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Hypothetical consequences of chemical contamination in the territory of the Municipality of the City of Szczecin during transport of hazardous materials

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Abstract

The modern security environment is marked with significant changes and unpredictability. This is true both for natural threats caused most often by forces of nature and for threats to civilization such as technical disasters or failures. The fact that these threats may be synergistic not only complicates efforts that are mainly intended to mitigate them but also makes it difficult to determine their direct cause. The article presents a hypothetical model of the spread of dangerous substances released during a disaster involving a tanker carrying 20,000 kg of anhydrous ammonia by road, by rail, and by water in the territory of the Municipality of the City of Szczecin. A 2016 rail disaster involving two derailed tankers carrying ammonia is proof of the likelihood of such an event. Great amounts of dangerous substances are transported through Szczecin's densely populated areas, most often to and from Zakłady Chemiczne Police S.A. (Police Chemical Plant), which causes a risk to the life and health of persons on the premises. The method of situation assessment in chemical, biological, and radiological contaminations (ATP 45 (Delta)) and the Promień IT system were used to forecast the hypothetical development of contamination. The results were compared with those of the ALOHA program. The author assumes that the conclusions from this paper will be used in the assessment of the likelihood of threat categories (KZ-3) and in the crisis response procedure (PRK-15), both included in the Municipal Crisis Management Plan.

Introduction. Normative and functional aspects

The changeability of today's environment of security, resulting mostly from civilizational changes, means that existing functional and operational solutions must be realized on an ongoing basis. The emerging threats are increasingly synergistic, which is an additional complication, especially at the stage of their neutralization.

Ensuring the efficiency of the national security system (security of the state) should be a key task for all levels of public administration (central and local). The civic plan has been given a key role in this system. This plan is an integral component of crisis management (hereinafter CM), implemented at each level of the country's administrative division and by local and central authorities alike. In particular, it should result in the drafting of response procedures and in the determination of forces and measures adequate for removing threats that occur within the administrative boundaries of a given local government unit (LGU). The provisions of the Crisis Management Law (hereinafter CML) regulate the subject matter of civic planning relatively precisely in the institutional, formal, and substantive spheres, and their ultimate goal is to prepare public administration for CM (Journal of Laws, 2020b). However, these provisions expressly emphasize that taking control over crisis situations, removing their consequences, and rebuilding of resources must be well thought-through and achieve purposeful moves forward. Therefore, there is no doubt that a thorough CM preparation should result from multidimensional actions, including the preparation of reliable planning documentation. CM plans (municipal, county, provincial, and national plans) are focused according to a uniform cycle specified in the statute (Article 3(7) CML).

This cycle provides for the following stages: analysis, programming, drafting of the plan or program, implementation, testing, and launching. The actions stipulated in these stages are conceptual, organizational, and executional and place special emphasis on the programming of relevant steps and their coordination and supervision during their implementation. At the same time, the planning process guarantees respect for the territorial or operational competence of the entities involved and the normative relations between them.

In preparation for a discussion of the said planning, the author used the findings included in the Municipal Crisis Management Plan (hereinafter MCMP) of the Municipality of the City of Szczecin (hereinafter Szczecin Municipality), the drafting of which is the responsibility of the Crisis Management and Civil Protection Department (BIP, 2021). The plan respects CM's essence and chronology: prevention, preparation, responding, removing consequences, and restoring resources and critical infrastructure (hereinafter CI). Apart from the planning, it also stipulates the improvement of existing solutions and the improvement of collaboration between the entities involved and the use of their resources, including warning, informing, monitoring, and alarming residents, rescue operations, medical and social assistance for their evacuation, training, and education. An in-depth analysis of likely threats and the real capacity to combat or prevent them is an integral part of the planning itself and updating it. The plan is periodically updated to take into account changes in baseline parameters and the experience from crisis incidents that have taken place in the territory of the Szczecin Municipality.

Due to the MCMP's volume, the author characterizes only its most important elements:

1. The master plan.
2. The set of actions to be taken in the event of a crisis situation.
3. Functional annexes.

The details of the plan are preceded by an introduction to the CM subject matter and a list of normative acts, internal management laws, and recommendations that provide the interpretation for the structure of its individual elements. The principal content of the master plan takes into account CM organization and general rules, characterization of threats with an assessment of their likelihood, identification of tasks and responsibilities of stakeholders involved, their relations and competences (security network), specific characteristics of forces and measures necessary to counteract threats and incidents, and the possible removal of their consequences. The characteristic features of the Szczecin Municipality and of the threats identified include an evaluation of their likelihood (risk and threat maps). Under a general typology, threats were systematized into two basic categories: the complex threats category (principal and related threats) and the cause-and-effect category (primary and secondary threats). The principal threats include those that require the concentration of the greatest number of response forces and measures, that decide whether the entity competent for their removal is the head executive officer of emergency response actions, and that may cause the greatest losses and damage. In turn, related threats accommodate those that run parallel to the major event, require the concentration of additional numbers of (usually a specialist) response forces and measures, that decide whether the entity competent for their removal supports the head executive officer of emergency response actions, and that may cause additional losses and damage. It is also assumed that primary threats are those that cause a dangerous situation, whereas secondary threats are dangers that emerge as a result of the activity of primary threats. When assessing the likelihood of threats, five categories are formulated: very rare (once every 500 or more years), rare (once every 100 years), possible (once every 20 years), likely (once every 5 years), and very likely (that happen once a year or more frequently). The five-level scale of threats (A to E) identifies potential consequences for life, health, and property and includes adverse effects (from negligent to disastrous). The plan also includes a list of abbreviations of parts of the world, meteorological data, risk level matrices, detailed descriptions of the 23 threat categories, and a register of potential causes of failures associated with the release of a dangerous chemical substance, which is crucial in verifying the hypothesis of this paper. This part of the plan is presented as tables, which undoubtedly boosts its functionality. These tables include category name and code, threat type and description (general and detailed), classification of likelihood, consequences and risk, description of consequences of the threat, and of the capacity to respond.

Part two of the MCMP includes operational measures, that is 23 crisis response procedures (CRP). Here too, a table arrangement was used to present the catalog of threats. It is preceded by a specification of the type, place, scale, and consequences of events, the marking of dangerous zones, and a forecast of threat development as well as a description of responsibilities relating to monitoring and alarming residents. Moreover, the document describes the procedure for launching necessary forces and measures engaged in the implementation of planned actions at the moment a crisis situation occurs and names entities authorized to make decisions on the engagement of forces and measures.

Functional annexes are part three of the MCMP. They refer to an array of actions, the organization of which was included in the previously drafted CRP. They require a separate systematic description in the plan. They include full, updated database resources necessary in the performance of CM tasks. These annexes include:

1. Procedures for the performance of CM tasks, including those relating to the protection of CI and the launching of reserves, the organization of communications, threat monitoring, warning and alerting systems, evacuation, medical aid, social care, and social assistance, and the protection against threats characteristic to the city of Szczecin.
2. Rules for informing residents about threats and procedures in the event of such threats and procedures for documenting and assessing the damage.
3. Lists of contracts and agreements relating to the performance of tasks covered in the CM plan for CI in the territory of the city of Szczecin.
4. Priorities in CI protection and restoration.

Apart from these, the statute requires that CM plans – at the preparation stage – be agreed with the heads of organizational units (within their competence) who can be engaged in the implementation of the planned actions (Article 5(4–5) CML). Moreover, there is an obligation to ensure cohesion between CM plans and other relevant plans drawn up by competent public authorities, the drafting of which result from separate laws, as seen in Article 4(1)(6) CML that determines the compliance of CM plans with plans drawn up pursuant to the Act of 22 August of 1997 on the protection of persons and property (Journal of Laws, 2020a).

The discussion on civic planning so far leads to the conclusion that for pragmatic reasons, the statute should also require that CM plans be coherent and take into account local and regional determinants. It is crucial that these plans are uniform at the regional level (within one province and its counties) and the local level (within each county and its municipalities) when it comes to monitoring threats, assessing forces, and the measures necessary in the event of a crisis situation and to the cooperation between these forces, warnings, and alarms, in particular informing residents about threats and related procedures, evacuation from vulnerable areas, and the organization of rescue operations, medical care, social assistance, and counseling (Guźniczak & Stempiński, 2021).

The methodological aspect

The article presents the projected development of a threat involving the release of ammonia compounds – UN 1005 (Messer, 2019) and chlorine compounds – UN 1017 (Messer, 2018) into the atmosphere The author assumes that the exposition of these compounds into the atmosphere is a result of a technical failure following a transport disaster to or from one of the upper-tier establishments (Informacja, 2021) located 10 km north-west of the Center of Szczecin.

The method of situation assessment in chemical, biological, and radiological contaminations (ATP 45 (Delta)) and the Promień IT system (hereinafter PITS) are used to model the development of each of the incidents. Their application requires an authorization to use the Operational Graphics Package (Pakiet Grafiki Operacyjnej, hereinafter OGP) (Częścik, 2013). The OGP is a program that allows the imaging of the development of a tactical and operational situation during the planning and managing of operations of the armed forces relevant to the hazards identified (Paprotny, 2012). The system was originally designed for the needs of the Polish Armed Forces; however, for a dozen years or so it has also been used by the bodies of Poland's CM system to model the development of threats. The use of said programs and applications in this study was possible because the employees of the Szczecin Municipality made them available to the author.

The article's summary method of the analysis of the release of a Type-D chemical substance allowed a prognosis of the development of the incident independently for three sub-types (from a stationary tank, from a moving tank, and in an unknown manner). The author used sub-type 2 of the method, that is the release of a substance from a moving tank (container) or from a container in motion, which in consequence causes the spread of contamination on large surfaces. By following rescue procedure rules – Emergency Response Guidebook (ERG) – and owing to the amount of the chemical in transportation (release amount), a large range of impact of the released substances was adopted. Using the method of a hypothetical case study analysis (Haramata & Witczak, 2018), the author assumed that

1. The incident occurs in June (air temperature of 24°C, permanent wind speed of 3 m/s NW, no precipitation).
2. The locations of substance release are 150 m to 400 m away from densely built-up and populated areas of the Szczecin Municipality.
3. The amount of the substance transported by road, rail, and water (river transport) is 20,000 dm^3.

The effects of the release of the chemicals were pictured on maps generated by PITS. Permission to use this system for CM purposes was granted to CM teams at the level up to and including counties (Jankowski, 2015). It needs to be emphasized here, however, PITS may be launched in a client-server structure and in a distributed computing environment.

The author used the ALOHA system to delineate threat zones and verify the forecasts for the spread of dangerous substances (Majder-Łopatka & Salamonowicz, 2019). This program is used by the Szczecin Headquarters of the State Fire Service for ongoing analyses. This program allows a simulation of the consequences of toxic, flammable, or explosive substance emissions. Under such assumptions, it was possible to obtain the length of the range of the vulnerable zone and concentration limits for the life and health of persons within the emissions area. The values for high and very high concentrations (marked in figures by a red ellipsis or its segment) are as follows: 30–35 mg/m^3 for ammonia and 2–3 mg/m^3 for chlorine. These values greatly exceed the permissible threshold limit values (TVL, 14 mg/m^3 for ammonia and 0.7 mg/m^3 for chlorine) and short-term exposure limit (STEL, 28 mg/m^3 for ammonia and 1.5 mg/m^3 for chlorine), whereas minor ammonia and chlorine concentrations (marked in figures by a blue ellipsis or its segment) are within the permissible TVL and STEL. The TLV determines the value of exposure of an employee during an 8-hour, 24-hour, and average week work schedule that should not have adverse effects on the employee's health during his working life, whereas the STEL means a value that should not cause adverse effects on the employee's health if it occurs in the workplace for up to 15 minutes and up to two times during a shift, with an interval not shorter than 1 hour (Journal of Laws, 2018).

In order to facilitate the comparison of contaminated areas, the author marked areas of major and minor contamination determined by the ALOHA system on a PITS-provided map.

On this basis, the author assumed that a substance release will pose a threat to persons present in the area of the Szczecin Municipality delineated by PITS and ALOHA. Where a hazard develops like this, it may provide a basis for ordering first-degree evacuation of persons outside this area. The author focused solely on the hypothetical determination of the area and number of persons at risk, and thus analyzed complex, multi-actor actions planned in the MCMP.

Hypothetical analysis of events

The City of Szczecin is located in the Szczecin Lowlands (approx. 60 km from the Baltic Sea and 30 km from the Szczecin Lagoon). The three micro-regions of the Szczecin Hills, that is the Warszewo Hills, Bezrzecze-Siadło Hills, and Bukowe Hills (highest hill – Bukowiec, 148.4 m above sea level), are the characteristic feature of the location of the city, which affects local wind conditions. Szczecin is administratively divided into four districts: Śródmieście (including Międzyodrze), Północ, Zachód, and Prawobrzeże. It borders Police County on the west, Gryfino County on the south, and Goleniów County and Stargard County on the east. The city's area is 301 km^2 (water bodies – 24%, forests and forest land – 16.9%, other utility areas – 51% (residential areas, industry, administration, etc.)). The population slightly exceeds 400,000 (211,000 women and 191,000 men). Szczecin's strategic importance as the node of the TENT network (rail, road, sea, river, and air transport) follows from its location at the crossing of transit routes that link Western Europe with Baltic Sea states and Scandinavia with the south of Europe.

One of the potential threats for Szczecin's residents involves the transport of hazardous materials through its center. In the first half of 2019, 214 tons of such materials, including anhydrous ammonia, methanol, butane, propane, fluorosilicic acid, and hydrochloric acid, were transported by rail transport alone. Additionally, the system of axle load sensors operating in the Szczecin Municipality noted in 2017–2019 on average annually 31 million vehicles coming in or going out, including close to 80,000 vehicles that exceeded the maximum authorized capacity of 40 tons (ZDiTM Szczecin, 2021). The author assumed that approx. 25,000 of these vehicles are those that transport dangerous materials. It needs to be emphasized that Zakłady Chemiczne Police SA (hereinafter Police Chemical Plant) owns the Port of Police, which handles approx. 1.5 million tons of cargo transported by barges annually (Gucma & Juszkiewicz, 2018).

Below, the author presents results of hypothetical simulations that delineate Szczecin's areas that are at risk of contamination with anhydrous ammonia and chlorine due to unsealing of tankers in road, rail, and water transport.

Release of ammonia and chlorine in road transport

The figures included in this chapter present a comparison of the development of threats of contamination with chemicals in the territory of the Szczecin Municipality using two programs: PITS (marked by a yellow triangle on all figures herein) and ALOHA (regions with major and minor contamination marked by red and blue ellipses, respectively). The first selected release location is at Szafera Street, *vis a vis* Netto Arena, which is on a road route to the Police Chemical Plant.

The first program (PITS) identifies the radius of the release zone and the radius of the threat zone (75 m and 4.6 km, respectively). This area covers 9.2 km^2, and close to 117,000 people may be present within its direct reach (10 neighborhoods: Arkońskie-Niemierzyn, Centrum, Łękno, Nowe Miasto, Pogodno, Śródmieście Północ, Śródmieście Zachód, Świerczewo, Turzyn, and Zawadzkiego-Klonowica). It needs to be emphasized that there are many facilities in this area, such as three hospitals with a total bed count of 835 (Jakubiak, 2021), university campuses, educational institutions, social assistance facilities, sports facilities (a stadium and a sports hall), leisure facilities, public administration, trade and services facilities, a major part of the cemetery (largest in Poland, third largest in Europe), and residential buildings.

ALOHA forecasts outline two contamination areas determining the range of emissions, which is 3.8×0.3 km (area, 1.3 km^2) for major contaminations (35 mg/m^3) and 6×0.4 km (area, 2.4 km^2) for minor contaminations (10 mg/m^3). Thus, the vulnerable area is substantially narrowed covering only a part of 6 neighborhoods (major contamination) in which approx. 50,000 people may be present. The minor contamination area covers 8 neighborhoods (approx. 67,000 people). The emission zone does not cover any hospitals or other large buildings.

The hypothetical model of chlorine contamination using PITS demonstrates that in the event of its emission from a tanker, the radius or the release region is 600 m, whereas the threat zone extends for 16 km, that is 110.8 km^2, which is more than a third of the area of the Szczecin Municipality. The maximum vulnerable area covers parts of the city located on the left and right sides of the river (22 neighborhoods). It needs to be noticed that the potential contamination covers a key area of economic activity (harbor, fuel bases, three heat and power plants, a waste incineration plant, a food processing establishment, large shopping centers, and others) and transportation links strategic for the city. Also, recreational areas, including those that are valuable in terms of nature, are located in the vulnerable area, which multiplies the effect of the contamination, and the number of persons directly at risk is 210,000.

Modeling with the use of ALOHA demonstrates that the area of a major threat (3 mg/m^3) spans across

Figure 1. Maps of the area of the Szczecin Municipality contaminated with ammonia (the part of the city on the left side of the river) and with chlorine (the part of the city on the right side of the river) as the result of a road incident

38 km^2 (10×3.8 km). The potential area of a minor threat (1 mg/m^3) has an area of 80 km^2 (10×8 km). It marks an area considerably smaller than what PITS forecasts, which is still more than 25% of the area of Szczecin, covering the strict center, including the business activity zone (all entities key to the maritime economy and the energy sector). In this case, the estimated number of those potentially at risk is close to 110,000 persons.

Release of ammonia and chlorine in rail transport

The next map shows the development of the threat of releasing ammonia in rail transport in the area of the Szczecin Municipality. The planned location of its release is on the overpass of rail route 406 situated above 26 Kwietnia St. The route links Szczecin and Trzebież and is used for cargo transport. The route also goes to and from the Police Chemical Plant.

PITS shows that the radius of the ammonia release region is 75 m, whereas the radius of the threat zone is 4.6 km. The maximum threat zone is 9.2 km^2. Approx. 92,000 people may be in direct danger (the area of 8 neighborhoods: Centrum, Międzyodrze-Wyspa Pucka, Nowe Miasto, Pomorzany, Śródmieście Północ, Śródmieście Zachód, Stare Miasto, Turzyn). The area covers the strict center, which accommodates various facilities, such as health care facilities, university campuses, educational institutions, social assistance, sports, recreation, and leisure facilities (allotments), public administration facilities, trade and services facilities, residential buildings, and part of the largest cometary in Szczecin. Moreover, the emissions area covers public transport centers (Szczecin Główny railway station, integrated tram and bus stops) and facilities strategic for the functioning of the city (Pomorzany sewage treatment plant and Pomorzany heat and power plant).

As in a road transport incident, ALOHA delineates two areas of contamination and determines their reach: 1.3 km^2 for major contaminations (35 mg/m^3) and 2.4 km^2 for minor contaminations (10 mg/m^3). The vulnerable areas cover only part of 7 neighborhoods (major and minor contamination) with approx. 60,000 residents. However, it needs to be noted that the maximum range of ammonia emissions projected in this way is about 6 km. Nevertheless, its area is much smaller than the area specified by PITS.

The chlorine contamination model determined by PITS demonstrates that in the event of emissions from a rail tank car, the radius of the release region is 600 m, and the vulnerability radius is 16 km. The maximum contamination area in this case covers 110.8 km^2. This is more than one-third of Szczecin's area, covering both the left and the right side of the river (20 neighborhoods with 185,000 residents). This covers an area of economic activity that is key to the city's development (harbor, fuel bases, three heat and power plants, a waste incineration plant, a food processing establishment, large shopping centers, and others) and strategic transportation links. This also applies to recreational areas, including those that are home to valuable nature. It needs to be emphasized that this multiplies the effect of the contamination, and the number of persons directly at risk must be updated to include those who are there temporarily (for work, school, medical treatment, official matters, shopping, etc.). Additionally, the modeling shows that areas of neighboring counties will also be partly at risk: Gryfino, Goleniów, and Stargard counties.

ALOHA shows that the zone with a major threat of chlorine contamination (3 mg/m^3) has an area of 38 km^2, whereas the minor threat zone (1 mg/m^3) has an area of 80 km^2. These areas, however, cover the strict city center, including the critical transportation

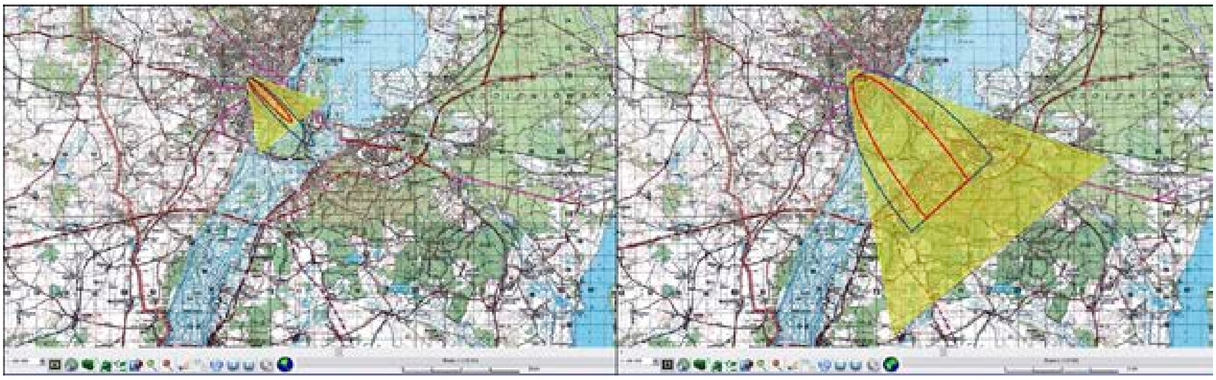

Figure 2. Maps of the area of the Szczecin Municipality contaminated with ammonia (the part of the city on the left side of the river) and with chlorine (the part of the city on the right side of the river) as the result of a rail incident

axis determined by national road 10 and railway route 351. There are no doubts that the risk involves the area of the harbor and industrial establishments located in its neighborhood (including those related to the maritime economy and the energy sector). The estimated number of persons potentially at risk is close to 165,000.

Release of ammonia and chlorine in water transport

The last incident in the analysis concerns emissions of ammonia and chlorine in water transport in the area of the Szczecin Municipality. The location of the release is situated in the West Oder flow, next to the Szczecin Harbor Administrative Office, 9 Jana z Kolna St. The author assumes that as in the previous cases, the incident is related to the transport of chemicals to and from the Police Chemical Plant. It needs to be emphasized that anhydrous ammonia is toxic and chlorine is very toxic to the water environment.

The PITS program analysis shows that the substance release region creates a circle with a 150 m radius, entirely within the water basin. The maximum area of the threat region is more than 9.2 km^2 (a triangle with 4.6-km sides). The direct risk covers partly or in whole the area of the following islands: Ostrów Grabowski, Ostrów Mieleński, Mieleńska Island, and Pucka Island. There may be approx. 5000 people at these locations, mainly employed in the territory of the harbor, in industrial establishments (including the industrial waste incarnation facility and the Szczecin Heat and Power Plant), and in recreation and leisure places (water bodies and allotments). Moreover, the emissions area covers transportation arteries with intensive traffic.

ALOHA-assisted programming delineates and determines two contamination areas: 1.3 km^2 for major contaminations (35 mg/m^3) and 2.4 km^2 for minor contaminations (10 mg/m^3). Despite the much weaker influence of ammonia, the area of major contamination covers part of the Dąbie Lake and harbor channels, whereas minor contamination affects marinas located in the south part of the small Dąbie Lake. This is particularly important in the summer season as then Szczecin's water bodies are used intensively by residents and tourists. The author assumes that about 3000 people will be at risk in this area.

The area of chlorine contamination determined by PITS demonstrates that in the event of emissions, the radius of the release region is 600 m, and the vulnerability radius is 16 km. The maximum contamination area covers 110.8 km^2. This area covers much of the Szczecin Municipality on the right side of the river, including strategic transportation links, large residential complexes, trade and service centers, logistics centers, food processing establishments, and recreational and sports areas. It also affects forest zones and water basins, which will undoubtedly have a negative effect on the condition of the natural environment (Gucma & Juszkiewicz, 2018). More than 85,000 people may be present in this area of the Szczecin Municipality. Additionally, one needs to forecast the risk to persons in part of the Goleniów, Gryfino, and Stargard counties.

ALOHA delineates a much smaller area. The area of a major threat (3 mg/m^3) covers 38 km^2, whereas the area of a minor threat (1 mg/m^3) covers 80 km^2. This, however, causes a significant risk to intensive economic activity, the movement of persons by public and individual transport (rail, buses, and tramways), and the enjoyment of recreational areas. However, the potential threat to persons who live in large neighborhoods is the most significant. The estimated number of persons at risk is close to 63,000.

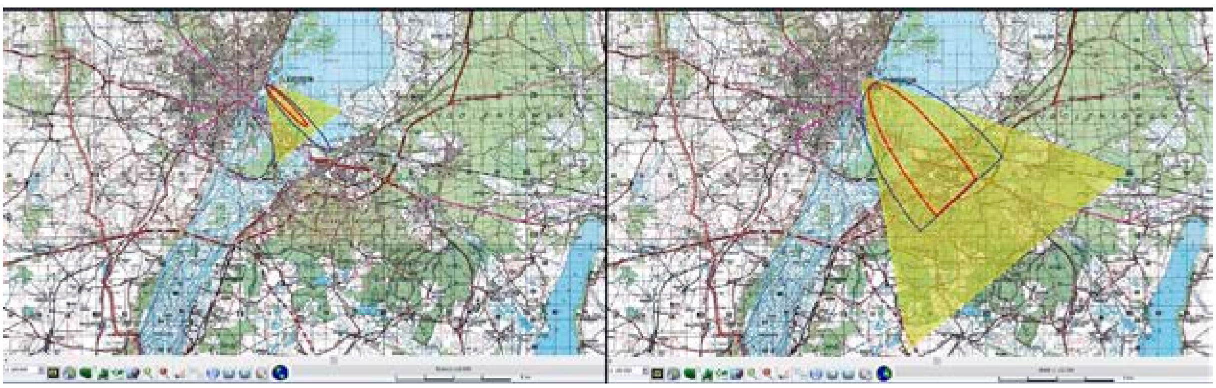

Figure 3. Maps of the area of the Szczecin Municipality contaminated with ammonia (the part of the city on the left side of the river) and with chlorine (the part of the city on the right side of the river) as the result of a water incident

Conclusions

The hypothetical development of contamination with two types of chemicals presented here (UN 1005 anhydrous ammonia and UN 1017 chlorine) in the territory of Szczecin encouraged the author to formulate the conclusions below.

1. There are significant differences between PITS and ALOHA when it comes to estimating the size of the area concerned and, thus, the number of persons at risk of contamination, in particular:
   a) Modeling by means of the Promień IT system specifies only the size of the vulnerable area, whereas ALOHA identifies multiple parameters, including concentration limits and length/range of the vulnerable zone.
   b) The PITS-proposed area of contamination with ammonia is 3 to 7 times larger than the area outlined by ALOHA; in the case of chlorine contamination, the differences in size between PITS and ALOHA estimates are 3.5- to 25-fold.
   c) The number of persons at direct risk of contamination with ammonia according to PITS is 5000 to 17,000, whereas according to ALOHA it is 3000 to 60,000.
   d) The number of persons at direct risk of contamination with chlorine according to PITS is 85,000 to 210,000, whereas according to ALOHA it is 63,000 to 165,000.
   e) The greatest potential threat is contamination through the release of ammonia and chlorine during road and rail transport.
   f) The greatest concurrence in estimating the number of people at risk of contamination calculated using PITS and ALOHA occurs in emissions of chlorine during rail and water transport.
   g) The greatest discrepancy in estimating the number of people at risk of contamination calculated using PITS and ALOHA occurs in emissions of ammonia and chlorine during road transport.
2. Such great discrepancies in determining the area and the number of people concerned using PITS and ALOHA programs cause significant difficulties in taking the decision to evacuate the persons at risk. It may also have negative procedural consequences for the decision-makers.
3. An operational decision made by persons in charge of neutralizing these threats should be based on an ALOHA-aided analysis.
4. There is an urgent need to develop a uniform, compatible model of forecasting the development of contaminations for the military and the civil sector, which needs to take into account the most modern and diversified technological solutions. The changing environment of contemporary threats forces a step away from a departmental approach (i.e., separate for different entities) to identifying such hazards.

The forecasts presented in the article do not refer to MCMP structures intended to be launched in the event of the incidents described above. However, we need to note that effective (quick and understandable for the addressee) alarming of the people and their evacuation is a key issue in the event of contamination. The entire area of the Szczecin Municipality is within reach of alarm sirens launched remotely, complemented by a sound system allowing broadcasts of voice messages about different types of threats. This system undergoes regular ongoing upgrades. Moreover, for the need to order and carry out the evacuation of persons, more than 105,000 places in Citizen Support Centers (largely in educational institutions) have been prepared in the territory of the Szczecin Municipality. However, this number does not correlate with the hypothetical number of persons at risk, which is an additional argument to design and launch an application for optimal threat modeling.

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