sciendo International Conference KNOWLEDGE-BASED ORGANIZATION
Vol. XXXI No 3 2025

THE ROLE OF CBRN WARNING AND REPORTING STRUCTURES – THE FUNCTIONAL DOMAIN OF CBRN INFORMATION MANAGEMENT IN OPERATIONS

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Abstract: *Some of the major crises have been shaped by the use or the threat of use of CBRN weapons of mass destruction (CBRN WMD), weapons that have posed serious problems both for the safety of the population, territories and forces of NATO member countries and for international security.*
The threat of using CBRN WMD can have a negative psychological effect, and if we add to this the possible accidents at nuclear and chemical risk targets, terrorism, ecological catastrophes, the result is a terrifying specter, which forces us to be circumspect and realistic, but also to plan and organize adequate measures to maintain troops at a high level of training and equipment for the purpose of defending against these threats in conflict or crisis conditions.
The ability of commanders to react to CBRN incidents in an efficient and safe manner depends on their ability to obtain clear CBRN information. This information is collected, evaluated, analysed and disseminated within the CBRN Surveillance, Warning and Reporting System (CBRN SWRS).

Keywords*:* **proliferation, CBRN threat, CBRN incident, CBRN warning and reporting, CBRN contamination forecasting**

1. Introduction

The complexity of the risks, threats and challenges existing worldwide, characterized by the proliferation of weapons of mass destruction and the increase in the intensity of the terrorist threat, determine the adoption of firm measures to face these challenges.

The proliferation of CBRN WMD, the expansion of the application of civilian technologies for military purposes, the intensification of illegal trade in radioactive and biological materials, as well as the lack of firmness manifested by some countries in taking appropriate preventive measures, highlights the existence and diversification of CBRN sources that can harm the security of states, can seriously affect the environment and the health of the population and can negatively influence the preparation and conduct of military actions [1].

The threat comes from states that possess weapons of mass destruction that proliferate technologies or development programs, but also from non-state actors (criminal networks, terrorists) that try to acquire such CBRN weapons or materials in order to use them. In this regard, national efforts aim to continuously update the doctrine specific to CBRN defence. This has as its starting point the Alliance's political guidelines specific to the pillars of CBRN defence: prevention, protection and recovery ("*to prevent, to protect, to recover*") [2].

DOI: 10.2478/kbo-2025-0086

CBRN incidents and contamination resulting from deliberate attacks or from accidental releases can have significant effects on military operations and they can also decisively influence the commander's estimates and decisions. Thus, the collection, assessment and dissemination of CBRN information through CBRN analysis and forecasting structures is an important component of CBRN defence.

2. CBRN Risks and Threats

The terrorist attacks of September 11, 2001, which killed, almost instantly, several thousand innocent civilians, followed by other similar criminal actions, carried out in various areas of the world, led to profound changes in the security environment, with significant consequences for the international community. In international law, the concept of proliferation was introduced during the negotiation of the Treaty on the Non-Proliferation of Nuclear Weapons of 1968, which defines proliferation as a transfer of nuclear weapons from states possessing such weapons to states without such weapons.

Assessing the risks and threats that may endanger national security and public security and citizen safety implicitly, we can talk about international terrorism, namely the proliferation of CBRN WMD.

The contemporary world is facing various CBRN-related risks and threats, among which we mention:

– the uncontrolled proliferation and dissemination of CBRN technologies and materials, weapons, and other unconventional lethal means;

– the expansion of terrorist networks and activities, as well as of transnational organized crime;

– environment degradation due to non-compliance with ecological standards, as well as the presence of high-risk facilities near national borders;

– the danger of breaking out of local military conflicts (as an extreme punitive measure against dictatorial regimes in states that violate international conventions and treaties on CBRN weapons of mass destruction).

The uncontrolled proliferation of CBRN weapons of mass destruction, with their enormous destructive capacity, constitutes the greatest risk humankind has ever faced and a severe threat to civilization and life itself. Following the 1995 use of sarin by the Japanese sect AUM Shinrikyo (in a surprise attack in the Tokyo subway aimed at causing numerous civilian casualties), the threat posed by chemical and biological weapons in the arsenal of terrorist groups and organizations became clear. Osama bin Laden declared that acquiring weapons, including CBRN weapons, is a "***religious duty***" for a Muslim [1].

CBRN threats to Romania can be classified as follows:

- ***external factors***, such as the proliferation of CBRN WMDs, terrorist networks, transborder organized crime, and the trafficking of radioactive and strategic weapons and materials;
- ***internal vulnerabilities***, such as the risk of nuclear, chemical, or radiological emergencies, the possibility of biological accidents, epidemics, and epizootics;
- ***asymmetric risks*** materialized in the form of terrorism in all its forms, including nuclear, chemical, biological, radiological, and informational threats.

All these threats, analysed as future military operation scenarios, have led NATO military structures coordinators and leaders to pay increasing attention to the CBRN component of the force.

3. Use of CBRN Weapons and Devices

CBRN weapons are defined as a technical assembly intended for use by the armed forces of a state for the purpose of releasing chemical, biological, radioactive agents or radiological materials in a chosen/selected area, or to generate a nuclear explosion. A CBRN device is defined as an improvised explosive assembly or mechanism intended to release biological, chemical substances/agents

or radiological materials into the environment or to generate a nuclear explosion.
The use of CBRN WMD by states can have particularly serious political implications, and authorizing their use must be a responsibility of the highest levels of state leadership.

An uncertain political and military response to a CBRN threat allows a potential aggressor to achieve maximum psychological and physical impact upon the first use of CBRN WMD or of a CBRN improvised explosive device (CBRN IED) by states.

Table 1: Ranking of CBRN WMD according to their effectiveness

No.	*Type of CBRN weapon/device*	**Level of use and hierarchy**		
		Tactical level	***Operative level***	***Strategic level***
1.	Chemical weapon	**1**	Prioritization is established based on the duration of the operation.	**2**
2.	Biological weapon	**2**		**3**
3.	Radiological device	**3**		**4**
4.	Nuclear weapon	**4**		**1**

The characteristics of CBRN weapons and devices are classified according to the associated hazards. Nuclear weapons are unlikely to be used at the tactical level due to their effects over large areas and over long periods of time. Most devices with radiological charge and most biological weapons and IEDs with biological charge have low immediate effects at tactical level. Chemical agents have rapid and visible effects at tactical level.
At strategic level, nuclear weapons generate rapid and immediate effects against strategic targets, including effects against the population. Biological weapons / IEDs have a similar effect but their persistence is greater. Chemical weapons / IEDs have limited effects, over small areas, depending on the characteristics of the agent that is used.

4. CBRN Warning and Reporting

Among the core principles of CBRN defence is the ***assessment of CBRN threats***, which represents the identification of the source, scale, and the nature of possible attacks, including an evaluation of the likelihood of such an attack. Equally important is the ***CBRN risk management***, referring to the process of identifying, assessing, and controlling the risks of a CBRN nature. CBRN defence comprises five ***essential components*** that act in an interdisciplinary manner:

- detection, identification, and monitoring of CBRN agents;
- CBRN information management;
- physical protection;
- hazard management;
- medical support and countermeasures [5].

CBRN warning and reporting is a functional domain of CBRN information management and ensures the rapid collection, evaluation, and dissemination of information specific to a CBRN incident, as well as the estimation of contamination hazard areas according to current regulations.
The assessment of the impact of CBRN incidents on operational plans and decisions is based on the evaluated CBRN information. When a CBRN incident is detected or anticipated, immediate measures for warning and alerting the forces must be implemented at all levels — both operational and tactical — through the use of the integrated CBRN communications and information system, in order to implement the necessary protective measures [4]. The timely provision of the most accurate information regarding CBRN attacks and the resulting hazardous zones and sectors is ensured through the **CBRN Surveillance, Warning, and Reporting System (CBRN SWRS).** The purpose of the CBRN SWRS is

to provide military commanders with prompt and relevant information about a CBRN incident or potential hazard.

The CBRN SWRS includes the following **functional components**:

- ***CBRN information sources***, which comprise:
  - mobile CBRN intervention teams;
  - CBRN reconnaissance groups or teams;
  - fixed radiological, biological, and chemical monitoring points;
- ***CBRN regional control centres,*** consisting of the following types of structures:
  - *CBRN operative control centre* – an operational level organizational structure;
  - *CBRN analysis and forecasting centres* – tactical level organizational structures, established at operational component/service branch, division, and multinational headquarters levels;
  - *CBRN analysis and forecast sub-centres, platoons, groups and* teams – organizational structures established at CBRN brigade/similar and defence battalion level;
- ***CBRN coordination centre*** – a strategic-level organizational structure established at the level of the General Staff of Defence [6].

The purpose of these warning and reporting structures is to provide commanders with relevant information both before and after the onset of a CBRN incident.

5. CBRN Incident Forecast and Reporting Procedures within the CBRN SWS

CBRN warning and reporting represents the capability to give a rapid and accurate forecast of the danger that enables the CBRN defence personnel to transmit warnings and reports to subordinates and neighbours, as well as CBRN reports to command posts.

Warnings of a CBRN event as well as the identified potential risk areas must be transmitted as quickly as possible to all the forces and units exposed to the risk. The information is essential for the timely use of protective measures and, at the same time, to reduce the negative impact on operations during the adoption of the CBRN personal protective equipment or of the use of CBRN collective protection.

When a CBRN incident is forecasted or detected, it is necessary to apply all the measures to warn and alert the forces, at all levels, as soon as possible, in order to adopt the appropriate protective measures.

Commanders and staffs at all levels must understand the impact of CBRN incidents on their plans and decisions based on timely, clear, and verified CBRN information. The collection, assessment, and exchange of information related to CBRN incidents ensures the accomplishment of CBRN defence missions.

5.1. Manual and Automated CBRN Warning and Reporting Procedures

In order to forecast CBRN attacks, CBRN defense structures with responsibilities in the field use standard CBRN warning and reporting procedures that provide a set of rules, constructions and standardized language.

Manual CBRN hazard forecasting procedures are defined as warning and reporting procedures used only manually, comprising common standards specific to most CBRN agents.

Automated CBRN hazard forecasting procedures are defined as warning and reporting procedures adopted by using the automated mode and include standards of automatic processing of data, models and databases with all the CBRN agents and substances.

The hazard forecasting procedures are divided into 3 forecasting methods:

- ***the simplified method,*** which is a forecasting method that is carried out manually upon receiving a message regarding a CBRN incident. This method is applied only for the first message that is received without taking into account the subsequent receiving of additional meteorological data;

- ***the detailed method*** is a forecasting procedure that can be carried out manually or automatically by using multiple messages. This method is used to fulfill the essential warning and reporting capabilities. The results can be updated based on the new information that is received;
- ***the enhanced method*** is performed using automated forecasting systems due to complexity and short time limits for reporting. The result is immediately updated upon receiving new data and information [6].

CBRN warning and reporting structures must be capable of executing CBRN warning and reporting procedures through both procedures, using any of the methods presented above.

Standardization of CBRN messages at national and NATO level is necessary to ensure the speed of transmission and the correct understanding of the content during operations, thus promoting cooperation between the different elements of the force. All these messages comply with the requirements for the protection of classified information, depending on the content [4].

5.2. The Use of Software in the CBRN Warning and Reporting Process

The automatic procedures for warning and reporting CBRN incidents by the CBRN warning and reporting structures within the Ministry of National Defense are executed by means of the CBRN Analysis application, both by the Permanent CBRN Surveillance Combat Service and for the training of military personnel with responsibilities in the field of CBRN warning and reporting for the forming and developing of the skills necessary for efficient and timely action within the CBRN SWS.

This is an official NATO software intended for the interconnection of CBRN analysis and forecasting structures and can operate in two working modes:

The application has a module intended for the representation of conventional signs on the map, thus being able to create tactical scenarios. On the same system of the application, multiple independent scenarios can operate simultaneously, or they can work together on a scenario that simulates different levels within the CBRN SWS.

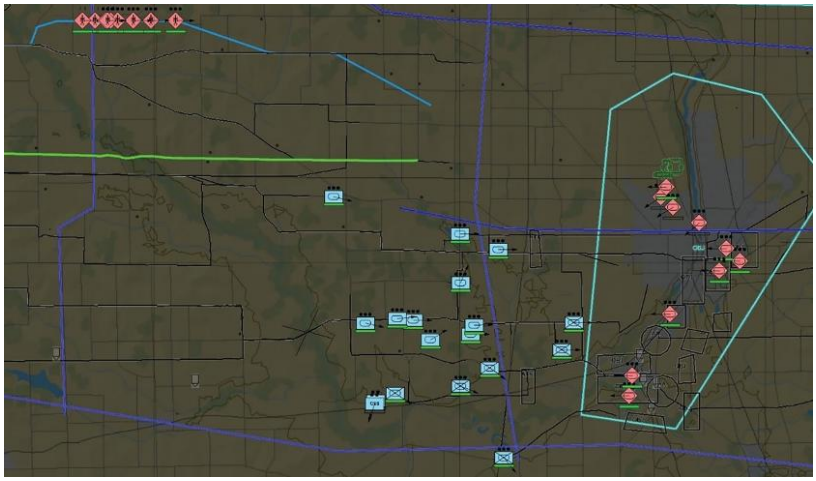

Figure 1: Creating tactical scenarios by using conventional signs
Source: https://campus.bruhn-newtech.com/tutorials/cbrn-analysis-basic-function/, accessed: 06.05.2025

With regard to the specific side of CBRN warning and reporting, the application has the ability to:

– execute the automatic forecasting of RBC contaminated areas, based on reports received from intelligence sources and the automatic transmission to CBRN risk units;

– automatically determine the actual contaminated areas following the research

carried out after the occurrence of a CBRN incident;

– calculate the doses absorbed by personnel depending on the time of exposure to radioactive substances.

The application allows for the automatic analysis, forecast and reporting of CBRN attacks, as well as accidents/incidents at facilities containing toxic industrial materials. The application also allows for the warning of units located in risk areas and for the introduction of tactical situations on the map.

At the same time, the application allows for the automatic transmission of CBRN reports and for the import of scenarios from previous exercises.

By using CBRN ANALYSIS one can generate scenarios for the training of personnel with responsibilities in the field who are employed at institutions within the national system of defence in order to:

– form and develop practical skills regarding the warning and reporting of CBRN incidents;

– form and develop skills regarding the monitoring of CBRN incidents;

– master specific procedures for exchanging information between institutions with responsibilities in the field in the event of CBRN incidents.

6. Chemical Forecast

6.1. Research Methodology

A chemical incident was simulated involving a substance characterized by medium volatility, high vapor pressure, and toxicity.

The contamination area is depicted on the chemical situation map, which was compiled by the CBRN Analysis and Forecasting Center based on pre-established reports. This information must also be transmitted to the responsible structures within the Inspectorate for Emergency Situations (ISU). The fastest method for transmitting CBRN-related information is by conveying data regarding the chemically contaminated area. However, wired or radio communication channels are not always available, in which case the contaminated chemical area must be transmitted in a timely manner. CBRN CHEM reports, generated by the CBRN Analysis software, identified the contaminated zone on the map, cumulatively including personnel within the affected area. On the map, the CBRN CHEM report provides essential information for decision-makers: specifically, the chemical substance used in the attack, the incident location, the actual contaminated area, and adjacent chemically contaminated zones.

After the CBRN Analysis software compiles all CBRN CHEM reports, it facilitates situation analysis on the map by providing an overall overview of the entire event and the chemical contamination. This encompasses all preceding steps necessary for generating the chemical forecast. The CBRN Analysis software is capable of automatically executing both the forecast and report generation. This capability is highly beneficial for commanders, as it provides them with essential information within a short timeframe, enabling them to manage the situation and implement the most appropriate and optimal measures for safety and to prevent contamination following a chemical attack.

Manually performing a chemical incident or accident forecast would necessitate a significant volume of time, substantially greater material and human resources, which would impede the warning and response process against a chemical attack. Replacing manual forecasting with automated computer-generated forecasts offers advantages in terms of both time, which is critical, and resource allocation and effort.

Chemical forecasting implemented using the CBRN Analysis program establishes a more efficient modus operandi, ensuring timely warning capabilities for military forces and the population in the event of a chemical incident or accident. The rapid transmission of information and early

warning are paramount for preventing uncontrolled contamination.

The scenario implemented in this case study illustrates the establishment and implementation of risk management pertaining to CBRN warning and reporting. It represents the capabilities of specialized forces within their own ranks to analyze and forecast a CBRN chemical event. In recent years, the capacity of CBRN Analysis and Forecasting structures has led to the equipage of forces with similar programs for event warning and reporting, an action that has enhanced the efficiency of CBRN Defense activities. These programs are capable of automatically generating forecasts, producing specific reports, and instantly transmitting these reports, gradually leading to the replacement of manual procedures that require a longer period of time and a greater quantity of resources to execute. Furthermore, areas of interest can be directly visualized on the forecast map, Figure 2.

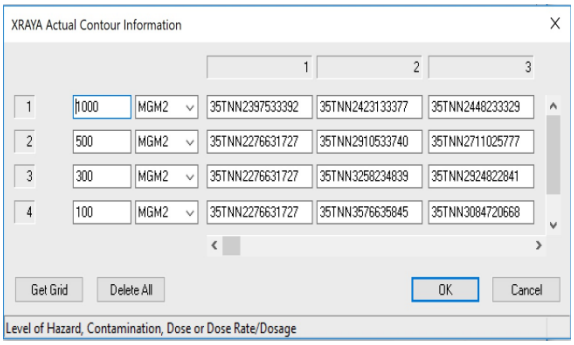

Figure 2: XRAYA Line from the CBRN CHEM Report

The CBRN Analysis software also provides the capability to generate contours of the actual contaminated areas. Consequently, within the CBRN CHEM report, the XRAYA line enables automatic determination of genuinely contaminated zones, the dispersion of the chemical agent, and the quantity of chemical substance deposited per square meter in the contaminated areas. These indicators denote the level of contamination hazard and delineate the boundaries of the truly contaminated zones, Figure 3.

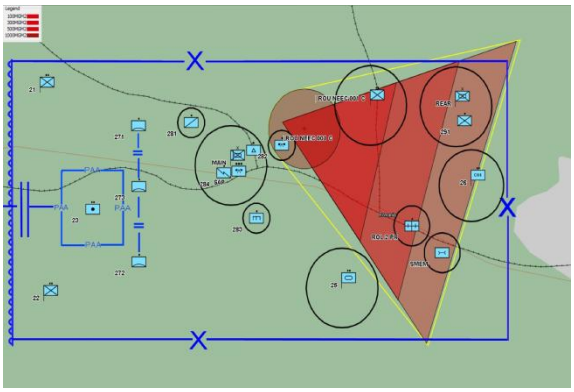

Figure 3: Chemical substance deposited per square meter

7. Conclusions

The content of the presentation illustrates the manner of concretization of the risk management in the field of CBRN warning and reporting, demonstrating the CBRN analysis and forecasting capabilities of the specialized forces of the Romanian Army. The efficiency of the analysis and forecasting structures has increased due to the possibility of using software that performs forecast-specific calculations automatically, with the possibility of visualizing the forecasted areas on a map.

The manual procedures, which require a large amount of time and significant material and human resources, are replaced by automatic calculations done in a much shorter time. In this way, the possibility of timely warning of the population in the event of an attack with CBRN weapons or incidents/accidents involving industrial toxic materials is offered.

The CBRN reports are generated much faster by the IT applications that are utilised. The CBRN forecasting and warning actions converge towards ensuring a high level of protection of the forces in the areas to be affected, towards the continuation of operations in CBRN environments and towards the successful accomplishment of missions.

The CBRN analysis and forecasting structures within the Ministry of National

Defence have their well-defined place and role. The response actions of the CBRN analysis and forecasting structures to the occurrence of CBRN situations are all the more effective as they are based on their own capabilities as well as on the external factors with which they interact for the good conduct of the specialized missions incumbent upon them.

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