HADMÉRNÖK

VI. Évfolyam 3. szám - 2011. szeptember

Földi László
foldi.laszlo@zmne.hu

IMPACTS OF CLIMATE CHANGE TO DISASTER MANAGEMENT TASKS WITH SPECIAL EMPHASIS ON CRITICAL INFRASTRUCTURES[1]

Absztrakt/Abstract

A globális klímaváltozás időjárás-módosító hatásai ma már a világon számos helyen, így Magyarországon is érzékelhetőek. A szélsőséges időjárási jelenségek mind gyakoribbakká válása komoly károkat okoz a gazdaságnak, a lakosságnak és megterhelő az emberek egészségére nézve is. Mivel a jelenségek és azok tendenciózus változásai ismertek, jó esély van arra, hogy alapos elemzéssel, megfelelő felkészüléssel, új eszközök és eljárások rendszerbe állításával az extrém időjárás olykor katasztrofális következményei megelőzhetőek vagy legalább enyhíthetőek legyenek. A cikk írója felvázolja és csoportosítja a klímaváltozás okozta fenyegetéseket, és igyekszik meghatározni azokat a válaszlépéseket, amelyekkel a katasztrófavédelem hatékonyan szállhat szembe ezekkel a kihívásokkal. A cikkben a védelmi feladatok bemutatása elsősorban a kritikus infrastruktúrák területére koncentrálódik.

The weather modification impacts of global climate change are already sensible in certain areas of the world and even in Hungary. More and more frequent occurrences of extreme weather phenomena cause serious losses to economy and population and also stresses human health. As the phenomena and their tendentious changes are well known, there is a good chance to evade or at least to ease the sometimes disastrous consequences of extreme weather with deep analysis, adequate preparedness and utilization of new equipment and methods. The author of this paper draws and configures the threats caused by climate change and attempts to determine answers and reactions that would useful for disaster management to efficiently face these challenges. In this paper the presentation of defence activities is focused on the area of critical infrastructures.

Kulcsszavak/Keywords: *globális klímaváltozás, katasztrófavédelem, kritikus infrastruktúrák ~ global climate change, disaster management, critical infrastructures*

[1] The paper has been supported by the Bolyai János Research Scholarship of the Hungarian Academy of Science

INTRODUCTION

Long range global climate forecast models dealing with climate change and irregular weather situations that occur more and more often are signing an imminent and growing danger to the critical infrastructure. This way, elaboration and evaluation of experiences from functional disorders of critical infrastructures emanating from extreme weather conditions are essential to shaping the actual reactions and future solutions of disaster management.

Forecasts concerning global climate change and climate models designate in general, that the load to critical infrastructure will rise heavily. In Hungary, the growing impact to critical infrastructure comes from the increasing amount and intensity of natural disasters that are consequences of the climate change process. Of course, extreme weather situations do not always mean disasters. The difference is easily separable from the definition of disasters. The circumscription makes the difference clear between extreme events and disasters of a natural origin.

EFFECTS AND INDICATORS OF CLIMATE CHANGE

Due to climate change, there are several negative consequences to the humans and/or the environment that can be grouped as primary and additional effects.

Primary effects are which directly come with climate change:

- Extreme low/high temperature;
- Extreme amount of precipitation (heavy rainfall, thunderstorm, drift, snowfall);
- Windstorm (gale, twister).

Secondary effects can be emanated from the primaries, occasionally as a combination of two or three of them:

- Flood, drainage;
- Mudflow, earthslide;
- Drought, desertification;
- Intensive fires, increase of explosion danger;
- Damage of critical infrastructure, disturbances in public utilities and other services, formation of shortages;
- Formation of negative consequences on sanitary and psychic human comfort;
- Social functional disturbances in financial, economic and/or administrative areas, e.t.c.

Primary effects and their consequences, the secondary effects together can cause disastrous events, which depend on their size, duration and the need of countrywide cooperation against them. Primary and secondary effects can be characterized with indicators, the so called primary and secondary climate indicators.

Primary climate indicators (meteorological indicators):

- Air temperature (average temperature, maximum and minimum values, their frequency and length);
- Ocean surface water temperature;
- Amount of precipitation (average amount, short time precipitation maximum, frequency of heavy rainfalls or snowfalls);
- Wind speed and direction (average wind speed values and maximums);

- Frequency and strength of storms.

Secondary climate indicators:

This group of indicators is further divided by environmental, ecological, health (sanitary), social-economical features.

Environmental indicators:

- Amount of ice in polar regions and in Greenland (size of territory covered by ice);
- Water levels in oceans, lakes and rivers;
- Date of frost-point temperate in calendar and duration of snow on lands;
- Level of ground water;
- Air and water quality;
- Humidity of soil;
- Forest and bush fires, e.t.c.

Ecological indicators:

- Date of leafing, flowering and defoliation of trees in calendar;
- Appearance and disappearance of butterfly species;
- Date of coming and leaving of birds of passage in calendar;
- Time of sittings of birds;
- Changes in populations of different species;
- Appearance of insects en masses;

Health (sanitary) indicators:

- Mortality due to extreme weather;
- Change in distribution of disease carriers, vectors;
- Appearance of new types of diseases, e.t.c.

Social-economical indicators:

- Financial losses due to bad weather (insurance costs);
- Water supply (shortages, restrictions to water consumption);
- Changes in agricultural production;
- Changes of human habits of life, e.t.c.

INCREASING RISKS FOR CHEMICAL INDUSTRY CAUSED BY THE CLIMATE CHANGE

Extreme weather can cause serious structural damages to human environment. Negative consequences can be deeper, if additional hazards exist in the effected area. In some cases, a serious natural event is only gives initiative of a disaster with the so called “domino-effect”. It means that a primary phenomenon can cause a series of incident with accumulated consequences. One of the critical areas is the chemical industry where dangerous goods can be stockpiled in great amount.

The adequate defence of industrial establishments producing dangerous substances is part of the common defence policy. In this field, a lot of national and international legislations exist that demand obligatory defence measures from the owners and operators of dangerous industrial installations.

In our country, the Act LXXIV of 1999 on the management and organization of the prevention of disasters and the prevention of major accidents involving dangerous substances defines the phrase "disaster" (or "catastrophe") as follows: "Disaster means a state or situation (with natural, biological, human or other origin)… which threatens human life, health, properties, support of population, natural environment or natural resources in such a way, that prevention, response, relief and elimination of damages exceeds the capabilities of regular forces and their normal co-operation forms and needs special counter-measures and synchronized co-operation of local authorities and governmental forces and sometimes international contribution."

During the use of hazardous materials certain events can happen, that can cause serious accidents such are:

- Large scale fires and/or explosions;
- Emission of toxic materials from enclosed technological systems.

In chemical industry, most of the accidents caused by emission problems from production or storage devices. In details, reasons for serious accidents could be the followings:

- Damage of a container or pipeline containing flammable material, emission of the dangerous substance to the environment, where the chemical mixed with air is producing a gas or vapour cloud that causes fire.
- Damage of a container or pipeline containing toxic material, emission of a toxic gas or vapour cloud that disperses in the vicinity causing risk for human life and health.
- Vapours from an explosive material container spill out to the environment forming explosive mixture with air.

In average circumstances, greatest risks to the human life, buildings and the environment are heat waves, overpressure and explosions where flying debris can cause mechanical wounds. These effects mean dangers in approximately some hundreds of meters from the centre of the accident. But sometimes, mainly in extreme weather situations, gas or vapour clouds can have lethal concentrations even in some kilometres of a distance.

In Hungary, main points of interest during the investigation of weather consequences can be:

- Floods caused by heavy rainfalls;
- Structural damages caused by extreme cold and icing;
- Extraordinary windstorms, supercells.

Focus of further investigations and researches can be the meteorological indicators. Main obstacle of these indicators' use in practice is the difficulty of their complicated quantification. For the use of these indicators in disaster management we need to know the primary and secondary effects of climate change more precisely. To get adequate numbers, deep analysis of event types initiated by them is also essential.

CONSEQUENCES OF CLIMATE CHANGE TO CRITICAL INFRASTRUCTURES

The National Climate Change Strategy for 2008-2025 includes effect of climate change to operability of critical infrastructures in many points. Situations and events emanated from nowadays weather anomalies are good starting points to build-up tasks of preparedness and reaction. In addition, to identify future production malfunctions, technology breakdowns and their possible consequences to other sectors of critical infrastructure it is imperative to reconsider some elements of operational safety that are not inspected or stated as non-relevant nowadays.

It is necessary to analyse the changes in climate that carry risks for critical infrastructures from many aspects. On one hand, it means the origin of resources bounded together to fulfil their functions, on the other hand, mean the allocation end-points. Other field of production malfunctions and technology breakdowns that can endanger security is the collapse of technological systems themselves and the damage in the environment as their consequence. Finally, the question that needs probably the deepest investigation is the problem and behaviour of risks arising from interdependencies.

So based on the above described the consequences and effects to the supply of population and to the distribution system must be revealed in the following situations:

- It is impossible to distribute the necessary raw material, product or service (resource in the followings) to the users on the essential infrastructure that is normally responsible for it due to obstacles emanating from modified weather circumstances.
- Although resources are accessible throw the essential infrastructure, but the functionally damaged system is unable to transport them to the users due to malfunctions caused by negative weather extremities.
- Existing weather circumstances are capable of damage the security system that stands against the environmental impacts of hazardous technology or resource used during production.
- There are disturbances in operation of a critical infrastructure that depends on other infrastructures exposed to extreme weather elements.

Growing impacts of climate change are new and arising aspects in defence tasks related to critical infrastructures, because they enhance their vulnerability. Probability of disturbances is expected to grow due to extreme weather phenomena especially in the following areas: road and railway transport, in electrical distribution system (damage of tower lines, span-wires), drinking water supply utilities (damage of water resources) and in connection with these in public services and info-communication.

Extreme weather events can cause a so called “domino-effect” in road and railway transportation networks. Consequences of a short-time current failure can grow up from local level to regional, national and even to international levels. Western European current failures in recent years can provide useful experiences for this. In 2003, about 30,000 passengers stalled on open railroad and needed help to reach the nearest railway station. As the impacts can appear directly or indirectly in many sectors at the same time, it makes the handling of these extraordinary situations even more difficult.

The above mentioned situations can take form because of extreme weather situations as weather components:

- can have direct impact to physical elements of critical infrastructures;
- can cause such environmental modifications, that neither preventive planning nor security systems for handling crisis situations can manage them.

Based on this, starting from the prognosed weather variations, in order to determine their threat to operational security of critical infrastructures, the followings are to be investigated

- extraordinary large amount of precipitation;
- heavy windstorms;
- unusual temperature fluctuation;
- radiations from extremely intensive natural sources (e.g. solar flares)

The fact, that these dangerous weather parameters can generate large modifications in environmental elements causing additional risks this way needs special attention. For example, an intensive precipitation zone can initiate spates going down the river endangering the stability of banks and bulwarks, in serious situations can cause floods. Earthslides caused by heavy local rainfalls can have similarly significant impact to critical infrastructures.

Constant heat waves are similarly dangerous for critical infrastructures that can go wrong due to structural damages. Water shortages caused by heat waves not only endanger technological water needs for critical infrastructural installations with large amount of water consumption (e.g. for cooling), but can degrease drinking water resources.

In Hungary, investigation of critical infrastructures with special attention to population support and settlement safety is a task of the National Directorate General for Disaster Management since 2001. As part of its annual plan it is an important task for the Directorate General to measure the states of essential services for the citizens as electrical, gas and drinking water (sewage-water) systems, certain types of transportation (road, railroad, inland water and air), telecommunication, information networks, power-supply (electricity, fuel, coal, natural gas and district-heating) and installations for flood control.

Climate change can amplify the above mentioned problems this way can increase the risk of damage to the critical infrastructures. Expected consequences of climate change in Hungary can be predicted as follows:

- Summers will be warmer and more arid;
- Winters will be milder with more precipitation;
- Weather extremities will be more frequent;
- More days with hotness and less with freezing can be expected;
- Risks of serious droughts and floods will simultaneously grow up;
- More serious and more frequent storms are expected;

So it is statable that climate change is such a phenomenon that increases the frequency of malfunctions in operation of critical infrastructures. However, its strength depends on many circumstances. Delay or cancellation of necessary maintenance works on safety installations against hectic variations of weather conditions and intensive harmful environmental events, reduction of budget on security structures can cause dramatic decrease of operational reliability of critical infrastructure elements. This way, some elements can not stand against the increased stress caused by repeated crisis situations and can not fulfil requirements on fail-safe operation. In our country most of the elements of critical infrastructures are operating near the maximum capacity, so the increased needs in case of critical situations caused by weather anomalies are hard to satisfy. In some cases, inadequate development of an area can slow down the advancement on other well funded fields of critical infrastructures through interdependency thus it can affect negatively the social development or operational readiness.

Cancelled measures towards risk reduction both on source and consumer sides there can be more and more difficulties with handling of crisis situations emanating from interruption of operational continuity.

KEY STEPS FOR EFFICIENT DEFENCE AGAINST THE ARISING THREATS

Most of the emerging problems can be handled as follows:

- Minimum requirements should be determined for factors influencing operational continuity and readiness capabilities of critical infrastructures.
- An adequate financing system should be established to form solid background to enhance the conditions to the appropriate operation of critical infrastructures.
- Elements of critical infrastructures should be identified that can be affected by harmful consequences of climate change.
- Periodic investigation of impacts of weather extremities should be a part of the operational continuity planning for the affected elements of critical infrastructures.
- Modifying effects due to climate change should be included to defence provisions and programs on critical infrastructures.
- Risk assessments should be carried out based on climate models to find optimal actions that guarantee the best and safest continual operation and availability of critical infrastructure elements.
- Common procedures should be formed in protection of with regional or global interdependencies tailored to the national defence structures.
- Necessary reserves and possibilities to apply alternative solutions should be improved during planning the protection of life and properties of population.
- Needs of significant amount of population, so called “climate refugees” should be taken into consideration during planning of adequate capabilities of certain critical infrastructures.
- Possible challenges of climate change should be included to institutional and technical development concepts of civil emergency management systems.
- Governmental, self-administrative, owner and operator tasks and responsibilities should be determined in the field of operation, maintenance and protection of critical infrastructures.
- Care should be taken on civilian preparedness in order to minimize damages and casualties in case of emergency situations.
- Procurement of new equipment should be necessary, as handling the consequences of more frequent and more intensive local and regional precipitations in some cases exceed the capabilities of regular engineering rescue tools. It needs additional extra founds to the annual budget.

It is essential to build up a system for protection of critical infrastructures against the harmful consequences of climate change that makes a common reaction possible from every related sector and installation in order to handle emergency situations effectively. International experiences in handling disastrous events are necessary to build in. Forming of integrated research teams is important to make risk assessments with scientific methods from as many points of view as possible. In addition, obtainment of a wide social support toward critical infrastructure protection is also needed, otherwise the efforts made in this field can be ineffective.

REFERENCES

[1] Nemzeti Éghajlatváltozási Stratégia (National Climate Change Strategy) 2008-2025, 75. o., http://www.kvvm.hu/cimg/documents/nes080214.pdf (2011. 08. 28.);

[2] Attila Horváth: Relationships of Sustainability, Climate Change and Security Policy. Review of the Air Force Academy. The Scientific Informative Review. Brasov, Romania. No 2/2007. pp. 65-68. ISSN 1842 - 9238 (peer reviewed)

[3] Dr. Halász László, Dr. Pellérdi Rezső, Dr. Földi László: Katasztrófavédelem I (Disaster management I.), ZMNE Elektronikus egyetemi jegyzet, 2009. https://olibx.zmne.hu/cgi-olib91/w207.bat?session=373703985&infile=&sobj=3725&cgimime=text/html

[4] Földi László, Halász László: Környezetbiztonság (Environmental security), Complex Kiadó (Kiskönyvtár a biztonságról, ISSN 2060-8047; 4.), 2009. Budapest, oldalszám: 419, ISBN: 978-963-295-020-4,

[5] Dr. Pálvölgyi Tamás: A klímaváltozás folyamata és társadalmi-gazdasági következményei (Course of climate change and its social-economical impact), http://www.eukn.org/Hungary/hu_hu/E_könyvtár (2011. 08. 11.);

[6] National Security and the Threat of Climate Change. The CNA Corporation final report. URL cím: http://securityandclimate.cna.org/report/SecurityandClimate_Final.pdf (2010. 09. 17.)

[7] Horváth Attila: Hogyan értessük meg a kritikus infrastruktúra komplex értelmezésének szükségességét és védelmének fontosságát? (How to explain the need of complex definition for critical infrastructure and the importance of its protection?) Hadmérnök on-line, Budapest, 2010. V. évfolyam 1. szám. pp. 377-386. ISSN 1788 1919. http://www.hadmernok.hu/2010_1_horvatha.pdf

[8] Nagy Rudolf, Földi László: A kritikus infrastruktúrák és védelmük nemzeti programja (Critical infrastructures and the national program for their protection), Polgári védelmi szemle, 2009./1. szám, 57-71. o. http://www.mpvsz.hu/letoltes/pvszemle/pv2009_1.pdf

[9] Horváth Attila: Az élelmiszerellátási lánc kritikus infrastruktúrái terrorfenyegetettségének jellemzői. (Characteristics of terrorist threat on the critical infrastructures of the food supply chain) Hadmérnök on-line, Budapest, 2009. IV. évfolyam 2. szám. pp.437-449. ISSN 1788 1919. http://www.hadmernok.hu/2009_2_horvatha.pdf