



Coping with uncertainty for improved modelling and decision making in nuclear emergencies



EUROPEAN JOINT PROGRAMME FOR THE INTEGRATION OF RADIATION PROTECTION RESEARCH

## Uncertainties related to radiological maps produced and used for nuclear emergencies

Authors: Ludger Benighaus<sup>1</sup>, Johan Camps<sup>2</sup>,  
Tanja Perko<sup>2, 3</sup>, Catrinel Turcanu<sup>2</sup>, Christina Benighaus<sup>1</sup>

---

<sup>1</sup> DIALOGIK; <sup>2</sup> SCK•CEN, <sup>3</sup> University Antwerp

Contact: [benighaus@dialogik-expert.de](mailto:benighaus@dialogik-expert.de)



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



Coping with uncertainty for improved modelling and decision making in nuclear emergencies



EUROPEAN JOINT PROGRAMME FOR THE INTEGRATION OF RADIATION PROTECTION RESEARCH

## Structure

- ✓ Introduction
- ✓ Characteristics of thematic maps in nuclear emergency
- ✓ What do maps provide in nuclear emergency?
- ✓ First findings for the use of maps in nuclear emergencies



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

18.06.2018 2




## Structure

- ✓ **Introduction**
- ✓ Characteristics of thematic maps in nuclear emergency
- ✓ What do maps provide in nuclear emergency?
- ✓ First findings for the use of maps in nuclear emergencies



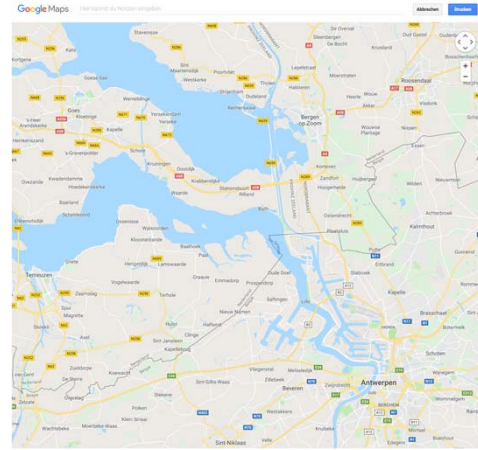
This project has received funding from the Euratom research and training programme 2014-2018 under grant agreement No 662287.

18.06.2018

3




## Topographic maps – general maps very popular and used every day





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

18.06.2018

4




# SOME MAPS FOR FOOD COUNTERMEASURES

Provided by SCK-CEN 2018.



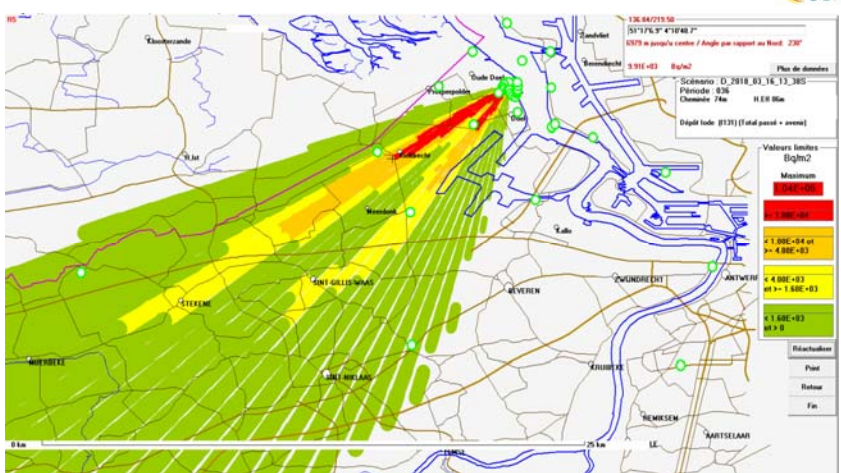
This project has received funding from the Euratom research and training programme 2014-2018 under grant agreement No 662287.

18.06.2018

5

## Thematic maps: Examples of radiation maps



Provided by SCK-CEN 2018.



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

18.06.2018

6


# SAME SCENARIO, SAME OUTPUT VARIABLE (OTHER REPRESENTATIONS)

Provided by SCK-CEN 2018,



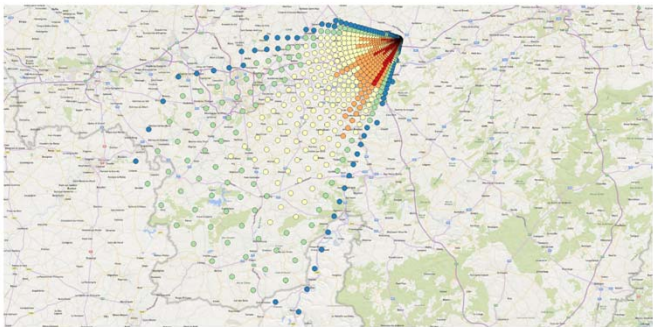
This project has received funding from the Euratom research and training programme 2014-2018 under grant agreement No 662287.

18.06.2018

7

## Thematic maps: Examples of radiation maps

10 0 10 20 30 40 km

**Legenda**  
 Tihange-T\_2018\_06\_07\_11\_115-Thyr\_child actual Sv-ki child dose thyroid OGRGeoJSON Point  
 • 0.000000 - 0.000016  
 • 0.000016 - 0.008324  
 • 0.008324 - 0.086379  
 • 0.086379 - 0.530037  
 • 0.530037 - 10.599586  
 Bing Road

Provided by SCK-CEN 2018,

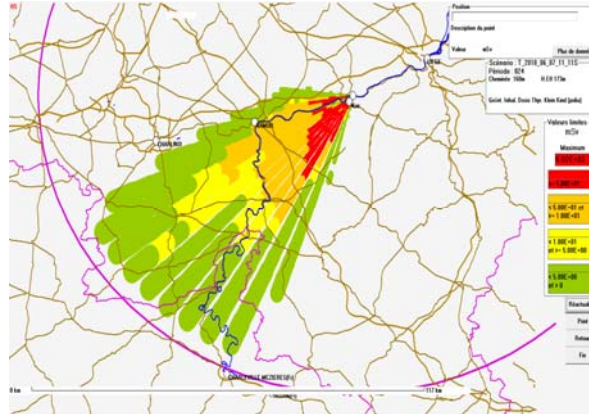


This project has received funding from the Euratom research and training programme 2014-2018 under grant agreement No 662287.

18.06.2018

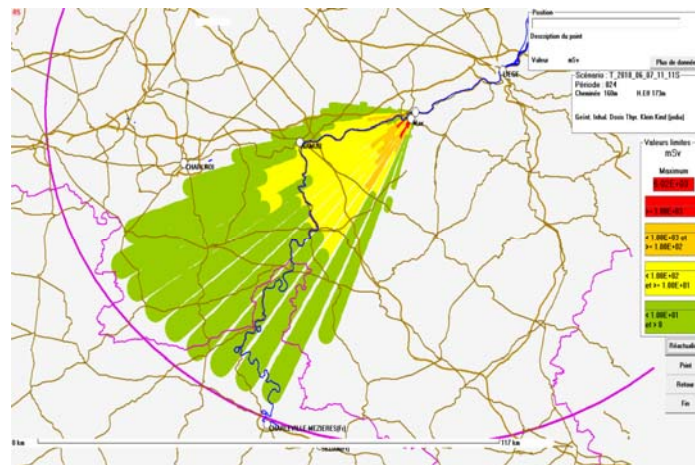
8

## Thematic maps: Examples of radiation maps



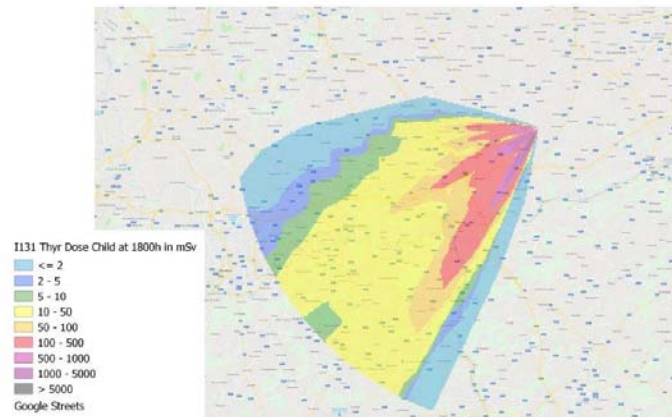
Provided by SCK•CEN 2018.

## Thematic maps: Examples of radiation maps



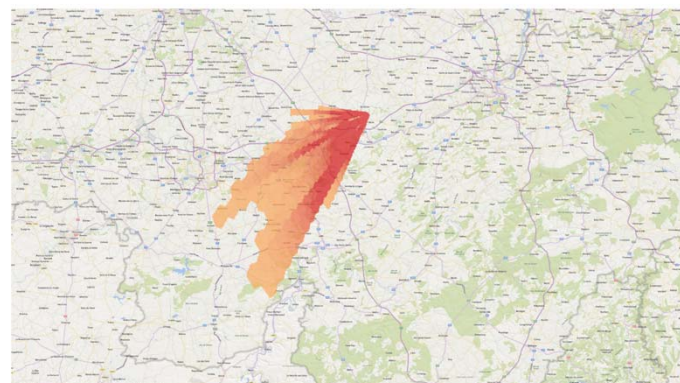
Provided by SCK•CEN 2018.

## Thematic maps: Examples of radiation maps



Provided by SCK-CEN 2018.

## Thematic maps: Examples of radiation maps



10 0 10 20 30 40 km

Legenda

10 mSv  
100 mSv

Provided by SCK-CEN 2018.



## Structure

- ✓ Introduction
- ✓ **Characteristics of thematic maps in nuclear emergency**
- ✓ What do maps provide in nuclear emergency?
- ✓ First findings for the use of maps in nuclear emergencies



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

18.06.2018

13



## Characteristics of thematic maps in nuclear emergency (1/2)

- Visualize information
- Developed for specific nuclear themes
  - to interpret spatial, qualitative and quantitative data: radiation contamination, releases and dose to population, radioactive contamination, affected areas, food contamination, planning of emergencies and evacuation zones, ...
- Designed for **specific audiences and different purposes**
  - interpret the map and advise the public for specific behaviour (emergency management, rescue workers)
  - understand the map and in order to know what and when to do (public)
  - publish the map in media, social media
  - use the maps to explain the situation (politics)



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

18.06.2018

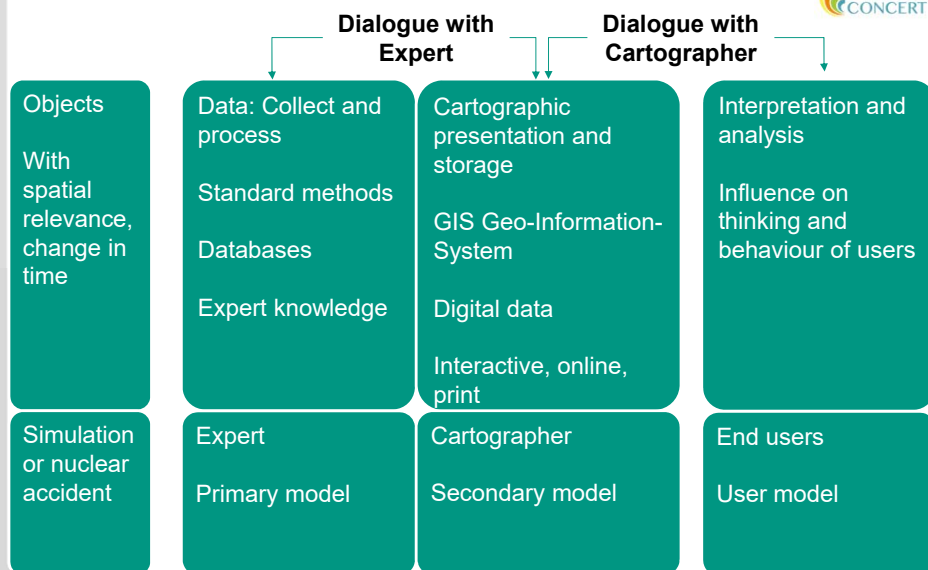
14

## Characteristics of thematic maps in nuclear emergency (2/2)



- Demonstration of the **purpose of the map** in a clear way (design), identify the message of maps easily
- Selected information is **encoded on the map** – symbols convert the message in a decoded form
- **Type of visualisation**
  - map colouring
  - standard feature: legend, title, compass rose, bar scale, map projection
  - quantitative symbols with patterns or symbols (measurement units)
  - Qualitative symbols (contours, shape, figures) in defined categories

## Cartographic communication model





## Structure

- ✓ Introduction: what are maps?
- ✓ Characteristics of thematic maps in nuclear emergency
- ✓ **What do maps provide in nuclear emergency?**
- ✓ First findings for the use of maps in nuclear emergencies



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

18.06.2018

17



## The situation in emergencies (nuclear and others)

- Situation in emergency
  - Lack of information, high uncertainty in the situation
  - Often unpredictable or unexpected
  - Everyone gives information and uses it, also non-scientific sources
  - Conflicting information creates fear, distrust & incredibility
- Needs in emergency and pressing issues
  - Quick decision making for emergency management
  - Trustful and clear information from one source
  - Effective communication by authorities, emergency management



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

18.06.2018

18

## What do maps provide in nuclear emergency?



- Clear visualisation of affected areas (and safe areas)
- Support the decision-making process for the emergency management
- Maps give multivariate information easily
- Good chance to be quickly understood and interpreted in one source
- Easy and quick production, online, offline, interactive, print
- Well known by many user groups, trusted source



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

18.06.2018

19

## Addressing uncertainties



- maps need contextual information (e.g. on-going release or predicted release; heading, legend);
- measurement units used ( $\mu\text{Sv/h}$ ,  $\text{mR/h}$ ) and explanation;
- Set of well-known colours, topic and main messages are linked to the meaning of the color (e.g. blue for the extremely low release, below legal norms);
- zones for protective actions clearly indicated, avoiding too much information;
- uncertainties presented (e. g. related to time of release, meteorological conditions, change of wind direction, probability of rain and a higher exposure);
- low doses presented in standard ways (e.g. white color, blue color, units);
- Public expects recommendation “to take action”: indication of health impact, sheltering, intake of iodine tablets, recommendation for evacuation and the direction of evacuation;



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

18.06.2018

20



## Structure

- ✓ Introduction
- ✓ Characteristics of thematic maps in nuclear emergency
- ✓ What do maps provide in nuclear emergency?
- ✓ **First findings for the use of maps in nuclear emergencies**

 This project has received funding from the Euratom research and training programme 2014-2018 under grant agreement No 662287. 18.06.2018 21



## First findings for the use of maps in nuclear emergencies

- Maps and all its elements have to be easily understood and interpreted by their users
- Design different maps for different user groups (public, emergency management)

 This project has received funding from the Euratom research and training programme 2014-2018 under grant agreement No 662287. 18.06.2018 22

## First findings for the use of maps in nuclear emergencies



- Maps assist first responders in rescue efforts
  - low ambiguity in a symbolic representation necessary
  - symbols used to describe action events (Fire Suppression Operation, Civil Displaced Population, Emergency Collection Evacuation Point, etc.) are too complex to be represented in a pictorial symbol
- Helps public as well, but testing of the understanding of symbols reasonable
  - Must be tested by rescue operation teams to achieve a high understanding of the symbols
  - Study for different user groups to examine how lay persons exactly understand maps and any kind of cartographic information, understand how they take action
- Implement the full potential of thematic maps in nuclear emergencies for managing a crisis



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

18.06.2018

23

Arthur H. Robinson (an American cartographer in thematic cartography, book “Early Thematic Mapping in the History of Cartography”(Robinson 1982)):

**“A map not properly designed, will be a cartographic failure.”**



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

18.06.2018

24



Coping with uncertainty for improved modelling  
and decision making in nuclear emergencies



EUROPEAN JOINT PROGRAMME  
FOR THE INTEGRATION OF  
RADIATION PROTECTION RESEARCH

---

Contact: Ludger Benighaus, Dialogik gGmbH Stuttgart Germany (presenter today)  
[benighaus@dialogik-expert.de](mailto:benighaus@dialogik-expert.de)



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