A system for the simulation and the operational prediction of the vegetation wild fires

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ABSTRACT: The wild fires of the vegetation are in the Mediterranean countries very frequent, the fire fighting requires extensive resources, material losses are significant and casualties of firefighters are one of the worst consequences. Due to large spatial extension, and the duration of several days, many of the vegetation wild fires are often demanding for advancement of the firefighting technology. In Croatia is the existing organization a mixture of the public professional firefighting brigades and firefighter volunteers and it can successfully cope with smaller and medium vegetation wild fires. In the case of the dynamic spreading of the fires at larger area and lasting more than day or two, these resources are not sufficient. There are several approaches how to improve efficiency of the available fire fighting resources and they are related to costly organizational changes, change of funding scheme, purchasing the new technology etc. Nevertheless, to the future of the started processes, the training of the fire fighting commanding officers and operations managers is a constant need and it is part of the normal activity. One part of the education and training not implemented yet is the training for management and commanding in larger and spatially and temporally changing fires of the vegetation, requiring more firefighters

(e.g. more than 100). The vegetation fires in the year 2007. In the coastal region, especially in the Dubrovnik – Neretva County, show all deficiencies of the existing fire fighting system in the Republic of Croatia and stress the need for urgent and significant advancements.

The training could be one of important goals. One of the contributions to the solution of the problem is to introduce the best suitable simulation program for the training of the commanders and operation managers. In many fires, the lack of information about the current state and the dynamic evolution of the fire play a central role. Thus, vegetation fire perception in real-time is a key issue for the development of advanced fire fighting strategies. For this purpose concept of the simulation system was derived that includes well selected software, that is approved by historical data of former vegetation fires, the matched digital elevation model, the spatial information of the vegetation cover, other contextual dependent data (wind strength and direction, moisture of the fuel, type of fuel). Analysis of various simulation software showed that some of them are suitable and reliable for short term, near real time prediction, when the uncertainty and the lack of information and data has the largest risky impact on decision. By use of the simulation for the determined starting position at time when the early warning information is received, several alternatives can be derived and ranked in accordance to the relevant criteria. Commander can evaluate options and his decision can better match to the likely development of the vegetation fire. The software for the simulation and the operational prediction of the vegetation fires was selected, approved on the historical fires data of islands Lastovo and Korčula, supported by needed spatial data and evaluated in the frames of the project. Further steps are: validate it preliminary at the workshop of firefighting commanders and operations managers and operationally evaluate its value during the firefighting season in the main firefighting operations centre. The experience collected in these steps will serve for definition and the design of the system for the simulation and the operational prediction of the vegetation wild fires.

1   INTRODUCTION

The severity of the wild vegetation fires in Croatia requires improvement of the efficiency of the existing firefighting system. There are several approaches how to improve efficiency of the use of the available fire fighting resources, all connected to the costly organizational changes, changes of funding scheme, purchasing the new technology etc. We consider following ways that can advance the existing firefighting system: a) involve training by the simulation, b) introduce application of the satellite borne early warning about forest fires approaching the borders of the country, c) apply the airborne remote sensing technology for the surveillance and reconnaissance of the wild fires, d) apply the simulation software for the operational prediction of the advancement of the vegetation fires, e) integrate all previous into an intelligence system. The activities and results regarding a), b), d), e) achieved in the frame of the technology project TP-06/0007-01 [12] supported by the Ministry of the science, education and sports of the Republic of Croatia are presented in next chapters, while the activities and results related to c) are separately shown in [9].

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2   TECHNOLOGY PROJECT INITIATIVES

The technology project "System for the multisensor airborne reconnaissance and surveillance in the crisis situations and the protection of environment", TP-06/0007-01, supported by the Ministry of the science, education and sports of the Republic of Croatia was prepared in the year 2006., and realized in the years 2007. and 2008. [12], [8]. The following set of the requirements determines aims, goals, tasks and expected results of the development and the implementation of the operational prediction module:

- Produce a software module for the operational prediction of the wild vegetation fires, by means of the public software system Farsite [7], following the conclusions and recommendations given in [4]; combine it with GIS software that is in use or is suitable to the user.
- Implement the operational prediction module in a way that can apply topographic maps, and/or digital ortho photo maps (DOF) and the digital elevation model (DEM)
- Complete the contents of the used maps and/or digital ortho photo maps (DOF) by data about objects existing in fact (vegetation polygons, types of vegetation, clearings in the forest, paths, ways, objects, etc.). For this purpose apply the data collected by the airborne remote sensing systems and implemented methods and procedures for the interpretation of the vegetation wild fires.
- Consider and select the sources that can provide data about the vegetation needed for the operational prediction of the wild vegetation fires (the biodiversity maps of the Republic of Croatia, the interpreted satellite images, the colour digital ortho photo maps, etc.).
- Foresee the options of the application of the prediction module a) in the field, on the Mission Control Station (MCS), during the use of the aerial survey system, based on the light unmanned aerial vehicle [9], after the flight and the processing of the images; b) in the Firefighting Operations Centre, where are available all needed cartographic and other data, which receives vectors of the actual, real thematic contents from MCS.
- Provide functionality for the analyses and simulation, for the operational advancements of the models that are implemented in the module for the operational prediction of the wild vegetation fires.
- Demonstrate the operational prediction module to fire fighting commanders and operations officers, test it in the fire fighting operations centre and decide about the future steps.
- Initiate further development of the simulation technology and its implementation into the fire fighting system in Croatia.

The mentioned initiative is accomplished in the technology project [12]. A group of researchers (from Institute for Physics Zagreb and Faculty of Geodesy University of Zagreb) and experienced firefighting managers presented their results at the workshop in the School of the firefighting and protection and rescue Zagreb on March 6, 2008, [6]. The response of the audience was very positive and supported the efforts for further development, see next chapters. The National protection and rescue directorate, of the Republic of Croatia decided to support in the years 2008. and 2009. further development and implementation of the simulation system in its various forms, for the needs of the firefighting in Croatia.

3   TRAINING BY THE SIMULATION

The training of the fire fighting commanding officers and operations managers is a constant need and it is part of the normal activity. One part of the education and training not implemented yet is the training for management and commanding in larger and spatially and temporally changing fires of the vegetation, requiring more firefighters (e.g. more than 100). The vegetation fires in the year 2007. in the coastal region, especially in the Dubrovnik – Neretva County, show all deficiencies of the existing fire fighting system in the Republic of Croatia and stress the need for urgent and significant advancements, [10], [11]. The training could be one of important goals. One of the contributions to the solution of the problem is to introduce the best suitable simulation program for the training of the commanders and operation managers, [4], [7]. In many fires, the lack of information about the current state and the dynamic evolution of the fire play a central role. Thus, vegetation fire perception in real-time is a key issue for the development of advanced fire fighting strategies. For this purpose concept of the simulation system was derived that includes well selected software [7], that is approved by historical data of former vegetation fires, the matched digital elevation model, the spatial information of the vegetation cover, other contextual dependent data (wind strength and direction, moisture of the fuel, type of fuel), [1], [6]. The firefighting commanders and the operations officers, who participated the workshop [6], stated that the system for the simulation of spreading the wild vegetation fires is a perfect tool for the training. Training by simulation is suitable for supposed larger and spatially and temporally changing fires of the vegetation, requiring more firefighters (e.g. more than 100). This initiative should be accomplished in the next year.

4   THE OPERATIONAL PREDICTION OF THE SPREADING OF THE VEGETATION FIRES

In many fires, the lack of information about the current state and the dynamic evolution of the fire play a central role. Thus, vegetation fire perception in real-time is a key issue for the development of advanced fire fighting strategies. For this purpose concept of the simulation system was derived that includes well selected software, [7], [4], that is approved by historical data of former vegetation fires, the matched digital elevation model, the spatial information of the vegetation cover, other contextual dependent data (wind strength and direction, moisture of the fuel, type of fuel), [1]. Analysis of various simulation software, [4], showed that some of them are suitable and reliable for short term, near real time prediction, when the uncertainty and the lack of information and data has the largest risky impact on decision. By use of the simulation for the determined starting position at time when the early warning information is received, several alternatives can be derived and ranked in accordance to the relevant criteria. Commander can evaluate options and his decision can better match to the likely development of the vegetation fire. The software [7] for the simulation and the operational prediction of the vegetation fires was selected, approved on the historical fires data of islands Lastovo and Korčula, supported by needed spatial data and evaluated in the frames of the project, [1]. The most critical issue of the implementation of the system for the operational simulation of the vegetation wild firs is the

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availability of the spatial data. Due to support of the National protection and rescue directorate of the Republic of Croatia, the geodetic data that exist in the Geodetic Directorate of the Republic of Croatia are provided for further implementation of the operational and training simulation systems. A further development and implementation of the simulation system is supported by the National protection and rescue directorate, of the Republic of Croatia.

5   APPLICATION OF THE SATELLITE PROVIDED DATA FOR EARLY WARNING

The early warning information about wild vegetation fire is extremely important, and efforts cope with this demand world wide, [2], [3], [5], [13]. A global initiative and service of the early warning about larger forest fires [3] has its European branch [5]. At the workshop [6] was announced possibility that National protection and rescue directorate, of the Republic of Croatia could start to use services [13], [5] and in June 2008. this functionality started. The main benefit of the applied function is the early warning about the wild forest fires approaching the Croatian borders from the territory of Bosnia and Herzegovina and Monte Negro. The seriousness of this kind of the fires ("imported from abroad") is thoroughly described in [10], [11], Figure 1. and Table. 1.

The initial testing of the satellite early warning service in a fire season of the 2008. contributed to the better awareness of a new potential resource, but its full value will be used when the operational simulation become operational.
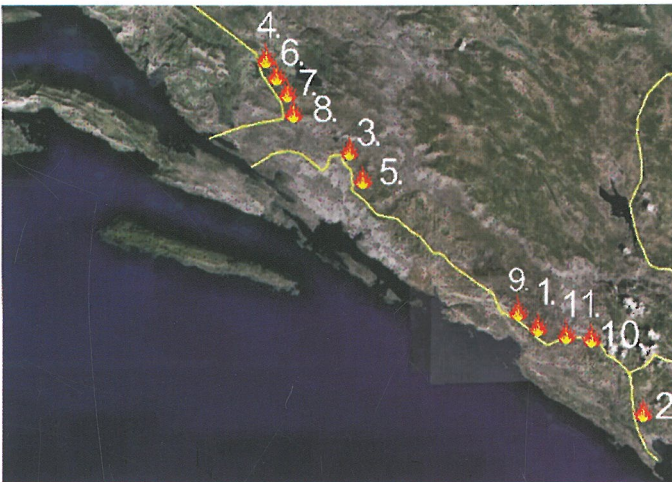

Figure 1. The forest fires that arrived in Dubrovačka Neretvanska County from surrounding countries as given in Table 1

Table 1. The forest fires that arrived in Dubrovačka Neretvanska County from the Federation of Bosnia and Herzegovina (Federation BH), Serbian Republic (SR) and Monte Negro, from 14.03.2007. to 6.08.2007., [10], [11]. Total area under fires in Croatia was 8311 ha.

Nr	Date	Time	Location	Town/County	ha	Arrived from
1	14.03.07	22:30	Plat	Župa dubrovačka	35	Federation BH
2	17.07.07	20:25	Debeli brijeg	Konavle	555	Monte Negro
3	19.07.07	06:40	Trnovica	Dubrovačko primorje	541	Federation BH
4	21.07.07	04:00	Šibenica	Metković	70	Federation BH
5	21.07.07	10:18	Čepikuće	Dubrovačko primorje	230	Federation BH
6	25.07.07	17:00	Glušci	Metković	10	Federation BH
7	28.07.07	16:00	Sanković	Metković	20	Federation BH
8	29.07.07	05:30	Zažablje	Zažablje	1800	Federation BH
	04.08.07	19:00	Zavrelje	Župa dubrovačka		
	04.08.07	20:30	Postranje	Župa dubrovačka		
9	04.08.07	22:00	Plat	Župa dubrovačka, Konavle	3476	Federation BH
	05.08.07	05:00	Ivanica	Dubrovnik		
	05.08.07	17:00	Golubov kamen	Dubrovnik		
10	05.08.07	21:08	Duba-Stravča	Konavle	764	SR
11	06.08.07	11:30	Ivan Križ-Stravča	Konavle	810	SR, Federation BH
	Sum of the fires in Croatia (from 14.03 to 6.08.2007) that arived from abroad, in ha.				8311	

6   APPLICATION OF THE AIRBORNE RECONNAISSANCE OF THE VEGETATION FIRES

Although the suppression of the wild vegetation fires is dominantly realized by the airborne technology (Canadair, Air Tractor, Mi-8 MTV), the airborne reconnaissance and the surveillance for this purpose is only visual and a helicopter Bell-206 is aimed for this purpose. In the frame of the technology project [12], were developed and realized two kinds of the airborne reconnaissance and the surveillance, [9]. One is based on the application of a "light aerial model" (this is strictly legal name for this kind of the plane, although is in common use the term the unmanned aerial vehicle (UAV)). The aerial model is advanced by the autopilot and ground based mission control station. Onboard of the aerial model are two sensors, a color camera and the long wave infrared thermal camera. Wireless microwave communication provides both video images in the real time on the ground. The other system is a multisensor system that is used onboard of the helicopter Bell-206. It is aimed to collect digital data about fires and deliver them after the landing. Both approaches are presented in [9].

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7 INTEGRATION INTO A FIREFIGHTING INTELLIGENCE SYSTEM

The year 2008. was successful regarding the new approved technologies that can significantly advance the command and control of the larger and longer lasting wild vegetation fires. They are considered in the previous chapters and in [9]. This situation is an ideal opportunity to integrate efforts of these different activities and establish an advanced firefighting system. The experience, references and approved own developments are guarantee that one such project is feasible.

REFERENCES

[1] D. Starešinić, S. Šamanović, A. Kuveždić, M. Miloslavić, K. Biljaković, 2008., Validation and calibration of Farsite vegetation fire growth simulation software on several Adriatic islands, First International Conference: Disaster Management and Emergency Response in the Mediterranean Region, Zadar, Croatia, 22 – 24 September 2008.

[2] D.L. Martell, R.S. McAlpine, 2003, Forest Fire Detection Economics, Fire Detection Workshop, Hinton, Alberta, Canada, Marc 25, 2003.

[3] FIRMS, 2008, University of Maryland, 2008, The Fire Information for Resource Management System, URL: *http://maps.geog.umd.edu/firms/default.asp*

[4] IST, 2001, Fire related models characteristics and recommendations on models standardisation, D4.3, CLIFF/WP400/D4-3

[5] JRC-IES, 2006, Forest Fires in Europe, Report No 7/2006, European Commission, Joint Research Centre, Institute for Environment and Sustainability, EUR 22931 EN -2007.

[6] K. Biljaković, M. Bajić, M. Miloslavić, D. Starešinić, A. Kuveždić, A module for the simulation and the operational prediction of the vegetation wild fires, workshop, March 6., 2008., School of firefighting protection and rescue, National protection and rescue directorate, of the Republic of Croatia, Ksaverska cesta 107, Zagreb (in Croatian).

[7] M. A. Finney, 1998, FARSITE: fire area simulator-model development and evaluation, USA Department of Agriculture, Forest service, RMRS-RP-4, March 1998.

[8] M. Bajić, H. Gold, T. Fiedler, D. Gajski, 2008., Development of a concept from 1998. and realisation of the system for the airborne multisensor reconnaissance and surveillance in the crisis situations and the protection of the environment in 2007. – 2008., First International Conference: Disaster Management and Emergency Response in the Mediterranean Region, Zadar, Croatia, 22 – 24 September 2008.

[9] M. Bajić, M.Miloslavić, M. Hucaljuk, N. Šosterič, D. Penzar, 2008., Airborne reconnaissance and surveillance of the vegetation fires, First International Conference: Disaster Man-

agement and Emergency Response in the Mediterranean Region, Zadar, Croatia, 22 – 24 September 2008.

[10] M. Miloslavić, 2008., Osvrt na požare raslinja u dubrovačko-neretvanskoj županiji uzduž državne granice sa Bosnom i Hercegovinom i Crnom Gorom tijekom 2007., 9.02.2008. (In Croatian).

[11] M. Miloslavić, 2007., Požari raslinja u dubrovačko – neretvanskoj županiji uzduž državne granice sa BiH i CG, kolovoz 2007., prezentacija, Vatrogasna zajednica dubrovačko – neretvanske županije. (In Croatian).

[12] MZOŠ RH, 2007., System for the airborne multisensor reconnaissance and surveillance in the crisis situations and the protection of the environment, technology project TP-06/0007-01 Ministry of science, education and sports of the Republic of Croatia, Faculty of Geodesy University of Zagreb, HCR Centre for testing, development and training Ltd., Faculty of traffic sciences University of Zagreb, Pastor Group, Zagreb (in Croatian)

[13] Y.J. Kaufman et al., 1998., Potential Global Fire Monitoring from EOS-MODIS, http://www.cstars.ucdavis.edu/papers/html/kaufmanetal1998a/index.html