Forestwatch® wildfire smoke detection system: lessons learned from its two-year operational trial

M. Lalkovič & J. Pajtíková
National Forest Centre, Slovak Republic

Abstract

In 2008 the wildfire smoke detection system Forestwatch® was introduced to Slovakia. The operational trial was set up at the State Forest Enterprise Kriváň and covered about 60,000 ha of mostly forested area. The trial benefited from the transfer of know-how from abroad. In 2008-2009, the trial focused on the system implementation and testing its feasibility in Slovak conditions. The trial results have fully confirmed its suitability for wider use in Slovak forests.

Keywords: fire monitoring, forests vulnerable to fire, wildfires.

1 Introduction

The Slovak republic is one of the most forested countries of Europe. Forests cover almost 41% of the country's area, which equals 1,934,000 ha. The proportion of coniferous and broadleaved species is 40.3% and 59.7%, respectively.

Every year fire damages extensive areas of forest stands. In Slovakia, fire prevention is currently performed by a combination of ground patrols of foresters and aerial monitoring, while the patrols are realised mainly during the weekends and holidays. Both methods are quite efficient, but rather limited in scope, particularly from the financial side. Due to the increasing topicality of this issue, it is important to search for and to apply alternative techniques of forest fire monitoring. The aim is to shorten the response time between fire occurrence and the start of its suppression while accounting for economic efficiency. One alternative possibility is to apply a fixed camera fire monitoring system.

WIT Transactions on Ecology and the Environment, Vol 137, © 2010 WIT Press
www.witpress.com, ISSN 1743-3541 (on-line)
doi:10.2495/FIVA100121

2 Fire detection system Forestwatch®

The fire detection system Forestwatch® is an automated fire detection monitoring system developed by the company EnviroVision Solutions PTY Ltd. from South Africa. In Europe, the product is distributed by Eagle Eye Protection from Greece, which is in Central Europe represented by ICZ Slovakia Ltd. This system is based on camera scanning of the area of interest and consequent evaluation of obtained images for the occurrence of smoke or fire signs. The system has over a 10-year history and has been applied in South Africa, Canada, USA, Chile, and other countries. The Forestwatch® system consists of several components fulfilling partial tasks to ensure the functioning of the system as a whole. The components are the following:

- Camera located at a tower (in our case we used model Pelco Esprit)
  - rotation mechanism (pan 360°)
  - tilt mechanism (tilt range from + 33° to -83°)
  - automatic focusing
  - 24x optical zoom
  - light sensitivity starting from 0.0005 lux
- Professional computer (ISE – Image Sampling Engine)
- communication subsystem
- Forestwatch® software

Figure 1: Control centre and camera.

The system has two main parts: towers with cameras, and a control centre. The Forestwatch® software is installed on the servers and computers in the control centre, while in the tower there is a camera, communication subsystem, and a professional computer (ISE). The system operates continuously 24 hours per day/7 days per week, when the camera scans the area of interest. The system is also able to perform night-time monitoring – the applied cameras have a high light sensitivity of 0.005 lux. Thanks to using 3D terrain models, the system can identify and position fires even in the areas without direct visibility, i.e. "behind the hill". Data collected by cameras are processed by the professional computer and transferred by the communication subsystem to the control centre for further processing. The software in the control centre receives, processes, and interprets the data. On the basis of the interpreted data, the operator of the control centre is alerted about the possibility of fire occurrence both visually and audibly.

The system has three alarm categories:

- new fire – the system alerts the operator to the fire in the area of interest
- old fire – the system signalises that in the monitored area there are still signs of an already identified fire
- unidentifiable condition – the system is not sure and needs the operator's interaction.

The operator has the possibility to take over the control of any camera and examine the indicated incident more thoroughly. The system works with a digital terrain model, in which the identified incidents are shown. Apart from the digital terrain model, the operator can also utilise a topographic map, data from cameras, and GPS coordinates of the incident. When the digital terrain model is used, no triangulation for the incident positioning is necessary.

The methodology of the operation is an integral component of the system. The methodology describes the work with the system, and consequent resolution of detected incidents, and utilises usual ways of fire reporting and communications with fire brigade and rescue service. The advantage of the system is the possibility to provide fire brigade with GPS coordinates of fire, which substantially facilitates and speeds up the process of fire positioning and suppression. The applied methodology can differ between the regions depending on local conditions and customs.

An example of resolving an incident can be described as follows:

1. fire occurs
2. system identifies the fire, a control centre operator is alerted visually and audibly
3. an operator takes over the control of the camera mounted on the particular tower
4. an operator performs a closer analysis of the situation, and identifies if the fire is under control or not
5. uncontrolled fire is reported to the control centre of Fire and Rescue Service

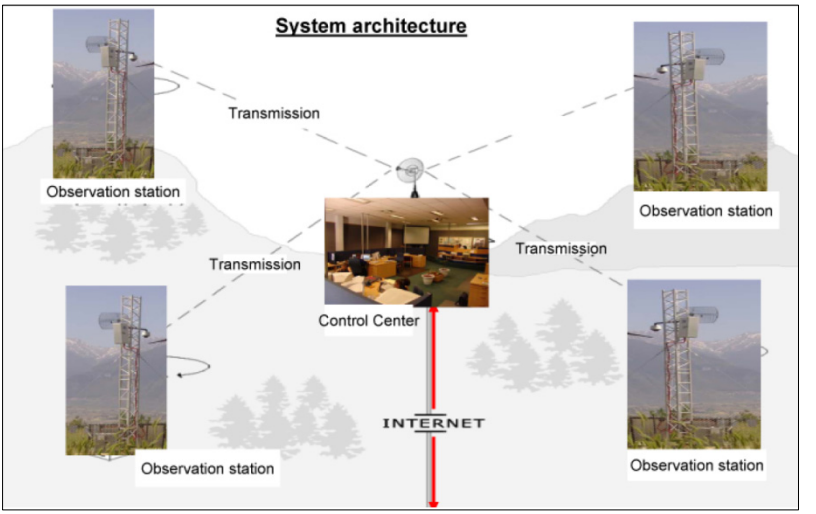

Figure 2: Scheme of functioning of system Forestwatch®.

3 Preparation, realisation and trial operation of the project

The project was realised with the support of the Ministry of Agriculture – forestry section, and on the base of the trilateral agreement between National Forest Centre Zvolen (coordinator), state enterprise Forest of the Slovak Republic (user), and ICZ Slovakia Ltd. (technology supplier). In addition, EnviroVision Solutions (Republic of South Africa) and Eagle Eye Protection (Greece) were cooperating in the project.

The operational trial was set up at the State Forest Enterprise Kriváň due to several reasons. The enterprise is situated in the area with higher fire risk, the majority of forests in the area are owned by the state, a great proportion of the area belongs to state nature reserve Poľana, and from the topography point of view the terrain is rather broken. Above all, the terrain ruggedness was an important feature for testing the system in Slovak conditions, since abroad the system has usually been applied in flat areas.

The system monitors the area of more than 60,000 hectares using 3 cameras. The cameras were positioned at mobile network towers. Due to the terrain configuration, it was needed to build one auxiliary tower at locality Ostrôžky to ensure data transmission. Within the framework of the trial operation, the system is also interconnected to the control centre of Fire and Rescue Service, which speeds up the response to fire occurrence. The connection is assured by multiple sources – telephone, e-mail, and web application.

In 2008, trial operation started on July 1st and lasted until October 1st 2008. During autumn and winter (i.e. from October 2008 to February 2009), the system was in so called sleep mode. It means that the system was in operation, but the

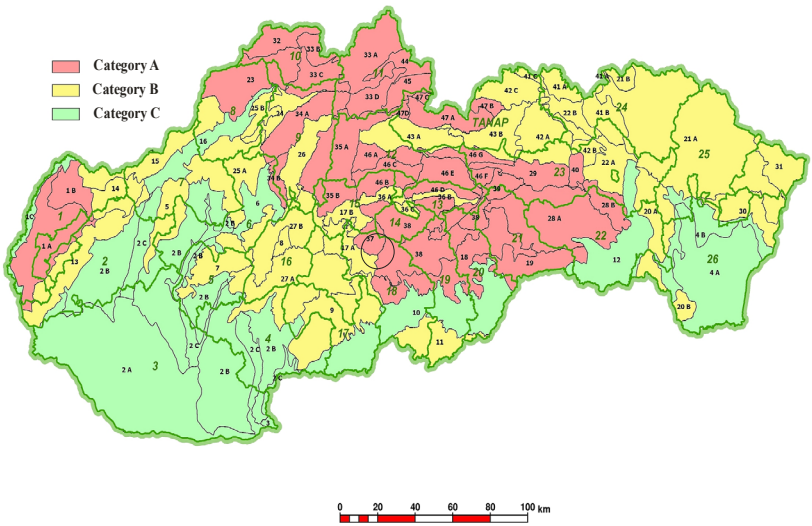

Figure 3: Regions of Slovakia according to the fire risk degree (dark grey/maximum, medium grey/minimum) and project location.

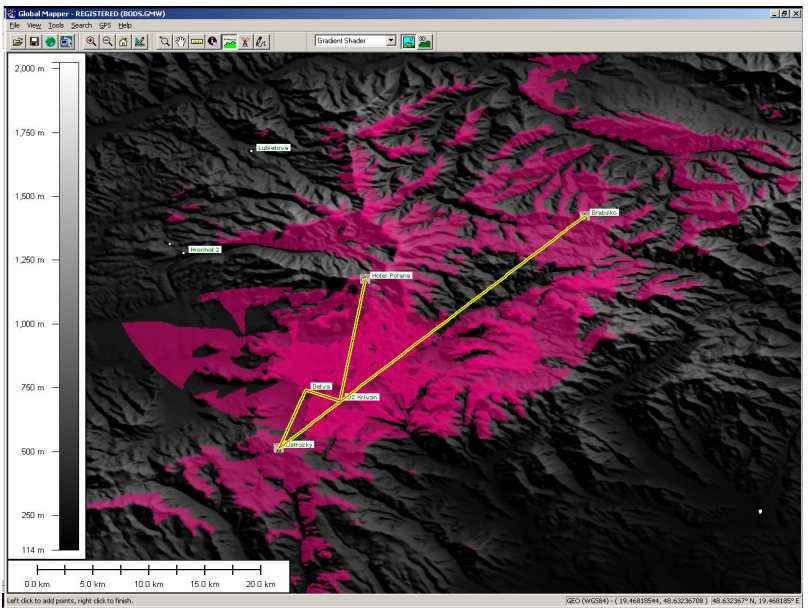

Figure 4: Preparation phase – visualisation of direct and indirect coverage of the area with cameras.

data were not processed because of very low or no fire risk. The new monitoring season was started in the middle of March 2009. Due to increasing fire risk, operators entered the system on May 15th 2009. The operation was terminated on October 31st 2009. Owing to financial problems, in 2009 monitoring was restricted to most critical periods of potential fire occurrence.

The successfulness and the suitability of the presented solution was determined on the base of the goals and the quantifiers specified in the project preparation phase and at its start as principal parameters, which could create a complex and a real picture about the possibilities and the risks of the utilisation of the given technology.

We accounted for

- The functionality of the system from the point of the needs of fire prevention
- The suitability of the system with regard to the area or locality
- The work methodology and service actions
- The system utilisation for other purposes apart from fire detection (e.g. illegal timber cutting, migration of wildlife, etc.)

Considering the personnel staff of the control centre, a so called mixed staff model was applied, i.e. during working days the operation of the control centre was realised by the employees of the Forest Enterprise, while during weekends and holidays by trained employees from forest districts. While the system was in operation, the staff was continually guided from the methodological aspect.

Figure 5: Pol'ana region – monitored area with marked mobile network tower, on which the camera is mounted.

4 Evaluation of the project realisation and operational trial

During the preparation and the realisation of the operational trial of the fire detection system no greater problems occurred, and the system was activated according to the planned schedule. The greatest requirements were put on the coordination of the activities, because, as it was already mentioned, apart from the three Slovak organisations two foreign partners from Greece and South Africa also participated in the project.

The actual fire detection process followed the applied methodology and fires could be evaluated in two basic categories:

- Controlled (reported) fires – identified by the system, planned, control centre (CC) was notified beforehand
- Uncontrolled fires – unplanned, identified by the system or an operator (grass burning, negligence, tourism...)

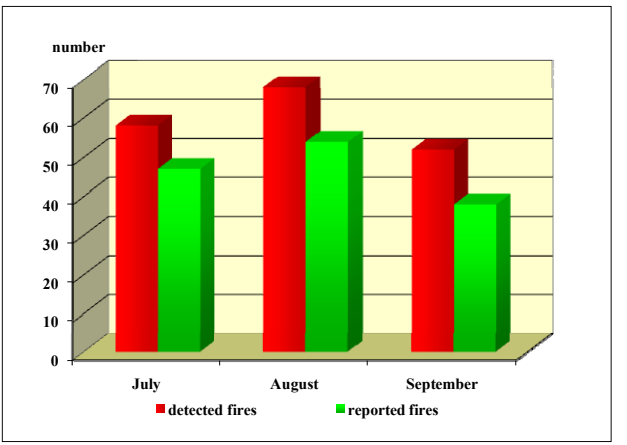

Figure 6: Fire occurrence in months of 2008.

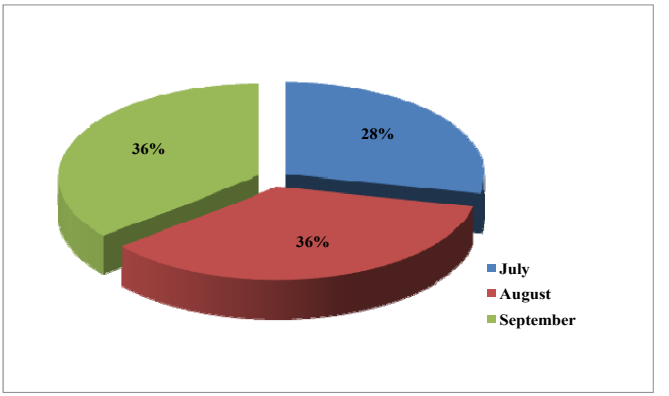

Figure 7: Uncontrolled fires in 2008 given in %.

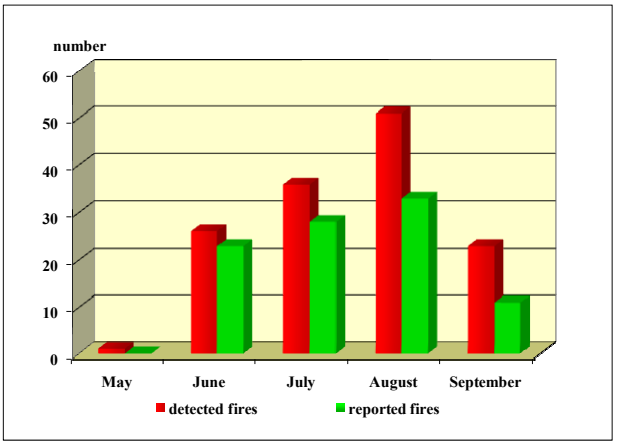

Figure 8: Fire occurrence in months of 2009.

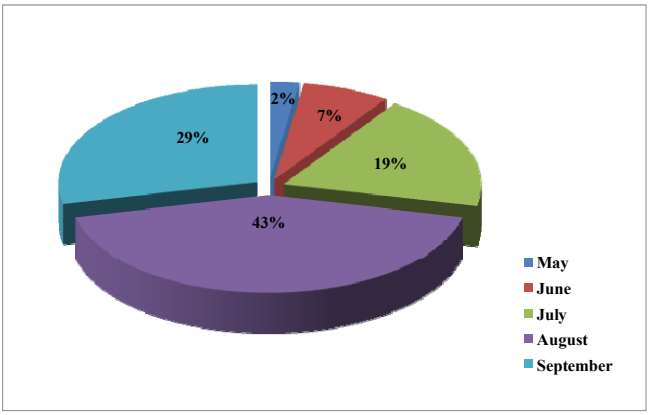

Figure 9: Uncontrolled fires in 2009 given in %.

Controlled (reported) fires were the fires, which were reported to operators of the control centre in advance, and hence, were only monitored or searched for. These kinds of fires were often reported by employees of forest districts, and in most cases these fires referred to prescribed burning of felling waste in forest stands. Uncontrolled fires were the ones that were identified by the system in the control centre, and subsequently the operators performed all relevant measures to suppress them, and to monitor them further.

Overall, during the trial operation the following number of fires was detected:

The highest frequency of uncontrolled fires was, as expected, in the summer months. It is mainly the result of more frequent movement of people in nature during holidays, as well as of favourable natural conditions (drought).

Table 1: Overview of detected fires in the trial years.

Year	Controlled (reported)	Uncontrolled	Total (detected)
2008	139	39	178
2009	95	42	137
Total	234	81	315

Table 2: Overview of detected fires in the trial months.

Month	Controlled (reported)			Uncontrolled			Total (detected)		
	2008	2009	Sum	2008	2009	Sum	2008	2009	Sum
May					1	1		1	1
June		23	23		3	3		26	26
July	47	28	75	11	8	19	58	36	94
August	54	33	87	14	18	32	68	51	119
September	38	11	49	14	12	26	52	23	75
Total	**139**	**95**	**234**	**39**	**42**	**81**	**178**	**137**	**315**

The afternoon hours of workdays between 4 pm and 8 pm, and Saturdays were found to be the most critical time periods for fire occurrence. This can be explained by the occurrence of personal agricultural activities, which are usually carried out by the population in the region in addition to their occupation.

Based on our two-year experience with the operation of the system Forestwatch we can state the following:

4.1 System benefits

- Continuous, automated control of the area of interest,
- Continuous evaluation of the situation in the monitored area,
- Alerting an operator to the changed situation in the area, and indication of the changes of examined state characteristics,
- Displaying information about the cause of alert,
- Determining of indicated problematic area with GPS coordinates and displaying it on a digital map,
- Possibility to define permanent sources of smoke (factory, dwelling – isolated house, …),
- Possibility of manual control of the system – cameras,
- An operator can monitor several areas at the same time – the system is automated, and hence, only the alerts need to be resolved,
- Reduction of costs for monitoring of areas at risk,
- Preventive psychological effect – by publishing information about the monitoring of an area, e.g. in media.

Apart from the listed advantages of direct fire prevention, the system also provides a user with the tools and the possibilities for efficient management and monitoring of forest stands concerning:

- Illegal timber felling
- Illegal movement of persons and motorised vehicles
- Illegal hunting or poaching
- Wildlife movement and migration
- General support of nature protection

4.2 Problems and shortcomings

Strong storms in the region were found to be one of the main, but hardly influence able factors affecting successful operation, as they often caused power outages.

The system itself is sensitive to accurate alignment of directional antennae of Wi-Fi devices, as the whole system is directly dependent on this communication. As far as the installation is precise, the system works reliably.

During the operation of the system, common operational shortcomings were being eliminated, and the whole system was being tuned. Frequently, system breakdown resulted from storms causing power outages on the towers, or from service works and replacement of components of electric power network by the company E-ON (Stredoslovenská energetika SSE – Central Slovak Energetic) in the areas around the towers. Such effects are difficult to be anticipated, with minimum possibility to reduce them by the system operator.

5 Other activities

As the Slovak republic is the first country in Central Europe, and after Greece the second one in Europe that uses the system Forestwatch, its implementation has also attracted interest of partners from abroad. In 2009, reference demonstrations were performed for the interested partners from Latvia, Poland, and Mongolia. The countries were represented by forestry professionals, who were mainly informed about the system implementation, its functionality, and practical experience from the operational trial concerning its functionality in the topographic and climatic conditions of Slovakia. The partners indicated their intentions to implement such a system in cooperation with our experts.

Due to the fact that the system can be applied not only for fire prevention, but also for other purposes (e.g. illegal timber felling, wildlife migration, etc. ...), these aspects were also monitored during the system operation. However, no significant activities or events of such kinds were detected during the trial period.

6 System installation costs and annual operating costs

Since the project was performed as an operational trial, the system was realised by cumulating technological, personnel, and financial sources of the three partners – State Forest Enterprise, National Forest Centre, and the private

company ICZ Slovakia. The overall costs for the trial realisation were estimated to be 450,000 € including non-financial inputs.

Average annual costs in the current operational regime are approximately 40 000 €, while both maintenance costs and direct operational costs make each about one half of the total costs.

7 Conclusion

The project of fire monitoring was realised at the Forest Enterprise Kriváň covering approximately 60,000 ha of forests, managed predominantly by the state enterprise Forests of the Slovak republic. During the trial period, the activities dealing with the preparation, realisation, trial operation, and evaluation were performed. The system is functional and suitable for a wider use in the conditions of Slovakia. The fire detection system has been found out to be an efficient complement to ground and aerial monitoring. It is of interest to extend the system to other parts of Slovakia, as this would provide an alternative to the present fire-fighting measures, and in addition, it would also reduce costs, primarily through the establishment of centralised control centres.

Further information

Websites: http://www.eep.eu.com/en/world.html (Europe)

http://www.evsolutions.biz/deployment.php (South Africa)