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GREEK ATOMIC ENERGY COMMISSION

Radiological impact assessment in preparedness and response phase for nuclear emergency management in Greece

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Relevant types of nuclear emergencies

- Greece is a non nuclear country with no intention to built an NPP
- As part of the new European BSS Directive implementation a new National Hazard Assessment has been undertaken
- Potential Radiological & Nuclear emergencies (IAEA GSR Part 7)

Relevant types of nuclear emergencies

- Nuclear emergency scenarios in HA
  - Nuclear vessel e.g. aircraft carrier visiting the country – IAEA Cat. II (IAEA GSR Part 7)
  - **Nuclear accident abroad with large release affecting the country**
    - No part of Greek territory is within the emergency planning zones of an NPP abroad
    - Therefore, this an IAEA Cat. IV emergency
    - Although, calculations, analysis and determining the core components of the protection strategy have been completed, yet, a number of significant questions – open issues related to the great uncertainties in assessing the actual impact and the optimal and most effective associated response remain!

First assessment, 2015-2016

- Source term: First 10 days Fukushima accident release time sequence (from Katata et al. 2015)
- Software: HYSPLIT
- Meteorology: ECMWF re-analysis
- Release start date: 20 July 2013, 04:00UTC
  - Extracted from the meteorology of one year (2013), along with a number of other dates having an adverse impact associated with enhanced (wet) deposition
- Dose calculation
  - Exposure pathways: cloud, ground shine and inhalation (only ground shine for longer term)
  - HYSPLIT post processing tool for dose calculation was modified

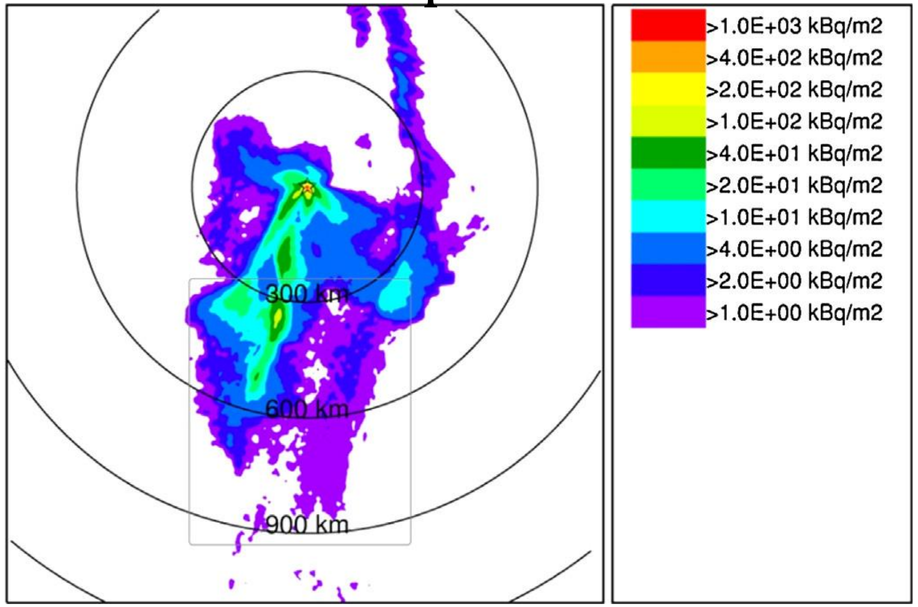
More details in Mitrakos et al. NED 300 (2016) 422-432

Later assessment, 2018

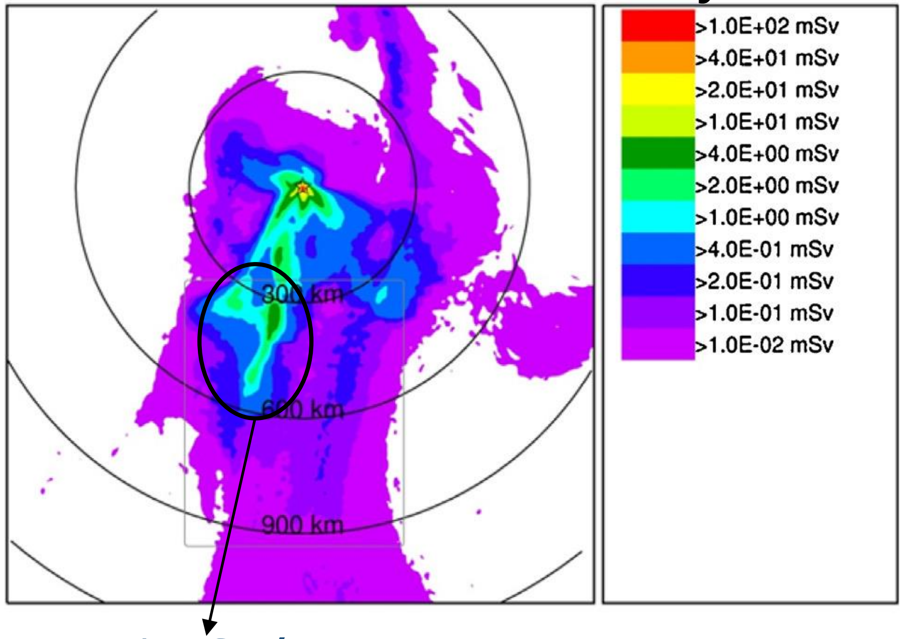
- Source term: 10% of the core inventory released in 10 hours (IAEA EPR NPP Public Protection Actions 2013)
- Software: JRODOS (is now used as the basic operational tool in EEAE with ECMWF daily forecast data)
- Release start date: 13 July 2017, 03:00UTC (selected from dates with enhanced impact on Greece identified by CIEMAT in the context of the European Project CONFIDENCE)
- Meteorology: NOMADS Re-analysis

First assessment, 2015-2016: results (1/3)

Cs-137 deposition



Effective Dose the first year



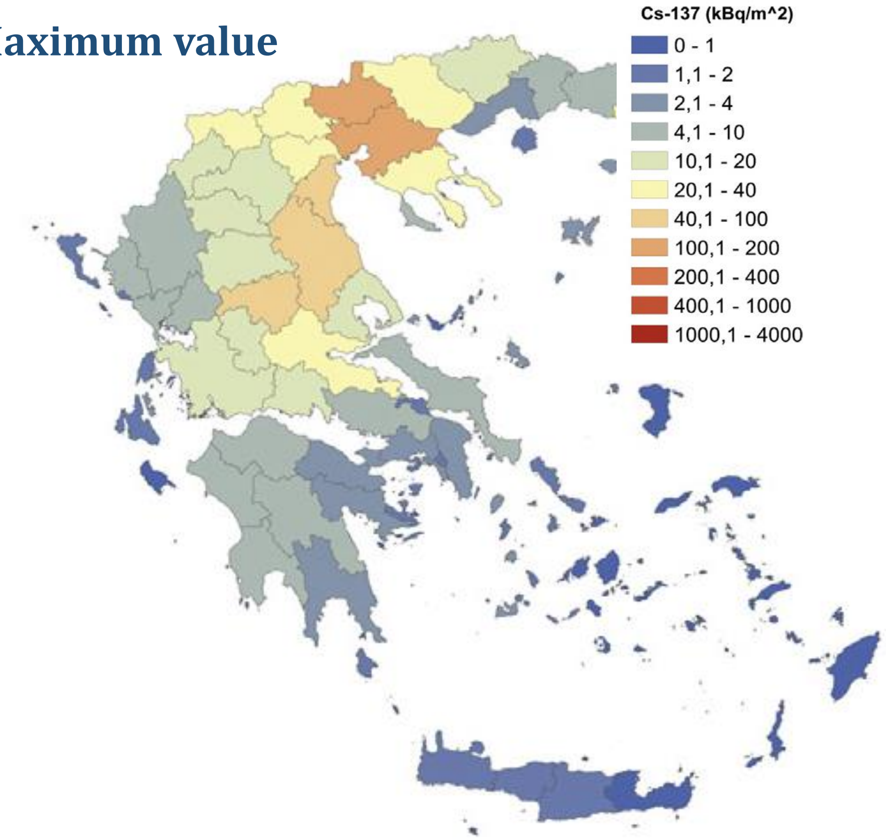
> 1mSv/y

- ✓ It seems prudent not to rule out completely a radiological impact, which cannot be neglected, even at distances considerably larger than the typical emergency planning distances (e.g. <300km)

First assessment, 2015-2016: results (2/3)

Calculated Cs-137 deposition in each administrative department

Maximum value

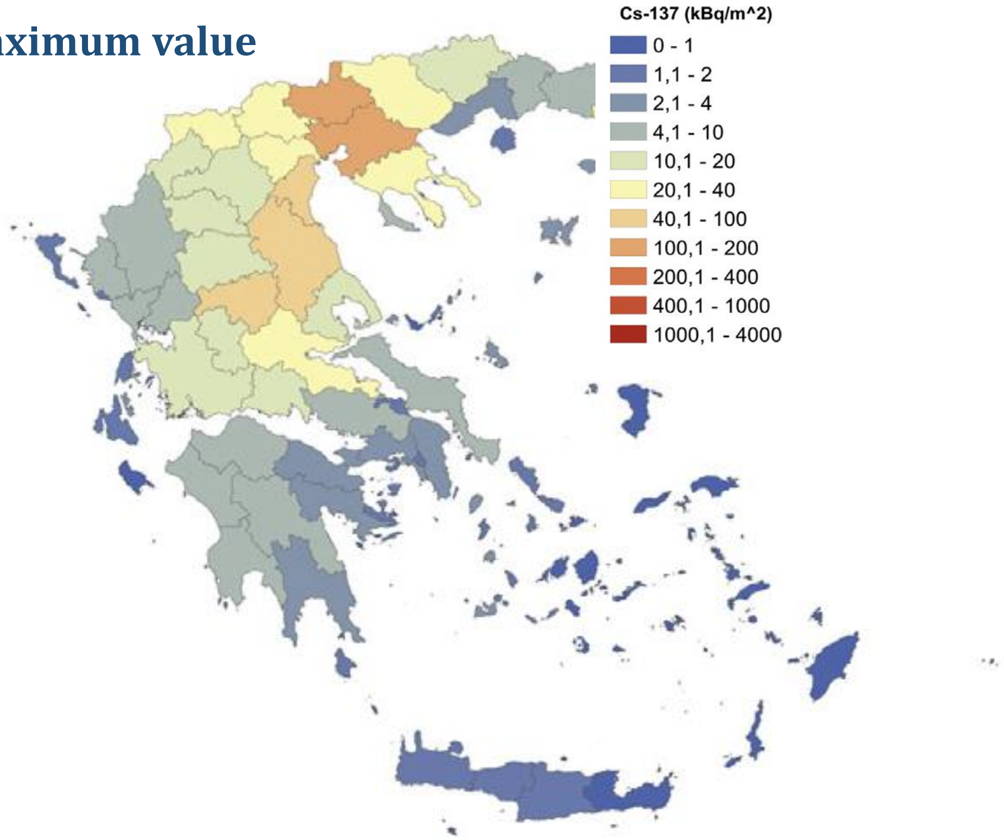


- Five departments with maximum Cs-137 deposition higher than 37kB/m2 (=1Ci/km2, the threshold value for "contaminated areas")
- 7% of the total released quantity of Cs-137 is calculated to be deposited onto country's land, from which one quarter is onto the two departments with the higher contamination
- In fact, however, it will be much more challenging to characterize radiologically the situation during the course of an emergency!

First assessment, 2015-2016: results (3/3)

Calculated Cs-137 deposition in each administrative department

Maximum value

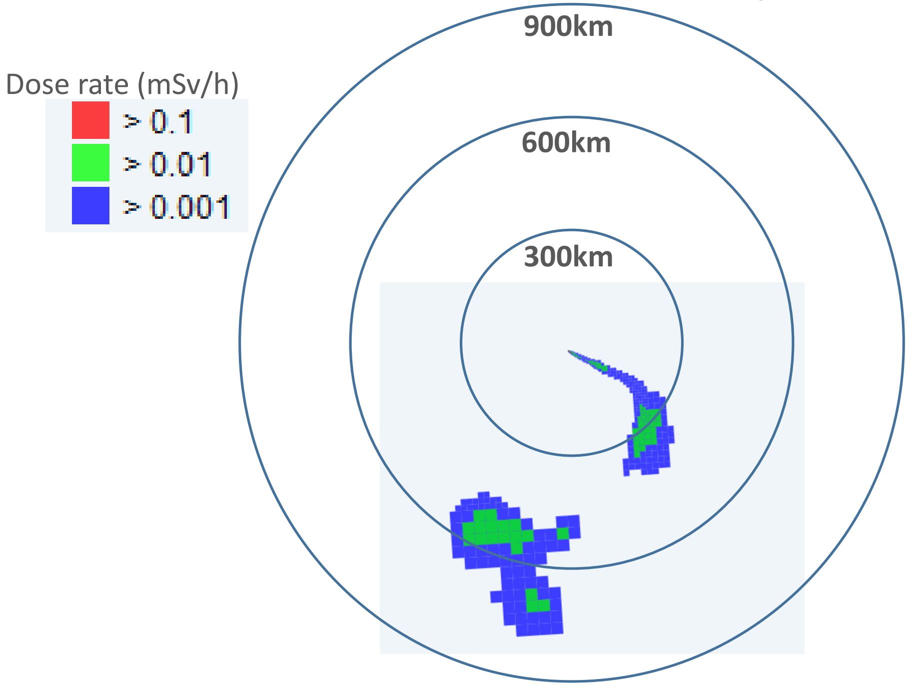


Hazy issues:

- *How feasible would be to spot the contaminated areas, if any, in a case of such an emergency?*
- *How long would it take?*
- *When would it be the optimal time to order food protection measures, taking into account, besides the radiological side, other factors such as:*
    - *the impact on and the effective protection of the image of the economic sectors (e.g. agricultural), and*
    - *sustain public trust?*

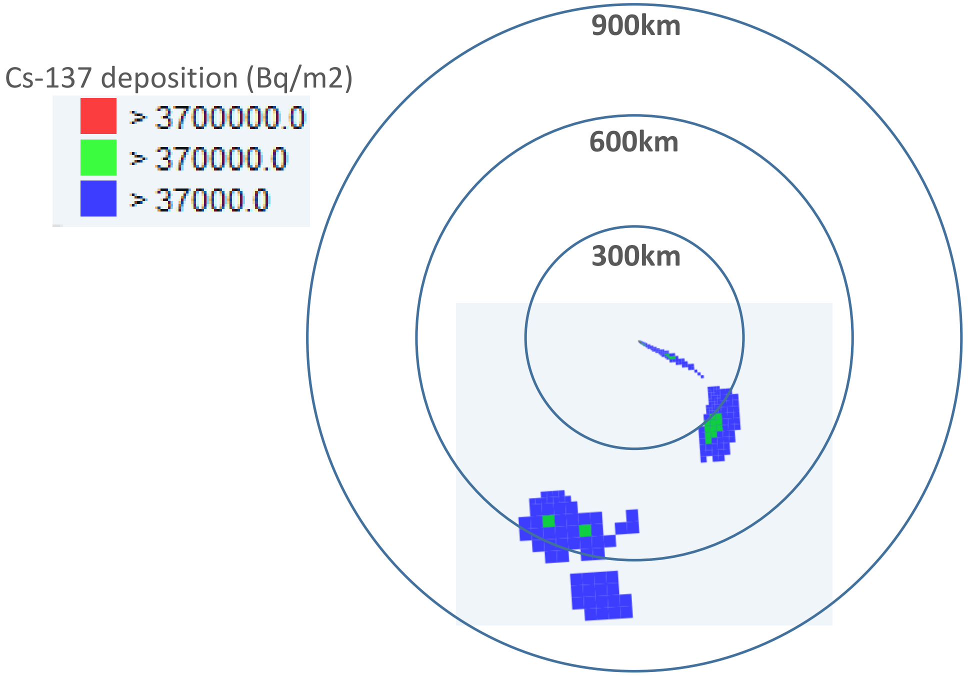
Later assessment, 2018: results

Calculated Dose Rate (1st week)



Colored areas: Dose Rate > IAEA OIL3 (=1μSv/h) for food protection measures

Calculated Cs-137 deposition



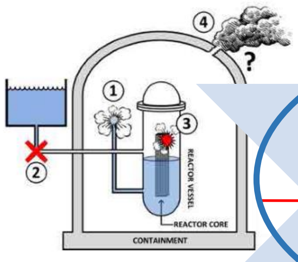
Colored areas: Cs-137 dep. > 37kBq/m2

- ✓ **Similar results**: significant deposition at distances and areas even larger than in the previous assessment (bear in mind that a more conservative source term is used now)

Overall assessment outcomes

- Similar results from the two assessment efforts
- Both show that depending on the prevailing weather a radiologically significant impact from a large release abroad cannot be totally precluded
- Soft measures (e.g. food restrictions, suggestions for limiting contact of children with the environment,…) may be needed
- Nevertheless, where and when such measures are to be taken is not clear.
- As it is not clear on which basis the decisions will be made (e.g. based on modelling or wait until enough measured data are available since no urgent radiological protection is required at such distances?)
- Assessment of the radiological impact in the course of the accident is expected to be much more challenging. Indicatively, an unknown actual source term would boost the uncertainties, especially in relation to distances of some hundreds kilometers

Emergency phases



Response

Days - Weeks

Transition

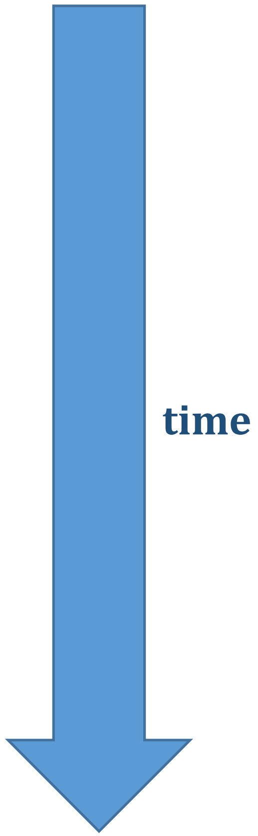
Months

Termination of the emergency, transition to an existing exposure situation

- Radiological impact assessment may be exceedingly uncertain in this phase.
- So, we are more oriented towards a robust, "precautionary approach", to sustain public trust along with a high level of radiation protection, that we presume will help to safeguard the image of agricultural and other economic activities (e.g. tourism).

Response approach

- First response (days)
  - **Precautionary** food restrictions and instruction to the public are decided even for a very large area of the country, based on the meteorology, as it reflected in dispersion **modelling**, and any available evaluation of the accident and potential release evolution.
- Initial refinement (weeks)
  - **Measures** and their spatial spread **are progressively refined**, based on **dose rate measurements** reflecting the actual contamination
- Further refinement of the measures (months)
  - **Further refinement and final adjustment** of the measures, if eventually needed, is made gradually based on the **sampling and radioactivity concentration measurements** in soil and products



Summary

- Elements of a nuclear emergency management were presented, from the perspective of a non-nuclear country, relatively distant from the accident location
- Issues we may face: Assessment of potential and actual contamination, avoiding loss of public trust, protection of economic activities and areas image
- At the moment we considering an (over-) conservative “precautionary response in the initial phase” as the predominating option, so as to retain public trust (virtually, we think responding as a large part of the country was within the emergency food planning zone of the plant).
- Radiological impact assessment and associated measures will be progressively refined from a first modelling-based approach to an actual contamination measurement-based assessment.

Thank you!