ASPires CATALOGUE

Advanced systems for prevention & early detection of forest fires

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Technical cooperation projects

European Commission

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ECHO A-Emergency Management

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Project coordinator

Fulda University of Applied Sciences, Germany

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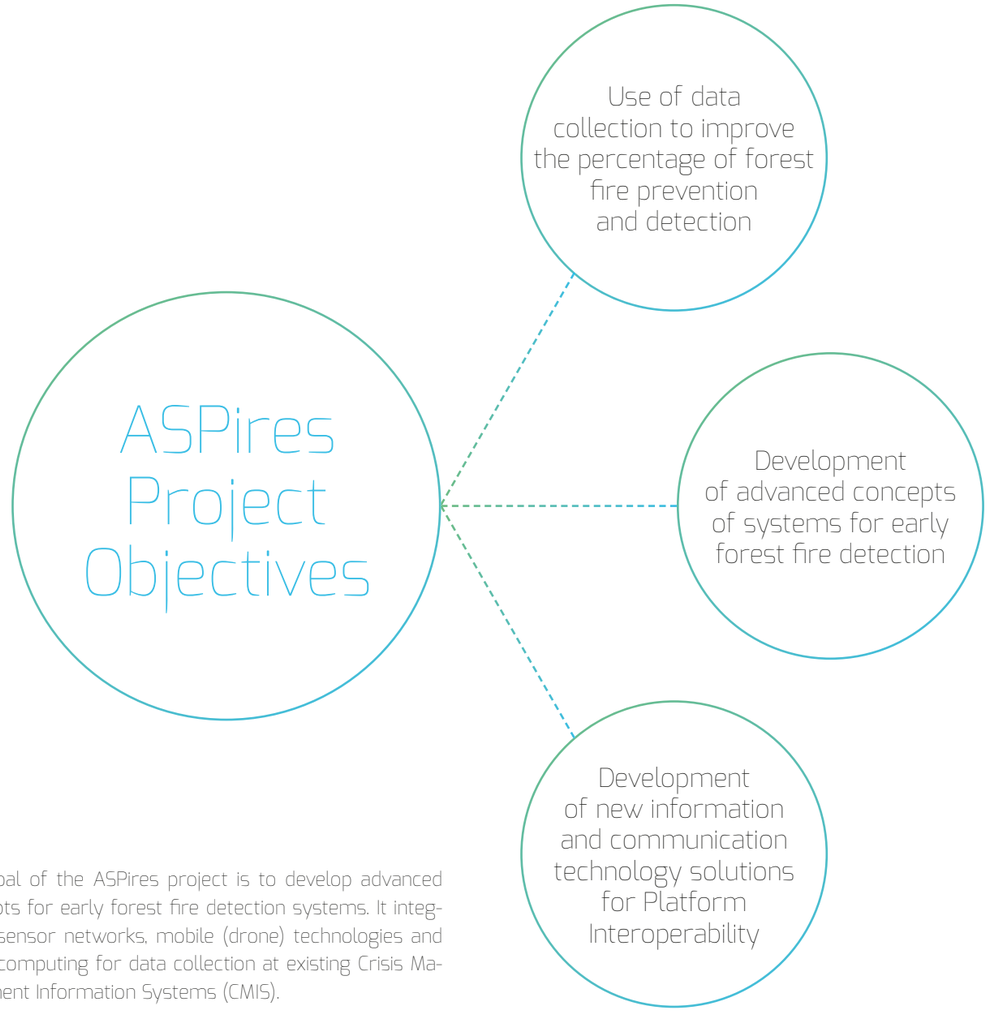
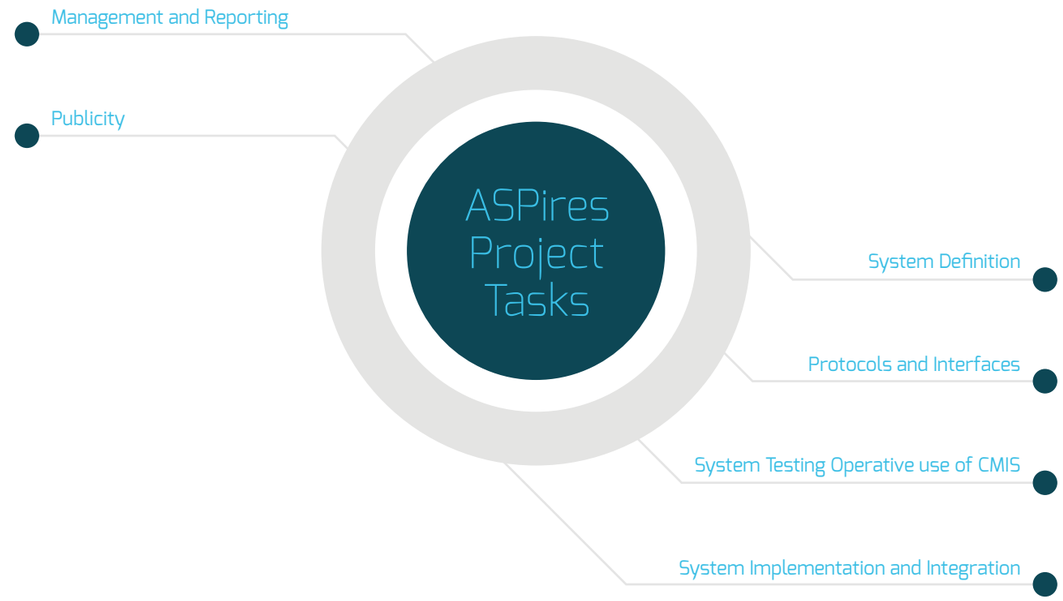


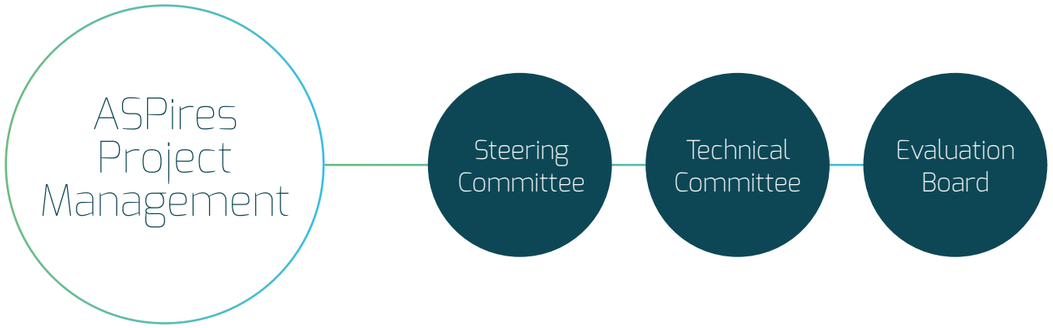
The goal of the ASPires project is to develop advanced concepts for early forest fire detection systems. It integrates sensor networks, mobile (drone) technologies and cloud computing for data collection at existing Crisis Management Information Systems (CMIS).

It will allow CMIS in Europe to develop and implement different methodologies and services for initial stage warning, prevention, localization and organization of the firefighting teams and tactics for disaster suppress.



To achieve the expected results the ASPires project is divided in several tasks, detailed described in ASPires project web site

https://www.aspires.eu/web/guest/deliverables



The coordinator of the ASPires project is Fulda University of Applied Sciences, Hesse, Germany.

The Coordinator is responsible to collect and submit all forms such as deliverables and reports, to the European Commission and represents all project partners in front of the European Commission.

The coordinator is also responsible for the financial and administrative management, which includes preparation of amendments to the grant agreement, final and progress reports and communication of changes regarding the beneficiaries to the European Commission. To ensure the cooperation and proper realisation of complex tasks, a Steering Committee (SC) was established and is headed by the coordinator.

The Steering Committee is composed of one representative from the coordinator and from all partners of the project, who have a mandate to take decisions.

The Steering committee is the body that is finally approving all project documents, deliverables, decisions, reports and the acceptance of every step of the project and guarantees the overall project coordination between tasks.

The Evaluation board takes care of the quality and completeness of the deliverables. The Evaluation board guarantees the integrity of the documents, their readability and style and reports to the Steering Committee.

The Technical committee is the body which makes technical decisions of the project. Participants are representatives from the coordinator and all partners of the project with technical expertise and experience.

Hochschule Fulda
University of Applied Sciences

Fulda University of Applied Sciences

Fulda University of Applied Sciences (www.hs-fulda.de/en/) is a research-oriented University of Applied Sciences in Fulda, Germany

Research is carried out in various areas such as „Nutritional, Food and Consumer Sciences ", „Food Technology ", „Electrical Engineering and Information Technology and Informatics" and „Applied Computer Science."

This research orientation is also reflected in the right to award doctoral degrees, which Fulda University of Applied Sciences has got since 2016 as the first University of Applied Sciences in Germany.

The University of Applied Sciences in Fulda runs furthermore cooperative doctoral programs and various doctoral research groups in collaboration with other universities.

The wide range of subjects offered by eight departments and several cross-disciplinary research centres and a regional innovation centre provide good conditions for interdisciplinary study, research and innovation activities.

As a university of applied sciences, strong collaboration with enterprises and society is part of the mission of the university.

The Aspires project, which is coordinated by the University of Applied Sciences in Fulda, is a good example of research and development resulting from cooperation between research organisations, companies, end users and further stakeholders.

The Military Academy

The Military Academy, Skopje, Republic of North Macedonia (MA, http://www.ma.edu.mk/?lang=en) was established with the Law on Military Academy, which stipulates that it works in accordance with the Law on Higher Education and the Law on Scientific Research Activity in the Republic of North Macedonia.

The Military Academy is accredited by the Ministry of Education and Science, Republic of North Macedonia in accordance with the European Credit Transfer System (ECTS), as an independent higher education and research institute.

Military Academy attains university studies of first cycle (undergraduate), second cycle (master's and specialization) and third cycle (doctoral studies).

The university diploma for students who complete MA education will be verified in the country, which will enable the cadets and students to have an occupation and opportunity for further education in the educational system of the Republic of North Macedonia and foreign member states of the Bologna Process.

The Military Academy as the only military higher education and scientific institution in the Republic of North Macedonia has the basic task of educating, training and improving staff for the needs of the MoD, the ARM, the Crisis Management System, the Protection and Rescue System and to deal with the NIR for defence needs according to law.

The role of Military Academy Skopje in the ASPires project is to conduct comparative analysis with other models of information systems for detection and monitoring forest fires, develop MOCK-UP for existing MKFFIS, installing a set of cameras detectors and mobile device (like drone) available on the market with a large optical range of monitoring forest fires in areas of importance. He performs research, testing and measurements of the detectors and sensors to analyse the degree of efficiency.

InterConsult Bulgaria

InterConsult Bulgaria (ICB, https://www.icb.bg) has been founded in 1996 with main business focus on software development and business consulting. Today more than 90% of the ICB turnover is generated from companies in the Nordic region, the UK, the USA, Germany and other countries.

During the years ICB has established itself as a leading provider of innovative software solutions in the fields of industrial engineering, maritime, banking and financial services and information technologies. ICB has more than 130 experienced professionals in staff today specialized in the areas of business process modelling, software architecture design, software development, quality assurance and 3D modelling and design.

ICB offers a wide range of professional services in the fields of:

- Development of world-class products and services focused on customer's core business
- Technology lift and modernization of existing software systems and infrastructure
- Business process modelling, optimization and automation

The role of the InterConsult Bulgaria Ltd. in the ASPires project is to develop solution for data management including storing of time series data in the cloud, data modelling and specifying of all data flows necessary for the interoperability of different systems through standard interfaces.

COMICON

COMICON (http://www.comicon.bg) has been established in 1991 as a private company by specialists experienced in the field of industrial automation.

MAIN ACTIVITIES
Turn-key solutions for automated control and monitoring of industrial processes and systems: design by certified designers, production of control panels, assembling, PLC, HMI & SCADA software, warranty and after sell service.

Production of ZigBee, EnOcean, LoRa products for wireless communication, interface converters (RS232, RS485, RS422, current loop), telemetric and embedded controllers, solar controllers, programmable logic controllers (PLC) and remote IO, signal conditioners, transmitters, signal devices.

R&D of hardware, firmware and software for industrial automation.

Energy management and monitoring systems.

Telemetric systems for wireless control and monitoring of remote installations.

Design, delivery and implementation of video wall systems for control rooms and other applications.

In the ASPires project Comicon Ltd., Bulgaria has made a research for wireless sensor networks, has designed and developed a prototype of LoRa based field gateway in fixed and mobile versions, has performed simulations through OMNET++. The aim of the simulation is to prove the vitality of the solution during disasters.

National Cluster for Intelligent Transport and Energy Systems (NCITES)

National Cluster for Intelligent Transport and Energy Systems (NCITES), Sofia, Bulgaria is a voluntary association of legal entities and individuals, established in 2014.

The aim is to achieve a more effective concentration of resources to improve competitiveness and to expand the scope of each participant's resources.

NCITES includes 12 leading companies in the field of education, IT infrastructure, software development, transport and energy control systems.

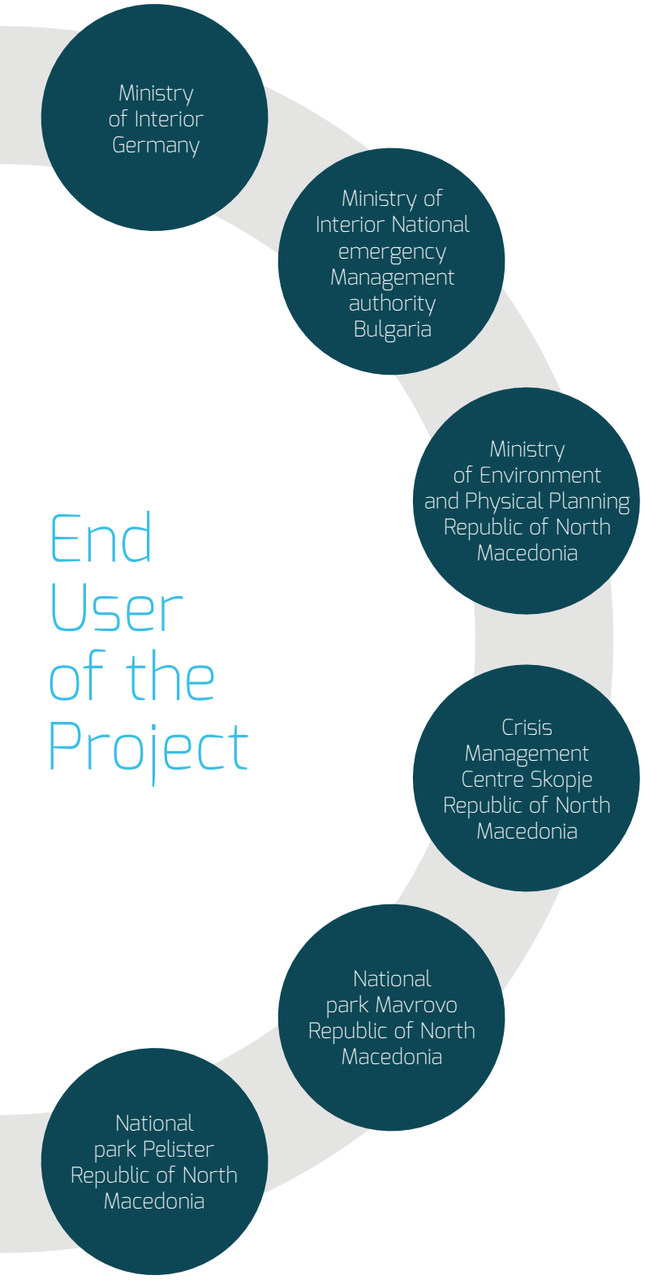
NCITES organizes the development of scientific and practical projects in the field of intelligent control systems. NCITES collaborates closely with research, training and engineering organizations.

From February 2017, the National Cluster for Intelligent Transport and Energy Systems was successfully categorized by the Ministry of Economy, the SME Agency, Bulgaria in the Cluster "Expansion" category.

The NCITES web site http://www.cluster-ites.org/en/home includes more information about the cluster.

In the ASPires project, NCITES has developed a real model of a fixed early warning system for forest fires based on cameras. The model is used to demonstrate the capabilities of the ASPires platform.

NCITES is also responsible for the creation and management of the ASPires project web site and a creation of a variety of dissemination materials.



End User of the Project

Comparative analysis of the existing systems for early forest fire detection

Forest fires undoubtedly have come to represent one of the greatest threats to nature's wellbeing and to the world in general. Usually accompanied with the loss of human lives, property damage and loss of homes, loss of forested area, biodiversity changes and climate change, forest fires should not go by being ignored.

As of 2017, in the world there are several systems as well as pilot-projects that have been created to aid the early prevention and detection of forest fires. There are also multiple scientific studies and research papers that cover this issue from different aspects.

The starting point in almost all of them is the great number of forest fires in recent years and the need to act preventively faster, easier and in a simpler manner in order to deal with the threat that forest fires have come to represent.

However, the existing systems differ from one another, and the goal of this project was to specify those differences, identify their strengths and weakness and propose a way to strengthen their reliability in a new system. ASPires combines the positive aspects of each system into a more, if not the most efficient alternative.

Accordingly, much like the leading idea behind the Advanced System for Prevention and Early Detection of Forest Fire Project, we are and we constantly looking for the technologies that would make the development of better forest fire detection systems possible. In this context, the ASPIRES team looked at a couple of ideas that would improve the whole system for fire detection, and they are as follows:

- implementation of LoRa and LoRa WAN as low powered wide area networks in the detection system especially Wireless Sensor N;

- use of drones as part of aerial reconnaissance and early detection of forest fires;

- use of a cloud computing platform for service virtualization at different levels of granularity;

- use of field gateways to map existing or proprietary solutions to the cloud platform;

- define the concepts for systems integration and interoperability at different levels;

- advance measures and image analysis using HD cameras in combination with the weather conditions and drones.

Aerial detection

There are 10 Polar-orbiting satellites (7 meteorological and 3 scientific) which cycles the earth in a sun-synchronous orbit. Some features related to the use of satellites are:

- Places with middle or higher latitude can be seen about 2-4 times a day from the satellite.
- Forest monitoring depends on accessible satellites.
- The use of the satellites is limited by high costs and limited resolution due to the large picture size.
- Satellites cannot detect small fires.

Camera Surveillance

Different types of detection sensors can be used in terrestrial systems:

- a video-camera, sensitive to a visible smoke spectrum, recognizable during the day and a fire recognizable at night;
- infrared (IR) thermal imaging cameras to detect of heat flux of the fire;
- IR spectrometers for identifying the spectral characteristics of smoke.
- systems for detecting and measuring light by measuring light rays reflected by smoke particles.

All these systems are useful for use in towers as tools to improve the quality of surveillance.

Wireless sensor networks (WSN)

WSN has gained worldwide attention, especially with the proliferation of Micro-Electro-Mechanical technology that facilitates the development of intelligent sensors.

For example, deploying a network of sensors with Internet Protocol (IP) cameras can be a great way to detect the fire in the beginning and send an alarm signal to the fire brigade.

Sensors sense physical parameters such as temperature, pressure and humidity, as well as chemical parameters such as carbon monoxide, carbon dioxide and nitrogen.

The camera is used to provide real images from forest fire, thus avoiding false alarms.

These sensor nodes are cheap and small, with limited productivity and computing resources.

They need to be organized to work with other technologies and systems to develop an algorithm for generating fire alarms.

These sensor nodes have limited battery power and limited memory and are usually located in hard-to-reach areas where people cannot go easy.

Some of the advantages of wireless sensing networks for early detection of forest fires are:

- No pre-installed communications network. Nodes require a GSM coverage or Wi-Fi network to work.
- Time-stamp of all measurements made.
- Dual functionality: environment monitoring and early fire detection.
- It is not based on cameras. The acquisition and transmission of video or image are very demanding in terms of bandwidth and power consumption.
- The advantage of sensor networks lies in their low acquisition costs and their easy installation in the forest.

As the area increases, the price advantage decreases as the time-critical fire registration requires a narrow network of separate nodes.

Using drones in forest fires detection systems

Commercialization has brought more unmanned aircraft to the market, making technology more accessible to emergency services. These eyes in the sky can be used in the public security services to identify the heavily affected areas after a natural disaster.

Each drone can be used as an air platform with the potential to carry the same sensors that would otherwise be placed on the ground surveillance pole. Depending on the characteristics of the drones, they can carry one, two or more sensors, a camera, and so on.

Comparison parameters

By comparing the methods and techniques applied in the existing fire detection information systems, it can be concluded that the benefit of the system is best assessed through seven parameters.

The table below gives an assessment of existing technologies.

Evaluation of existing technologies

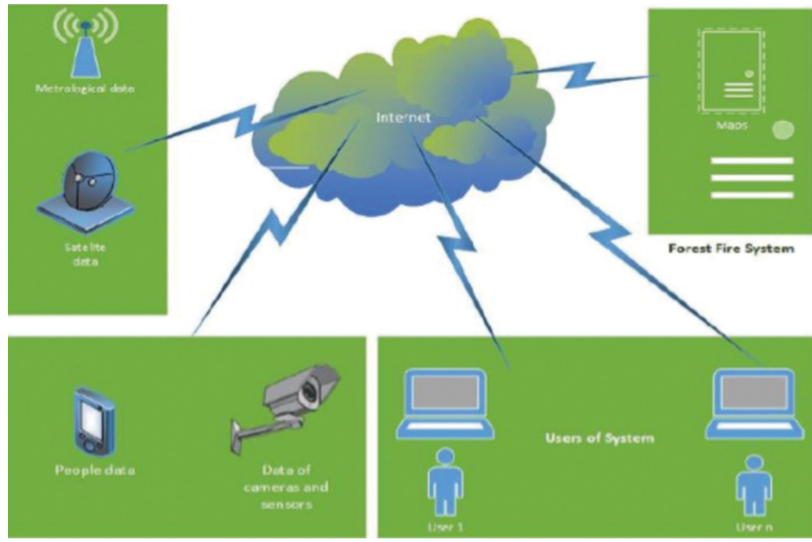
	Human Based Observation (HBO)	Satellite Based Systems (SBS)	Wireless Sensor Networks (WSN)	Camera Based Surveillance (CBS)
Cost (1)	low	very high	medium	high
Efficiency and practicality (2)	low	high	high	medium
Faulty alarm repetition (3)	low	low	medium	medium
Fire localizing accuracy (5)	low	low	high	medium
Detection delay (6)	long	medium	small	long
Behaviour information	-	yes	yes	-
Can be used for other perposes (7)	no	yes	yes	no

General architecture of forest fire prevention and early detection systems

The recommended architecture of a system for prevention of forest fires include:

- A network of automated measuring stations, suitable for obtaining meteorological data on the territory we aim to protect.
- Access to the data from the satellites to calculate the designated parameters.
- Combined set of cameras and sensors, extended with crowd-sourcing modules (such as citizens' smart phones) as needed in the area.

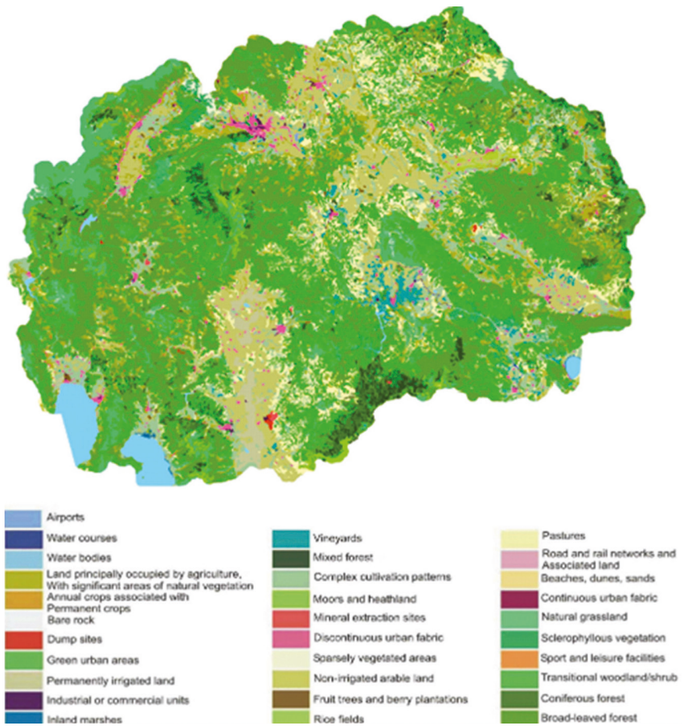
All these real-time data must be associated with static data such as a map of vegetation, demographic maps, orthophoto maps, etc. in an integrated system.



General architecture of a Forest Fire Prevention System

Published comparative analysis of occurred forest fires in Republic of North Macedonia

Forest land in Republic of North Macedonia



A multilayer map of Republic of North Macedonia

The total area of forest land in Republic of North Macedonia is 1.159.600 ha, of which forests cover 947.653 ha. They are characterized by a rich biodiversity and a significant non-timber forest resources: medical plants, mushrooms, forest fruits, game, etc.

The importance of forests is emphasized by the fact that the main part of the territory of the protected areas in this country are under forest.

Protected areas

Republic of North Macedonia recognizes several types of protected areas: national parks, strict animal species outside the natural reserves, and nature areas protected in the category of natural monuments. Officially, there are:

- 3 national parks, with an area of 108.338 ha, or 4.2%;
- 4 strict nature reserves, with an area of 12.855 ha, or 0.50%;
- 3 landscapes with special natural characteristics, with an area of 2.338 ha, or 0.09%;
- 14 areas with distinct plant and animal species outside the natural reserves, with an area of 2.709 ha, or 0.10%;
- 33 nature areas protected in the category of natural monuments, with an area of 61.655 ha, or 2.4%.

Causes of wildfires

The causes for most of the occurred fires are a combination of the overall climate conditions and a human factor. The most severe individual forest fire occurred in 2012 in the pine afforestation near the city of Strumica, when four people were killed and 12 injured (civilians), including seven children. The total damage (burned timber volume plus suppression costs) caused by forest fires in this period has been estimated at around EUR 51.000.000.

The changing climatic conditions have a potential to significantly impact human health, societies and economies, affecting all sectors. It is concluded that the climate characteristics in the period 2001-2005 had reflected well not just in the number of fires but also in the size of burned area. The total amount of economic losses due to forest fires in the period 1999-2005 was 28.298.245,10 €, of which only in the year 2000 the damage was 15.642.775,00 €.

The situation was similar in 2001, but not because of large number of forest fires and climate conditions, but due to improper extinguishing interventions of some of the fires. In the following years, damages from forest fires have seen a drastic decrease mainly because of climate conditions that influenced their appearance and spread.

Forest fires data (1998-2016)

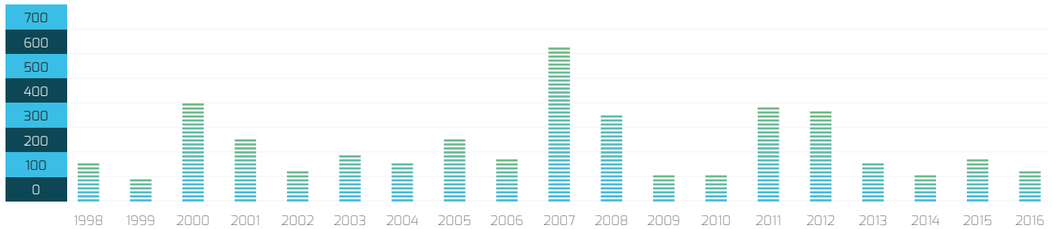
In period from 1998-2007 the highest number of forest fires (620) occurred in summer of 2007, when a state of emergency was declared. One of the contributing factors was the dramatic heat wave and extremely high temperatures that affected the region, along with a prolonged dry period. Related to the monthly data.

The months of July and August are the most intense, due to the high temperatures and drought that is characteristic for the climate at this period. The total number of fires in these months for the period 11998-2007 is 873 (35,7% of all registered wildfires), with 64.328 ha (66,7%) of burned area and 945.719 (82,8%) of burned timber mass.

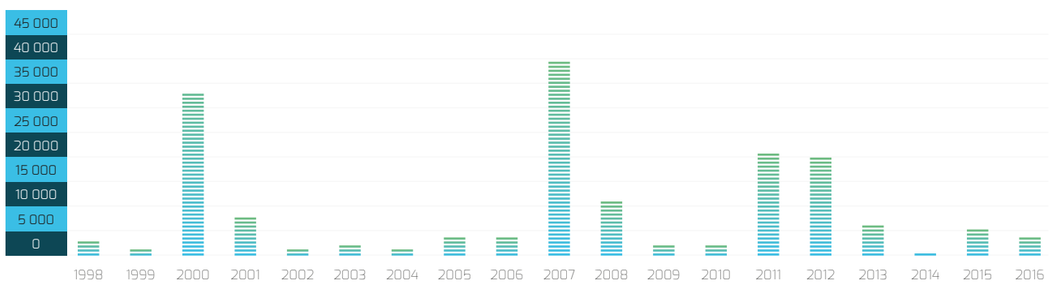
From 2008-2016, the 2008, 2011 and 2012 stand out as years with highest number of occurred wildfires: 339, 390 and 385 respectively. Still, the fires in 2012 were especially destructive, burning 19.967 ha (27,7% of the total burned area from this period) and 155.126 m3 of timber mass (43,6% from the total burned mass).

Monthly data in the period 2008-2016 show an increased number of fires in the months of July (265), August (517) and September (270). In these months, 55,3% of all fires occurred, the burned area amounts to 80,56% of the total, and the burned timber mass is 78,75% of the total.

Number of fires for the period 1998-2016



Burned area (in ha) for the period 1998-2016



Burned timber mass (m³)