Rehabilitation and decontamination of the area after emergencies

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Abstrakt
The article is aimed at acquainting readers with the remediation and decontamination of the area after an emergency. In one of the parts, there is a literature search on the topic of remediation, decontamination of the area, and emergencies. In the following sections, the article deals with the process of remediation of the area, liquidation of the accident after a specific accident with the leakage of a hazardous substance. In part of one of the chapters the article deals with the decontamination, the methods of removing substances as well as decontamination substances and reagents, and methods of decontamination are described. In the field of remediation, the article mentions methods that, according to remediation companies, are mostly used.

Keywords: Emergency, remediation, decontamination, leakage, hazardous substance, accident, diesel.

1. Introduction

The growing need of humanity harms several risks associated with the constant increase in production capacity, trade, and transport. In the past, there have been several different accidents, the most famous being the Bhopal accident in 1984, the Chernobyl accident in 1986, the chemical plant accident in the suburb of Seveso in 1976, and the deliberate release of almost two thousand million liters of diesel into the sea in Gulf in 1991. These events had a major impact on changing humanity's view of possible risks.

The first decontamination work and decontamination itself began during the First World War when chemical weapons began to be used. Since then, decontamination methods have become more and more advanced, also because hazardous substances have become more widely used for the manufacturing industry and thus more emergencies have arisen with the release of these hazardous substances into the environment.

In today's world of trade, goods are transported by various modes of transport by ship, air, rail, and road. With each type of transport, there is a risk of hazardous substances escaping into the environment, which sometimes leads to the fatal destruction of the landscape, human and animal health. In the Czech Republic, road and rail transport are among the most widely used, with most fuels being transported for the most part. Oil products contaminate soil, groundwater, and surface water in the event of a spill. One of the chapters of the article mentions a traffic accident that happened in 2014. Part of the chapter is a description of all actions that were performed until the completion of the liquidation of the accident.

2. Extraordinary event

There are all harmful effects of forces and phenomena caused by human activities, natural influences, but also accidents that endanger lives, health, the environment, or property that require rescue and liquidation work. Thus, an emergency can be considered as a sudden serious event that has the effect of disturbing the stability of the system with a threat to its security or existence. In general, an emergency can be divided into three categories, namely natural (naturogenic), anthropogenic, and combined emergencies. [1]

2.1 Negative effects of an emergency

The negative effects of an emergency are most reflected in the lives, health, and safety of the population, as well as in their mental hardship, economy, and environment. Emergencies in the past have affected, in the present affect and in the future will affect lifes, health, property, environment, and economy, thanks to climate change, terrorism, industrial revolutions, socio-pathological phenomena of human society, and globalization. [2]

3. Decontamination

Decontamination can be called a set of procedures, methods, means, and organizational measures to remove the contaminant from the surface or environment as effectively as possible or to try to reduce the harmful effects to a predetermined safe level. If the contaminant is not removed, it acts on the contaminated surface and its immediate surroundings. The concept of decontamination can also be interpreted as a special cleansing. Decontamination aims to reduce the time required to use protective equipment at the site of intervention, as well as to reduce the consequences and irreversible losses of health and life. [3]

3.1 Characteristics of decontamination

Decontamination is an important measure of active protection against the consequences of the release of hazardous substances in operational accidents or the consequences of the use of weapons of mass destruction. Its ultimate goal is to reduce medical and irreversible losses, shorten the necessary period of use of personal protective equipment, which makes it difficult to operate in contaminated areas, and create conditions for restoring normal life in contaminated areas, rescue operations, and urgent remediation work. In emergency work, life-saving operations take precedence over decontamination. [4]

Decontamination is divided according to the type of substance removal

- chemical detoxification,
- radioactive by deactivation,
- biological by disinfection.

Decontamination is performed on contaminated ones

- rescue teams,
- affected persons,
- material resources and mobile technology,
- surfaces and terrain.

Methods of decontamination are divided into:

- mechanical - vacuuming, washing,
- physical - evaporation, sorption,
- chemical - reaction of contaminants with a suitable reagent, in which either to completely dissolve and decompose the substance or to convert it to less toxic products, or to be converted to compounds that are easier to remove. [5]

3.2 Detoxification (disinfection)

Detoxification, or decontamination, is taken as the decomposition of chemicals and pollutants or their removal from various objects, surfaces, and terrain to reduce contamination to a given standard. Decontamination by detoxification can be either complete or partial. [5]

3.3 Deactivation

Deactivation is the removal of radioactive substances from the surfaces of the material, armaments, people, objects, and terrain below the maximum accessible limits of activity. The aim is also to reduce the risk of human exposure to a minimum, and also to reduce the spread of contaminants by transmission through direct contact. Last but not least, this prevents secondary internal contamination. Thus, in general, deactivation is performed by approximately the same procedures and methods as all other decontamination. However, deactivation has its specifics, which are good to know and observe, namely that radioactive substances can only be removed from surfaces, but they cannot be destroyed by any known method. They are subject to gradual decay, which is characterized by a half-life. Therefore, we must dispose of contaminated waste after subsequent deactivation. Deactivation is also divided into either partial or complete, depending on the range of means used [6]

3.4 Rehabilitation

The term remediation originated from the Latin name sanare, which means to heal or correct. It is the adoption of measures to fully repair the damage caused by man and his activities on nature or property. Nature remediation measures are called reclamation and revitalization. [7]

Technology of remediation processes

Physical - Filtration, dilution, gravity separation, solidification, distillation, sedimentation, homogenization, stabilization, magnetic separation, flotation, extraction (steam, water, plants, air, microbes), thermal processes (vitrification, sintering), stripping, venting

Physicochemical - dialysis (sorption), adsorption, desorption, chemisorption, ionic exchange, electrochemical processes, solidification, reserve osmosis, thermal processes

Chemical - dissolution, oxidation (drying, burning, ozonation, UV radiation, aeration), coagulation, reduction, photosynthesis, dehalogenation

Biological - degradation in buoyancy, aerobic processes, anaerobic processes, bioreactors, plant extraction including plowing [8]

4. Transport of hazardous substances and materials

Dangerous substances and materials are transported by road, rail, waterway but also by air; these types of transport pose a significant risk to society or the environment. Due to this danger, it was necessary to lay down the basic conditions and individual rules for the transport of dangerous goods and thus ensure safety. Due to the high level of transport of dangerous goods at the international level, an international agreement on the transport of dangerous goods was negotiated. [9]

4.1 Kemler and UN code

Vehicles transporting hazardous substances and mixtures must be marked on the rear and front with an orange plate measuring 30x40 cm. This table is framed in black and divided in half. In the lower half of the rectangle is the substance identification number, the so-called UN code, and in the upper half, there is the Kemler code indicating the imminent danger. The UN code is characterized by a four-digit number, which is now assigned and identifies about 3000 substances and their mixtures. [10]

Figure 1 Kemler and UN code, Source: [10]

5. Liquidation of an accident with an oil spill

The accident is divided according to several aspects, the main characteristics of the distinction include:

- cause of the accident
- the environment that was affected by the accident
- type of dangerous substance, its harmfulness and resistance

According to the cause of the accident, it can be further divided into accidents caused by:

- a technical defect, means of transport or production equipment
- exposure to natural influences such as storms, severe frosts, hail, etc.

According to the environment affected by the accident:

- surface water accidents: this type of accident, where there is the presence of oil substances in the water, can be identified by oil stains or films on the water surface. These oil stains begin to form even at low concentrations of free oils, and because these substances float on the surface, the access of oxygen from the atmosphere to the water is stopped and thus both the self-purification of the water and the planting of plants or animals are affected.

- Groundwater accidents: in this accident, oil substances enter groundwater from unpaved surfaces, leaks in sewers and piping systems. The extent of pollution is determined by the composition of the rock environment, where contaminants can enter the groundwater due to leaching by rainwater and continue to spread in the direction of groundwater flow to the surroundings. [11]

- Accidents contaminating the soil: this accident, when oil substances leak into the soil, is affected by the properties of the soil, where the permeability of the soil is very important. Well-permeable soils include gravelly or sandy soils, which are easily decontaminated without further treatment. In the case of clay soils, the soil must first be mechanically ground into larger clods. Thus, when the soil is affected, a solid and humid environment is less permeable to oil than weathered and dry surfaces. [11]

6. Example of liquidation of consequences of the ecological accident

The company for rescuing a truck was approached, when an accident on the 3rd class road 4942 caused a leak of about 230 liters of diesel. The oil contaminated the unpaved grass area with an area of about 25 m2. [12]

Figure 2 Situation before the start of land remediation, Source: [12]

The liquidation company was informed about the accident by telephone by a representative of the Municipal Office and was called upon to carry out an emergency intervention aimed at removing contaminated soils and their professional liquidation.
Due to the state of pollution at the site, the following emergency response procedure was agreed upon,

- arrival of hydrogeological supervision at the accident site,
- perform sampling of contaminated soil,
- arrival of a loader for loading contaminated soil,
- import of containers for loading and subsequent removal of contaminated soil,
- extract massively contaminated soils,
- carry out control sampling of the walls and bottom of the excavation for the performed extraction,
- restore the site to its original condition. [12]

Description of the location and location of the diesel spill

The accident happened on the 3rd class road 4942 in between, diesel leaked from the crashed truck onto an unpaved area off the road. [12]

Figure 3 Aerial photograph of the accident site, Source: [12]

From the geological point of view, the subsoil of the localities is formed by the Vsetin layers, flysch layers with a predominance of calcareous claystone from the Tertiary period. [12]

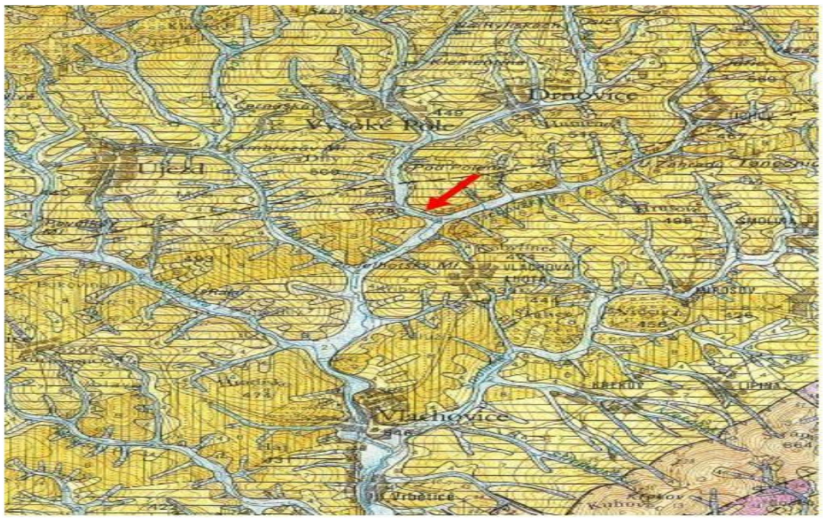

Figure 4 Geological map of the accident site, Source: [12]

The hydrogeological environment at the site consists of a regional insulator, in which only the surface zone is used as a collector. The assumed direction of groundwater flow is in the direction from north to south. [12]

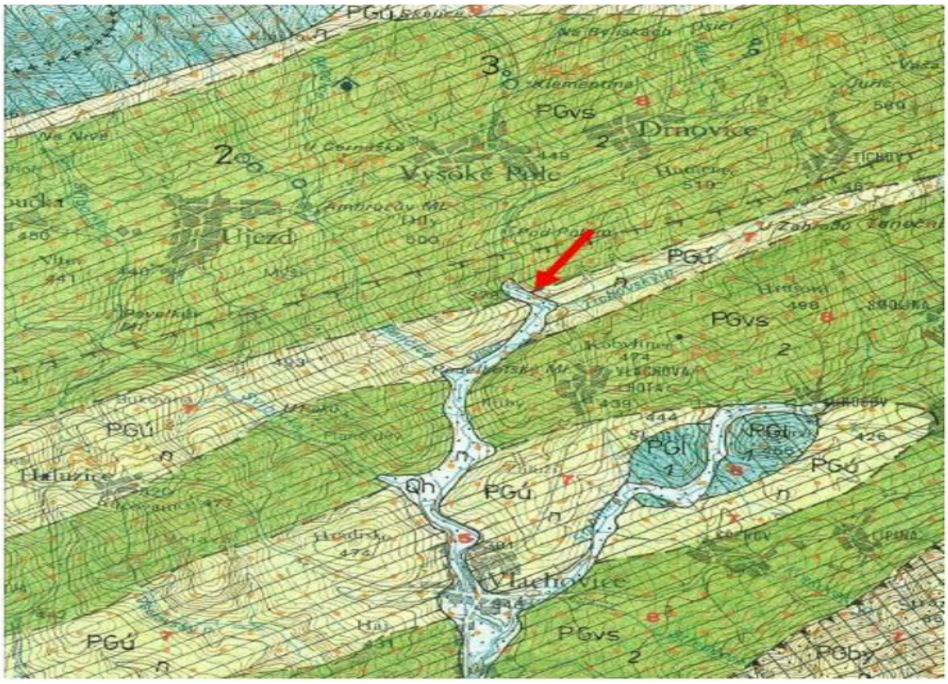

Figure 5 Geological map of the accident site, Source: [12]

7. Description of works performed by the fire brigade

After the arrival of the Fire brigade at the scene, it was found that it was a traffic accident of a set with a semi-trailer. The set was located in the left ditch, leaning against a tree with a trailer and reaching one meter into the road. The driver and front passenger were unharmed and left the vehicle before the unit arrived. [13]

The set transported metal folding boxes for material weighing 12 tons to a nearby manufacturing company. The unit secured the scene of the accident with the help of cones, and also carried out fire prevention measures by drawing up a high-pressure jet and a powder fire extinguisher. Oil leaked from the punctured tank into a ditch. The fire brigade unit first caught the escaping fuel in a drip tray, and then in a collection bag. Police arrived at the scene. Due to poor access to the car battery, it was not possible to disconnect it. After consulting with the driver and subsequently with the management of the company of the crashed truck, it was found that they could not ensure the rescue of the set themselves, the intervention commander through the Regional Operations and Information Center provided the towing service. It completed the Fire brigade with CAS 24 and TACH technology and using a manual diaphragm pump, pumped fuel from the right undamaged tank into barrels. The units pumped out and captured about 210 L of diesel. After the diesel was depleted, the damaged exhaust system behind the left front wheel was released and then dismantled using the Holmatro rescue tool expansion tool, which was hit by a fuel tank and punctured as a result of the accident. The punctured left fuel tank was also removed from the vehicle. [13]

According to the information, the tank had about 430 L of diesel, about 20 L of fuel leaked into the ditch. In this fact, the commander of the intervention reported to the Regional Operations. The Regional Operations and Information Center informed the emergency service of the Czech Environmental Inspectorate and the environment of the Municipality with extended powers about the leakage of a dangerous substance into the soil.

The environment of the municipality with extended powers sent its workers to the scene of the accident. A Renault Kangoo vehicle was called to the scene to take the spent diesel. After the agreement with the owner of the crashed vehicle company, the diesel was taken to the Zlin Fire and Rescue Service station for subsequent disposal. Excavation work began, coordinated by a company representative who evaluated the excavated soil samples.

After the documentation of the traffic accident by the police, the collection of the crashed set was started. The unit helped rescue the set and illuminated the scene of the accident with reduced visibility. After pulling the set on the road, it was found that the damaged left front wheel could not be replaced due to deformation of the rim. The unit used a hydraulic expander to partially compensate for a damaged rim. The hydraulic expander was damaged during the intervention. After fitting the spare wheel, the set was towed. The unit swept the road off the dirt. The

administration of communications was also notified of the situation. Connection with KOPIS maintained by mobile, pocket RDST, and mobile phone. There were no injuries to the firefighters involved during the intervention. [13]

8. Conclusion

The article "Rehabilitation and decontamination of the area after an emergency" summarizes the basic concepts of the issue. Regarding the issue of remediation, the article deals mainly with remediation methods, which are in our country, the most used by remediation companies. And last but not least, the issue of decontamination, types of substance removal, methods of decontamination, and decontamination substances and mixtures. Decontamination is a very complex process; it is not possible to completely determine a certain amount of force and means to perform it. Decontamination must be carried out as quickly and as far as possible, taking into account the affected population, directly at the scene of the emergency. In recent years, the increase in traffic on road networks has been increasing, which has worsened the condition of our roads. Roads are often impassable for cars, let alone for trucks carrying heavy loads or hazardous substances. Thanks to these conditions, and also to human error, there are more and more accidents with the leakage of hazardous substances and the need for rapid intervention by fire protection units.

The main goal was to be acquainted with the description of the solution of remediation of the area after a traffic accident, during which a dangerous substance leaked. It described the individual steps taken by the unit of the Fire and Rescue Service, as well as companies specializing in the liquidation of environmental accidents, which was invited to deal with the consequences of the accident and performed both control sampling of soil and water from selected sampling points and analysis, which, among other things, determined the content of petroleum substances in the sample and ensured the liquidation of the consequences of the accident.

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