

ANALYSIS OF THE ORGANIZATION AND PROVISION OF FIREFIGHTING ACTIVITIES AND PROTECTION OF THE POPULATION DURING DISASTERS AND ACCIDENTS

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Abstract: This article is the first part of a complex scientific study aimed at analyzing all components in the process of protecting the population from disasters and accidents and proposing a logistic system aimed at improving the response and effectiveness of the actions of the services responsible for this protection. More specifically, we focused on fires and fire fighting, as a key factor in environmental protection. Global warming is an undeniable fact that has been talked about and written about a lot in the last 30 years. According to UN experts, the next increase in global air temperature during the 21st century may reach from 1.5° C to 4° C. The current trend of global warming is the result of the increase of greenhouse gases in the atmosphere due to burning of fuel minerals, agricultural activities and deforestation (Vladev, I., 2023). According to the study by William et al (2023), the total amount of CO₂ released into the atmosphere in the last 30 years alone has increased by 62% or from 24gt in 1990 to 39gt in 2020. As we know deforestation is mainly caused by fires. The contribution of this factor to the total emission of carbon dioxide for 1985 was 24.6% according to Vronsky, V. (2000). So, the problem of timely detection and extinguishing of fires is serious. In order to create a more effective logistics system, it is required to first analyze the types of fires, the reasons for their occurrence and to define all the elements of the system related to extinguishing and liquidating their consequences. The analysis of the fire situation in the forests of Bulgaria for the last 30 years shows a sharp increase in the number, size of burned areas and their intensity. From the analysis made according to (Report on the state of national security of the Republic of Bulgaria, 2018) two main factors stand out for the increase in fires: - Climate changes, aggravated by anthropogenic activity; - Human intervention – fires caused by deliberate arson or negligence (Grigorov, 2020). The statistics of the last 30 years unambiguously show that over 80% of all forest fires in Bulgaria are the result of human activity, including - the burning of stubble and pastures, which are the cause of 34% of the fires that occurred. On average, no more than 2.5% of the fires in the forest territories were caused naturally by lightning. The proven anthropogenic nature of over 80% of fires necessitates the categorization of forests near settlements, especially in densely populated parts of the country, as high risk from a fire point of view. The systematic analysis described in the article gives us the basis to draw conclusions and findings on the basis of which to define the main elements of the logistics system, subject to further development and modeling.

Keywords: fires, general engineering, logistics systems.

1. INTRODUCTION

Global warming over the past 30 years is an indisputable fact. According to UN experts, the next increase in global air temperature during the 21st century may reach from 1.5°C to 4°C. The increasing role of the anthropogenic climate-forming factor contributes particularly to this result. While at the dawn of the technical revolution this factor played a minor role, now it turns out to be essential. The current trend of global warming due to human activity is the result of the increase of greenhouse gases in the atmosphere due to the burning of fossil fuels, agricultural activities and deforestation (Vladev, I., 2023). According to the study by William et al (2023), the total amount of CO₂ released into the atmosphere in the last 30 years alone has increased by 62%, or from 24 gigatons in 1990 to 39 gigatons in 2020. As we know, deforestation is mainly caused by fires. The contribution of this factor to the total emission of carbon dioxide for 1985 was 24.6% according to Vronsky, V. (2000). Again according to William et al. (2023) the area of burned land in Canada in 2023 has nearly tripled since 2000, reaching 15 million. the hectare. So, the problem of timely detection and extinguishing of fires is serious and is subject to the effectiveness of existing logistics systems. In order to create a more effective logistical system for fighting fires, it is first required to analyze the types of fires, the causes of their occurrence and to define all elements of the system related to extinguishing and liquidating their consequences. This analysis is the subject of the present work.

2. DISCLOSURE

In the last 30 years, the number and size of burned areas and their intensity in the forests of Bulgaria have increased sharply, according to data from (IAG Bulletin, 2021). The most pronounced tendency of increase was found for the period from 1999 to 2001, as well as in 2007. In these years, in terms of fire risk, our country is on the same level as the traditionally high-risk countries of the Mediterranean. The largest number of fires occurred in 2000 and 2007 -

respectively - 1,710 and 1,478. with an area of 430,000 to 574,060 [acre]. In the last decade, the years with the most forest fires were 2012, 2017 and Until August 10, 2021, according to the statistics of the Forestry Executive Agency (IAG) (IAG Bulletin, 2021), about 200 forest fires were registered in the country's forest territories . fires that affected more than 15,000 [acre], nearly 2,000 [acre] of which were burned by peak fires, far exceeding critical numbers in the worst years. For comparison, in the same period of 2007 (the last crisis year for forest fires in the country), the indicators are as follows - 1400 pcs. fires that affected over 370,000 [acre] of forest territories, of which 62,147 [acre] were peak fires. Sooner or later, our country will again face such a challenge, in which the readiness of all departments to deal with the disasters that have arisen will be essential.

It is interesting to trace the causes of fires in 2021 according to data from the IAG analysis of over 200 fires: - caused by natural causes from lightning are less than 8% (which is one of the highest percentages of natural fires recorded in the last decade); 5% are intentional; caused by human negligence are 57% and 30% are due to unknown causes.

Statistics from the last 30 years clearly show that over 80% of all forest fires in Bulgaria are the result of human activity, including - the burning of pastures and stubble, which are the cause of 34% of the fires that occurred (GSP-2018, 2019, 2020). On average, no more than 2.5% of the fires in the forest territories were caused naturally by lightning. The proven anthropogenic nature of over 80% of fires necessitates the categorization of forests near settlements, especially in densely populated parts of the country, as high risk from a fire point of view. The same applies to forests around roads, industrial plants, tourist routes and centers and other places with a strong human presence.

In the last ten years, the percentage of fires caused by negligence is the highest, as can be seen from Table 1 below. Out of an average of 500 fires in the last 10 years, 390 were caused by human error. On average, more than 50 thousand acres of forest areas are affected per year. All this has resulted in damage to the national economy in the amount of over 830 thousand BGN, on average per year. As this amount does not include the costs for the restoration of the burned peak forest areas, which are usually assessed in the next three years by the State Forestry Enterprises and other owners of forest areas.

Table 1. Statistics of forest fires in the country according to IAG data 2011-2020 (IAG Bulletin, 2021)

year	Total number of fires	Affected forest areas (acres)	Causes of fires - human(a), natural(b) or unnatural activities(c) (number)			Direct damage(BGN)
			a	b	c	
2011	635	68830	418	7	210	1783544
2012	876	127300	669	42	165	2 375756
2013	408	33140	334	12	62	737593
2014	151	9160	128	3	20	76360
2015	429	43130	335	12	82	736961
2016	583	63390	463	22	98	76360
2017	513	45690	431	14	68	3987532
2018	222	14530	166	7	50	39286
2019	668	56190	550	8	110	2071115
2020	499	52580	350	13	136	621130
Average	498	51400	389	14	100	830700

The data confidently indicate that more than 80% of all forest fires originate outside the forest territories and subsequently transfer to them. Among the main causes, apart from the meteorological factor, are the carelessness of farmers, especially in clearing pastures and uncultivable agricultural lands. In recent years, they have been a major factor in Northwestern Bulgaria and in the regions of Sliven, St. Zagora and Haskovo. The biggest and most difficult to control forest fires in the summer months are caused precisely by this kind of carelessness, turning into irresponsibility. In this regard and as a result of the established numerous fires occurring during the clearing of pastures and subsequently passing into forest areas, it is necessary to update the administrative procedures for establishing fires in agricultural lands, to foresee a regime for sanctioning the owners, users and/or applicants on the schemes and measures for direct payments in the event of non-compliance with fire safety rules and causing fires, and in general for the prevention of fires in agriculture.

The main method for preventing, reducing or quickly eliminating the effects of fires, industrial accidents and natural disasters is prevention. According to (Mitkov, A.L. & Minkov D.P., 1993), the measures that need to be taken to reduce this type of impact are:

- Carrying out preventive activities - training, maintaining a resource of people and equipment for timely extinguishing fires, creating the necessary organization for taking measures to protect the life and health of people, the environment and identifying the necessary actions of the management bodies and response forces for anticipated fire disasters, annual update of fire protection plans and others;
- Keeping the forces and means in readiness - providing and keeping in constant readiness the forces, the means, the communication and information system for monitoring, analyzing and assessing the situation, as well as determining the duties and responsibilities of each of the participants in the rescue activities and in liquidating the consequences from fires;
- Timely implementation of fire prevention measures in the forests to limit fires, maintain the old ones and build new barrier barriers and mineralized strips;
- Appointment of fire watchers for timely disclosure in the event of mass forest and field fires, construction and maintenance of observation towers, fire depots and signboards;
- Building firefighting groups in town halls and in State Forestry, creating an organization for mass participation of forces and means to extinguish forest and field fires;
- Timely notification of the population, management authorities and the forces necessary to carry out rescue and urgent emergency-restoration works in the event of mass fires;
- Providing all kinds of assistance to the population caught in the area of the mass fire.

It is necessary for the structures of fire prevention and emergency safety to carry out preventive measures to prevent and limit the occurrence of fires, observing the following directions:

- creation of an organization for the implementation of measures to secure the forest and agricultural massifs and for the interaction of the municipalities with other institutions to take specific measures aimed at reducing the prerequisites for the occurrence of fires;
- creation of maps classifying forest territories according to degree of fire danger;
- timely and complete implementation of the planned fire prevention measures in the forest territories, regardless of their ownership;
- organization of effective interaction between the structures of the municipality and other institutions for the implementation of activities to reduce the conditions for the occurrence of fires in the forest territories;
- creating conditions and carrying out successful fire extinguishing of fires that have occurred;

The defined areas aim to reduce the risk of fires and build logistics systems guaranteeing the activity of structures responsible for preventing the consequences of natural disasters and emergency situations.

Based on the analyzes of statistical data on fires, accidents and disasters, we can summarize the following impact measures :

A. Designation of specific facilities for restoration or construction of:

- barriers to divide the forests into sections with an area of 2,500 to 4,000 [hectares] clearings, cleared of dry vegetation, roads and routes of high voltage transmission lines with a width of $20 \div 30$ [m];
- run through 5 [km] in forests of I and II class and through 15 [km] in forests of III class of fire danger;
- silvicultural barriers - clearings cleared of dry vegetation with a width of $5 \div 10$ [m] , which are pushed through 400 $\div$ 500 [m] in the large complexes of young coniferous forest crops and regeneration areas, as well as in broad-leaved ones that are grassed or are of the 1st or 2nd fire hazard class, in order to be divided into cells of $20 \div 40$ [hectares];
- protective mineralized strips - non-forested strips with a width of $3 \div 5$ [m], where the forest cover has been removed to the mineral soil layer. They are designed in the middle of unforested barriers, on the periphery of field protection belts, as well as for separation from cottage and working lands, commercial and residential buildings, industrial enterprises, landfills, roads, railways. lines etc.;
- provision of approaches for suction of water from the fire fighting vehicles;

B. Logistical systems for monitoring, early warning and notification of management bodies, response forces and the population in the event of disasters and fires include the following points according to (Georgiev V., 2004):

- determining the need to build or modernize existing monitoring, early warning and notification systems;
- the analysis of fires and natural disasters should be directed to a logistic information system directly connected to the warning system;
- building an information system for the exchange of information between municipalities and forestry companies, to receive information in real time about the development of the fire situation, from which conclusions can be drawn about the likely development of the fire, the necessary actions and the expected damages. Need to

provide and maintain in constant readiness the communication and information system for monitoring, analysis and assessment of the situation.

C. Modernization of the system of connection and exchange of data from the OSS duty officers to the OC and all forces and means related to crisis management and liquidation of the consequences of fires.

D. Training of management authorities, response forces and the population on the activities of:

- the duties of the responsible officials from the regional administration for organizing and conducting the training;

- obliging the bodies of the executive power and other state institutions to organize training for employees from their subordinate units, services and other operational structures for the implementation of fire protection activities;

- regional offices "Fire safety and protection of the population" to conduct exercises to work out the interaction between the management bodies, the constituent parts of the Unified Rescue System and the population in the event of a fire.

E. Fire risk reduction activities.

- ❖ The development of the fire risk assessment aims to create the necessary organization to take measures to protect the life and health of people, the environment and identify the necessary actions of the management authorities and response forces in the event of fires, as well as crises caused from fires (Georgiev V., 2004). The activities can be summarized in the following points:

- ❖ Maintaining continuous operational duty in the OC to "Fire safety and Civil Protection", the municipalities and formations of legal and natural persons to ensure timely warning and disclosure;

- ❖ Ensuring and maintaining the communication and information system in constant readiness, as well as monitoring, analysis and assessment of the situation;

- ❖ Determining the duties and responsibilities of each of the participants in the rescue activities, in liquidating the consequences of fires and in restoring the normal rhythm of life.

- ❖ Development and implementation of fire risk reduction programs;

- ❖ Identification of facilities for rehabilitation or construction and preparation of a proposal for inclusion in the national disaster protection program;

- ❖ Modernization and construction of notification systems for management bodies, response forces and the population;

- ❖ Training of management authorities and response forces;

- ❖ Conducting exercises to work out the interaction between management authorities, response forces and the population during hypothetical fires;

- ❖ Practical exercise of the actions in case of fire in potentially dangerous objects, schools, kindergartens, public transport, electricity supply, gas supply, social services, buildings with mass residence of people and others;

- ❖ Update of the telephone directory of the departments with fire protection tasks;

- ❖ Preparation of standard operating procedures and instructions - rules for the behavior and actions of the population in the event of a fire with the aim of broadcasting them on the mass media and, if necessary, with mobile announcement systems installed on motor vehicles.

Collecting and disseminating information on good practices would help to successfully develop comprehensive fire risk reduction policies. Useful in forest fire management and fire fighting activities can be countries where all or most of their territory is designated as highly threatened by fires (Greece, France, Spain, Portugal, etc.). Measures in good practices for extinguishing forest and field fires are divided into preventive and active. Preventive measures include a set of methods and activities determining the level of familiarization of residents with the real situation before an emergency situation occurs. The purpose of the preventive activities is to outline a coherent framework for determining the strategic priorities for action to reduce the risk of forest and field fires and to support the implementation of measures for their implementation at the municipal, regional and national levels. Active measures include actions during a disaster and those to overcome the damage caused by it. All of them are carried out according to a certain logistic scheme, the improvement of which is the subject of further research.

3. CONCLUSION

The systematic analysis made gives us reason to believe that the obtained results can define the following conclusions and findings:

A. The reviewed structural schemes define as comprehensively as possible the participating elements and their interrelationships, enabling an accurate and comprehensive analysis with a view to creating appropriate models and algorithms for the assessment and correction of errors in the occurrence of fires, industrial accidents and natural disasters.

B. The analysis performed is based on the cited statistical studies and shows that in order to minimize the risk of damage, a study of the effectiveness of the various components in the logistics system ensuring the efficiency and operation of the machines and equipment is required.

C. The analysis of the fires, accidents and natural disasters that have occurred shows that there is a need to develop models for the implementation of such systems with modern adaptive management, reducing the risk and damage from the impacts on people and nature.

D. The advantages and disadvantages of impact monitoring systems have been analyzed in order to specify the possibilities for their evaluation and localization using real and simulation models for evaluation and correction of errors in the modeling of logistics provision.

These results are the basis for developing a new, more optimal logistics scheme for action before, during and after a fire or natural disaster. This is a topic for further development.

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