



Decision-makers in a post nuclear accident situation: confronting uncertainties, criteria supporting decisions and tools for their presentation

Training Course

Use of uncertain information by decision makers at the various levels within the decision making process and its communication

13-15 May, 2019

VUJE, Okružna 5, Trnava, Slovak Republic

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1. French regulatory framework for emergency and recovery phases management
2. Usual tools for decision-making
3. CONFIDENCE WP4 – French panel
4. Decision-makers' findings

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- Implementation of the emergency response national plan

- EPZ guidance evolution for PWR

- 20 km radius (ITB pre-distribution)
- 5 km radius : immediate evacuation
- 2 km radius : sheltering in reflex mode

- Transposition of the Euratom directive 2013-59 in the French law

- Based on ICRP guidance
- Introduction of 3 exposure situations : planned, emergency and existing
- Introduction of dose Reference Levels and Intervention Levels.

Urgent Protective Actions Guide-levels		
Sheltering and listening in place	Projected Effective Dose	10 mSv
Evacuation	Projected Effective Dose	50 mSv
Stable Iodine Prophylaxis	Projected Thyroid Inhalation Equivalent Committed Dose	50 mSv

+ Recommendation of non consumption of local foodstuffs

Relocation Perimeter (PE)

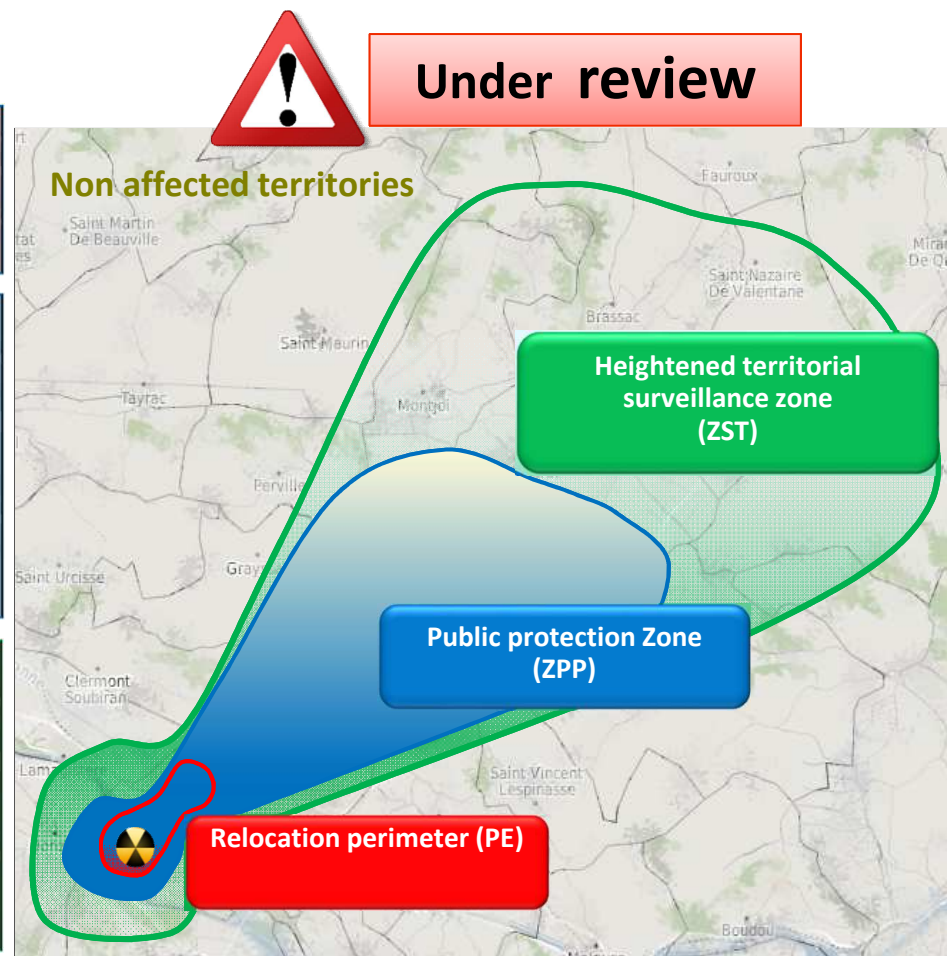
- High ambient radioactivity
- Temporary relocation of residents

Public Protection Zone (ZPP)
Protection of local population

- Residents can stay
- Food bans (consumption/distribution)
- Actions to reduce exposure to ambient radioactivity and internal dose due to ingestion

Territory Surveillance Zone (ZST)
Preservation of foodstuff quality and economical activities

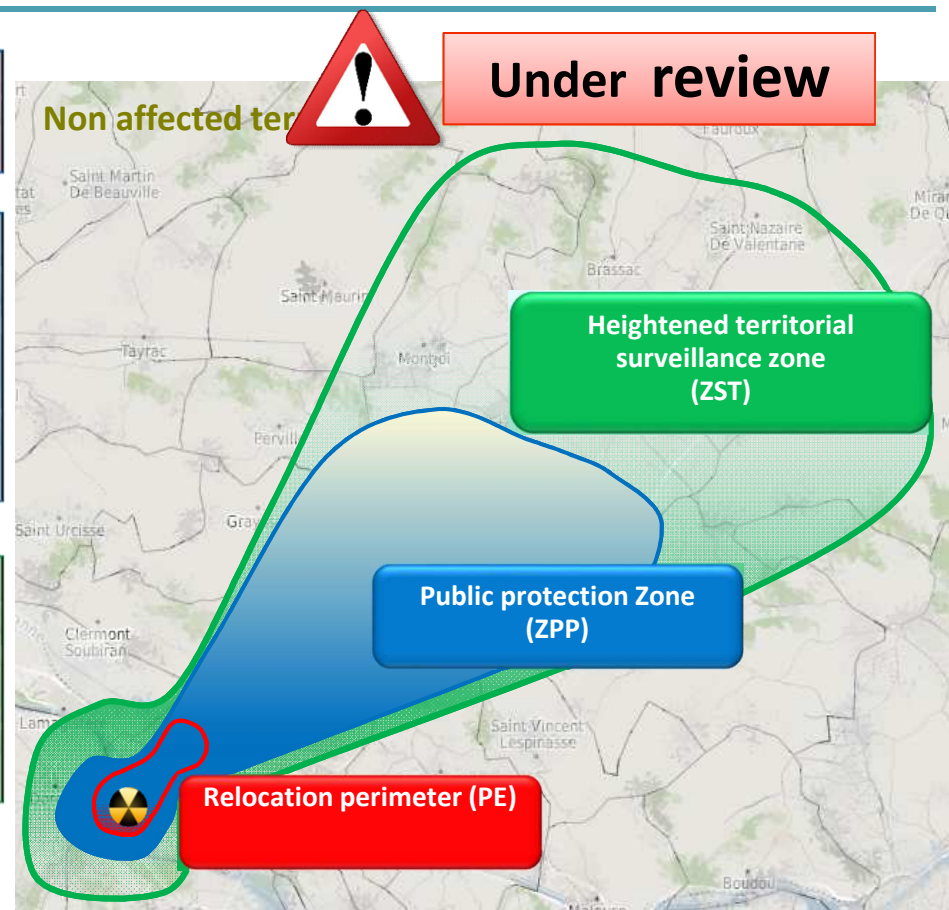
- No specific action for the protection of residents
- Surveillance of foodstuff and farm products intended for public sale



Relocation Perimeter (PE)
Projected effective dose, except ingestion / 10 mSv

Public Protection Zone (ZPP)
Projected effective dose regardless the exposure pathways: 10 mSv
Or
projected thyroid equivalent dose regardless the exposure pathways: 50 mSv

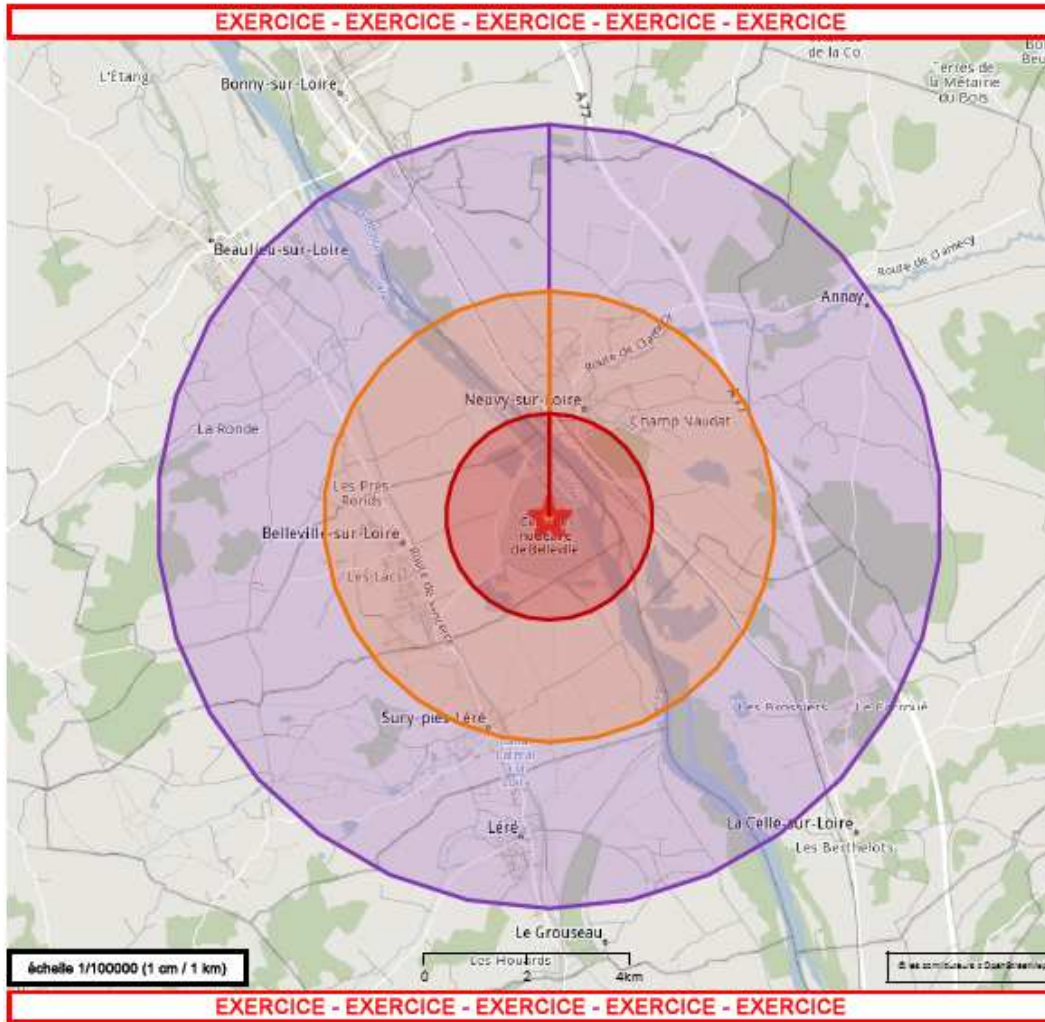
Territory Surveillance Zone (ZST)
Zone where one Maximum Permitted Level for food contamination* can be exceeded
*Maximum permitted levels - Regulation (Euratom) 2016/52 of the Council January 2016




- A first zoning is evaluated for the first one month period / 1st month zoning
- When the situation is stabilized a second zoning is established for the next twelve months zoning

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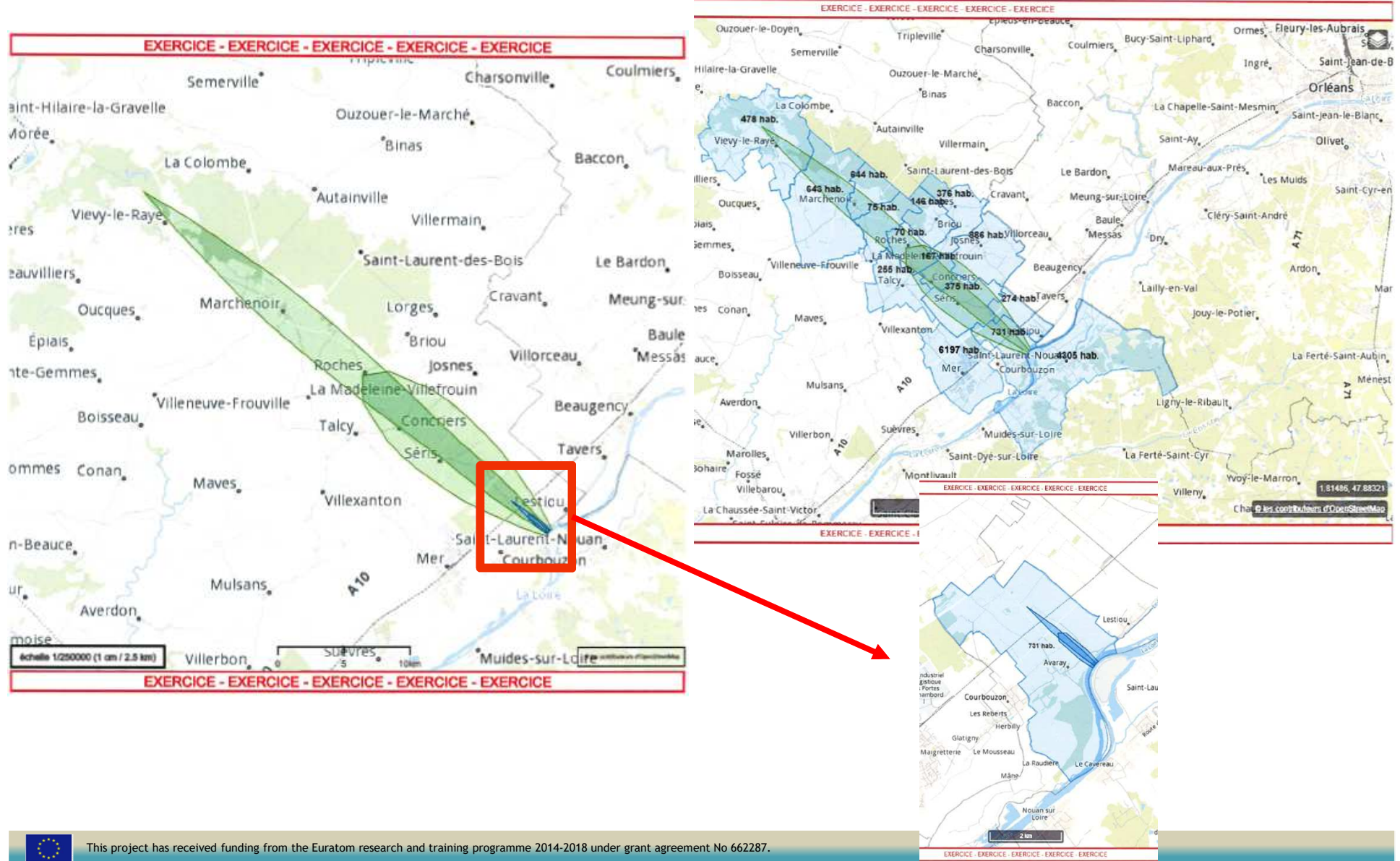
Type of maps usually used for helping in decision-making (1/3)



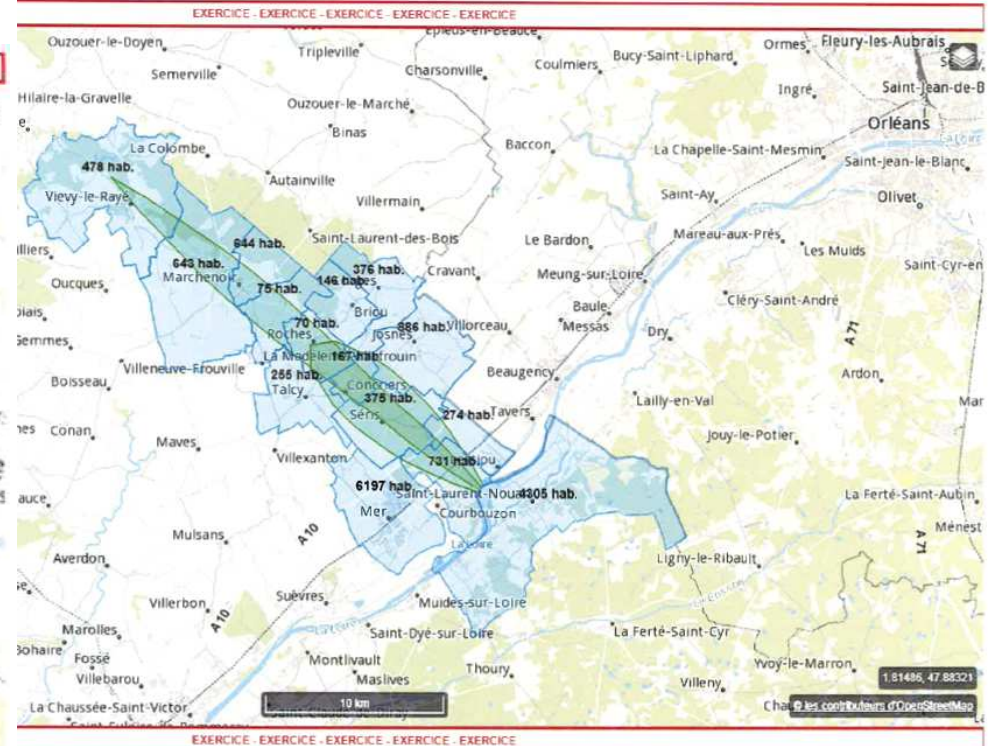
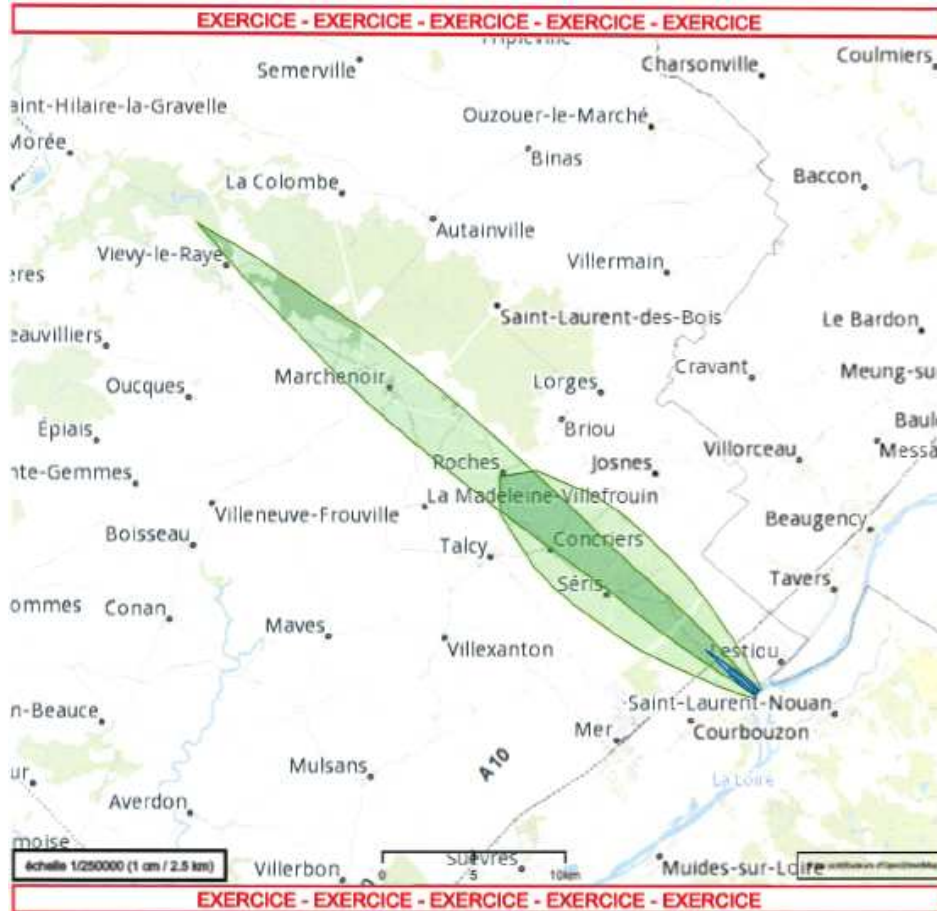
*Example : exercise
around Belleville NPP*


Urgent Protective Actions		
Sheltering and listening in place	Projected Effective Dose – 10 mSv	3 km
Evacuation	Projected Effective Dose – 50 mSv	1,4 km
Stable Iodine Prophylaxis	Projected Thyroid Inhalation Equivalent Committed Dose – 50 mSv	5,2

Type of maps usually used for helping in decision-making (2/3)



Type of maps usually used for helping in decision-making (3/3)



Recovery Protective Actions		
Public Protection Zone (ZPP)	Projected effective dose: 10 mSv Or projected thyroid equivalent dose: 50 mSv	<3 km
Territory Surveillance Zone (ZST)	Zone where one MPL for food contamination* can be exceeded	~25 km

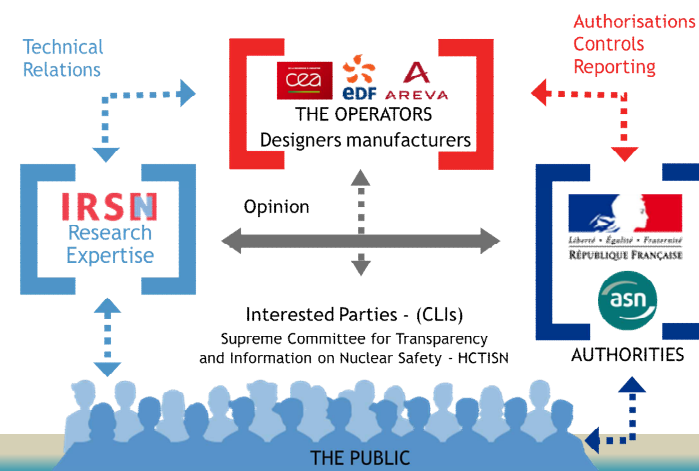
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- A scenario-based Stakeholder engagement exercise to identify and evaluate the uncertainties which are part of the decision-making process (emergency and transition phases)
 - Evacuation and relocation strategy
 - Food restriction strategy
- Analyse the implementation of the criteria proposed in the French doctrine
- Assess if decision makers take into account uncertainty inherent to modelling in their decisions
- Identify other uncertainties they take into account in their decisions
- Analyse how decision-makers anticipate the adverse consequences in the longer term, identify the data they would need to do so

Experts of the institutional French organizations and authorities

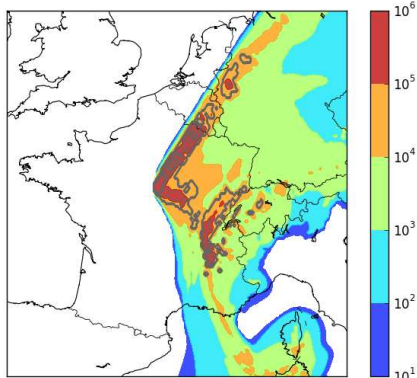
- Institute for Radioprotection and Nuclear Safety
- Nuclear Safety Authority
- *Directorate General for Food*
- Regional health agency
- *Directorate General for Competition Policy, Consumer Affairs and Fraud Control*
- Departmental Directorate for the protection of population
- Retired Prefect and retired mayor
- Interdepartmental Civil Defense and Protection Service
- *Chamber of agriculture*
- Firefighter forces
- Local Liaison and Information Committee

Several decision makers at the national and local levels of the French post-emergency response system



Taking into account inherent uncertainties about the real situation: direct links with CONFIDENCE WP1 to develop a basis of work for the panels meeting

- For the first panels meeting, WP1 CONFIDENCE outputs allow to provide:
 - Maps of probability of threshold exceedance, for reference levels
 - Deterministic simulation: a single contour shows the impacted area
 - Ensemble of simulations: Probability maps of threshold exceedance = probability that a given zone is contaminated above a given level.
 - Maximum distance for a reference level +/- the uncertainty

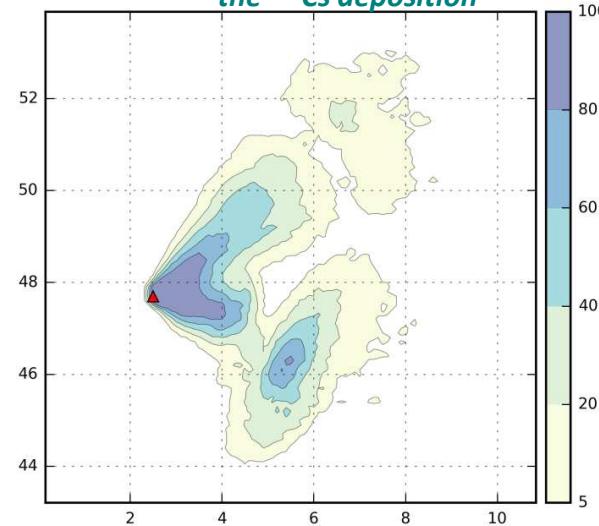


- **Probability of threshold exceedance:** computed by counting the number of simulation within the ensemble that predict a value above the given threshold at a certain point

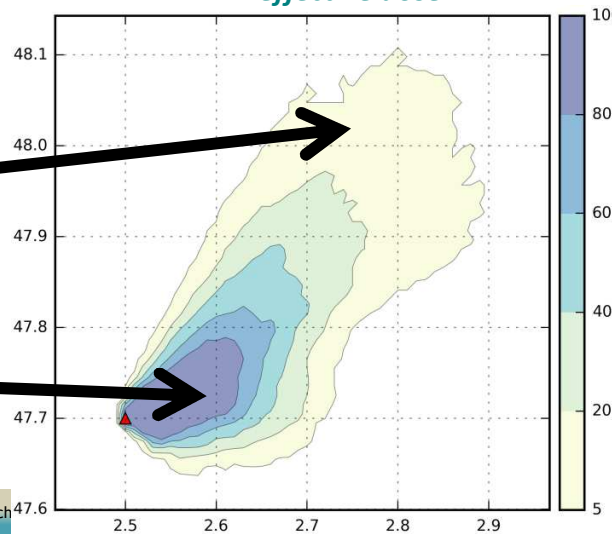
- **Colored zones:** The lighter colors = the lower the probability of exceeding a given threshold (simulation forecasts)

Dark blue area = zone with the higher risk (80-100% probability of exceeding the threshold)

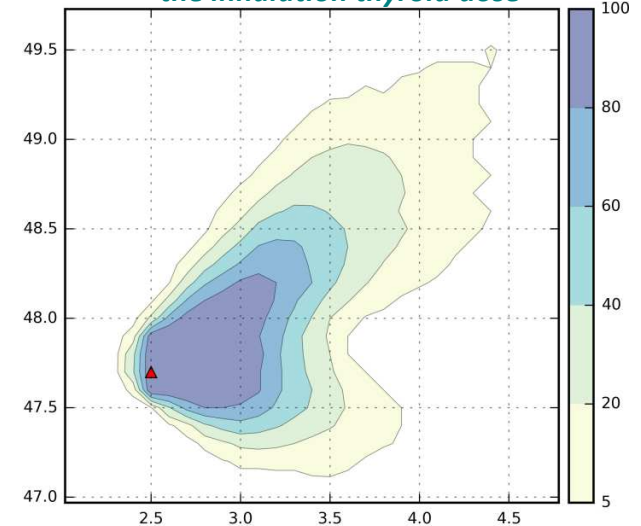
Probability map for threshold of 37 kBq/m² on the ¹³⁷Cs deposition



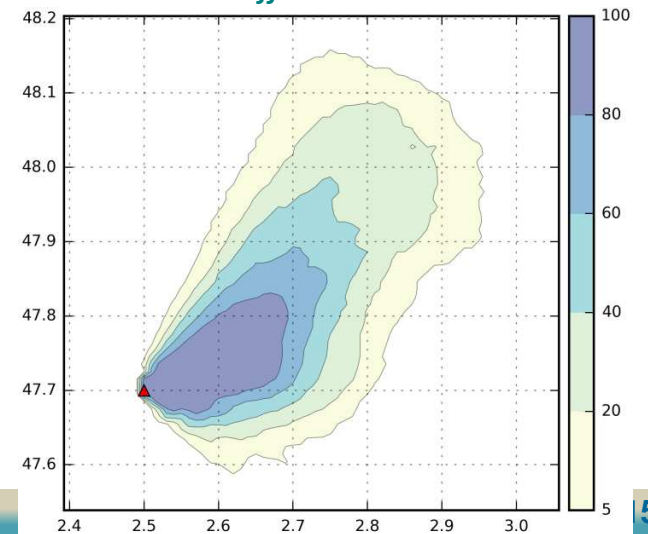
Probability map for threshold of 100 mSv on the effective dose



Probability map for threshold of 50 mSv on the inhalation thyroid dose



Probability map for threshold of 50 mSv on the effective dose



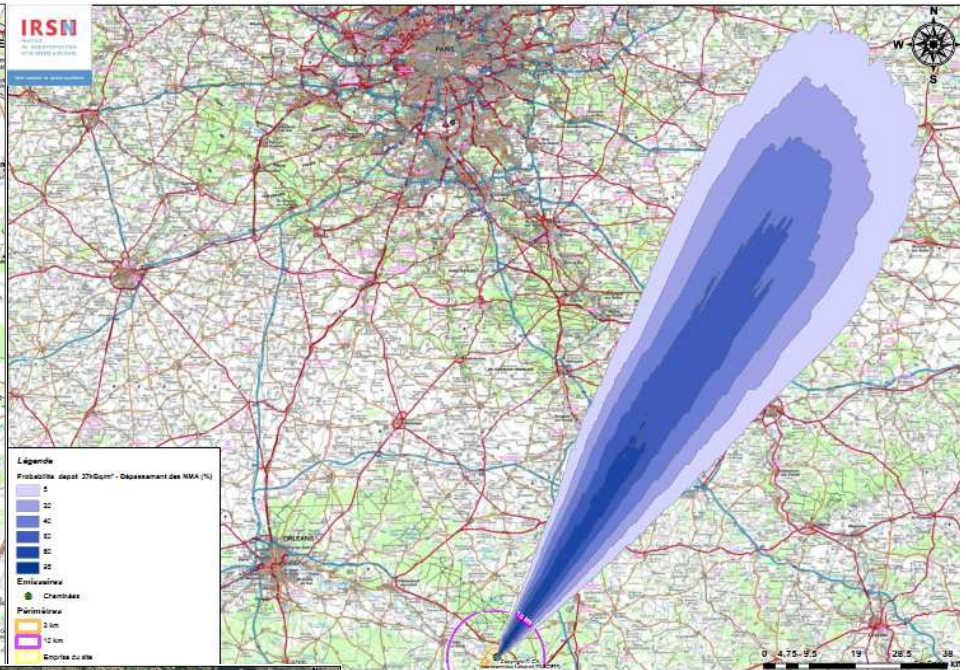
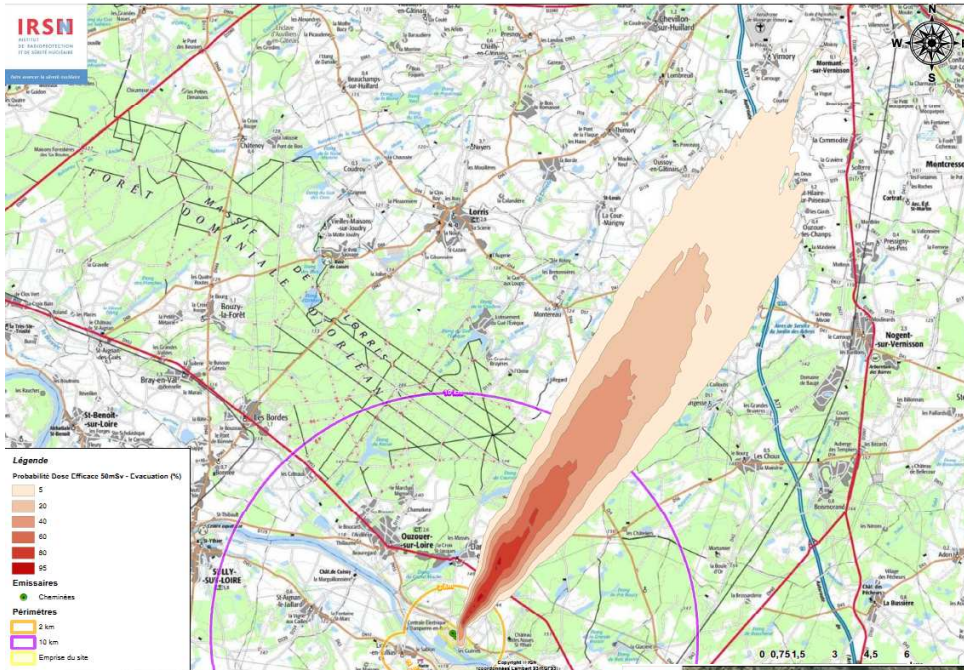
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- For the second panels meeting, WP1 CONFIDENCE outputs allow to provide :
 - A synthetic map of “real measurement data” from simulated airborne monitoring used to show the difference between forecast data and measurement (overlaps, zones not initially included in the decision...)
- For both panel meetings, preparation of maps representing the socio-economic issues of the affected territory :
 - Agricultural production;
 - Population density;
 - Public buildings (school, hospitals...).

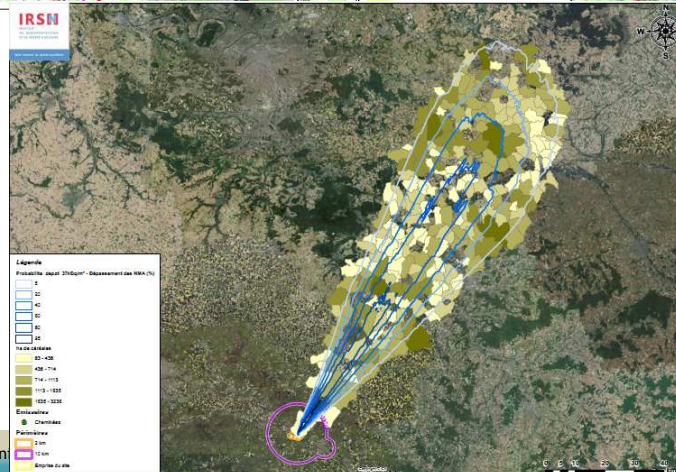
Case used (on Dampierre NPP site) for emergency phase

Probability map for threshold of 50 mSv on the effective dose

Probability map for threshold of 37 kBq/m² on the ¹³⁷Cs deposition

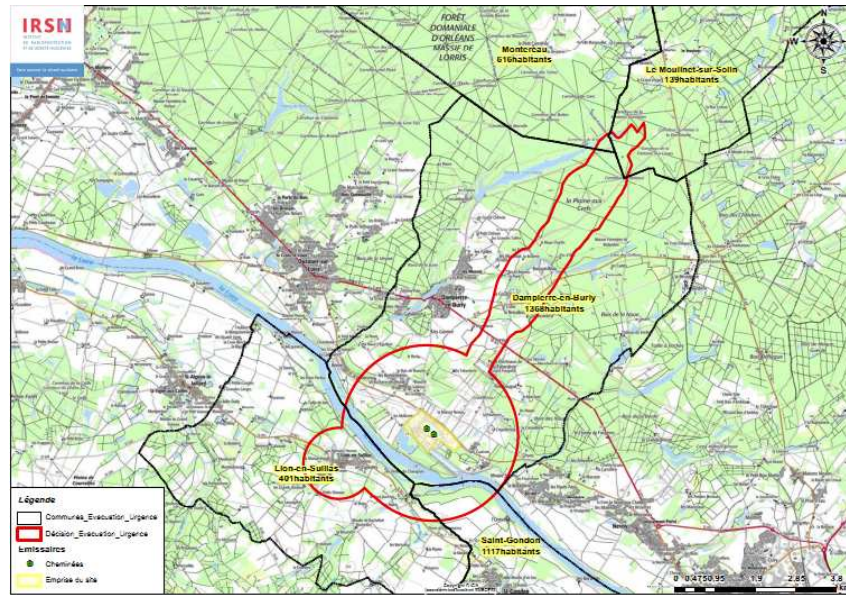


Probability map for threshold of 37 kBq/m² on the ¹³⁷Cs deposition with the area under cereals (vineyard, cows, etc.)

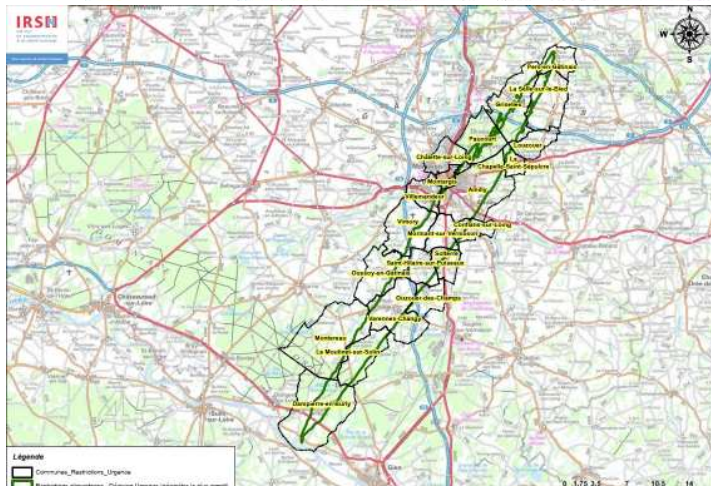
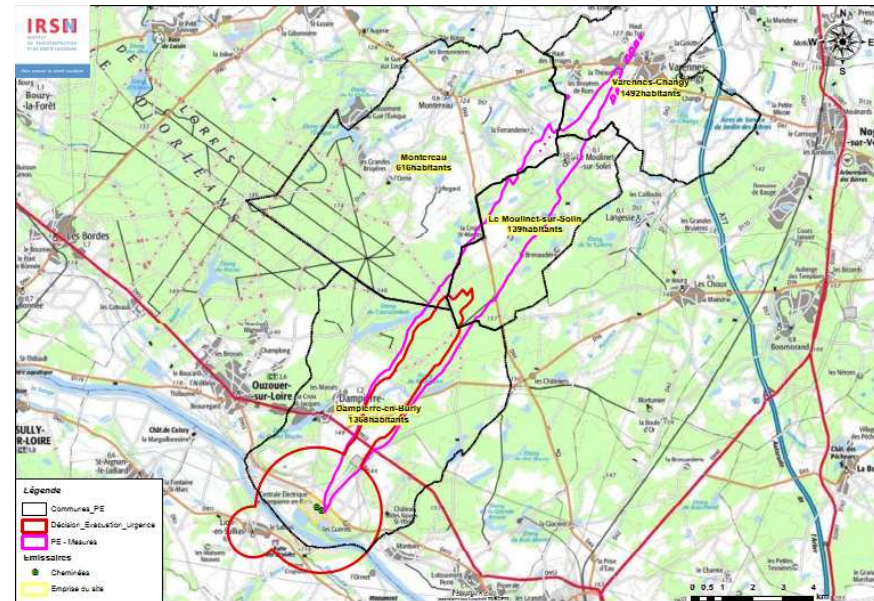


Case used (on Dampierre NPP site) for the transition phase

Emergency decision: evacuation of populations during the emergency phase (1800 people - Dampierre and Lion-en-Sullias municipalities + some people from neighboring municipalities)

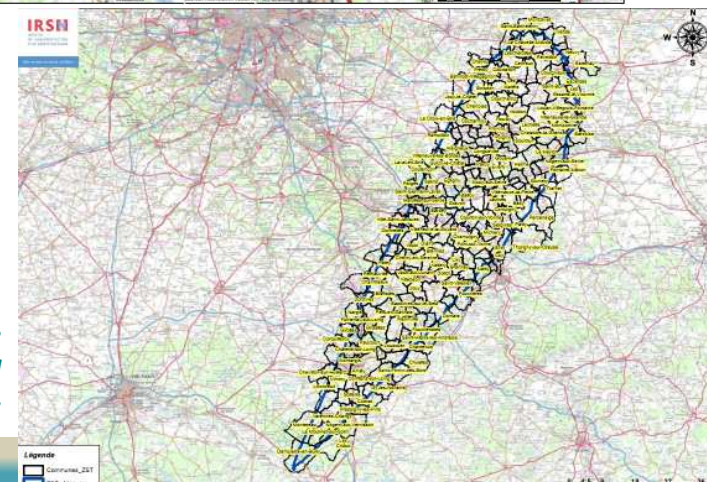


Relocation of population at the end of releases (airborne measurements)



Emergency decision: restrictions on consumption of locally foodstuffs: 19 municipalities.

Municipalities concerned by the distribution restrictions at the end of the releases: 258 municipalities



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- ~50 uncertainties for evacuation/relocation and ~30 for food restrictions
 - Analysis of the stakeholders' questions to identify various issues raised by the panel members regarding evacuation/relocation and food restrictions;
 - Uncertainties have been classified depending on topics and the emergency / transition phase

- Classification used: *S. French et al., in The Various Meaning of Uncertainties.*

1/ Uncertainties associated with the production of information (external uncertainties)

- Stochastic, epistemological, judgmental, computational, modelling uncertainties
 - “What is the level of reliability of the probability maps?”
 - What if the release occurs during a longer time frame?
 - How do you consider the meteorological forecast (wind)?
 - What is the level of reliability of the measurements? What is the level of conservatism?”



2/ Uncertainties associated with the use of information (internal uncertainties)

- Uncertainties related to the decision itself – how to shape the strategy given the available information
 - “When should we communicate about relocation? Is it when the results of the model are available or after a few days when the zoning is well established based on field measurements?”
 - “Should we not wait for the first map of contamination based on field measurements?”
 - “Should we consider other criteria (geographical, socio-economic) in addition to the radiological ones? How to put into balance these different criteria?”
 - “Should we make a distinction between consumption and commercialization or link both?”
 - Where to put the higher protection: on food intended for commercialization or food intended for self-consumption?
 - Which strategy to adopt? Create an extended restriction zone to be reduced progressively according to on-the-field measurements (“from big to small” approach) or instead, a small restriction zone that could be expanded if necessary (“step by step” approach)?”

2/ Uncertainties associated with the use of information (internal uncertainties)

■ Uncertainties related to the **governance**

- “Taking into account the “Safety Contingency Plan” at communal level, is it possible that mayors decide evacuation by themselves?
- Will this strategy for evacuation, **decided** at local level, be **validated** by higher authorities?
- Will higher institutional actors/decision-makers change this strategy and implement a new one?
- Will this zoning for food restrictions be agreed and validated by higher authorities?”



■ Uncertainties related to **communication issues**

- “Will prior communication (by social media, traditional media, etc.) able to broadcast **the “right” messages** and prevent panic?
- Besides traditional media (TV, radio), what can be done to limit the spread of rumours and broadcast reliable information on the social media?
- When should we communicate about relocation? When the results of the model are available or after a few days when the zoning is well established based on field measurements?”
- “What are **the best messages** given the circumstances?
- To what extend does the population **understand** the evacuation procedures and the doctrine?
- How will the messages be understood?
- What information is clear and concrete enough to reassure on the effectiveness of protective actions and provide support to the individuals according to their situation?”

2/ Uncertainties associated with the use of information (*end*)



- **Social and human issues** – behaviours and reactions
 - “What to do if the bus drivers use their right to withdrawal?”
 - Will the military or police forces be able to contain any potential panic?
 - What are the options at our disposal if some **first responders/actors** (e.g. bus drivers) use their **right of withdrawal**?”
 - “How to outreach the general population and the hosting territories in particular, and not generate stigmatization of the relocated individuals and affected territories?”
 - To what extent will the messages be understood? In particular for the individuals living outside the zoning borders?”
- **Economical** and other side-effects uncertainties
 - “What will be the **socio-economic impacts** on the affected territories? How to maintain an activity in these territories over the long term?”
 - “What about the brand damage/loss for the products and for the (affected) territories? How can we evaluate the impacts?”
 - What will be the situation for the affected territories?
 - What will be the socio-economic impacts on each production sectors (considering the added value of the sector and the actors)?
 - What are the **economic losses** for each food production sectors if they are « **stigmatized** »?

3/ Uncertainties related to the evolution of the situation over time

- “What will be **the evolution of the situation** in the next hours?”
- Is it possible to anticipate now the zonings at far distance from the nuclear plant that will be concerned by relocation?”
- “What will be the evolution of the radiological situation?”
- What will be the evolution of the zoning for relocation in the next months?”
- What is **the level of reliability** of this evolution?”
- “How to adjust the strategy for relocation (and the protective actions) according to the evolution of the radiological condition?”
- How to link the evolution of the restrictions with the calendars of harvest and effective consumption of the products?”



4/ What information and support of information should be produced?

- “What is the **sociological profile** of the population? What is the **level of self-sufficiency** of the population (consumption of the food produced in garden, harvest in forest, hunting, etc.)?”
- What are the products that have the higher impact (dose) when it comes to ingestion?”
- “What is **the reliability of the boundaries** proposed for the relocation zone?”
- What will be the radiological measurements performed at the boundaries of the zoning for relocation?”
- How to ensure that the boundaries of the zoning for relocation actually protect the individuals living nearby?”

- Overall, these two meetings raised the following findings:
 - **The temporal dimension** (evolution of zoning over time) is confirmed as very useful for decision-makers;
 - The importance of **diverse information**, not only focused on radiological impacts, helps decision-making: geographic information, socio-economic issues of the territories, etc.;
 - The fact that **the transition from emergency to post-accident phases** is a challenging period;
 - The decisions taken during the emergency/post-accident phases could be **political** and might be taken over at high levels.



Thank you for your attention!