The role of atmospheric dispersion and impact modelling systems and expertise in crisis situation

A methodology to assess their support to crisis command centers

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Atmospheric Dispersion and Impact Assessment Modeling (ADIAM) systems are more and more developed as decision support tools for radiological and chemical emergency situations. However, Fukushima nuclear accident illustrated that their operational and effective application still raises many issues regarding constraints associated to crisis management such as uncertain conditions, time-pressure and high stakes. In addition, ADIAM use is mainly grounded in a social context at the boundary between scientific organizations which develop and operate them and emergency decision makers in charge of population protection countermeasures.

This research aims to contribute to assess the kind of support ADIAM systems and expertise can bring regarding crisis command centers and their decision making environment.

Cases study

Introduction

The collection of empirical data is performed through the observation of radiological and chemical crisis exercises designed and hosted by the French National Institute for Advanced Studies in Security and Justice (INHESJ). They gather actors from different core competencies (police forces, Defence forces, health services, communication, transport and decision makers).

Exercises' presentation

- Data were collected from 5 exercises performed between 2012 and 2014 of three hours long each.
- They consisted in tabletop exercises that reproduce a crisis command center (COD) (Figure 1).
- Scenario: a radiological terrorist attack in a metropolitan train station.
- INHESJ animation team plays the upper and lower levels of the French crisis organization surrounding the COD level, as well as the media pressure.
- A scientific advisor (an ADIAM expert) takes part to the exercises.

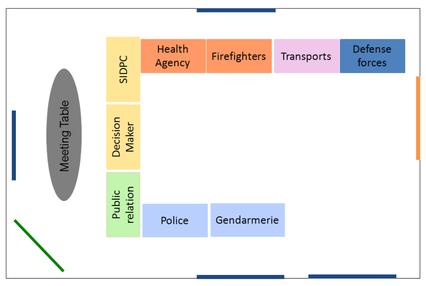


Figure 1: *Representation of the INHESJ crisis command center during the December 11th 2013 exercise.*

Each cell generally gather one to two actors. Each actor is equipped with a computer and a phone. A collective map and white boards are also available in COD.

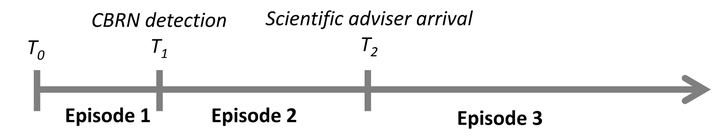
Data collection

"In situ" and non participative observation

- Aim: To assess coordination and communication processes between COD actors and scientific adviser in their context and the associated constraints (*Suchman, 1985)*:
  - Before scientific advisers' arrival: observation focuses on explicit oral communication between COD teams.
  - When scientific advisers arrive: the observation mainly focuses on their activities and interactions with COD participants.
- Data are collected by one observer through audio recording (when allowed) and handwriting notes. The verbatim of each exercise is transcribed in order to be analysed qualitatively and quantitatively.

Data analysis

- Each exercise is analyzed in 3 episodes.



- Content analysis *(Grawitz, 2001)*: development of 4 categories analysis grid *(Boos et al., 2011)*.

Study of how information is propagated through the crisis center.

Study of communication supports use to ease the crisis center situation assessment.

Information percolation (4 categories)	Communication styles (34 categories)
Coding categories	
Communication artifacts (3 categories)	Communication content (8 categories)

Study of phases dedicated to:
(1) situation assessment;
(2) its management.

Study of situation stakes and their management.

Results

Results are illustrated through the comparison of two exercises

Study of actors interactions inside the COD

- Figure 2 and 3 illustrate similar interaction patterns.
- It seems that the decision maker mainly relies on firefighters :
  - To assess the situation and actions proceedings on the field.
  - They are also the first expert advisors on chemical and radiological risks before the arrival of scientific advisers.
- Once the scientific adviser arrives at the COD, the Decision maker's CBRN situation assessment is mainly based on a tight collaboration between firefighters and the scientific adviser.

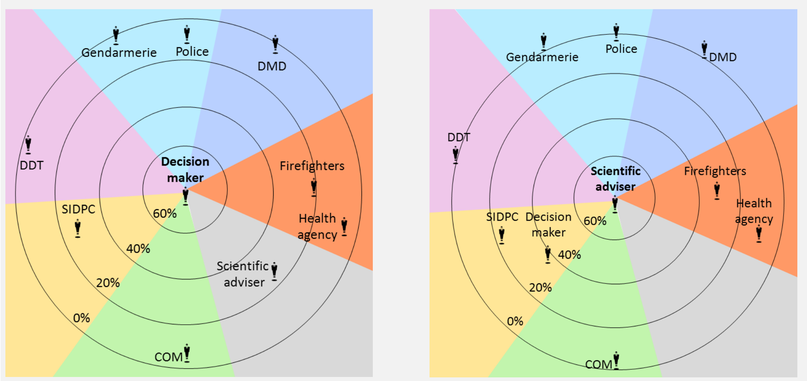


Figure 2. *Assessment of the COD teams interaction with the Decision Maker (left) and the scientific adviser (right). Radial scale: exchanges frequency.*

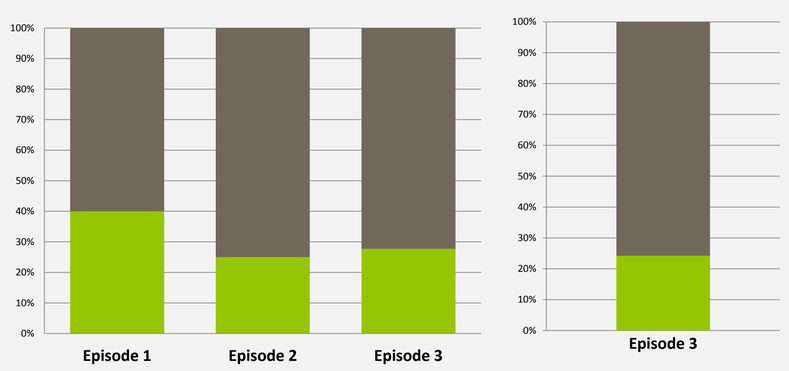


Figure 4. *Quantitative distribution of interactions regarding situation assessment (grey) and situation management (green) in the COD (left) and with the scientific adviser (right)*

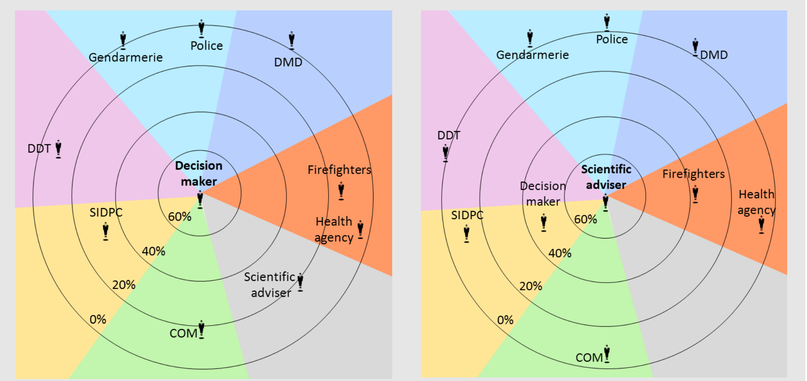


Figure 3. *Assessment of the COD teams interaction with the Decision Maker (left) and the scientific adviser (right). Radial scale: exchanges frequency.*

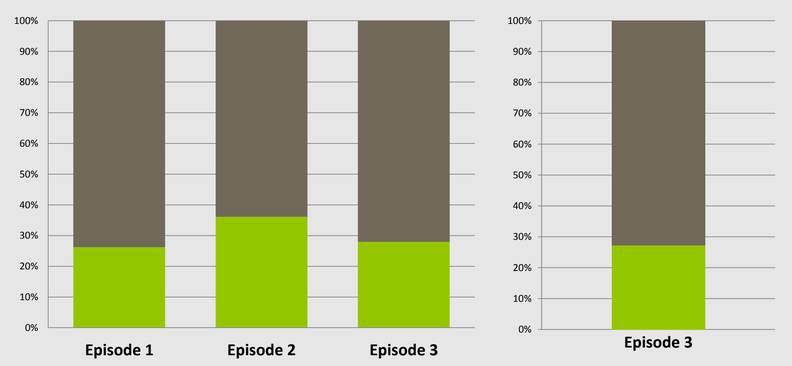


Figure 5. *Quantitative distribution of interactions regarding situation assessment (grey) and situation management (green) in the COD (left) and with the scientific adviser (right)*

Communication distribution between situation assessment and management

- Codification sub-categories regarding communication styles allow to assess the contribution of exchanges relating to situation assessment (grey) and management (green) illustrated in Figure 4 & 5.
- Results underline that communication exchanges in the COD regard mainly field situation assessment.
- In the same trend, Scientific adviser interactions mainly support the understanding of the release phenomenology and its potential consequences rather than the formulation of response strategies.

Qualitative analysis of the contribution of ADIAM results and expertise to the crisis command center.

Episode 1

- The COD teams work mainly to find and share information of the situation that come from emergency services on the field.
- The main uncertainty regards the accidental or malevolent nature of the event.
- First decisions are taken regarding emergency means, plans activation, and the alert of the emergency organization.
- First evacuation decision are also implemented. They mainly aimed to make the event perimeter available for emergency services and protect people against toxic plume.

Episode 2

- The main uncertainty regards the breadth and the level of the contamination.
- The CBRN specific plans are activated and a radiological expertise is required in the COD.
- A first reflex zoning is proposed and implemented by fire-fighters (exclusion area, supported area and controlled area). In addition, sheltering area is also decided but with much difficulties as the COD doesn't have specific guideline in this situation.
- By consequence, even in great uncertainty, it seems that the decision process regarding population protection is not delayed.

Episode 3

- ADIAM advisor contributes to give factual elements regarding atmospheric dispersion dynamic and to express the kind of information he can provides regarding the COD situation assessment.
- He also helps in the assessment of the first measurements that come from the field.
- ADIAM cartographic results presentation supports:
  - The 4D reconstruction of the contamination distribution regarding the one-time measurements coming from the field at the beginning of the event.
  - The dose assessment after the radionuclide identification is done and arrives to the COD allowing preliminary feedback regarding population protection first decisions and the adaptation of these decisions.

- On-going and future work will more specifically analyse the use of ADIAM cartographic results as a support to build common situation awareness and a better collaboration between crisis teams.
- The research needs also to integrate data from different experimental fields. INHESJ crisis training events have three main biases regarding national crisis exercises: (i) participants don't know each other before the exercise; (ii) they don't know necessarily the area in which the scenario takes place; (iii) they are not familiar with the tools used during the exercises. In order to address these biases, this methodology will be applied on two national-level exercises simulating a chemical terrorist attack and a nuclear power plant accident.

References

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