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ÚJÍTÁSOK A KATASZTRÓFAVÉDELEM TERÜLETÉN SZLOVÁKIÁBAN

Absztrakt

A cikk a katasztrófavédelem területén bevezetett újításokat mutatja be, különös tekintettel a Szlovák Köztársaság árvízvédelmére. Az eredmények mellett a cikk ismerteti az árvízkockázat értékelésére alkalmazott módszereket, az árvízmodellezést és a lakosság ellenálló-képességének növelése érdekében tett lépéseket.

Kulcsszavak: katasztrófavédelem, árvízvédelem, modellezés, kockázat, mentési tevékenység, Szlovák Köztársaság

INNOVATIONS IN DISASTER MANAGEMENT IN SLOVAKIA

Abstract

In the paper, there are introduced the innovations in disaster management, especially in the flood protection sphere in the Slovak Republic. There are introduced not only the results, but also the methodologies applied to assess the flood risk, modelling of flood as well as the approaches to increase the level of resilience of the population.

Key words: disaster management, flood protection, modelling, risk, rescue services, Slovak Republic

INTRODUCTION

The flood protection is such an activity that is aimed at reducing the flood risk at flood threaten territory, flooding prevention, and mitigation of the adverse consequences of flooding for human health, the environment, cultural heritage and the economic activities.

New approaches to flood protection have been transposed into national legislation, especially after Slovakia's accession to the European Union. These approaches are particularly aimed at preventing flooding and minimising their consequences.

Mainly because of the transboundary nature of floods and the need to improve the situation in the field of flood prevention, the European Commission proposed a common approach to flood risk management. For this reason, the plans for the organization of flood protection in the Slovak Republic passed a new comprehensive treatment. Municipality has an important and decisive role in the field of flood protection currently. Its roles and responsibilities consist of various positions of flood authorities. Municipalities are committed the corporate executives, managers (owners, users) of water bodies and other objects threatened by floods to implement the measures related to flood protection, in terms of the flood protection plans. The new concept of flood protection takes into account and use all the experience gained in implementing the flood protection in recent years. In addition to the specific tasks of the municipal authorities and their components (e.g. municipality voluntary fire brigades), managers of water flows, there are determined the specific tasks to other bodies, organizations and citizens of the Slovak Republic. One of the key issues of flood protection is the flood risk management.

The principle of risk management is guiding the processes, resulting in the identification of risks, their purposeful reduction and minimizing the likelihood of crises. Risk management process, referenced to the system with the human factor, has to reduce the risk to a socially acceptable level through the legislative, administrative, technical and social measures implemented at all stages of risk development. The basis for risk management is a thought process that is based on information about possible threats / hazards on the one hand and the opportunities and resources to minimize the risk, on the other hand. The objective of risk management is to use all available resources to prevent the breaking out the security / safety risks into the crisis situations (Reitspies et al., 2004).

When assessing the flood risk, we are essentially expressing the economic risk. The consequences of the flood risk reflect the extent of the damages likely level (estimated, possible), losses or other negative consequences which may result, because of activation of flood risk, in immediate flood danger.

METHODOLOGY TO ASSESS THE FLOOD RISK

In this part of the paper are described the different methodologies for assessment of selected components of flood risk, namely susceptibility, vulnerability and resilience.

Susceptibility is a system property closely linked to the system sensitivity to be damaged by the negative phenomenon action. Vulnerability represents potential impacts of an emergency, respectively the damages caused by the action of negative phenomenon. Resilience can be introduced in terms of preventive measures and measures relating to minimizing the effects of emergencies.

METHODOLOGY TO ASSESS THE SUSCEPTIBILITY TO FLOOD

The first component of flood risk is the susceptibility of a territory to flood. In terms of susceptibility of an area to flood, we must consider not only the kind of floods (caused by torrential rain, ice drifts), but also the environment for which the analysis is performed (forest, inhabited area). According to the type and nature of the environment, there is also different assessment methodology used.

The issue of determining the susceptibility of an area to floods, using the existing geodata about the area, as well as the application of geographic information systems in the assessment, was the subject of solution of a number of research works. An example of one of them is introduced in the work of Majlingová, Sedliak, Komjáhy [2].In the work is presented one of the approaches to flood risk assessment in the border region Slovakia - Hungary. The experimental site is the catchment of the river Bodva. Besides this work other innovations are also known from this area – Bodva valley – even if that focused on forest fires. Restas reported an installation of an early warning forest fire detection system [3] and also a drone applications [4] [5], moreover drone was used not only for supporting forest fire management but in case of flood management too [6].

This approach is focusing mainly the assessment of the susceptibility of the catchment to the flood. The work deals not only with the assessment of the susceptibility of catchment, but also focuses on defining the critical points that have a significant effect on the formation of analyses of this kind. The susceptibility of Bodva River catchment area was evaluated based on factors such as the erosion factor of torrential rainfall efficiency, soil loss due to the torrential rainfall, expressed as the amount of eroded soil, slope of the terrain and the land use. All these factors were classified into classes based on severity (weight), which they affect the formation of floods. The methodology described herein is suitable for use in any catchment. The only limitation is the availability of data on this area. This method is suitable for processing using the spatial analysis, respectively geodata at scale of 1:50,000.

Already in 2012, there has been published a methodology for assessing the susceptibility of the territory (natural environment) to flood, on the basis of forestry data[7] - data related to the selected parameters of forest environment. This methodology, in view of the spatial resolution of the input data, respectively geodata, is suitable for processing the spatial analysis using the geodata at scale of1:10,000.The work deals with the assessment of the susceptibility of the catchment of the Hučava stream to flood. Studied Hučava stream catchment is located on the territory of the Protected Landscape and Biospheric Reserve Polana. The assessment of overall susceptibility to flood is based on the multicriterial evaluation of environmental factors that crucially affect the hydrological cycle in the studied territory. It is the bedrock, soil types, groups of forest types, degree of ecological stability, the use of non-forest landscape and potential run-off. The methodology is based on processing and subsequent synthesis of the data in the GIS environment. The result is the determination of categories according to assessed susceptibility to flood in the studied catchment and creation of a map showing the spatial representation of the different categories in this catchment.

To automate the process of assessing the susceptibility to flood in terms of the above mentioned methodology, there was developed and built a decision model [8]. In the work of Majlingova and Galla [8], there is introduced an approach to the assessment of the susceptibility of an area, which provides a danger to people and the environment from the perspective of two hazards - floods and fires in the natural environment. To assess the susceptibility of an area, there has been applied a method of multi-criteria analysis (MCDA) and an environment of the spatial decision support systems For the automation of the entire process of decision-making, the decision model was built. The experimental area was the territory of the Breznodistrict. The susceptibility assessment results are immediately applicable in practice of the crisis management and civil protection at the district level.

The basic characteristic, common to all Slovak rivers, is the increased flow in spring time, low flow in summer and in winter, with a slight increase during the late autumn. Moreover, the increased flow rate in the spring is not caused by excessive precipitation, since the precipitation in this period is minimal. Therefore, the regime of monthly rainfall is expressed as a long term average. The increase in spring run-off is due to the accumulated melting of snow in winter. This fact is related to the occurrence of the threat of spring flooding in the catchment. In the work of Hríbik et al. [9] is introduced an approach for assessing the susceptibility of an area to spring flood, caused by melting of snow in mountain areas, based on modelling the spatial distribution of snow, snow water equivalent values analysis and its impact on the flow rate values of the studied catchment.

METHODOLOGY TO ASSESS THE VULNERABILITY TO FLOOD

For purposes of assessing the vulnerability to flood, it is appropriate to use the tools specified for modelling and simulation of phenomena. These are often available as an Open Source software solutions to work with them is not required the purchase of license. One of such tools is the HEC-RAS hydrodynamic model for modelling the extent of the flood zone. The alternative to HEC-RAS is the MIKE commercial software to work with which it is necessary to buy a license. Both software environments are deployed in flood risk management practice in Slovakia, whether at Slovak Water Management Enterprise or DHI Slovakia.

HEC-RAS – a hydrodynamic model designed to allow one-dimensional (1D) hydraulic calculations for the implementation of the entire network of natural and artificial water channels (streams). The model consists of four components of one-dimensional analysis of the watercourse: calculations of steady flow water surface profile); unsteady flow simulation; calculations of movable boundary sediment transport; and analysis of water quality. A key element is that all the four components share the common geometrical representation of data and common routines of calculation of geometric and hydraulic properties. Besides the four components, the model includes a number of hydraulic design elements which may be used if the basic profiles of water surface are calculated (www.hec.usage.army.mil/software).

HEC-GeoRAS - the set of processes, tools and services for processing the geospatial data in ArcGIS environment, using a graphical user interface (GUI). This interface allows the preparation of geometric data for their subsequent import into the HEC-RAS environment and processing of the simulation results exported from the HEC-RAS hydrodynamic model. To create a file for importing, it is required to have a digital elevation model of the river system in the area in the ArcInfo TIN format.A series of line layers relevant for the creation of geometric data for the HEC-RAS model is generated. These layers include: Stream Centerline, Flow Path Centerline (not required), Main Channel Banks (not required), and Cross Section Cut Lines, all of them belong under the RAS Themes Menu. Other RAS Themes (RAS layers) can be created / used to extract other geometric data and their subsequent import into the HEC-RAS environment (www.hec.usage.army.mil/software).

MIKE FLOOD - provides complex of tools for flood modelling, which are characterized by the flexibility of connections between 1D and 2D models. It allows simulate virtually any situation associated with floods on the rivers, in flood plains, urban and coastal areas. MIKE FLOOD is also used for water quality analysis and offers tools for both hydrodynamic modelling and simulation of the transport of pollutants. It is accepted by the US Agency FEMA (Federal Emergency Management Agency) as part of a national program of insurance against floods.

MIKE Urban - is a combination of modelling and GIS for mapping water in the city. It contains information on all waterways in the city, the public water supply systems, drainage systems for intensive storms and sewage systems.

In practice, often is used a combination of both of the above systems, based on the results that can be identified flood endangered area, identify populations and infrastructure at-risk and to plan the evacuation of the population or manage the flood prevention and rescue works.

The implementation of the HEC-RAS model in the process of assessing the vulnerability of an area (urban area) to flood in Slovakia was focused in several works (see Lubinszká, Majlingová [10]; Majlingová, Boguská, Monoši [11], Majlingová Galla [8] and Majlingová Galla [12]).

There is exemplified one of them [12]. In the work [12] is introduced an approach and also results of the flood risk analysis of in the Poprad town and in Poprad district, and also of Banska Bystrica town [13]. Individual spatial analyses were performed in ArcGIS and HEC-RAS, respectively HEC-GeoRAS, environments. As the input data to analyse, there were applied the geographic data (especially orthophotos and digital terrain model) and text and numerical data on existing water systems at the city and district level. In terms of results achieved, there was performed the assessment of the susceptibility of the Poprad district to flood and assessment of the vulnerability to flood of the Poprad town territory, which was set based on the results of modelling the 100-years and 500-years flood. Summarized, analysed and synthesized have been the knowledge on flood protection measures and rescue operations during the flood at the town level to analyse the flood resilience situation.

METHODOLOGY TO ASSESS THE RESILIENCE TO FLOOD

To assess the level / degree of resilience to flood, it is necessary to take into consideration as the results of flood vulnerability assessment as well as all the existing precaution measures and mitigation measures applied as from the water management as from civil protection and emergency services point of view.

RESULTS OF THE ANALYSES

Results of the susceptibility to flood assessment

First, there are introduced the results of the flood susceptibility assessment based on the methodology where the geographical data at the scale of 1:50,000 were applied (Fig. 1).Those are the results of the Poprad district territory assessment [12].The susceptibility of the territory to flood was assessed based on the meteorological, soil conditions, terrain morphology and land use type.

Fig. 1 Results of flood susceptibility assessment of the Poprad district territory [12]

Further, there are also introduced the results of Hucava stream catchment flood susceptibility assessment (Fig. 2), where the geographical dataat the scale of 1:10,000 were applied [11].

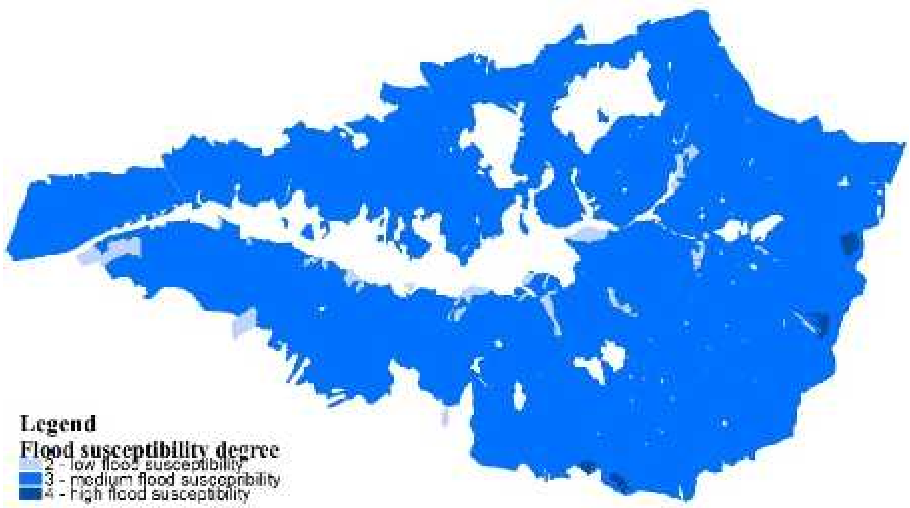


Fig. 2 Results of flood susceptibility assessment of the Hucava stream catchment [11]

Results of the vulnerability to flood assessment

In practice is most often possible to meet with the 100-year flood modelling results. Only exception are the results concerning the modelling of high flow rates, e.g. Q_{500} and $Q_{1,000}$ (500-year and 1,000-year flood), although the need for modelling these scenarios is gaining importance, especially in recent years, associated with increased frequency of extreme weather events, respectively in relation to the impacts of ongoing climate change. Here presented work presents one of the possible approaches to assessment of risks in relation to a changing climate and population adaptation to new conditions.

Here are introduced the results of 100-year (Fig. 3) and 500-year (Fig. 4) flood modelling for Banska Bystrica town.

Fig. 3 Results of modelling the 100-year flood in BanskaBystrica town [13]

Fig. 4 Results of modelling the 500-year flood in BanskaBystrica town [13]

Overlaying the geographic layers representing the flooded area in a city / town with a geographical layer of buildings (provided by the Topographic Institute) (Fig. 5), it is possible to identify specific buildings to be inundated during the flood, with an indication of the level of water. Based on this information it is possible to plan as the precaution measures in order to prevent the damages caused by flooding, but also to plan ways and procedures for the evacuation of the population from flooded areas, plan the rescue roadmaps and the capacities for coping with this emergency.

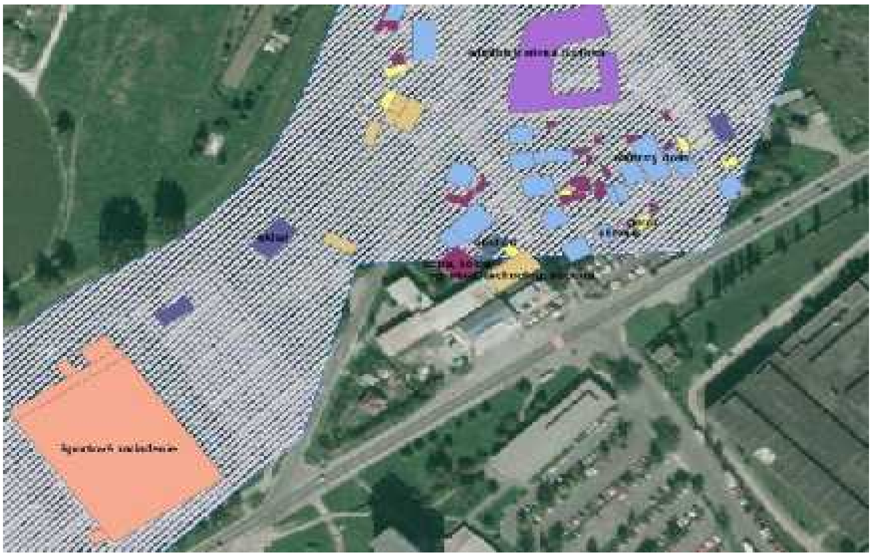


Fig. 5 Overlaying the geographical layers [12]

Resilience of the Slovak Republic to flood

With the Decision from 23.03.2015 the European Commission approved a financial contribution from the Cohesion Fund for the project entitled "Active anti-flood measures." The beneficiary of this contribution is the Ministry of Interior of the Slovak Republic. The project is a part of the Operational Programme “Environment”, under the Priority Axis 2 “Flood protection” and its total budget amounts to 159,719,101 euros.

The main ambition of the project was to enhance the country’s preparedness for floods and to mitigate their consequences by streamlining the work of rescue services and improving their technical equipment. As the total amount of damage caused by floods in the last decade exceeded the amount of 707 million euros, the Ministry of Interior through the project Active anti-flood protection measures supported effective protection of life and health of citizens, their property, protection of social and economic infrastructure and environmental protection at the time of flooding. The project also contributes to enhancing the protection of members of intervening units and more efficient and faster performance of rescue works during the flood and after the flood.

Individual activities and their distribution were designed based on a detailed analysis of flood risks (Fig. 6) and interventions in Slovakia in recent years, based on national analyses relating to flood risk assessment as well as in-depth comparative analysis of available and required technical rescue equipment of professional intervention units, such as Fire and Rescue Service, Voluntary Fire Protection of the Slovak Republic and the Slovak Water Management Enterprise, S.E.

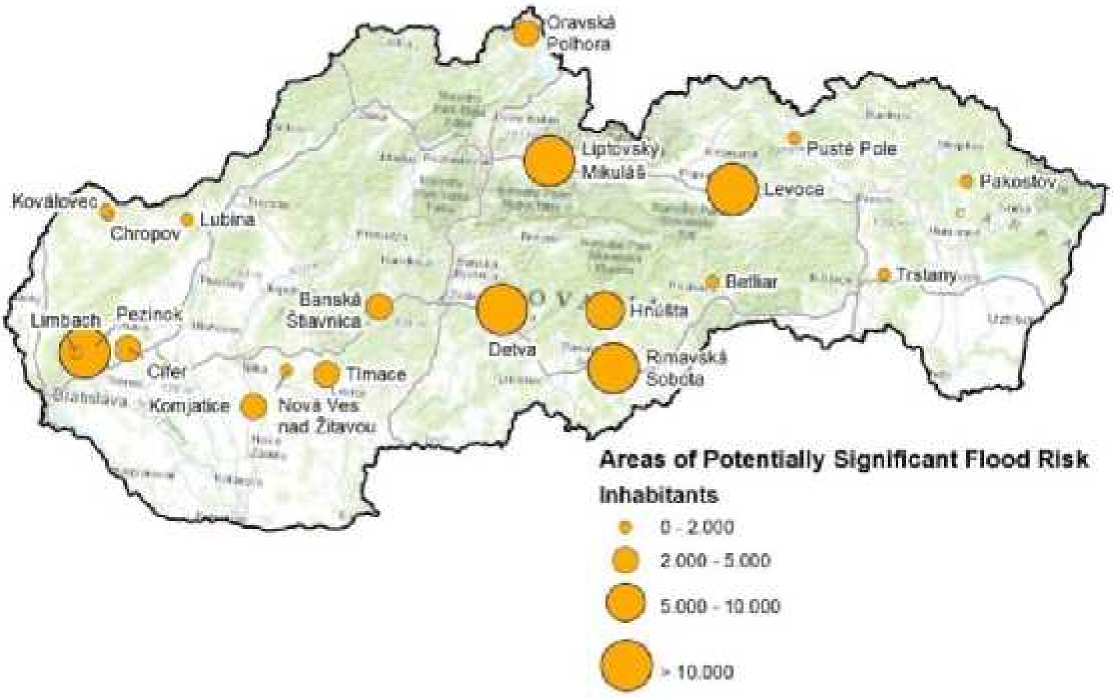


Fig. 6 Areas of potentially significant flood risk

In order to mitigate the negative consequences of floods at the entire territory of Slovakia, the project supported the rescue services on four horizontal levels:

- Local level,
- Regional level,
- National level,

-	European level.

The aid in the form of special flood equipment was distributed to the Fire and Rescue Service, Slovak Water Management Enterprise, S.E. and to 771 municipalities. At the local level, theanti-floods action pack (Fig. 7),completed the technical equipment of the each municipality voluntary fire brigade, which facilitates the management of emergencies at this level. Also 150 municipalities were equipped with the CAS 15 Iveco Daily vehicle.

Fig. 7Anti-floods action pack components

A part of the project was also training of intervention capacities for handling and use of the equipment, while the training was carried out in the regions according to the respective municipalities.

Among the flood rescue equipment of the Fire and Rescue Service belong also (Fig. 8 – 28):

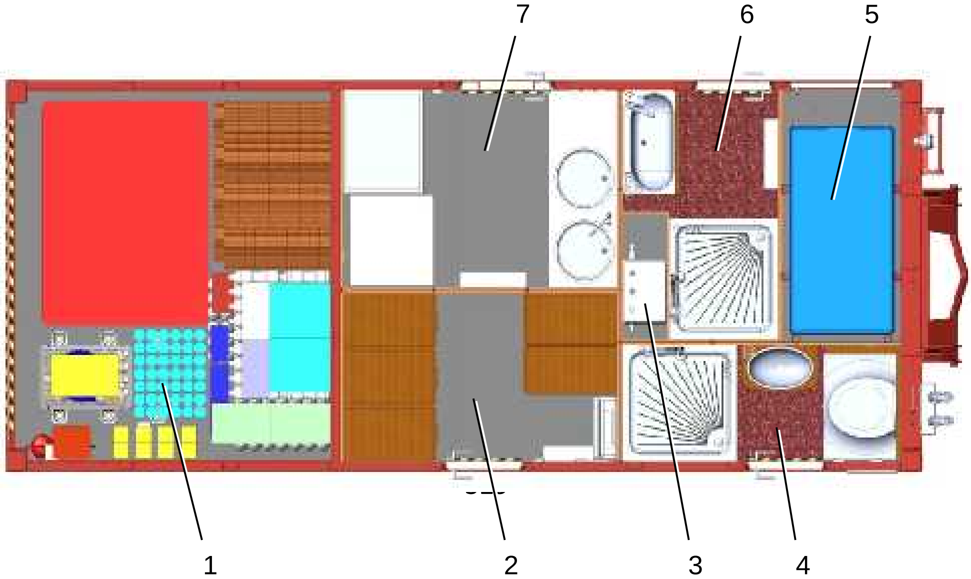
- Transport vehicle with stretcher and trailer for containers and container systems 6x6 on the chassis of MB Arocs – Fig. 8

- Transport vehicle with stretcher and trailer for containers and container systems 8x8 on the chassis of Tatra – Fig. 9

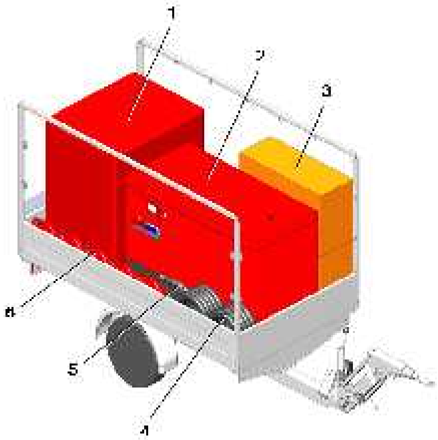
- Universal multipurpose loader JCB 4 CX – Fig. 10

- Polaris IPS XP 900 RANGER – Mobile multiple-purpose vehicle for transportation of rescuers and equipment in the hardly accessible terrain and on the unpaved anti- flood embankments (4x4 194 pcs and 6x6 30 pcs)– Fig. 11

- Container for long-lasting interventions equipped for heating/food release, relaxation, hygiene (sanitation) – Fig. 12



- Trailer with a power generator and accessories to the container for long-lasting interventions (Fig. 13)



- Separator of oil agents with accessories– Fig. 14

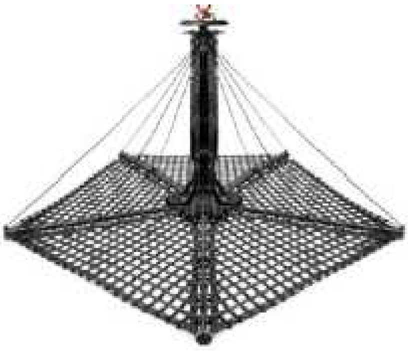
- Mobile purification device/ preparation of drinkable water – Fig. 15

- Sewage (sludge) pumps – Fig. 16

- Boat with solid frame for operation in the big watercourse with trailer and accessories – Fig. 17

- Personal protective equipment for water rescue – Fig. 18

- Rescue evacuative net under helicopter (escape platform) - Fig. 19

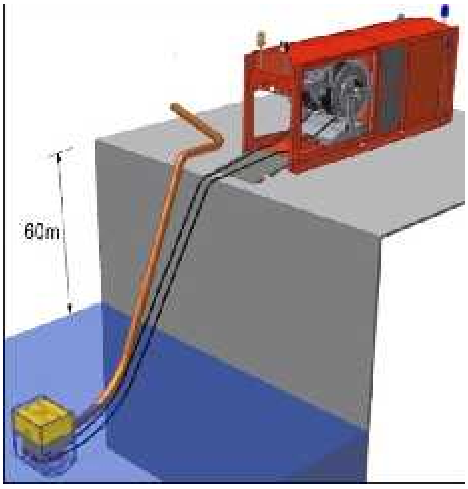


- Helicopter under-slung floating stretcher for water rescue – Fig. 20

- Bus for evacuation of victims and transportation of rescuers – Fig. 21

- Mobile pressure decompression chamber for divers – Fig. 22

- High capacity pumping system – Fig. 23



- Container for volunteers during floods with the basic personal protective equipment (raincoat, cap, gloves, rubber boots) and basic tools (shovels, mattocks, spades, axes), single-use clothing, masks, boxes) – Fig. 24

- Doser with stoker for filling of sand bags – Fig. 25

- Mobile container power generator - reserve for strategic objects (hospitals, evacuation centers) in case of power cut – Fig. 26

- Walking mobile spider excavator with trailer – Fig. 27

- Command post vehicle – Fig. 28

Slovakia is also building several national rescue modules to operate not only at national, but also at European level:

- Module HCP (High Capacity Pumping) exists – provides the high capacity pumps with complete logistics intended to major floods.
- GFFM Module (Ground Forest Fighting Module) - designed to fight forest fires in the most severe terrain conditions, using special fire equipment.
- AFFM Module (Aerial Fire Fighting Module) to fight the forest fires aerial technologies.
- MUSAR Module (Medium Urban Search & Rescue Module) - designed to search people in the rubble, e.g. after landslides and earthquakes.
- ETS Module (Emergency Temporary Shelters) - for emergency accommodation of persons affected by natural disasters or in case of unmanageable migratory flows.

The modules are able to work week 24 hours a day without any support in the area of responsibility.

CONCLUSIONS

In the paper, there are introduced several ways, respectively methodologies, to assess the flood risk in terms of the susceptibility or vulnerability of an area to flood. Except those methodological approaches a very valuable part of the paper represent the introduction of the special flood equipment with which the existing equipment of Fire and Rescue Service, Voluntary Fire Protection of the Slovak Republic and also Slovak Water Management Enterprise S.E. was completed. This equipment significantly contributed to the increasing level of resilience of the Slovak Republic, while reducing its vulnerability to flooding. This is very important impulse also for the civil protection authorities, because it enhances the existing situation in this sphere, too.

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