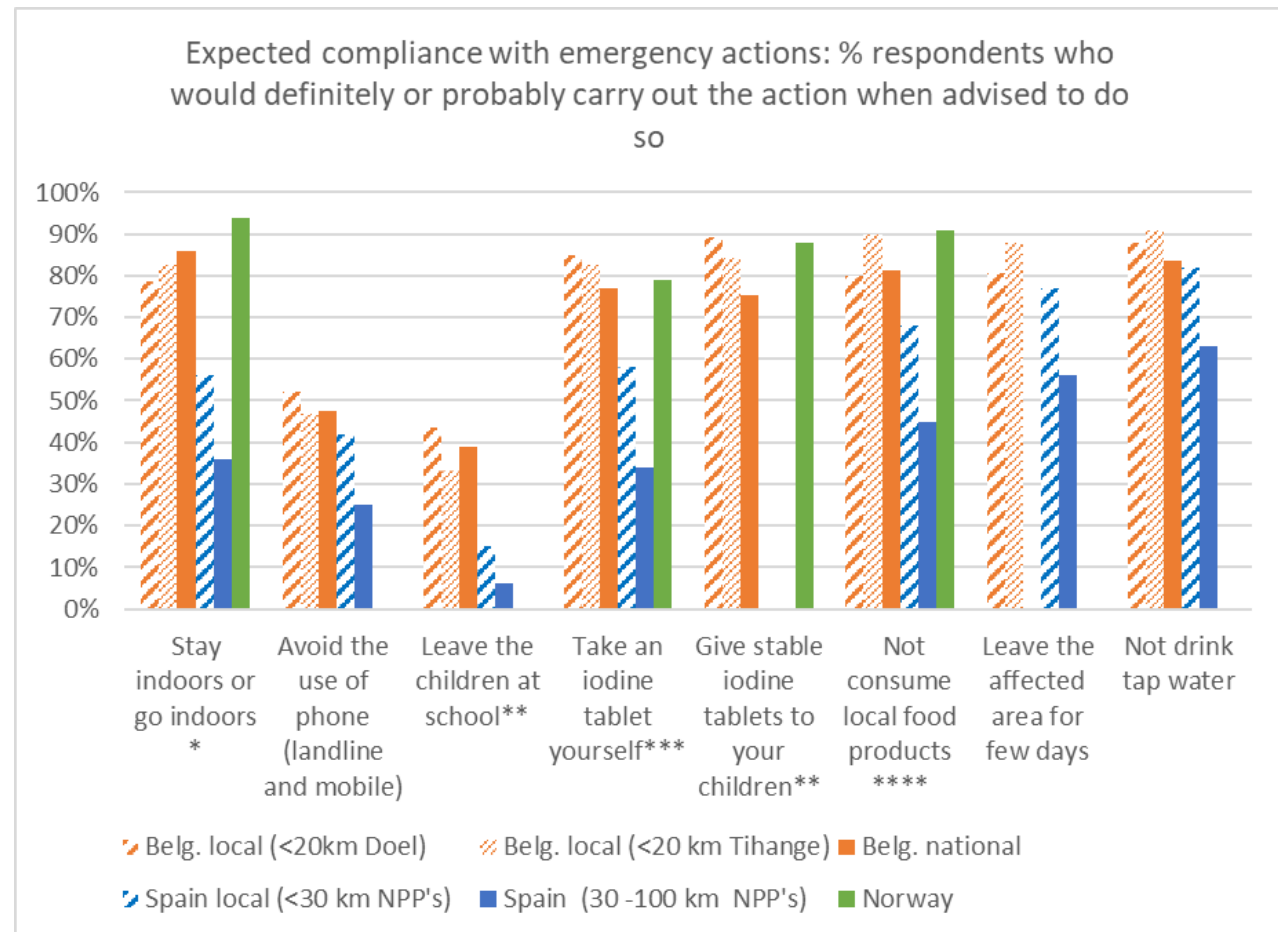
# CONFIDENCE – early phase

- 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
- The question remained: **How to use** the ensemble approach in the **best possible way** operationally?



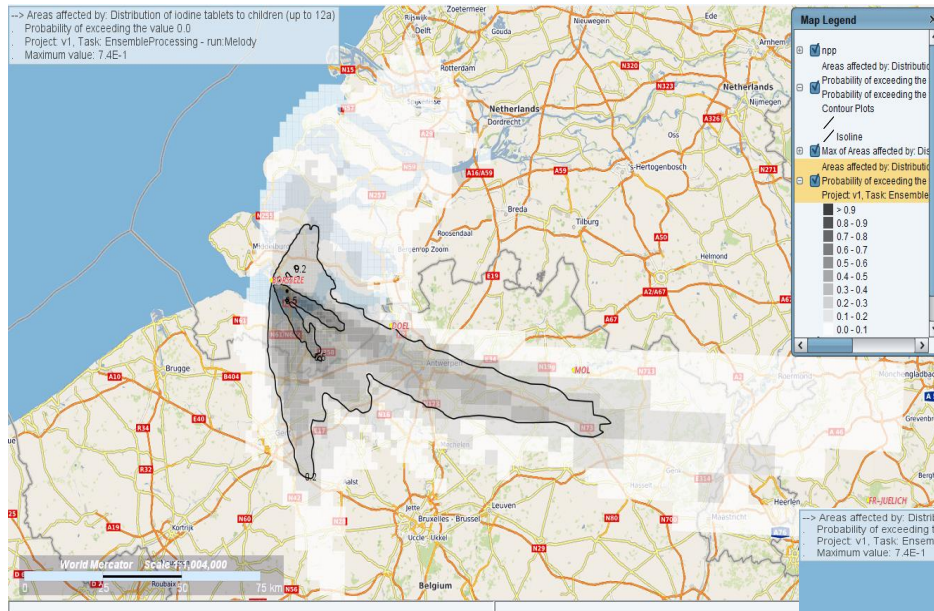
# CONFIDENCE – communication

- Is the operational community aware of the **reaction of the affected population?**
- About **3000** people have been asked in **Belgium, Spain** and **Norway** in the frame of the **CONFIDENCE** project

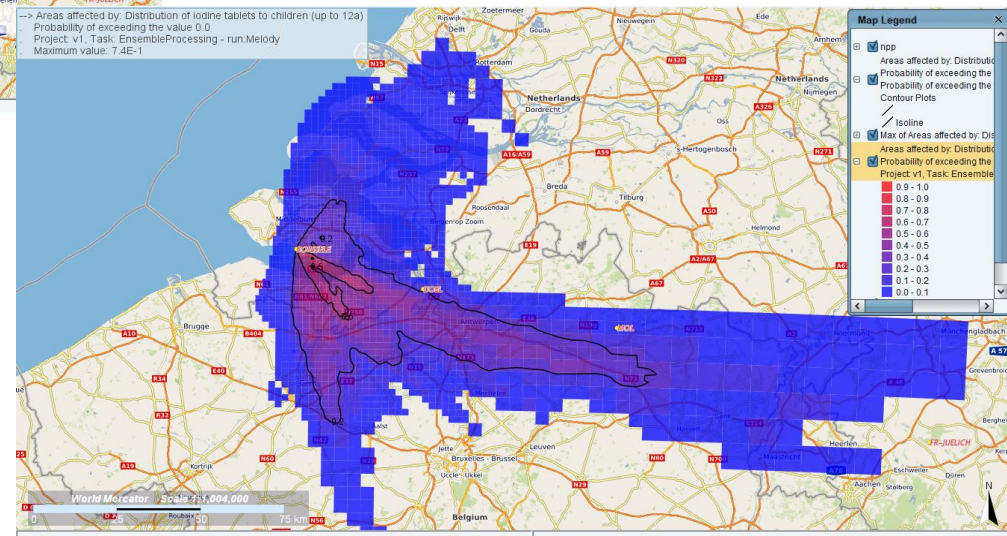




# Communication of uncertainties / ensembles

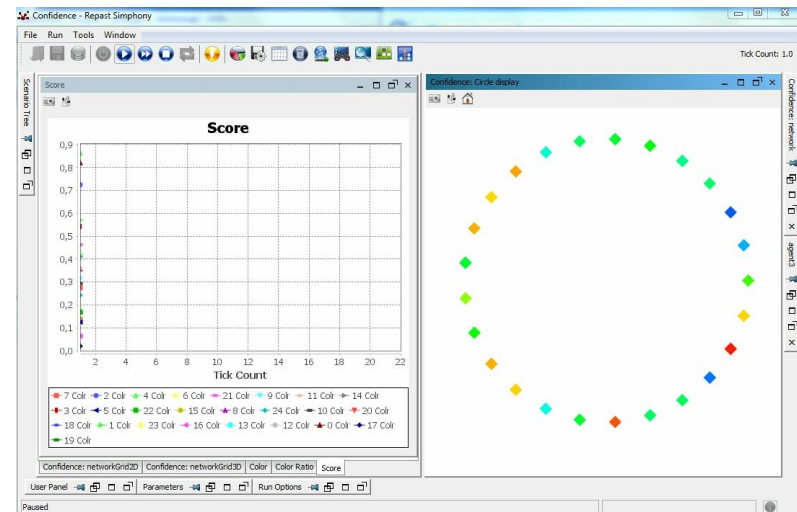
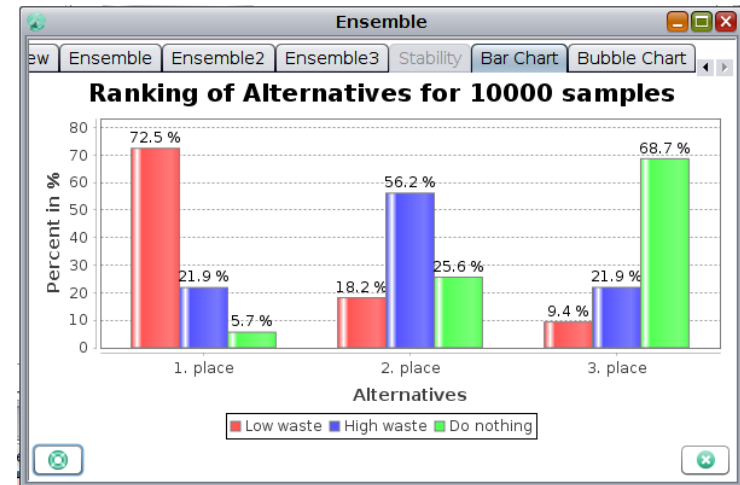


Probability that dose at a grid points exceeds reference value



# CONFIDENCE – formal decision aiding tools

- Use formal decision aiding tools such as Multi Criteria Decision Aiding (MCDA)
- Preferences and strategies, generated in other work packages were applied to the MCDA including uncertainty information
- The MCDA model was extended to deal with uncertain input information and ensemble calculations could be performed
- Agent Based Simulation model (ABM) have been developed to better understand the importance of the negotiation process



# Conclusions from CONFIDENCE project

- Can we use **simple** models as they need much **less computing** time; increasing the number of ensembles might compensate model simplifications?
- **Use of scenarios** to better represent “deep” uncertainties
- **Recommendations** were developed how to improve the **strategy development** together with **stakeholders** (e.g. governance, economy, environment, health, society) – how to make them operational?
- **Communication** is a key for success in emergency management and recovery – there is a need to demonstrate the findings from CONFIDENCE
- There is a need to further test and apply the formal decision aiding techniques (**MCDA**) that were improved and tested in panels
- There is a need to improve the strategy development in DSS allowing the **end user** to **define** his or her **objectives/goals** and the **system identifies the best possible strategies**

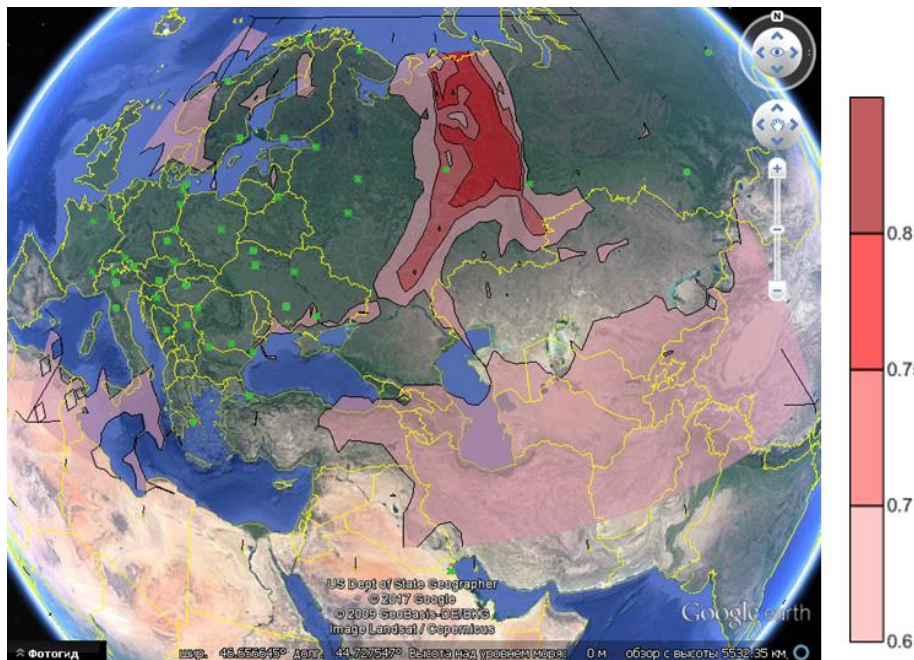


# Fukushima/Ukraine

- The accident happened in March 11, 2011, a Friday
- There were many requests to national emergency management organisations (national and from abroad) to provide guidance for nationals living abroad, industry and aviation
- There was **no harmonised response** in Europe!
  - Each country announced recommendations for their own citizens
  - Potential source terms became available shortly afterwards but only for internal use
  - The first “**official**” source terms was published by **IRSN March 22**
- As a consequence the PREPARE project performed research to investigate the technical means for a so called “**Analytical Platform**” to allow exchange of technical information at a European level
- The Platform was developed but **so far not used**
- **The same** can be seen now with the **war in Ukraine**
  - Source terms are available but **not shared** – at least as far as I know

# Ruthenium 106

- Late September 2017, RU-106 was detected in several European aerosol monitoring stations
- Level were very low and there was no risk for European citizens
- The location of its **origin was not known** as no country reported an incident/accident



Spatial distribution of the maximum correlation coefficient of calculated vs. measured values which correspond to the location of the source. The maximum value is 0.81 (located in the Ural region)

Calculations performed with JRodos (I. Kovalets, Ukraine)

# Ru-106 response

- No harmonised European response!
  - Some bilateral discussion, e.g. IRSN and BfS, also workshops later on
  - An international Commission of European and Russian Experts was created discussing the case
- Other observations
  - Using the agreed range of possible Ru-106 released (between 100 – 300 TBq, **INES 5** (*hundreds to thousands of TBq of 131I*) - Ru-106 has multiplication factor of 6)
  - IAEA cannot become active as only the accident country can activate support by and work activities of IAEA
  - Aerosol stations (e.g. ring of five - *informal network of experts*) are not part of an early notification system, information from these stations are not “official” and might be difficult to refer to – *do we need something such as ECURIE for aerosol monitoring?*
- Do we need a European Exchange platform for such events and could we think about something in the frame of the NERIS Platform?

# Interaction with SNETP/NUGENIA

- The Sustainable Nuclear Energy Technology Platform (**SNETP**) was established in September 2007 as a platform to support and promote the safe, reliable and efficient operation of Generation II, III and IV civil nuclear systems
  - Over 100 European stakeholders from 25 different countries
  - Development of a **Strategic Research and Innovative Agenda** (SRIA) to ensure that fission energy is generated in a way that meets the criteria for sustainable development and is compliant with safety requirements
- The Nuclear Generation II & III Alliance (**NUGENIA**) is dedicated to the research and development of nuclear fission technologies, with a focus on Gen II & III nuclear plants
- Eight research areas, some of high interest for RP research
  - Technical area 1 – Plant safety and **risk assessment**
  - Technical area 2 – **Severe accidents**

# NUGENIA-MEENAS meeting in 2020

- Representatives from all **six Radiation Protection** platforms met with representatives from **NUGENIA** in February 2020 in Fontenay-aux-Roses
- Research ideas were exchanged and the following topics identified as of interest for all participants
  - **Source term** calculation / estimation from **in-plant information** and based on **off-site** gamma dose rate monitors and atmospheric dispersion models – can both approaches be combined?
  - **Future of nuclear energy** in Europe and how risks, benefits and potentials are seen by stakeholders – social science topic
  - Enlarging the nuclear workers cohorts – **low dose research**
- Even if interest was there, realization of common working groups was difficult and the EURATOM call could not be influenced – **again EJP problem**

# Brainstorming on NERIS research needs for PIANOFORTE (2022)

- Countermeasure strategy preparedness and improved decision making
  - Improve preparedness of strategy development
  - Better support of decision making by improved decision support systems and using AI techniques
  - Better combining human, technical, economic, societal dimensions
- Improved modelling
  - Inverse modelling for unknown source location and source term reconstruction
  - Nuclear explosion model
  - Updated databases for inhabited area countermeasure models
  - Better consideration of uncertainties in the simulation models
- Optimisation and resilience/sustainability
  - Reflect on concepts of tolerability and reasonableness in decision-making processes
  - Consider resilience and sustainability as elements of optimisation taking into account humans and the ecosystem

# Conclusions

- Research landscape has changed significantly with Co-fund Actions and RP platforms that are key player in defining research needs
- Improvements can be clearly seen in
  - Simulation models and DSS
  - Strategy development and engagement of stakeholders
  - First ideas about uncertainty handling
- Gaps identified (personal prioritisation)
  - Harmonised response all over Europe – Platform?
  - Communication at all levels and engagement of stakeholders
  - Better uncertainty handling from the input data up to the decision making process
  - Inverse modelling and source term reconstruction – with NUGENIA?
  - More intuitive handling of DSS to better support the end user
  - Research needs from Ukraine war – nuclear explosion modelling
- Engage in the RP platforms!

Thank you for your attention!  
<https://www.eu-neris.net/>

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