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FIRE DETECTION

When you protect what matters - everything matters

ASSESSMENT OF RESULTS TRANSFERABILITY

Project "Fire Detection"

Nalyan Gyudzhen

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PROJECT "HIGH TECHNOLOGY FOR PROTECTION OF BIODIVERSITY THROUGH EARLY FIRE DETECTION IN HIGH SIGNIFICANCE PROTECTED FOREST AREAS"

PROJECT ACRONYM: "FIRE DETECTION"

EVALUATION REPORT

"ASSESSMENT OF THE RESULTS TRANSFERABILITY"

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ACKNOWLEDGEMENTS

This study was developed as a part of the "Fire Detection" Project joint activities aiming to enhance the CB cooperation between Greece and Bulgaria.

The project is implemented under the 2nd Call of proposals of the Interreg V-A Cooperation Programme Greece – Bulgaria 2014-2020 that is co-financed by the European Union under the European Regional Development Fund.

The assessment report was designed firstly to standard the coherence of project investment actions to the objectives of the Program - Priority Axis 2: "A Sustainable and Climate adaptable Cross-Border area", Thematic objective 06: Preserving and Protecting the Environment and Promoting Resource Efficiency, Investment priority 6d: "Protecting and restoring biodiversity, soil protection and restoration and promoting ecosystem services including NATURA 2000 and green infrastructures", Specific objective 5: "To enhance the effectiveness of biodiversity protection activities".

It was also subjected to evaluate the transferability of the results of the pilot investment actions for biodiversity protection through high technology monitoring and risk management of fire hazards.

The study was prepared by **Nalyan Gyudzhen**, an external consultant who led the evaluation. Mrs. Gyudzhen worked under the direct supervision of the project team that provided strategic and technical guidance, coordination, and methodological support.

The evaluation team would like to express gratitude to the Project team and the administrations of Soufli and Haskovo Municipalities for the cooperation throughout the evaluation process and their assistance, and also to participants in interviews and on-line questionnaires for the time and efforts devoted to the project.

The views expressed in this report are those of the author and do not necessarily reflect these of the Contracting Authority.

ACRONYMS & ABBREVIATIONS

Acronym	Definition
EU	European Union
ERDF	European Regional Development Fund
PA	Priority Axis
SO	Specific objective
Program	Interreg V-A Cooperation Programme Greece – Bulgaria 2014-2020
NATURA 2000	Ecological network of protected areas in the EU
GFW	Global Forest Watch
EEA	European Environment Agency
IR	infrared
AOS	Automatic Observation Station
EFFIS	European Forest Fire Information System
GIS	Geographic Information Systems
DDS	Decision Support System
NRT	Near Real-Time
MODIS	Moderate Resolution Imaging Spectroradiometer
VIIRS	Visible Infrared Imaging Radiometer Suite
NASA	National Aeronautics and Space Administration of the United States of America
NOAA	National Oceanic and Atmospheric Administration of the United States of America
SNPP	Suomi National Polar-orbiting Partnership
ICS	Incident Command System
OSS	Optical Sensor System
EMS	Emergency Management Service
PTZ camera	Pan Tilt Zoom Camera
ToR	Terms of Reference
MIS	Management Information System
AF	Application Form
LP	Lead Partner
WP	Working Package
EAFRD	European Agricultural Fund for Rural Development

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INTRODUCTION

This report represents the evaluation of results transferability of the pilot investment actions of project "High Technology for Protection of Biodiversity through Early Fire Detection in High Significance Protected Forest Areas" with project acronym "Fire Detection".

The project was financed under the 2nd call for proposals of the Interreg V-A Cooperation Programme Greece – Bulgaria 2014-2020 and implemented in partnership by the Soufli (Greece) and Haskovo (Bulgaria) Municipalities. It was initially planned with 28 months duration with indicative start in September 2017 ending in December 2019 for a total budget of EURO 798153,10. An extension until October 2020 was approved by the Program Managing Authorities.

Its aim was to strengthen biodiversity protection capacity by enhancing the response capabilities of local stakeholders and reducing the CB natural and man-made risks. This objective was to be achieved through several expected accomplishments:

- Establishing of high technology forest fire real-time monitoring systems in Soufli (Greece) and Haskovo (Bulgaria)
- Designing of effective prevention, risk management and project result dissemination plans
- Rising public awareness on fire prevention and biodiversity protection

The intervention logic of the project in relation to main activities, the expected outputs, and indicators is summarized in **Table 1 "Project Intervention Logic".** The objectives of the project were targeting two main intervention fields:

Prevention – constant real time observation and early confrontation to any threat in the monitored area through the established high technology hazards management facilities.

Effective crisis management – assessment of potential risks and application of effective danger response means, public and institutional awareness rising initiatives for sustaining and replication of project outputs.

Beneficiaries of the project were the Municipality of Soufli (Greece) and the Municipality of Haskovo (Bulgaria). They have the status of local administrations that both are navigating local policy and influencing community decisions on regional level.

Main stakeholders of the project were not limited only to the local administrations of Soufli and Haskovo as their legal duty is the protection and conservation of natural environment. They are also the local people and entrepreneurs in Soufli and Haskovo Municipalities. Still as main stakeholders are recognized to be also the regional civil protection units, other municipalities in the CB region, people who live and work near the protected areas.

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Table 1 "Project Intervention Logic"*

Main Accomplishments	Main Activities	Indicators
Establishing of high technology forest fire real-time monitoring systems	Installation of monitoring infrastructure Purchase of maintenance vehicles	2 tubular steel guy-roped towers with thermal and observation cameras, autonomous power supply unit, image transmission appliances established – 1 in Soufli and 1 in Haskovo Municipality 2 System Management Centers operating– 1 in Soufli and 1 in Haskovo Municipality 1 basket crane purchased – for Haskovo Municipality 1 4x4 pick – up car purchased – for Soufli Municipality
Designing of effective prevention, risk management and project result dissemination plans	Pilot operation of the monitoring systems and management centers	1 study "Fire Risk Assessment" elaborated 1 analysis "Capabilities of Utilizing the System for Other Purposes than Fire Detection" elaborated 1 report "Assessment of the Results Transferability"** elaborated
Rising public awareness on fire prevention and biodiversity protection	Information campaign for students Workshops for public, local authorities, and policy makers	2 workshops for presenting project results conducted – 1 in Soufli and 1 in Haskovo Training package with printed materials disseminated in municipal schools in Soufli and Haskovo Municipalities 2x5 signboards installed– 5 in Soufli and 5 in Haskovo Municipality Awareness rising campaigns held in primary schools in Soufli and Haskovo Municipalities Web site launched

**prepared by the evaluator based on project documents*
***the current report*

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Project's background was determined on common needs for preserving the biodiversity in the CB region. Soufli and Haskovo Municipalities have, in their territory, large, protected areas, characterized as NATURA 2000 lands. These represent unique ecosystems of high significance for preserving rare Fauna and Flora and many protected and endangered species.

Furthermore, the project intervention focuses on pilot decisions for monitoring the protected areas and detecting the threats on time. In this respect one of the sought direct and immediate effects resulting from the project is the further reinforcement and adoption of pilot approaches that test new ideas and eventually scale them up through supplementary funding.

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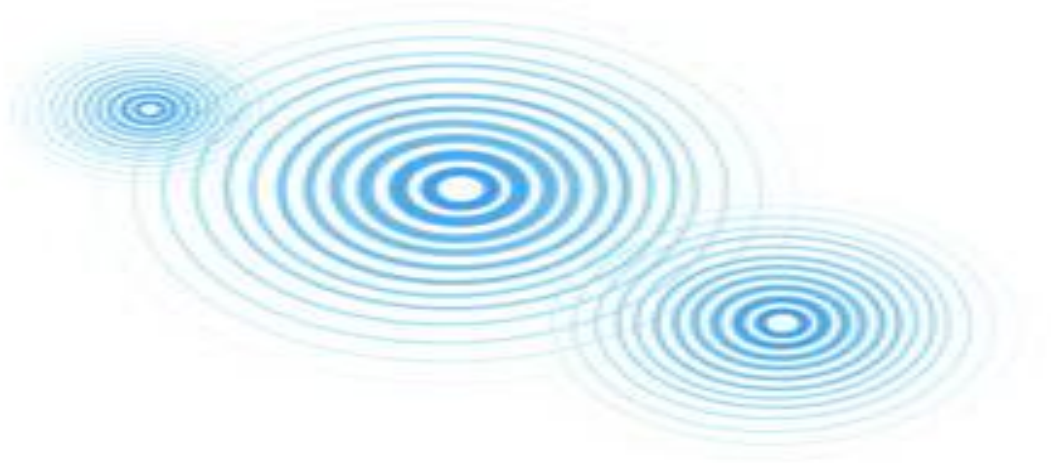
BACKGROUND OF THE EVALUATION



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Biodiversity, Protected Areas, Forest Habitats

Though the area of the Municipality of Haskovo is small compared to other administrative areas in the CB region, due to climatic, geological, topographical, and hydrological conditions it is characterized by great biodiversity.

It can be claimed that Bulgaria is among the countries with the greatest biodiversity in Europe, and this is largely due to the Bulgarian forests. They cover about 35% of the total area of the country, and about 60% of them are of natural origin. This applies completely for the territory of Haskovo Municipality, though it has mainly hilly-plain landscape.

According to the on-line platform for forest change monitoring "Global Forest Watch" (www.globalforestwatch.org) 17% of the territory of Haskovo Municipality is covered with natural forests. The information from the GFW database is presented in **Chart 1 "Forest Territories in Haskovo Municipality".**

The natural vegetation on the territory of Haskovo Municipality is represented by the tree species of blagun (Quercus frainetto), winter oak (Quercus pubescens), cer (Quercus cerris), maple (Acer), manna ash tree (Fraxinus ornus), hornbeam (Carpinus orientalis), ash (Fraxinus) and others.

Chart 1 "Forest Territories in Haskovo Municipality"

The region owns a rich biological environment with numerous protected animal and plant species - a total of 178 animals and 18 species of plants are placed under protection as endangered and the preservation of most of them is dependent on the protection of forest habitats.

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The Biological Diversity Act, adopted by the National Assembly in August 2002 is the main document that settles the principles for protection of natural habitats and species of animals and plants, which have been identified as important for the European Community. The so-called "protected areas", which are part of the "national ecological network" are established according to this law.

Protected areas are places in the country that meet the requirements for the presence of habitats and species included in the annexes of the Birds Directive and the Habitats Directive. They are a subject of biodiversity protection activities according to approved preservation management plans and constant monitoring of their status is carried. The aim of these measures is to ensure the survival of the most valuable and endangered species and habitats in Europe.

There are five protected areas of the NATURA 2000 Ecological Network on the territory of Haskovo Municipality. Protected areas under the Habitats Directive are - "Maritsa River" BG0000578, "Rhodopes-Medium" BG0001031 and "Ostar Kamak" BG0001034, with a total area of 5728,9 ha within municipality borders, 3443,3 ha of which are municipal property. Those under the Birds Directive are the "Harmanli River" BG0002092 and "Zlato Pole" BG0002103, with a total area 1067,2 ha within municipality borders, 946,2 ha of which are municipal property.

Detailed information for the forest habitats in protected areas on the territory of Municipality of Haskovo is presented in the table below:

Table 2 "Protected areas"*

Protected area	Protected forest habitats/species	Total area of protected forests
BG0000578 "Maritsa River" Habitats Directive Site incl. ornithologically important place **BG002103** "Zlato pole"	Natural habitat 91 AA Eastern white oak forests	22.2 ha
	Natural habitat 91 M0 Pannonian-Balkan turkey oak-sessile oak forests	10.5 ha
BG0001031 "Rhodopes-Medium" Habitats Directive Site	Natural habitat 91 AA Eastern white oak forests	218.1 ha
	Natural habitat 91 M0 Pannonian-Balkan turkey oak-sessile oak forests	836.6 ha
	Natural habitat 91 Z0 Moezian silver lime woods	1.9 ha

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BG0001034 "Ostar kamak" Habitats Directive Site incl. ornithologically important place **BG0002092** "Harmanli River"	Natural habitat 91 AA Eastern white oak forests	1114.1 ha
	Natural habitat 91 M0 Pannonian-Balkan turkey oak-sessile oak forests	2177.7 ha
BG0000434 "Banska River" Habitats Directive Site	Invertebrates species – R. alpina, U. crassus, C. cerdo, Fish – Rh. ceriseus, C. taenia, Amphibians and reptiles – T. graeca, T. karelinii, Mammals, excl. bats – L. lutra, S. citellus	-

**based on information from the National NATURA 2000 database*

The protected under the NATURA 2000 areas, located on the forest territories of Haskovo Municipality cover 4 389.5 ha, which represents 38.2% of the total area of the municipality. For comparison, the average level for Bulgaria is 34.4% which determines the significance of these lands. Moreover, the partial overlapping of ornithologically important sites with the protected habitats requires application of specific conservation measures and increases the importance of monitoring for vulnerabilities and threats.

Protected areas occupy large territories of the municipality, but they are fragmented and most of them located near settlements. The forests are scattered among the open spaces and mainly around the rivers. This makes them extremely sensitive to external influences.

Forest ecosystems and forest habitats in protected areas are under the constant pressure from climate change and other stressors that have wide-ranging impacts resulting also on economic sectors and human health. In response to such stressors, many land-based animal and plant species are changing their life cycles and are migrating; regional extinctions are observed; various invasive alien species establish themselves or expand their range.

The maps in **Figure 1 "Protected Area "Harmanli River", Figure 2 "Protected Area "Ostar kamak, Figure 3 "Protected Area "Maritsa River" incl. "Zlato pole" and Figure 4 "Protected Area "Rhodopes-Medium"** illustrate the boundaries of the protected forest habitats and ornithologically important sites that fall within the territorial boundaries of Haskovo Municipality.

Threads to Biodiversity in Forest Habitats

The biological diversity of Bulgaria, and in particular that of Haskovo Municipality lands is an invaluable wealth, which along with other characteristics defines the national identity of the country. At the same time, it is facing huge environmental problems. According to some researches 85% of river water is polluted with industrial waste and 70% of agricultural lands are destructed by emissions from industrial production. The air is also significantly polluted, and in some areas the waste gases emitted into the atmosphere by factories are sufficient to cause temporary or permanent health problems to residents.

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Figure 1 "Protected Area "Harmanli River"*

**extracted from the Interactive Map of NATURA 2000 Protected Areas database*

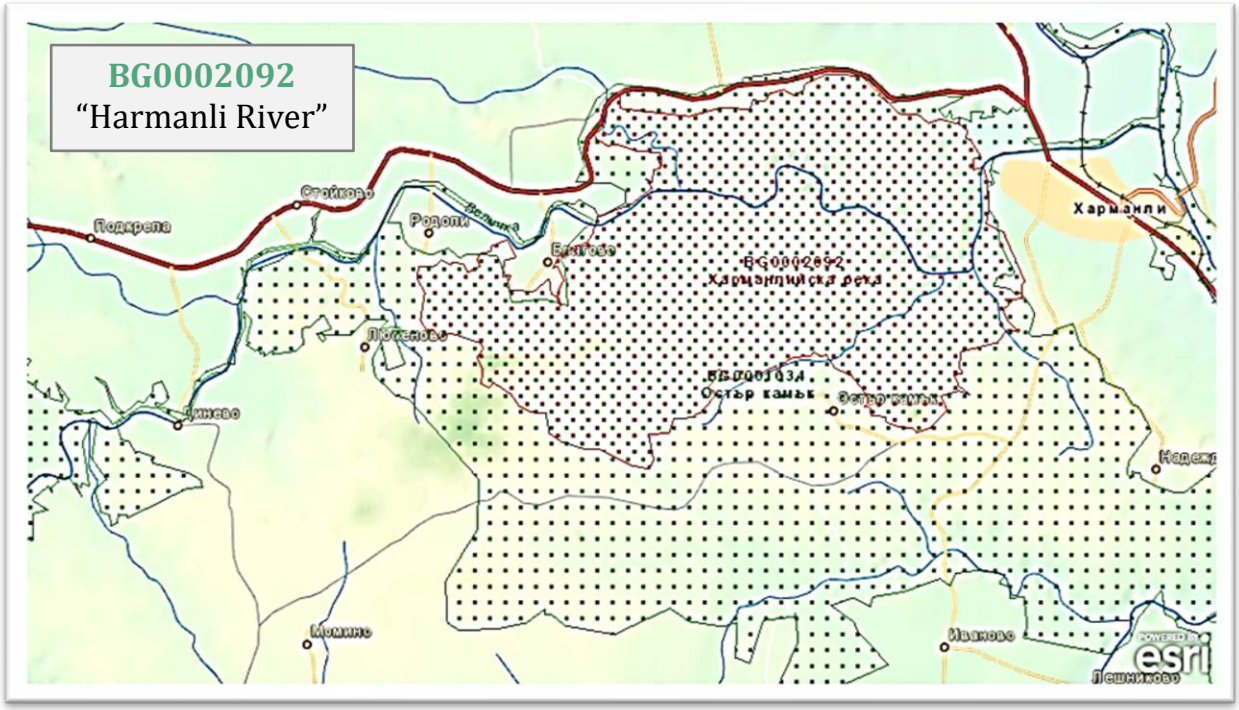

Figure 2 "Protected Area "Ostar kamak"*

**extracted from the Interactive Map of NATURA 2000 Protected Areas database*

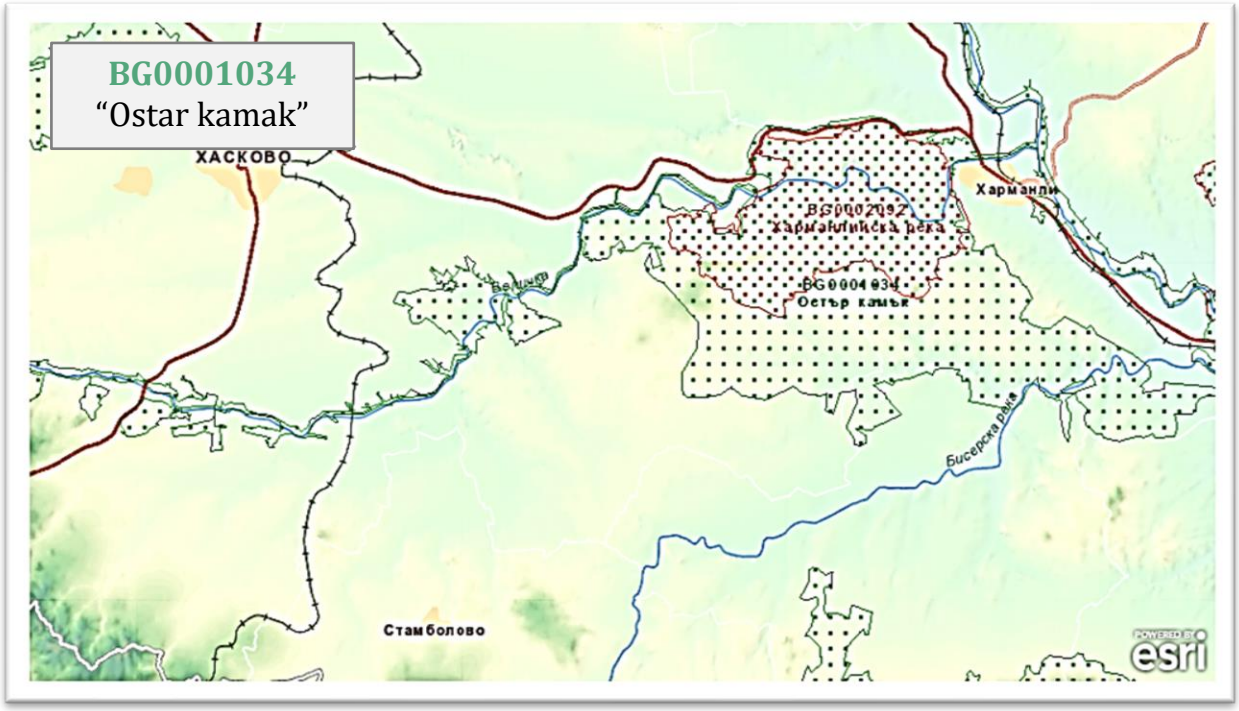

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Figure 3 "Protected Area "Maritsa River" incl. ornithologically important place "Zlato Pole"*

**extracted from the Interactive Map of NATURA 2000 Protected Areas database*

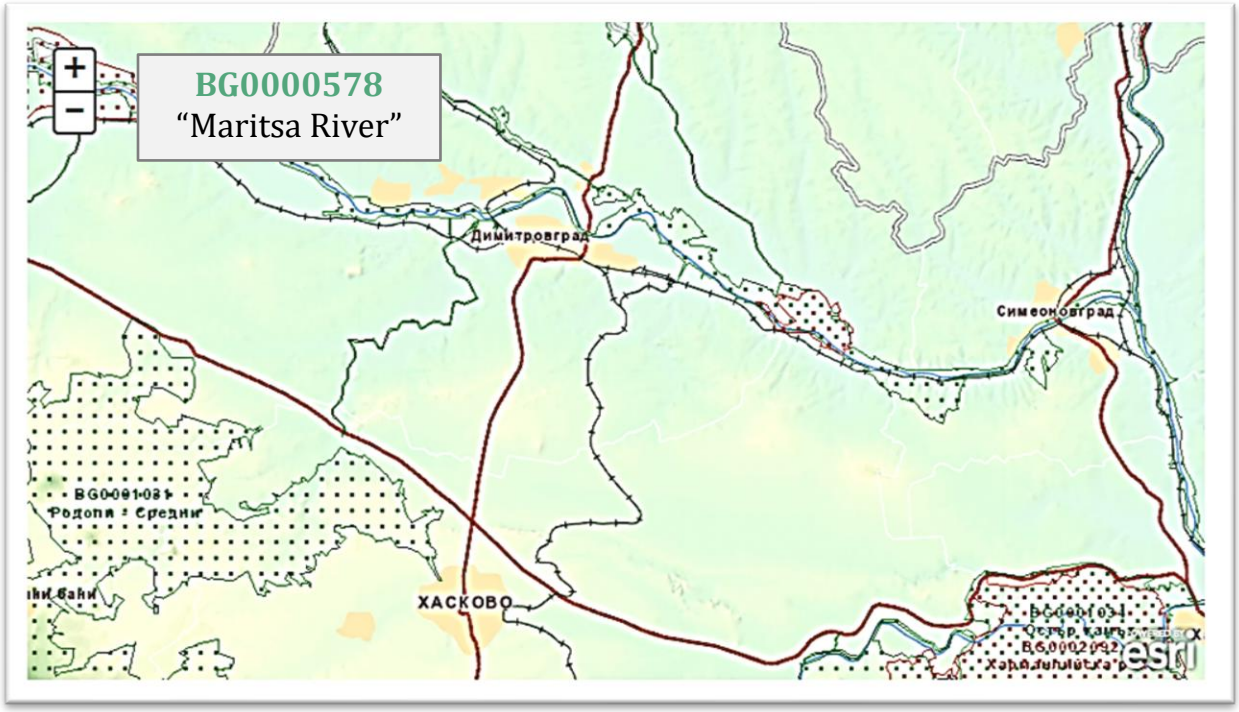
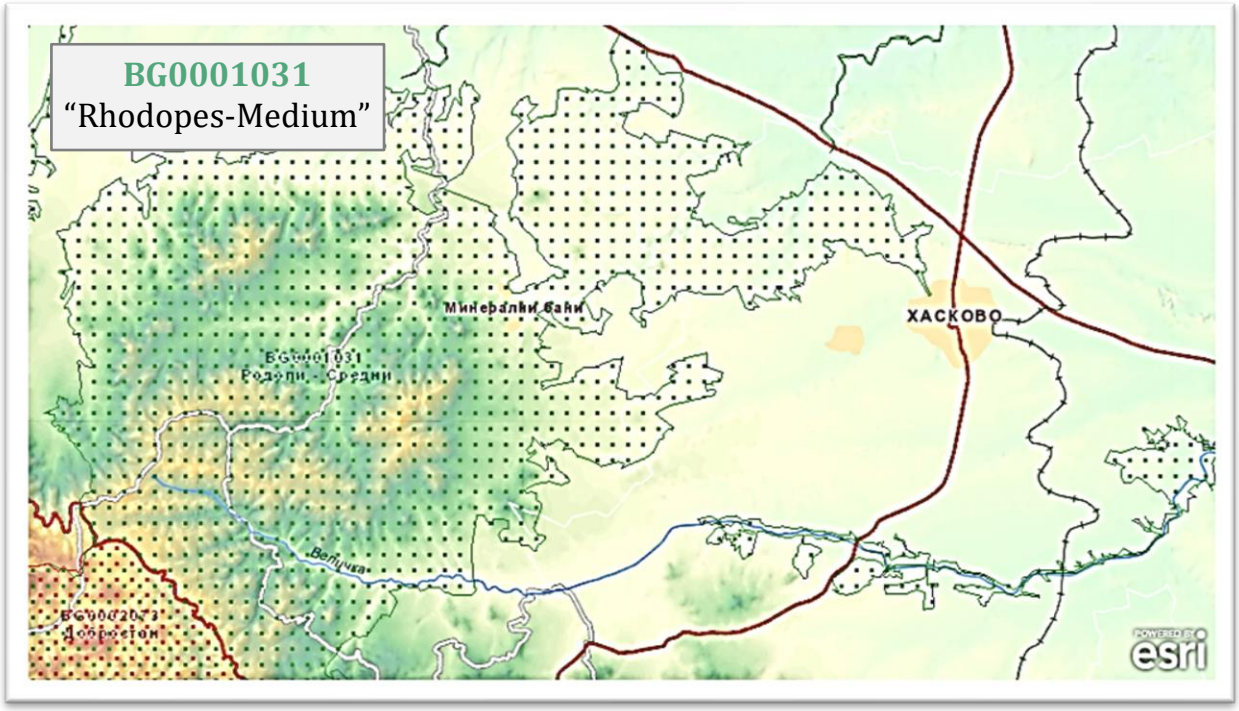


Figure 4 "Protected Area "Rhodopes-Medium"*

**extracted from the Interactive Map of NATURA 2000 Protected Areas database*



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In this context, the protection of the biosphere and the resource functions of the vegetation cover of the planet is a very urgent task. Without its solution any concepts for the sustainable development of our country will be impossible.

Forest habitats are facing many threads. The huge number of large and small settlements exposes natural forests to overexploitation of their resources, as well as to illegal logging. This can reduce the quality of forest ecosystems, and even lead to disturbance of the natural water balance throughout the region and cause erosion and landslides.

Existing derivations and catchments for water supply utilities also contribute to serious disturbances in natural forests.

Cutting down of the dry, old, or dying trees significantly restricts the capabilities of woodpeckers, owls, and other birds to find suitable nesting places and food. This "traditional" activity inflicts serious harm also to many small predators, reptiles, and insects. Illegal logging and the collection of firewood degrade the quality of forest habitats.

Poorly planned construction activities related to the development of tourist infrastructure cause disruption and destruction of valuable habitats in easily accessible areas. Poaching is a direct threat to birds, especially rare birds of prey.

Lands near rivers are used extensively, mainly for animal husbandry and to a lesser extent for agriculture and forestry activities. Forest habitats are sensitive to the intensification of agriculture as well as to the change of agricultural practices. Reduction of grazing followed by succession, as well as the plowing of pastures leads to the loss of habitats for birds and small rodents. Next to the forests there are dry pastures and meadows particularly vulnerable to fires, both natural, and caused by human activities.

The threads to biodiversity in forest habitats regardless of their natural or anthropological origin and the reasons for them are classified in several main categories in the table below:

Table 3 "Threads to Biodiversity"*

LOSS AND DESTRUCTION OF HABITATS
Pollution from household, agricultural, and industrial waste
Changes in the hydrology of running waters, including the construction of dikes, strengthening of the banks and barrages, diversion of water for irrigation and water supply that leads to changes of the processes in adjacent habitats
Drying of wet areas
Deforestation of the natural plain forests for agricultural purposes and of the elderly forests for wood production purpose

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Widespread changes in forests because of bare felling, fires, intensive grazing
Excessive use of agricultural land such as expansion of monoculture agriculture, intensive use of fertilizers and pesticides
Poorly planned construction and development projects, including tourist sites and resorts, highways and other road construction, dams, mines, and quarries, as well as general urbanization
Genetic isolation because of habitat fragmentation
ENVIRONMENTAL POLLUTION
Domestic wastewater and other toxic and organic domestic waste
Agricultural organic waste and chemicals (pesticides and fertilizers)
Large-scale industrialization
EXCESSIVE EXPLOITATION
Excessive collection for sale and export of medicinal plants, edible mushrooms, illegal collection of animal species
Poaching and excessive sport hunting
Improper measures for regulation of predator numbers
INVASIVE AND INTRODUCED SPECIES
Conscious introduction and resettlement of non-native species resulting in reduction of the genetic resources of wild plants and animals, including endemic Bulgarian species
INTENSIFICATION OF AGRICULTURE
Hybridization between wild and domestic species
Loss of local or wild varieties of plants and animals due to development of forest

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lands into agricultural fields
GLOBAL CLIMATE CHANGES
Increase of the greenhouse effect in the atmosphere
Changes in temperature, distribution and seasonality of precipitation, and other meteorological characteristics of the weather
Increasing frequency and intensity of fires, storms, and other destructive natural disasters

**based on information from the National Biodiversity Strategy*

Forrest Fires – origin, cause, impact

Fires in forests are not unnatural. They have been a part of the ecosystems since their origin and many experts still claim that they are important for natural forest regeneration and development. Prescribed burning has been used for centuries.

However, nowadays the scenario is changed. Although as a natural process it serves for maintaining the health of certain ecosystems, uncontrolled fires may engulf and destroy healthy thick forest cover within no time.

"Fire is a good servant but a bad master" – nowadays the saying is more than ever true for forest fires. Besides direct loss to forest cover, uncontrolled forest fire also kills wildlife, damages environment, degrades soil quality and retrogrades forest regeneration. Fires have a significant impact on the ecological balance of the planet and are spotted as main reason for biodiversity loss.

Recognized as the most serious threat for the existing forest habitats the uncontrolled fires are expected to be more frequent and destructive, as the climate change increases the possibility of drought in wide areas. They are defined as one of the highest potential risks to natural and human induced disasters.

Forest fires have become a global challenge, causing enormous damage not only to forests but also reflecting the economic and social environment of entire geographical areas.

Reports of The Ministry of Interior General Directorate "Fire Safety and Protection of the Population" assert that for the last 20-25 years about 10,000 ha of forests burned annually in Bulgaria which represents approximately 5% of the total forest territory of the country.

According to data obtained from the on-line platform for forest change monitoring "Global Forest Watch" (www.globalforestwatch.org) from 2001 to 2019, due to various natural and

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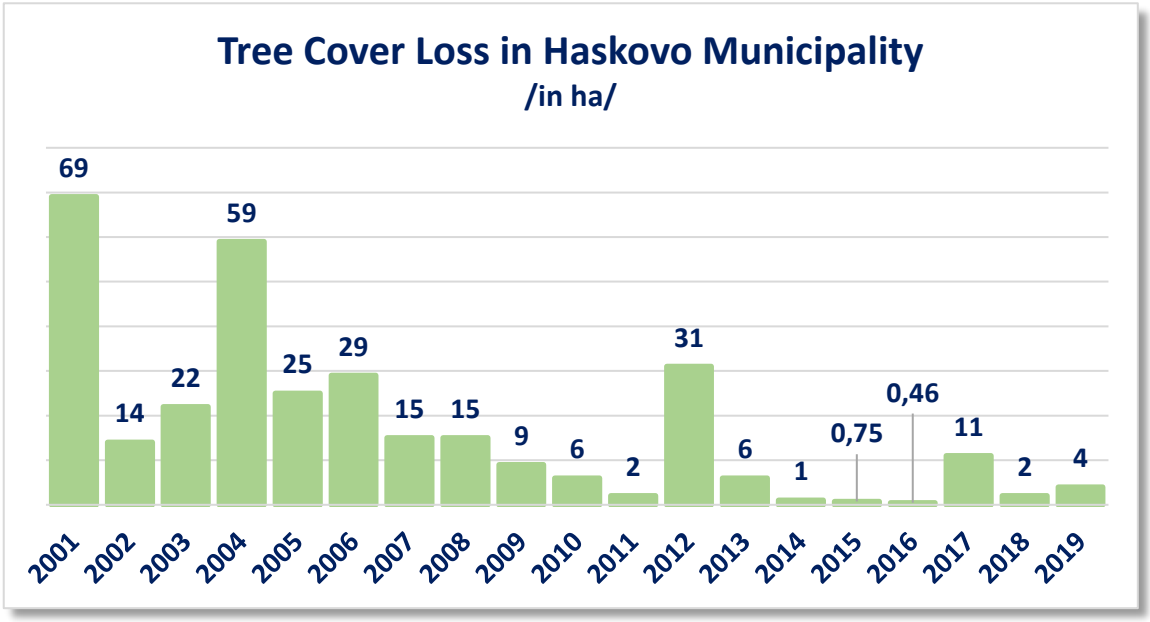
anthropological reasons Haskovo Municipality territories lost 336 ha of their tree cover, equivalent to a 2.8% decrease in tree cover since 2000.

According to the Risk Analysis and Mapping of Forest Fires in Bulgaria Report in the period 2006–2015 a total number of 294 forest fires are registered in the forest territories of Haskovo District. 1453.3 ha are reported as devastated from fires which represents 16.37% of the total burned area in the country for the same period. The average annual rate of fire in the forest areas in the district is 0.69%, which is 3.29 times above the national average. Being part of the Haskovo District, this defines Haskovo Municipality as one of the highest forest fires risk territories in the country.

Chart 2 "Deforestation of Territories in Haskovo Municipality"



Forest fires lead to **deforestation** of vast areas resulting in soil erosion and other negative geomorphological processes. Disruption and deterioration of forest vegetation, destruction of huge biotope zones, and extinction of almost all the species – plants and animals reached by the fire front line, are the inevitable subsequences of forest fires.

During a fire, the temperature raises up to 1100˚C that causes **degrade of the soils** and other abiotic nature elements. Ecosystems are badly damaged and their capacity to overwhelm destruction sequences are exhausted. Sometimes their restoration is impossible.

In addition to these direct damages to nature, fires also cause minor indirect damages that spread far away from the boundaries of the affected areas. Polluted by smoke air, long-term **disbalance in the CO_2 absorption** because of disruption of the green system functions affects large geographical areas far beyond the range of burning of the active fire.

The water cycle in nature cannot be restored long after the fire is extinguished. The organic matter of dead plants impedes infiltration, and the soil loses its natural protection against **erosion** after heavy rains. The release of huge amounts of steam during firefighting leads

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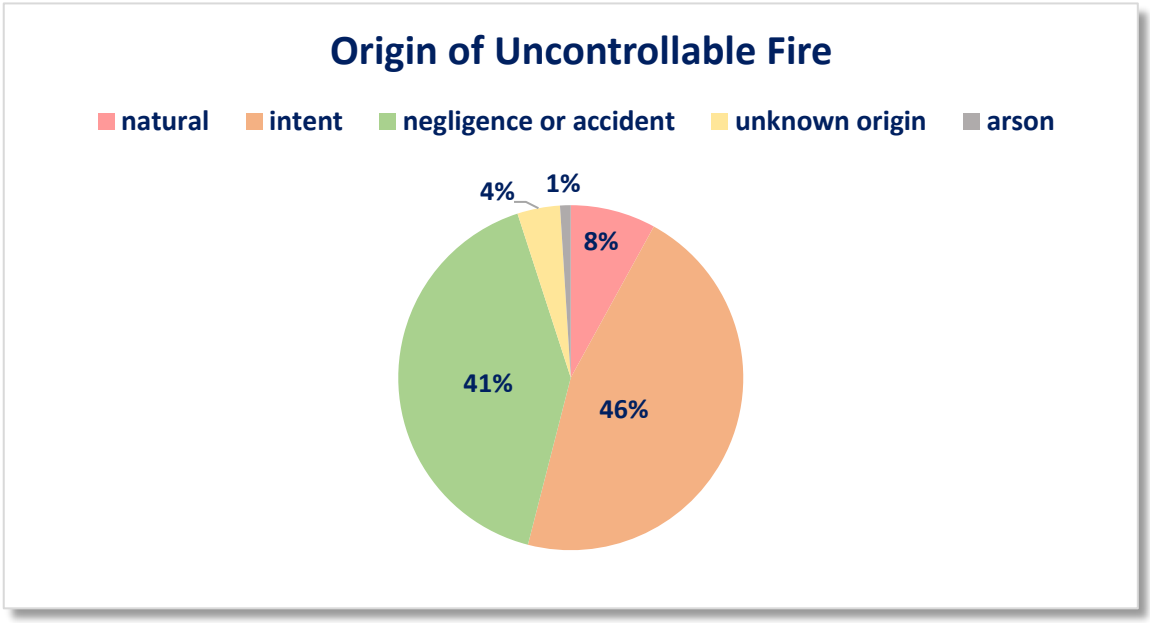
to atypical atmospheric processes in neighboring areas that cause other indirect damages to the ecosystems.

The **social and economic aspects** of fire disasters are no less essential. Fires destroy many resources used by humans. The livelihood and income of the population is seriously affected for a long time. Firefighting measures absorb huge financial resources for provision of specialized technical facilities and rescue equipment, for operational actions in emergency situations. Recovery works after fire disasters are expensive and long-lasting and can lead to serious economic recessions.

The main causes of forest fires are the climate changes, natural disasters such as thunderstorms with lightnings, and human negligence or intent. According to data obtained from the annual reports of The European Forest Fire Information System (EFFIS), (www.effis.jrc.ec.europa.eu) there is a dependence that the origin of uncontrolled fire remains in certain ratio regardless of the general number of events. This bond is demonstrated in **Chart 3"Percent Ratio of Causes for Uncontrolled Fire"**.

As seen from the diagram only 8% of forest fires have natural origin and 87% are due to anthropological causes of intent, negligence, or accident. And while habitats have the potential and capacity to recover from natural fires, the damage caused by induced fires exceeds the ability of ecosystems to regain biological balance.

Chart 3"Percent Ratio of Causes for Uncontrolled Fire"



As per capitalized international classification specific causes of fires are divided into nine categories of standard cases. This is done to harmonize disaster impact evaluation and risk management reporting and should not be an exhaustive list of specific reasons.

Standard categories include:

- Lightning: Any forest fire started because of thunderstorms

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- Campfire: A forest fire started by an open fire used for heating, lighting, or cooking
- Smoking: Forest fires caused by smoking or smoking accessories, including matches, cigarettes, cigars, lighters, tobacco, or other smoking-related materials
- Burning debris: Forest fires originating from the burning of refuse, junk and yard wastes, stubbles, or any other controlled incineration
- Arson: Intentional ignition of a forest fire in which a property is burned without owners' consent
- Use of machinery: Forest fires caused by the operation of mechanical equipment (excluding railway equipment)
- Railways: Any fire related to the operation of the railways, including smoking, lighting fires, burning rubbish, etc., when set on fire by employees or equipment related to the operation of the railways
- Children: Unintentional fires started by youngsters during play
- Other: Forest fire, which cannot be classified in other standard causes This category includes power lines, fireworks, blasting, cutting, welding, and grinding, reflective glass, and spontaneous ignition, etc.

In all cases and despite of any standardized classifications the cause of any fire is a combination of an actual ignition source (a heat source or flame that ignites the fire) and an action or activity that brings the ignition source into contact with the fuel material.

For the purposes of the current pilot fire protection facilities assessment it is important to examine the different aspects mainly of natural forest fires and fires due to negligence and accidents.

Natural causes that originate forest fire in our geographical conditions are limited to lightings and friction of rolling stones. Lightning during thunderstorms may lead to the occurrence of forest fires. In dry season friction leading to even small sparks by rolling stones especially in the mountainous areas may also generate forest fires when fanned by strong winds.

More often forest fires are due to **anthropological reasons** - caused by human beings, deliberately or merely due to negligence or just by accident. Deliberate or intentional fires may occur because of land cultivation, to meet the need of fodder for grazing cattle, for concealing illicit felling, for cleaning forest paths.

Unintentional or accidental causes are usually due to negligence and may be burning farm residue or debris, careless throwing of cigarettes or match sticks by grazers or travelers, negligence in camp fires, sparks from transformers or vehicles passing through the forest, protecting crops from the wild animals, etc.

Climate plays a vital role in determining fire patterns and intensity and, in turn, fire influences the climate system via the release of carbon. According to the Report for Climate Change, Impacts and Vulnerability in Europe of the European Environment Agency (EEA)

there are more extreme weather events, such as more frequent and intense heat waves, floods, droughts, and storms registered during the last decade.

New record levels of some climatic variables have been established in recent years. Land and sea temperatures are increasing; precipitation patterns are changing, generally making wet regions in Europe wetter, particularly in winter, and dry regions drier, particularly in summer. Almost in all Europe there is a significant decrease in river flows, which increases the risk of longer droughts, poorer crops, biodiversity loss and forest fires.

Global **climate changes** have substantially raised the probability and amplified the magnitude of various weather and climate events in Europe.

Observed changes in climate are already having wide-ranging impacts on ecosystems, economic sectors and human health and well-being. They are affecting all regions in Europe, but the impacts are not uniform. South-eastern and southern Europe are projected to be hotspot regions, having the highest numbers of severely affected sectors. The water sector, agriculture, forestry, and biodiversity show strong interdependencies. That is why even for modest levels of climate change economic costs can be potentially high.

Forest fires are obviously one of the major responses to climate change. But fires are not only a response: *"Fires feedback to warming, which feeds more fires."*

The changing weather pattern is one of the major factors contributing to current increase in instances of forest fires. The main reason for this is the overall increase in temperatures, the change in precipitation cycle and moisture content in the atmosphere.

Drier soil leads to less evaporation and so the heat goes into higher temperatures, less recycled moisture in the atmosphere, and hence less rain during summer. Forest fires affect the global carbon cycle, and thus the climate. Fire of vegetation and other organic materials releases large quantities of carbon into the atmosphere. Fire killed vegetation decomposes over time continuing to emit carbon. The new vegetation on burned sites does not absorb as much carbon from the atmosphere as the pre-fire vegetation absorbed, for several years or decades after a fire.

Thus, forest fires could be viewed as major and rapid respond to climate warming having the potential to overshadow the direct effects of climate change on biodiversity, species distribution and migration.

On the other side, it can be confidently said that forest fires are the major culprits in climate change. The process of dependence between global climate changes and forest fires is illustrated in **Figure 5 "Forest Fire and Climate Change".**

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FOREST FIRE AND CLIMATE CHANGE

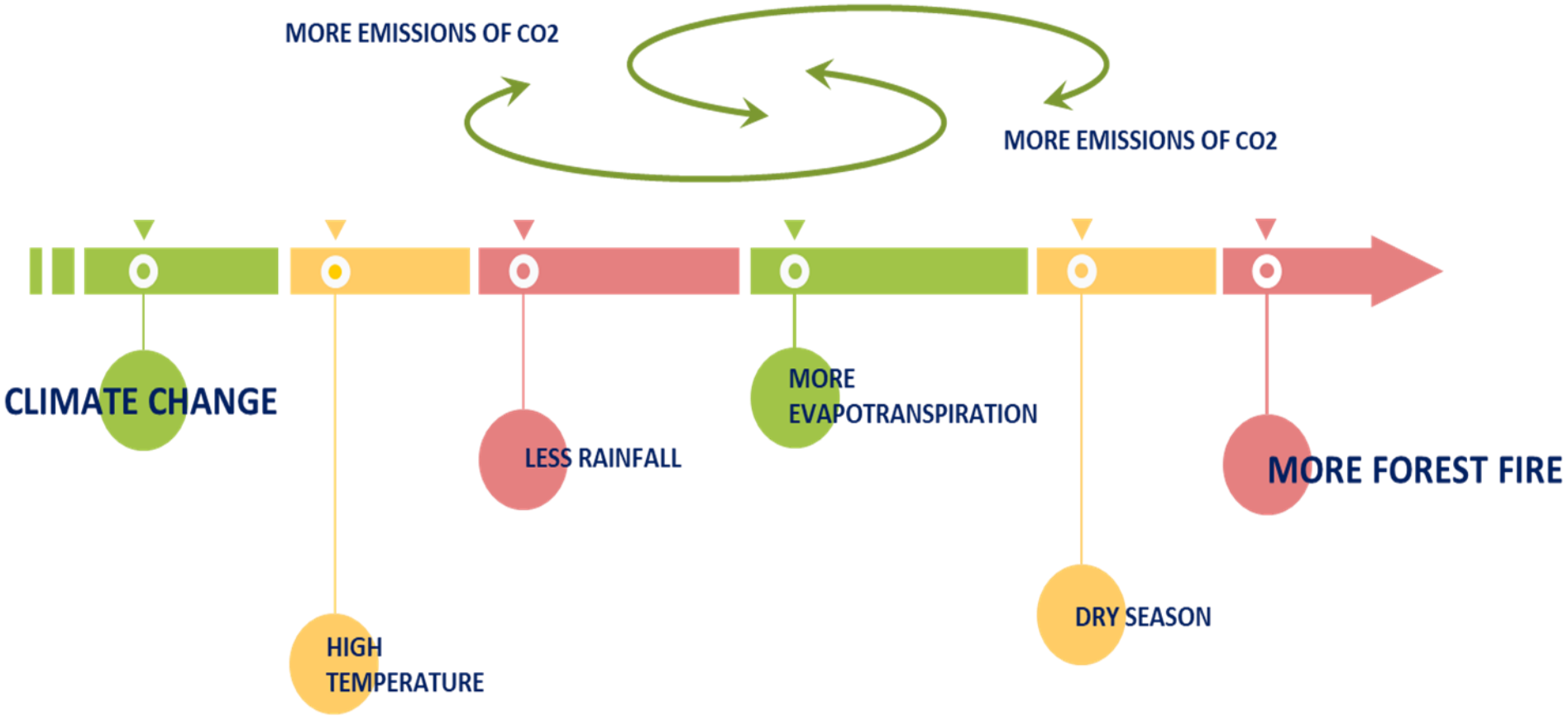

Figure 5 "Forest Fire and Climate Change"

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Forest Fire Management

Forest Fire management is a set of measures requiring a comprehensive approach and long-term vision based on continuous monitoring and analysis of data. The main management tools with proven practical focus and effectiveness are activities of prevention and mitigation of events, emergency planning, awareness raising, preparedness and response to threads.

Prevention

In recent years tactics and strategies for fire prevention have changed. And that is due mainly to the fact that today's forest fires have become harder to control, expensive to suppress, and a significant threat to the lives of firefighters and civilians. "Reactive" fire suppression attitude has modified into "proactive" fire management programs involving new techniques and educational measures. Key prevention fields are focused on education, engineering, and enforcement.

Raising awareness have proven to be fire prevention activities that are successful in reducing ignitions and losses from fires, when applied effectively and in the appropriate situations. Trainings, workshops, volunteering initiatives and other groups are recognized not only as significant prevention methods with direct impact on mitigation of events but also are a tool for advance mobilization at fire starts and an adequate response when fire danger conditions worsen.

There are many types of initiatives that are applied as effective awareness tools for developing a prevention education plan. Internal newsletters, information board posting, staff meetings, dispatch morning reports, on-site trainings are recognized to provoke excellent communication and discussions on prevention.

Unified fire prevention messages can be delivered to shared audiences through different channels. Broadcast and network mass-media such as television, radio and internet can solicit support for public assistance in fire prevention programs.

By means of public announcements and meteorological forecasts providing fire danger and prevention messages, interviews and videos stressing the importance of increased fire suppression efforts, information for community activities like neighborhood patrols, show-me tours, photo opportunities, and demonstrations, changing of people's behavior and understanding of the issues can be effectively ensured.

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Preparedness

Preparedness is a field of activities that are planned and implemented prior to fire ignitions. It is a continuous process that includes developing and maintaining a firefighting infrastructure, predicting fire activity, hiring, training, equipping, and deploying firefighters, evaluating performance, correcting deficiencies, and improving overall operations.

Preparedness is a long-term process that includes routine pre-season actions as well as incremental in-season actions conducted in response to increasing fire danger. As such, in a broad sense, it constitutes part of fire prevention.

Preparedness is a process of ensuring that an organization has complied with the preventive measures and is in a state of readiness to contain the effects of a forecasted disastrous event to minimize loss of life, injury, and damage to property. Direct results of preparedness activities are the provision of rescue, relief, rehabilitation, and other services in the aftermath of the disaster. The main challenge that is faced in this process is the capability and resources of fire management systems to continue to sustain their essential functions without being overwhelmed by the demand placed on them.

Good planning is the basis for being prepared. The objective of such planning is the development and application of a fire **preparedness and emergency plan**. The core of this plan is the assessment of operational needs and corresponding budget for firefighting resources and fire management infrastructure, planning fire prevention and suppression, and setting rules for building-up measures, training personnel and providing appropriate equipment according to changing fire activity conditions as predicted by a reliable operational fire danger rating system.

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Response

However strong the effort to prevent forest fires may be, it is not possible to eliminate their ignition completely. The need for a suppression mechanism, named "response", capable to respond quickly and extinguish fires is absolutely necessary.

Response usually refers to the dispatching of personnel and resources to fight a starting fire (initial attack), trying to control it as quickly as possible while keeping the burned area to a minimum. Most fires are controlled through initial attack in case of good preparedness and accurate emergency planning.

However, in spite of the best of efforts, some fires escape initial attack and run uncontrollable for hours and their control requires what is termed "extended attack". Then, the fire spreads in many types of fuels and in varying topography. The number of resources sent to the fire increases very rapidly and so does the probability that the fire will reach high value areas and will cause serious damages.

The key elements for effective response are the existence of a good pre suppression plan, a well-organized system of command and control that foresees the build-up of an onsite organization as the fire is growing, appropriate number of capable firefighting resources, including firefighting personnel, fire engines, firefighting airplanes and helicopters as well as highly qualified and experienced officers.

Not less important is the operation of a well-organized and equipped coordination center, with highly trained personnel undertaking coordination of the on-site firefighting effort ensuring a good support mechanism capable of accurate fire danger prediction, effective fire detection, meteorological support, logistics support, and all types of needed support by the local authorities.

The **pre suppression plan** is the link between fire prevention and fire suppression. Actually, it is prepared before the onset of fires and can be thought as part of fire prevention. This plan focuses on the arrangements made for setting the suppression of an actual fire into operation.

A pre suppression plan includes layout of the structure of the firefighting organization, data analysis for the potential firefighting workload, evaluation of the required resources, special fire danger conditions that constitute a threshold beyond which the available resources are unlikely to cope with the fires and should foresee a procedure for requesting additional resources and help.

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The aim of the pre suppression plan is the creation of the complete firefighting scenarios - the tactics to be used are decided in advance, the required resources are specified, and all the necessary information are analyzed in advance. In this respect, such a plan needs to be justified with data e.g. fire danger rating predictions, satellite images, burned area estimates, maps, data for available resources of different authorities such as Forest Services, municipalities, volunteer groups, military, etc.

Once a fire is detected and reported, **dispatching** of the appropriate firefighting resources for suppressing it becomes the most critical element of response. Correct dispatching needs to send enough resources to minimize the chance that a fire will escape initial attack. The decision for dispatching of the first fire engines is made immediately to avoid spreading of the fire but at the same time it should be followed by a thorough assessment of the situation in order to prevent unnecessary deployment of resources on the landscape and respectively unjustified costs.

The potential of the fire should be evaluated as best as possible, combining data from maps for topography, road network, forest fuels, and information for fire danger predictions, current weather measurements and forecasts, as well as information from the first on-spot reports of firefighters reaching the ignition area e.g. fire size, perimeter, flame length, etc. A reply to this problem and a true tool for better dispatching is the use of computer based Decision Support Systems (DSS).

Technology Controlling Risks - DSSs

In the years, computers became much more powerful and inexpensive. Geographic Information Systems (GIS) advanced impressively and found their place in fire spread simulation systems. Digital spatial data availability became commonplace. And all these made it possible to develop highly advanced ground or spatially based Decision Support Systems (DDS) in support of fire management, either at the coordinating center or in the field.

Nowadays, there are a number of contemporary "intelligent" fire detection, monitoring and suppression managing systems used. These include satellite based systems and the increasingly promoted detection and monitoring systems based on optical camera sensors, and different types of detection sensors or their combination.

Satellite-Based Systems are using data from earth-orbiting satellites for observation and detection of forest fires. Unfortunately, it takes a long time for fire scanning and provision of the images of the regions of the earth. The quality of satellite images can be affected by weather conditions.

One of the limitations of these systems in addition to the high maintenance costs resulting in a failure in speedy and effective control of fires in forest areas is the fact that the optical

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and the infrared radiation emitted by a fire in early stages, before it spreads over a wide region, may be too feeble in intensity to be detected by the satellite located on orbits of thousands of miles above the earth's surface. That is why due to the large spectrum of maintained by these systems data, they are generally used for fire danger forecast.

Some examples of such systems are:

- The **Fire Information for Resource Management System** (FIRMS) that distributes Near Real-Time (NRT) active fire data within 3 hours of satellite observation from both the Moderate Resolution Imaging Spectroradiometer (MODIS) sensors on board of the TERRA and ACQUA satellites and the Visible Infrared Imaging Radiometer Suite (VIIRS) sensors on board of the NASA/NOAA Suomi National Polar-orbiting Partnership (SNPP). The active fire/hotspot data can be viewed in FIRMS Fire Map.

The **European Forest Fire Information System** (EFFIS) that is part of the EU Copernicus Program, under the Emergency Management Service (EMS). Copernicus services are based on the processing of environmental data collected from Earth observation satellites - Sentinel-1, -2, -3 and -6 and Sentinel-4 and -5 and data delivered from contributing missions from other 30 other satellites. The EFFIS system is supported by experts of 40 countries involved in the EFFIS network incl. Bulgaria.
Screen shots of data maps of the two satellite-based systems for fire monitoring, detection and decision support are presented in **Figure 6 "The FIRMS platform", Figure 7 "The EFFIS real time fire monitoring platform"** and **Figure 8 "The EFFIS fire danger forecast database"**.

Figure 6 "The FIRMS platform"*

available at https://firms.modaps.eosdis.nasa.gov/

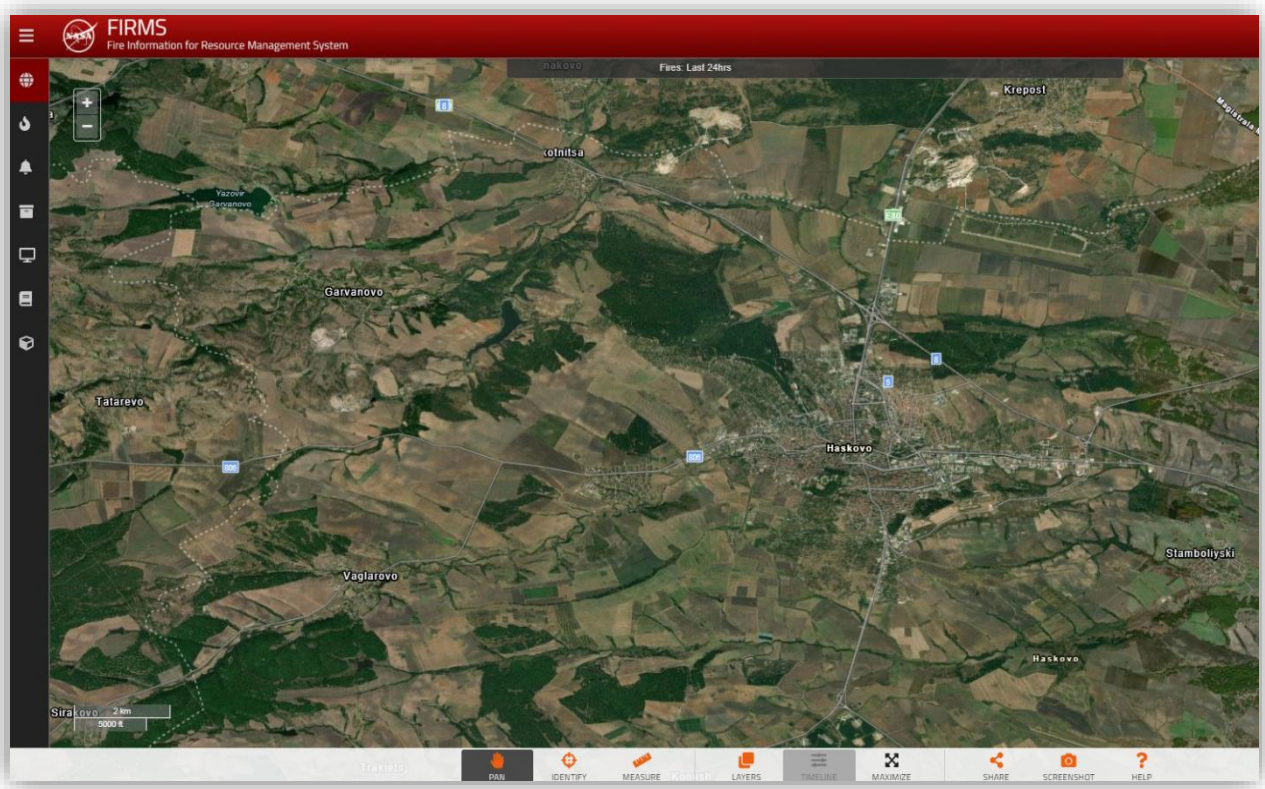

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Figure 7 "The EFFIS real time fire monitoring platform"*

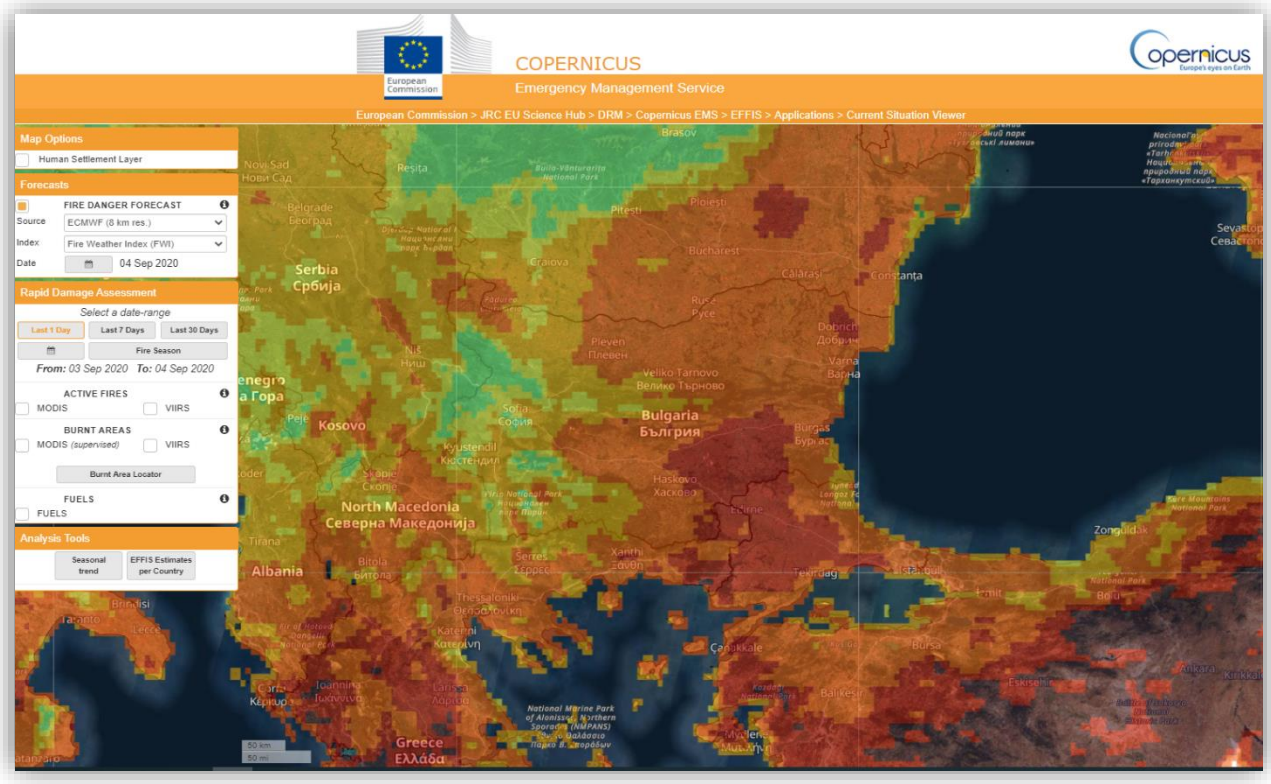
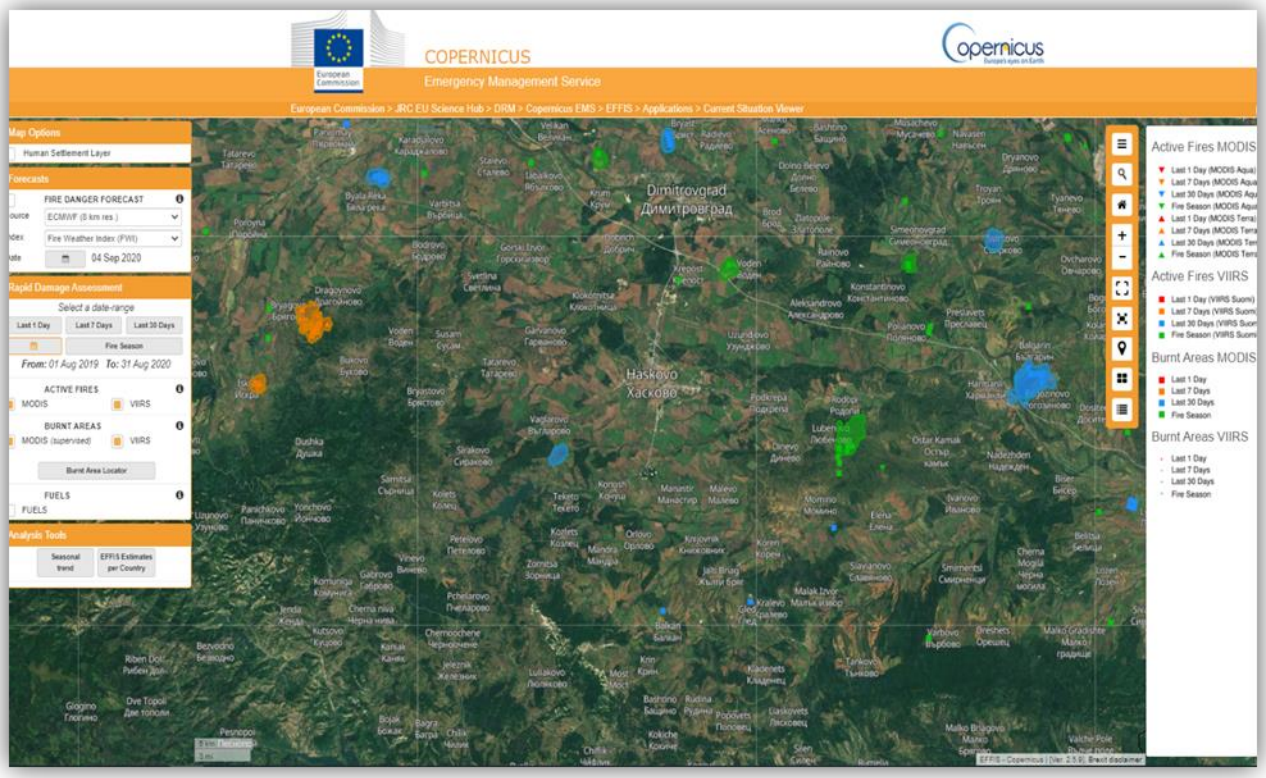


Figure 8 "The EFFIS fire danger forecast database"*

**available at https://effis.jrc.ec.europa.eu/*



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The development of sensors, digital camera, image processing, and industrial computers resulted in the development of terrestrial systems for optical, automated early recognition and warning of forest fires by a wireless sensor network.

Different types of detection sensors can be used in terrestrial systems. These can be **video-cameras**, sensitive to visible spectrum of smoke recognizable during the day and a fire recognizable at night, **infrared (IR) thermal imaging cameras** based on the detection of heat flow of the fire, **IR spectrometers** to identify the spectral characteristics of smoke, light detection and ranging systems that measure laser rays reflected from the smoke particles. All these systems have the same general concept - detection of smoke and fire glow. Cameras are producing images that are processed by a DDS algorithm for decision if there is a fire hazard and whether or not to produce an alarm. These optical systems are integrated with GIS for location of the fire. Usually a weather station and PTZ cameras are also included to the unit for more accurate analysis of received data.

Some examples of such systems:

- The **EYEfi SPARC** is an optical sensors system based on data collected via camera (color during the day and ultralow light greyscale at night), a weather station and a lightening detection sensor. The system also includes a communication unit and a power system.

  The system is produced and deployed in Thailand. Similar systems are used in France.

- The **FireWatch** is also designed for automatic detection of smoke and consists of an optical sensor system (OSS) that rotates 360° every 4-6 minutes in 10° steps. The system includes data transfer unit by a wireless connection from the observation tower to a computer and a control center.

  Operational FireWatch systems are existing in Germany (178 towers and 22 control centers), Estonia (5 towers, 1 control center), Cyprus (2 towers, 1 control center), Czech Republic, Portugal, Spain, Italy, Greece, Bulgaria, and the USA.

In Bulgaria Automatic Observation Systems (AOS) based on the FireWatch system techniques are installed on the territories of Municipality of Kostenetz (3 towers, 1 control center), Municipality of Dimitrovgrad (1 tower, 1 control center), Municipality of Stara Zagora (2 towers, 1 control center), Municipality of Sevlievo (1 tower, 1 control center), Minicipality of Aksakovo (1 tower, 1 control center), Municipality of Samokov (1 tower, 1 control center), Belasitsa Nature Park Directorate (1 tower, 1 control center), Vrachan Balkan Nature Park Directorate (3 towers, 1 control center), Southwestern State Enterprise Blagoevgrad (9 towers on the territories of Blagoevgrad, Gotze Delchev, Kresna, Satovcha, Petritch, Garmen, Hadzhidimovo, Sandanski and Bansko Municipalities, 9 control centers).

A map of the AOS operating in Bulgaria is presented in Figure 9 “Map of the AOS in Bulgaria”. The control centers are connected to the National Emergency Management Service Network.

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MAP OF THE AOS IN BULGARIA

AUTOMATIC OBSERVATION SYSTEMS (AOS) IN BULGARIA

AKSAKOVO - 1 tower, 1 control center

BELASITSA Nature Park Directorate - 1 tower, 1 control center

VRACHAN BALKAN NATURE PARK DIRECTORATE - 3 towers, 1 control center

DIMITROVGRAD - 1 tower, 1 control center

KOSTENETZ - 3 towers, 1 control center

SAMOKOV - 1 tower, 1 control center

SEVLIEVO - 1 tower, 1 control center

SOUTHWESTERN STATE ENTERPRISE BLAGOEVGRAD - 9 towers in Gotze Delchev, Kresna, Satovcha, Petritch, Garmen, Hadzhidimovo, Sandanski and Bansko Municipalities, 9 control centerS

STARA ZAGORA - 2 towers, 1 control center

HASKOVO - 1 tower, 1 control center

Figure 9 "Map of the AOS in Bulgaria"

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Disaster Protection System

Provision of fire safety and protection of fire, disasters, and emergency situations in Bulgaria is performed by the fire safety and civil protection authorities in accordance with the Law on the Ministry of Interior and the Disaster Protection Act.

The territory of Haskovo Municipality is serviced by Regional Office for Fire Safety and Civil Protection - Haskovo Unit which is directly subordinated to Regional Directorate of Fire Safety and Civil Protection Haskovo part of the national specialized structure of the General Directorate of Fire Safety and Civil Protection of the Ministry of Interior.

Activities for disaster management are carried by unified rescue system - the National Emergency Management Service Network, which includes units of the ministers, administrations, municipalities, companies and entrepreneurs, emergency centers, non-profit organizations incl. volunteer formations and armed forces. The main structural parts of this unified rescue system are the General Directorate of Fire Safety and Civil Protection of the Ministry of Interior, Regional Directorate of Fire Safety and Civil Protection and emergency centers.

In case of a disaster or incident, the District Governor is the responsible local authority to organize, coordinate and control forces and means for management and mitigation of effects through established in connection with the Disaster Protection Act regional and municipal emergency councils. The actions of these councils, respectively of regional and municipal authorities, are coordinated through the National Emergency Management Service Network.

Disaster protection is carried out through performing protective activities, protection activities in case of disaster events, and recovery. Activities are based on Protection Plans that are developed on municipal, district and national level.

The disaster Protection Plan at municipal level is worked out and implemented based on a Disaster Risk Reduction Program. The activities and budget allocation for the plan and the program are approved annually.

Main activities related to protection of the population in case of danger or occurrence of disasters are warning and announcement, search and rescue operations, emergency measures for mitigation of effects, provision of medical assistance, initial psychological counselling to victims and rescue teams, etc.

At municipal level the mayor is the responsible authority for the implementation of preventive actions for avoidance and reduction of consequences of disasters, coordination and management of protection and rescue activities on the territory of the municipality in case of a disaster event, for ensuring early warning of the population, for development and implementation of the disaster risk reduction program and the protection plan, for planning financial resources and contingencies fund for disaster management.

Disaster protection on the territory of Haskovo Municipality is carried according to the approved in 2019 Disaster Management Plan. A municipal disaster protection council responsible for the implementation of the Disaster Management Plan is officially established upon mayor's ordinance and operating according to approved annual program.

A security unit performing a 24 hours disaster monitoring is established. The unit is operating as part of the National Emergency Management Service Network and is the municipal level headquarters for early warning in case of disaster events.

Forest Fire Management – key gaps

As discussed previously in detail the intangible loss due to forest fire includes impact on biodiversity, damage to watershed services, loss of soil fertility, increase in soil erosion and landslides. In the present day context forest fire has developed a dangerous relationship with the global warming by adding Green House Gases. Although, the direct loss due to forest fire may not be much evident in economic terms, its long term impacts mainly on environment are more devastating and need serious efforts to manage forest fires in more effective manner.

The forest fire management in Bulgaria is a priority task on national level and is carried with systematic efforts and scientific approach. However, according to the analysis of secondary as well as primary information collected from various stakeholders there are still some key gaps in the system:

- Existing forest policy and other strategic documents on local level, including plans etc. lack clear cut guidelines to tackle forest fire with the means of volunteering prevention or fire suppression patrols, fire watch initiatives, etc. The local community may play significant role in forest fire management, however, there is not much sincere efforts done in this regard.

- In the present scenario, response is the main emphasis of forest fire management. Sufficient importance should be given to other issues i.e. mitigation, preparedness, awareness creation, etc.

- Forest fire management activities are provided with budget at state and international level by the means of many EU Programmes. However, this allocation is not sufficient to meet the challenges. In general, there is no provision for separate budget for forest fire management at local community level.

- There are many new developments in the field of detection of forest fires using various indicators and disseminating the information received to the field staff to take quick possible action. However, the used techniques and methodology are still based on the traditional methods to detect fires. There is a constant need to revitalize the early warning system in up-dating of used techniques and training the field staff to use modern tools more effectively.

The scientific approach to gain fire data and document it for forest fire management with the means of contemporary facilities that can collect and compile fire information related to area burnt, damage to forest crop, environment and wild life along with indirect loss to soil and water resources should be constantly applied. This information can be obtained only thorough research and investigation.

Automated System for Prevention and Early Warning – technology, technical description, capabilities, and operational limitations

The pilot investment activities under the "Fire Detection" project realized in Haskovo and Soufli Municipalities represent measures for establishing of an integrated early warning system for forest fire prevention. The application of modern technical solutions for detection of forest fires such as the video surveillance aims to ensure:

- Detection of forest fires in the process of their inception
- Reduction of analysis errors for emerging forest fire due to human inaccuracy in the visual estimation and errors in the localization of the fire
- Immediate response, prevention of spread and effective suppression of fires

The system for automatic fire detection settled in Haskovo and Soufli Municipalities are based on terrestrial systems using a ground monitoring station. Such system models ensure higher precision in timely detection of fires than the satellite-based ones and are suitable for monitoring forest areas with a high risk of fire. They enable location of the fire with an accuracy of 700 sq.km. Principle scheme of the fire monitoring systems is presented in **Figure 10 "Automatic Monitoring Tower System for Forest Fire Prevention"**.

The automated monitoring is carried with the application of thermal cameras and spectral processing of received from them images. The monitoring method is based on an infrared camera performing continuous automatic temperature measurement and functional software for processing digital infrared images.

The infrared camera rotates horizontally and vertically in the monitored space, which is divided into separate sectors and constantly measures the temperature at different positions. When the set values are exceeded the software signals an alarm state and archives the corresponding results. The system reacts in the form of a visible signal on monitors and an acoustic signal in a Control Center. The thermographic images are displayed on a black and white scale. Dark areas reflect cold areas, and light areas reflect high temperatures. In case of fire, the areas with exceeded values are colored. In this way, the operator immediately recognizes the location of the fire and can introduce appropriate fire management measures.

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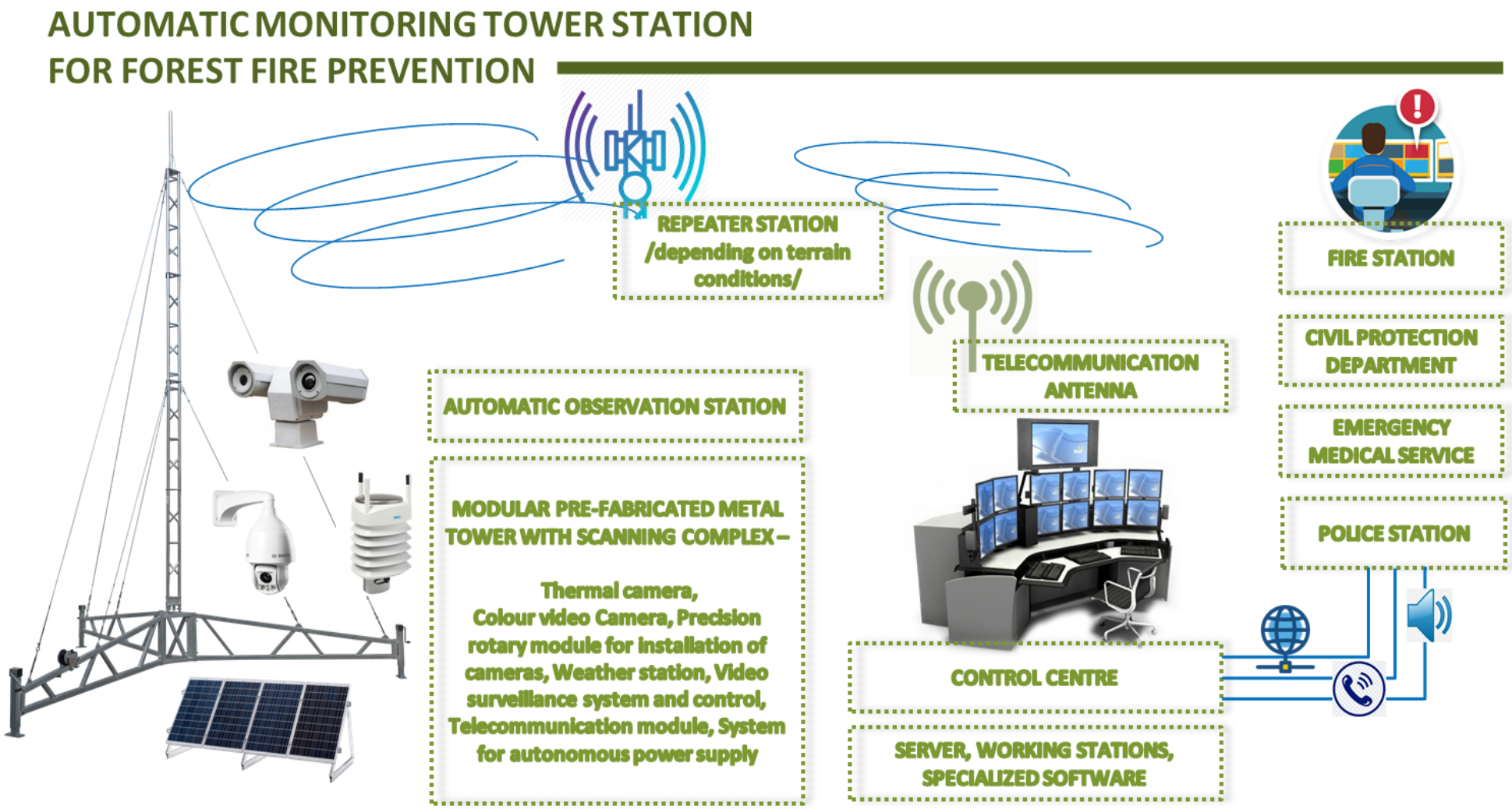

Figure 10 "Automatic Monitoring Tower System for Forest Fire Prevention"

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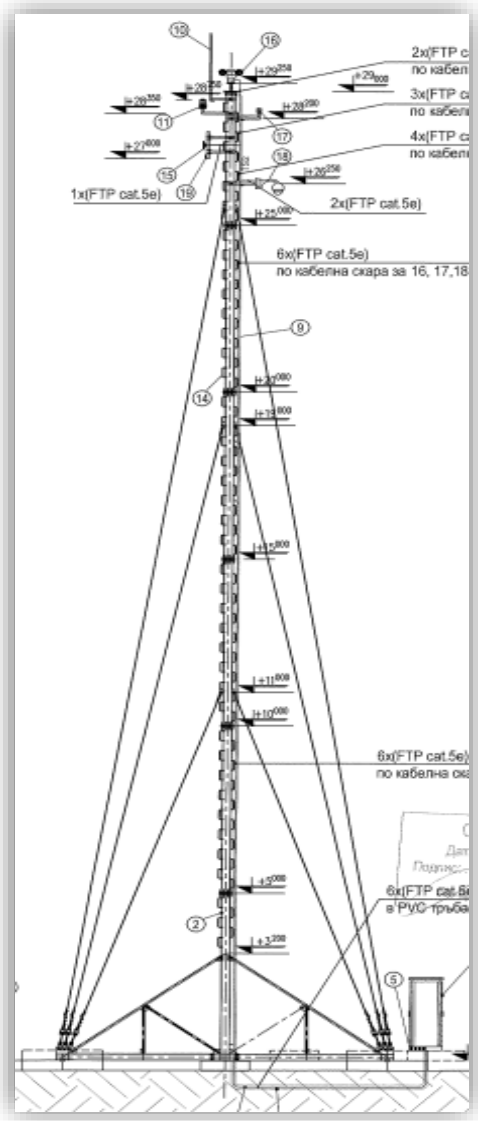
AUTOMATIC OBSERVATION STATION (AOS)

The technological observatory is located on a metal structures and includes functionally related electronic equipment and components, combined into a single system for monitoring, security, analysis, communication, and early warning of risk events, which could jeopardize the target areas and species. AOS can remotely monitor, manage, diagnose, and reboot. The radius of action of the observation station is not less than 10 kilometers.

AOS consists of elements that ensure necessary observation technical parameters and functionality of the entire system.

Metal tower



The **metal tower** is a modular steel structure – a modular prefabricated antenna mast, designed to provide resistance to deformation, overturning and sliding.

The mast consists of tubular sections connected through bolts and flanges. The construction is reinforced with steel ropes in perpendicular directions anchored to the ground. All items are made by hot galvanized steel from zinc layers with thickness ensuring the reliability of the facility to load – that of the mounted equipment, from snow, icing, and wind.

The tower is secured with lightning protection and grounding system and can be accessed at the top. The tower is provided with a protective metal fence of concrete poles and galvanized wire.

The height of the tower must ensure the reliable operation of the system, in view of the terrain and the presence of threes with different height.

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System for autonomous power supply

The system provides electricity for the full autonomy of the AOS without any units that are using liquid or solid fuels. For this purpose, photovoltaic panels are tailored to the electricity consumption of the system and integrated to the complex.

Locating station

The station consists of integrated thermal and color video cameras, which are mounted on automatic electro-mechanical rotary module. The ultra-sensitive thermal imaging camera (**infrared camera**) for outdoor installation placed in a protective shell provides a coverage radius of not less than 10 km. The camera performance is effective in the temperature range from -20°C to +50°C. Other technical characteristics are - minimum IR resolution of 320 x 240 pixels, uncooled micro bolometer, spectral range: 7.5-13 μm, The camera is designed to measure temperature range from 0°C to 350°C. A possibility of increasing the temperature range up to 1200 ° C is available.

Additional video surveillance and control, by means of an operator-controlled video camera for outdoor installation with automatic image stabilization, remote video surveillance and control of the adjacent territory of the AOS is ensured.

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This parallel surveillance is performed also to confirm the alarm events on secondary signs. The color video camera has 36x optical zoom for video and effective performance in the temperature range from -20°C to +50 °C.

Precision rotary module for installation of cameras is used to combine the thermal and normal visual cameras in one module, providing simultaneous automatic control of the AOS. The rotary module ensures 360° horizontal and ±45 ° vertical rotation angle.

The **weather station** reports weather data from the territory of the AOS in real time. The system measures temperature, relative humidity, wind direction and speed, precipitation, atmospheric pressure, and other weather data. Collected data is operated by the specialized software for fire detection. Archive of events, statistics and analysis of climate changes are created.

The effective performance of the station is in the temperature range from -20°C to +50 °C.

Intrusion system is designed for perimeter security of the AOS and for equipment protection ensuring day and night surveillance with remote control. It consists of a control panel in with power supply, external infrared motion detectors, magnetic contact, and manageable Internet module. The system transmits alarm signals in wireless communication channel to the Control Center.

The **telecommunication module** is digital system for two-way communication with the Control Center for sending and receiving data in real time. The communication is carried out in a license-free frequency range of 5.4GHz. The system is equipped with protection against dust and moisture and has effective performance in the temperature range from -20°C to +50 °C.

The **lightning protection and grounding installation** is a complex of technical measures and means of protection from the dangerous and harmful effects of lightning. It ensures the safety of people and helps avoiding inducing voltages in the equipment on the conductive parts of the site.

Control Centre

The AOS fire recognition system is controlled from a remote Control Center. Maps with location of the different elements of AOS in Haskovo and Soufli Municipalities are presented in **Figure 11 "Map of the AOS in Haskovo Municipality"**.

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The Control Centre of Haskovo Municipality is located in the community center of the town of Haskovo. The system offers the necessary software applications to manage all components integrated into a single graphical environment for monitoring and management. The Control Center disposes with a complex of specialized hardware, software, visualization tools and telecommunication equipment for the implementation of remote monitoring and control of the protected area.

Two workstations with specific functions are established. **Workstation 1** is monitoring data for fire detection. It is used for system integration, visualization, control, and archive of the AOS integrated thermal and color video cameras.

The station includes professional monitors (one 42" and one 21.5"), an emergency power supply backup and software for integration, visualization, reporting and archiving of alarm events from the AOS. The workstation is able to perform remote control, change of the assigned surveillance zones and the parameters of detection thresholds of pre-alarm and alarm levels. It allows remote diagnosis and restart of the AOS, as well as system integration with real GPS coordinates, and visualization of trajectories and surveillance zones. The specialized software for visualization, reporting and archiving meteorological data, transmitted by the weather station is installed on this workstation.

Workstation 2 serves for video surveillance purposes and additional video estimation of registered alarms. The station is used for system integration, visualization, management and archive for surveillance and control. This station also includes professional monitors (one 42" and one 21.5"), an emergency power supply backup, specialized visualization software for the PTZ camera. The station is able to control the PTZ camera remotely and to change or set routes for automatic patrol surveillance.

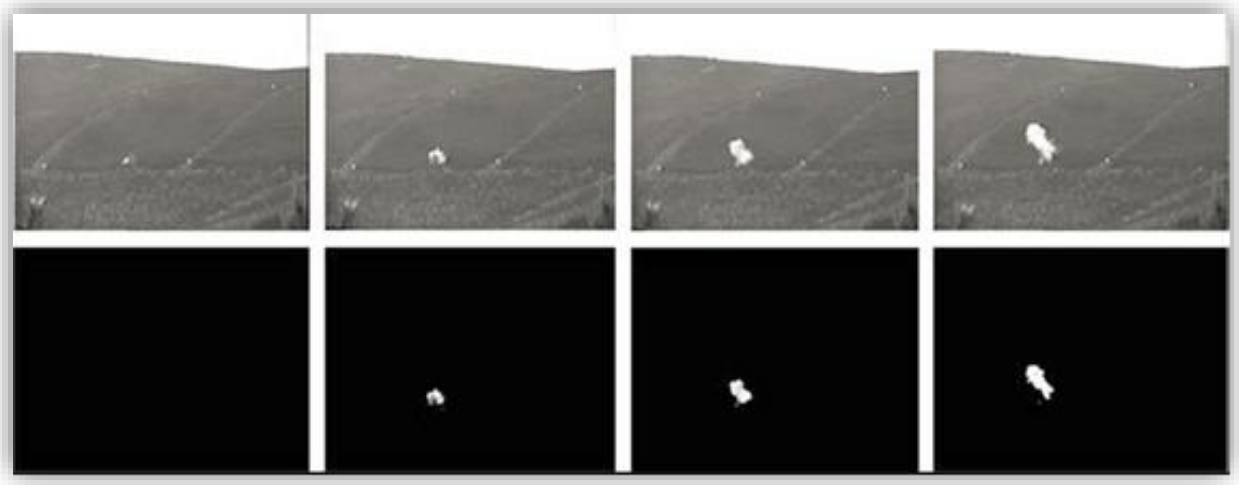

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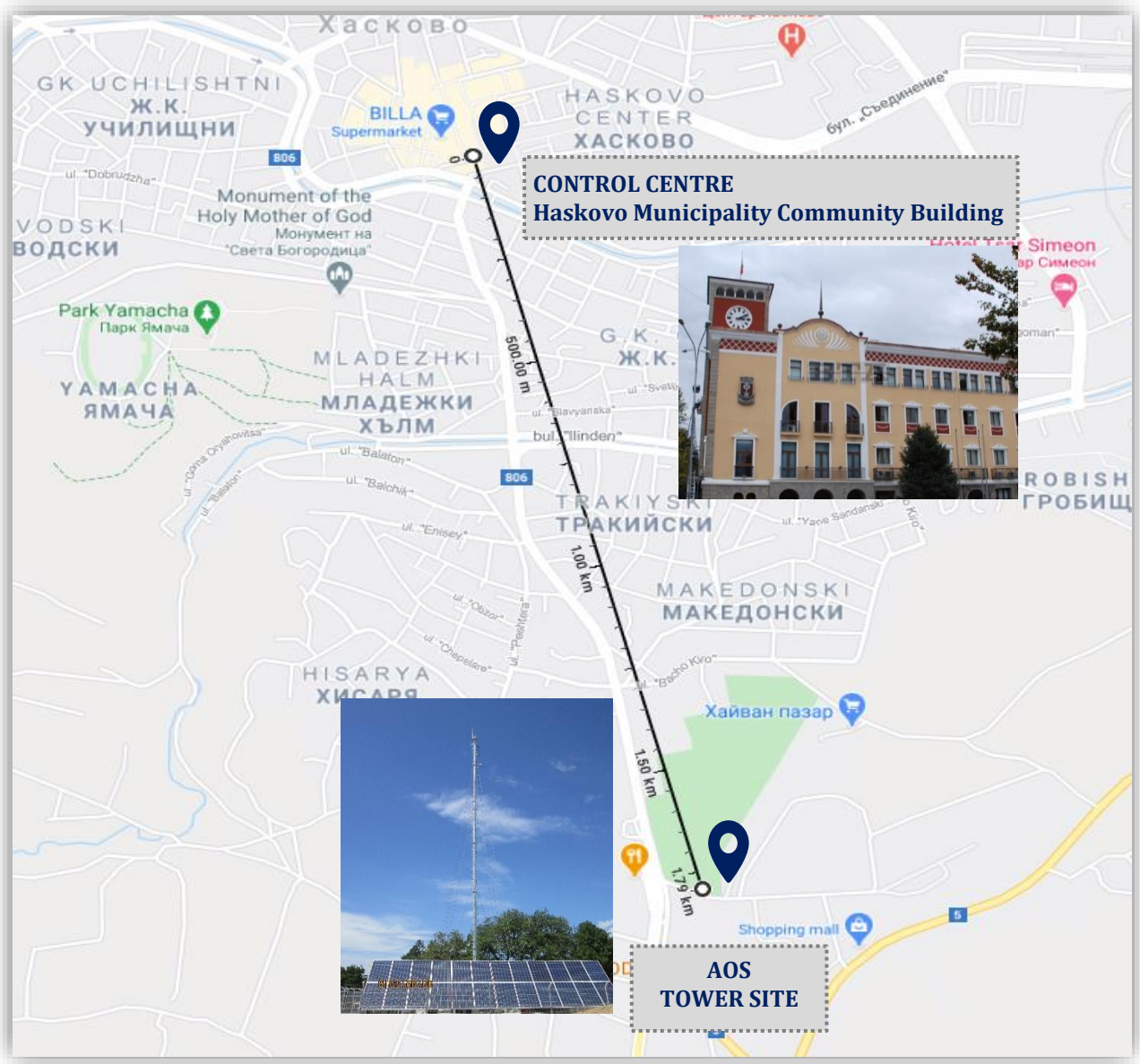
Figure 11 "Map of the AOS in Haskovo Municipality"



Specialized software provides complete solution for monitoring, early detection, and localization of forest fires, based on geographical data by detecting thermal hot spots. The software performs user control, automatic and manual movement of the scanning devices, data stream from the weather station integrated into the application. Study zones of the cameras can be set upon dimensional local and geographic databases and viewed in real time.

In case of alerts the software reproduces acoustic and visual alarms and provides information for the GPS coordinates, distance from the AOS of the thread, size, and temperature of the fire. Images from the color camera can be increased in high resolution for more precise analysis of the fire detection point and direction of spreading.

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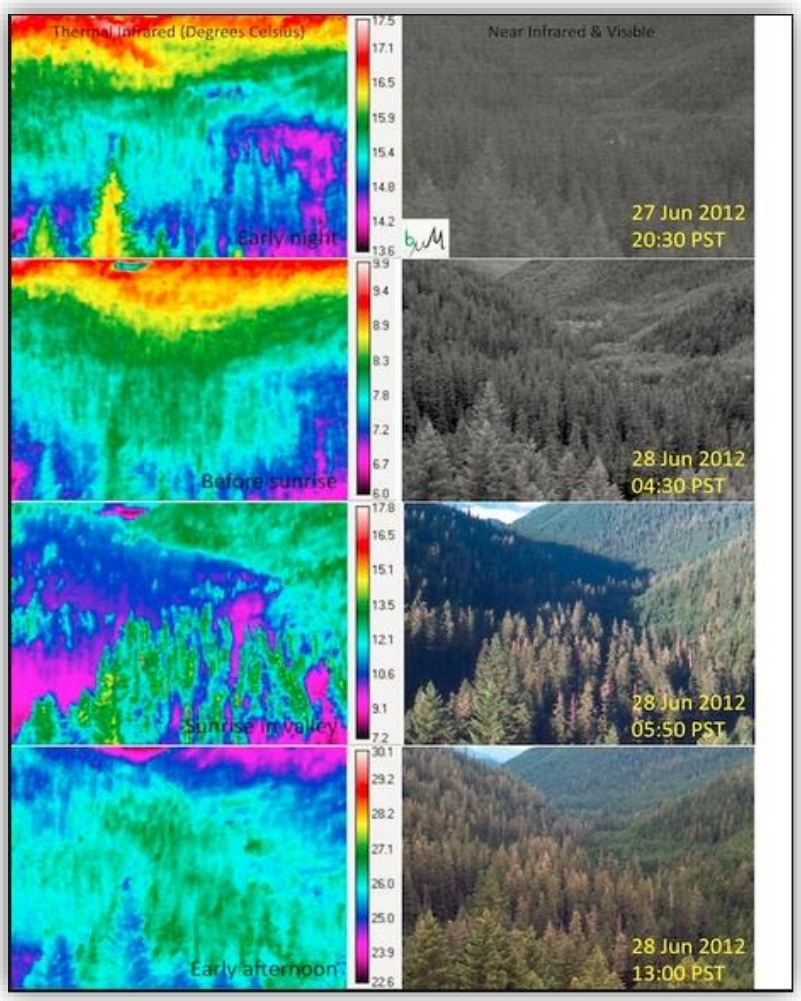
Collected data is arranged into a database with information for alarms, weather data and users/operators' actions. The software is capable of handling up to 10 cameras simultaneously.

The system is designed in a way that allows configuration and remote setup of parameters. By means of a **configuration software** each user with appropriate access rights is able to change the configuration parameters, if necessary. Whenever a change is made, the system automatically accepts it and makes an entry in the database for the user and time of the change. The software provides tailoring the system settings – allows setting zones with different sensitivities at different times, GPS settings of the camera positioning, quality and frame rate of the images transmitted to the control center.

During the fire data processing is limited only to the information that the operator needs for the system for decision support. This allows the dispatcher to work more efficiently. Key features of the system for decision support are the management of alarms, and the automatic creation of informational messages. The system follows algorithms of basic pre-set rules, warnings, and automatic solutions trained in advance.



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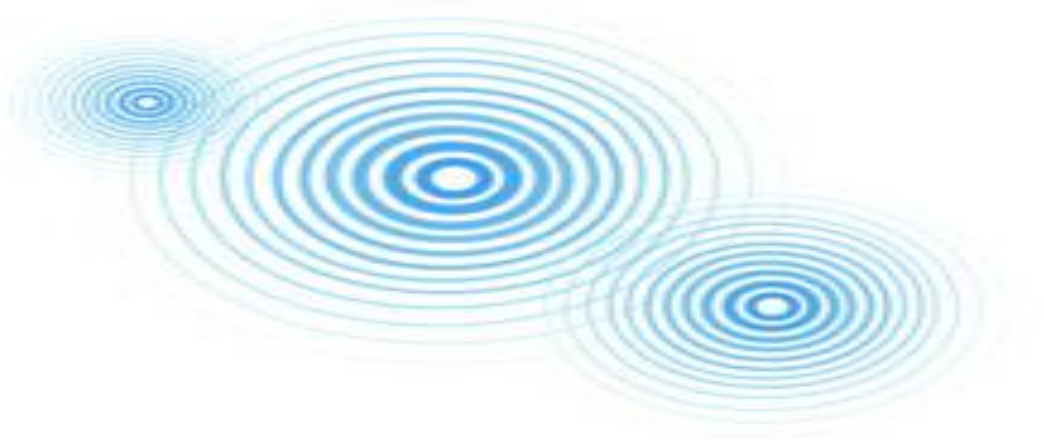
ASSESSMENT OF RESULTS



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Objectives of the Evaluation

The main purpose of the report is to develop a comprehensive ex-post evaluation of the implementation, the results and impacts of the interventions realized under the "Fire Detection" project.

The process of establishing the level actual progress towards objectives and the efficiency with which outputs were delivered is carried in close reference to the Interreg V-A Cooperation Programme Greece – Bulgaria 2014-2020 main and specific objectives. In this regard, strategic and implementation documents of the Programme are used as a milestone for the conclusions and recommendations stated in the report.

The main purpose of the external independent evaluation has been defined in the Terms of Reference (ToR) and confirmed during a kick-off meeting. Based on them it has been agreed that the evaluation will include assessment of the relevance, effectiveness, efficiency, impacts and sustainability of the project and its activities. It will provide information that covers operational aspects of the project implementation and analysis of the achievement of project objectives. Furthermore, the evaluation will identify the challenges that have been faced.

In this regard, conceptual clarifications have been commented and agreed by the parties that following terminology used in the evaluation process shall be understood as follows:

Relevance of the project - problems and needs of the community e.g. are the overall project designs relevant to the needs of the target groups

Efficiency - sound management and value for money or how far funding, staff, time, and other resources were appropriate to contributing to the achievement of project results; what was the quality of monitoring during project implementation

Effectiveness - achievement of purpose or to what extent were the intended outputs and outcomes level indicators achieved in relation to initially set targets; how well was beneficiaries' and stakeholders' participation incorporated in the project cycle

Impact - achievement of wider effect or were the project activities helpful to stakeholders and target groups; what differences are expected in the lives of those targeted in the project in comparison to baseline benchmarks and are there any indirect/wider beneficiaries of the project

Sustainability - likely continuation of achieved results or what are the prospects for the benefits of the project being sustained after the funding will be over and how will be project outcomes managed after the end of the funding period, how the project idea and know-how will be multiplied/transferred to other projects

As a result of the pre-assessment discussions, clarifications, and TOR the evaluation was focused on four main tasks:

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- Assessment of the relevance of the implementation of the project both in relation to the problems and needs of the main target groups and also in connection to the priorities and objectives of the Programme
- Assessment of the effectiveness and efficiency of implementation of project activities
- Assessment of the impact of project interventions on local and Programme level and of the achieved sustainability of results, including environmental impact assessment and contribution to the implementation of horizontal policies
- Assessment of achieved project good practices and formulation of recommendations/working models and specific guidelines for their implementation identified as the most specific part of the evaluation carried as a separate task

The overall objective of the evaluation is to assess the project progress and final implementation and to provide recommendations for follow-up actions which could contribute towards successful achievement of objectives, results, and outputs of similar CBC projects. In addition, the evaluator is expected to potentially provide feedback and important aspects for consideration for future application for EU funding of risk management and disaster prevention projects.

Regarding the time frame, the evaluation covers the period beginning with the project's design through to the completion of its final activities, including any results and impact generated since project completion.

Evaluation stages

The evaluation process was carried according to a pre-designed schedule linked with a structured evaluation plan methods grid. Evaluation stages are presented in **Table 4 "Stages and activities of the evaluation"** provided below:

Table 4 "Stages and activities of the evaluation"

Structuring	Data collection	Analysis and reporting
- Kick-off meeting - Preliminary document review - Intervention logic analysis - Elaboration of detailed evaluation methodology and drafting of Inception Report	- Documentary review - Project implementation and progress survey data - Interviews with project team members, steering committee members, local groups of stakeholders	- Data analysis and answering of the evaluation questions - Preparation of a draft report - Revision of the draft report - Preparation of the final report

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	- On-the spot visit to the project office in Haskovo municipality and investment activities' site	

EVALUATION METHODS AND TOOLS

A process of evaluation design was carried to establish the methods for research - both quantitative and qualitative, to define the sources for assessment and the way of gathering information and preparing conclusions and recommendations. The evaluation approach was to place particular emphasis on measuring the project's adherence to key criteria such as:

- To result in durable, self-sustaining initiatives with measurable impact and multiplier effect
- To utilize the available technical, human, and other resources
- To create synergies with other development interventions and benefit from partnerships

As a result of the evaluation design process following tools were identified to be appropriate and sufficient to measure outcomes and impacts of the project:

- Implementation reviews & Records analysis – based on the review of progress reports, documents issued in implementation of project activities and assignment of tasks and subcontracting, etc.
- Surveys – review of final reports, documents elaborated as part of conducted under project activities' surveys and studies, etc.
- Questionnaires & Interviews – with project team members, steering committee members, local groups of stakeholders, representatives of specific units of the beneficiary's organizations, etc.

The information seeked for relates to results achieved both on project and Programme level as well as to the major difficulties and bottlenecks in the implementation.

Data collection, analysis, and reporting

Desk research

The desk research was the main method of gathering information for carrying out the analysis and answering evaluation questions. It was used to collect secondary data from:

- Strategic documents

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The Cooperation Programme Interreg V-A "Greece-Bulgaria 2014-2020", the Application Package for the 2nd Call for Proposals under the Interreg V-A "Greece-Bulgaria 2014-2020" Programme, the Programme and Project Implementation Manual, Information and Publicity Guide, the Project Closure Manual and other related to the cross-border cooperation and territorial cooperation activities documents were reviewed

- Project implementation documents

The (AF), the Subsidy contract, the Partnership Agreement Project Progress Reports, First Level Control Documents, sub-contracting documents, information and publicity related documents, reports on communication and dissemination events were reviewed

Reviewed documents are listed in the Bibliography part of the current report.

Data

Under the supervision of the project manager the evaluation expert was given access to the Management Information System (MIS). It allowed review and investigation of the project life cycle including reporting, observation of deadlines, requested and verified expenses.

Interviews

Interviews with the project team, municipality officers engaged in project implementation, and stakeholder were carried face-to face and via a structured questionnaire. The focus was on providing information on specific topics related to the evaluation process. At the same time, the possibility to explore sub-themes and to develop new topics was given to the interviewees.

On-site visits

On-site visits to the project office in Municipality of Haskovo and at the investment site were carried. The project office was visited to conduct interviews with the project manager and other decision makers in beneficiary's organization. The investment site was visited with project team members appointed to perform investment control during construction and delivery of supplies.

Analysis and reporting

The data collected by these diverse tools was utilized to ascertain the trustworthiness of meanings and assertions from the different sources and to identify patterns in the data.

The content analysis of findings from the document review to the extent that they provide answers to the evaluation questions was supplemented with the development of specific tools for gathering primary data such as an interview and survey questionnaire.

3 face-to-face interviews were conducted incl. the project manager, the chief of specialized project implementation unit in beneficiary's organization, the investment control expert.

Regarding questions that were not entirely clarified by the documentary evidence, both quantitative and qualitative information was collected from key project stakeholders through an electronic self-administered survey. The survey was developed both in English and Bulgarian to meet language limitations of the focus group. The survey was sent to 8 participants.

For those questions that were answered through the documents, responses from interviews and the survey were cross-checked for convergence. A check for internal consistency (between the different respondents) and external consistency (between the survey results and the findings from other sources) was also performed.

Evaluation matrix

The evaluation was managed, and the results of different measures applied were analyzed based on the following evaluation matrix provided in **Table 5 "Project Implementation Evaluation Matrix"** below:

Table 5 "Project Implementation Evaluation Matrix"

Relevance *The extent to which the project and its activities were suited to the priorities and policies of the region and to what extent they were linked or related to main stakeholders needs*		
Indicators	*Collection methods*	*Sources*
- Evidence of coherence against main CBC policies	Implementation Documents review Records Analysis Interviews Survey	AF Project documents (e.g. Progress Reports, Meeting Reports, etc.)
- Evidence of complementarities and synergies with other initiatives		
- Contribution and consistency with program priorities		
Efficiency *Measurement of the outputs in relation to the inputs, including complementarity and value added*		
- Extent to which the management structures of the project facilitated the implementation	Implementation Documents review Records Analysis Interviews Survey	AF Project documents (e.g. Progress Reports, Meeting Reports, etc.) Project
- Planned versus actual work plan		
- Planned vs. actual allocation of expenses		

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- Nature of changes and delays that affected the implementation		Managers/Team Beneficiaries
Effectiveness *The extent to which the project attained its objectives and expected accomplishments*		
- Degree of satisfaction of the project's main beneficiaries	Implementation Documents review Records Analysis Interviews Surveys	AF Project documents (e.g. Progress Reports, Meeting Reports, etc.) Project Manager/Team Beneficiaries
- Evidence of the project contribution to a more diversified use and sustainable exploitation of resources		
- Evidence that the project made a difference in the beneficiaries' behavior, attitude, skills, etc.		
- Evidence of the project contribution to reach a greater complementarity of policy approaches in the region		
Impact *The extent to which the project activities were effective in influencing the social, economic, and natural environment*		
- Extent to which the project utilized the technical, human, and other resources available	Implementation Documents review Records Analysis Interviews Survey	AF Project documents (e.g. Progress Reports, Meeting Reports, etc.) Project Manager/Team Beneficiaries
- Evidence of the project's main results being used by beneficiary institutions		
- Evidence that the project has catalyzed or identified opportunities that if acted on will improve likelihood of impact		
Sustainability *The extent to which the benefits of the project are likely to continue after funding has been withdrawn, including long-term impact, dissemination, and replication*		
- Evidence of an "exit strategy" being considered during the design/ implementation	Implementation Documents review Records Analysis	AF Project documents (e.g. Progress

- Evidence of a scaling or replication plan	Interviews Survey	Reports, Meeting Reports, etc.) Project Manager/Team Beneficiaries
- Budget for scaling out to other locations		

Questionnaire

Based on the elaborated detailed evaluation methodology a questionnaire was designed that was used for interviews for the needs of the current report. To ensure credibility of the analysis the questionnaire was organized with close-end questions grouped according to the evaluation matrix topics. Respondents were given prompts for each of the sections of the questionnaire and an opportunity for comments.

Respondents were chosen among project team members, beneficiaries' employees, participants in project activities, etc. in coordination with the contracting authority. The questionnaire was administrated on-line as respondents were provided a link to fill it remotely. The content of the questionnaire is provided in **Table 6 "Contents of the Questionnaire"**.

Table 6 "Contents of the Questionnaire"

Relevance - The extent to which the project and its activities were suited to the priorities and policies of the region and to what extent they were linked or related to main stakeholders need
Consider the following areas: Was the overall project design relevant to the needs of the target groups? To what extent community problems were solved by the project?
▪ Project activities demonstrated clear synergies and complementarities with other regional and CBC initiatives ▪ Solutions that were developed and implemented met the intent of the promise
Efficiency - Measurement of the outputs in relation to the inputs, including complementarity and value added
Consider the following areas: Were the appropriate resources involved? Was the project team skill level correct? Was the organizational structure and hierarchy of the team (as a separate unit & as part of the overall organization well designed? Was there sufficient control/tracking information? How efficiently was progress monitored? Were there any changes to the scope, and how they were monitored and controlled?

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- Project roles & responsibilities were communicated and understood
- Team members were adequately involved in project decisions
- The project schedule was effectively monitored and tracked throughout/
- Corrective actions were taken (& communicated) when actual timings were different from scheduled
- Appropriate decisions and actions were undertaken to embed changes and eliminate risks

Effectiveness - The extent to which the project attained its objectives and expected accomplishments

Consider the following areas: Were key stages followed in reaching project's objectives? Were key deliverables/milestones achieved as defined? Were stakeholders and target groups sufficiently involved in publicity activities?

- Appropriate methods of dissemination of project outputs and results were applied throughout the project
- Project stakeholder relationships were managed well by the project
- The intervention logic "project objective – activity – result/output" was kept
- The project was successful in achieving planned objectives

Impact - The extent to which the project activities were effective in influencing the social, economic, and natural environment

Consider the following areas: What is the project long-term impact? Were the project activities helpful to stakeholders and target groups? What differences are expected in the lives of those targeted in the project in comparison to baseline benchmarks and are there any indirect/wider beneficiaries of the project?/

- The project has contributed towards a shared vision in the region
- Project activities and accomplishments proved appropriate at strategic and operational level
- Project implementation influenced positively the target groups

Sustainability - The extent to which the benefits of the project are likely to continue after funding has been withdrawn, including long-term impact, dissemination, and replication

Consider the following areas: To which extent the benefits of the project are likely to continue after funding has been withdrawn? Will project outcomes be properly managed after the end of the project? Are you aware of any opportunities of dissemination and replication of the project?

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- Project accomplishments are supposed to be effectively used/incorporated in the work and practices of the beneficiary institution after completion of the project's activities
- The project is supposed to multiply its impact in other scaling or replication plans/projects

EVALUATION FINDINGS

This section outlines the main findings and analysis related to each of the evaluation criteria - relevance, efficiency, effectiveness, impact, and sustainability.

The assessment was guided considering the following key evaluation topics, which have been enrolled in a way of guidelines also in the questionnaire:

Relevance – were project activities linked to local and regional priorities and are changes brought to the community still relevant

Efficiency – are outputs gained against specified time and allocated budget, were activities cost efficient compared to available alternatives

Effectiveness – what was the degree of effectiveness of the activities on the lives of people, are people engaging and taking ownership of the project

Impact – what are the social, economic, and environmental changes, direct and indirect, intended, or unintended, introduced by the project.

Sustainability – is there a plan/an "exit strategy" how the project will develop after the funding has exhausted, will project benefits continue after its completion and can its continuation be ensured with other activities/projects

The findings on the main components of the evaluation matrix, made on the basis of the conducted research on the project implementation, the interviews and the answers to the questionnaire, are described in detail in the thematic presentation that follows. Details of the questionnaire are attached in Annex 1.

Relevance

The coherence of the project idea to the "Interreg V-A Greece-Bulgaria 2014-2020" is fully proven by the content of the AF. Project activities are highly correlated with the Common Strategic Framework 2014 - 2020 and with the general and specific objectives of the Strategy "Europe 2020". In particular, the project addresses challenges in two of the five thematic objectives of Europe 2020 - promoting climate change adaptation, risk prevention and management and preserving and protecting the environment and promoting resource efficiency.

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Joint investment activities for development of contemporary early wildfire detection and management facilities demonstrate clear consistency with the cross-cutting themes of "innovation" and "smart and sustainable growth".

The precise needs/challenges that the present project is designed to address are:

- To increases the ability of the CB area to adapt to climate change
- To reduces CB natural and man-made risks and enhance the response capabilities of local stakeholders
- To protect biodiversity and the health of eco-systems, and
- To reduce the environmental footprint of illegal activities in the CB area.

The intervention logic (see Table 1 "Project Intervention Logic") of the project aims three main accomplishments - 1) prevention through public awareness, risk analysis and protected areas monitoring, 2) on time detection of the danger through monitoring system consisting of high technology fire detecting cameras that will be installed (One in Soufli and one in Haskovo), and 3) effective crisis management through real time integrated image of the fire given by high technology cameras.

To this extend, the project entirely contributes to Thematic Objective 6 of the Programme that seeks an integrated approach to environmental protection and adaptation to climate change where collaboration is either necessary or is expected to produce significant added value.

At regional and local level, the consistency with prevention and risk management policies is confirmed by the Haskovo District Regional Development Plan and the Haskovo Municipality Development Plan for 2014-2020.

Project activities are coherent to Strategic Objective 5: "Territorial cooperation - a tool for integrated development through a broad partnership that engages different sectors and levels of government", Priority 2: "Promoting stability and competitiveness in the region through the development of transnational partnerships and joint venture actions on issues of strategic importance" of the Haskovo Municipality Development Plan.

The Haskovo District Regional Development Plan Strategic Objective 4: "Development of cross-border and transnational cooperation contributing to economic and social development and convergence" and Strategic Objective 4: "Preservation and improvement of the quality of the environment through integration of global environmental goals and development of environmental infrastructure" are the key intervention fields addressed by project objectives.

The assessment of the project's concept and design evidences that the project responded to the needs identified in the CBC region by proposing a path for transforming the existing risk management structure into a more knowledge-intensive and diversified system. One contribution of the project was to introduce an innovative approach by specifically

addressing the use of modern ICT tools. It also represented a comprehensive effort to enhance institutional dialogue for a common understanding of the problem in the region.

The design identified some of the main bottlenecks, including the lack of technical capacity of the existing fire prevention facilities. Introduction of DDS utilities and their direct contribution to the national common EMS was a priori assessed by the pertinent criteria of the Call of proposals and during the project proposal evaluation process.

Credible cause-effect relationships demonstrating the adequacy of the project for addressing the biodiversity protection challenges were included in the project attachments - Annex 1: "Scope of Project and Sustainability" and investment designs documentation.

CONCLUSIONS:

Nevertheless, a more thorough and explicit analysis of the demand side could have been demonstrated in the AF to better understand the rules and incentives that govern the implementation of risk management and biodiversity protection policy and to define more clearly the roles of the various actors.

The project design would have benefited from a more thorough description of its logic that explicitly verified the causality of the objectives. Building capacity, awareness raising and policy influencing activities should have been linked more definitely to the investment interventions.

The simplified logic framework was useful at the project proposal stage but should have been improved for it to be useful as an effective project management and implementation tool.

Efficiency

As a result of the competence and experience of the **partnership** in management of public funded projects, especially in the field addressed by this project the activities were implemented as planned and synergies and efficiency gains were exploited. Though certain limitations were faced because of the COVID-19 virus spread mainly in communication and project management activities the level of reached coordination and dissemination is consistent to initially set target values.

The **project team** was established according to approved internal rules of Municipality of Haskovo and as per the project management and coordination structure defined in the AF. According to job descriptions attached to the assignment documents, project team members have been chosen among employees with the necessary skills and experience in the implementation of similar project initiatives.

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The project was managed from headquarters directly from the partner institution in Haskovo Municipality where a project office in compliance to the visibility requirements of the Programme has been established at project beginning.

The **organizational structure** of the team was substituted to the general hierarchy of the beneficiary's organization. Nevertheless, compliance with both internal rules of the organization and personal responsibilities, according to the team appointment documents has been properly ensured. This is mostly due to the fact that project team members are also participating as fully occupied employees in the functional structure of the beneficiary in its capacity of public administration. That also is acknowledged to be one of the main reasons that appropriate resources have been involved or available in case of necessity during the whole project implementation cycle.

The AF foresaw the establishment of a 5 member Steering Committee, which would meet six times to review the project's progress, based on reports provided by the project manager. In addition, due to the intense investment character of the project a Technical committee of 5 members was also envisaged in the AF. As per revised progress reports and the interviews held, it was found that the established Steering and Technical Committees were hindered to perform effective participation in project delivery. Due to the COVID-19 restrictions no committee meetings have actually taken place. The project team took the full responsibility for implementation and monitoring, under the supervision of a senior officer/team leader from the Lead Partner (LP) and project partner and the collaboration with both supporting committees was rather informative.

Though the face-to-face meetings between project partners were restricted to only 4 events the communication carried by various types for exchange of information can be evaluated as effective. Timely and adequate response both to questions of operational character and in cases of problems have been demonstrated during project implementation.

Project reports were well documented. The existing clear audit trail for the document flow in beneficiary's organization ensured monitoring of all the operations related to project implementation such as launching public procurement procedures, subcontracting, project progress reporting to Programme authorities and funds reimbursement, etc.

Delays from the initial time frame occurred that were justified by project managers with delays in procurement procedures and the emergency state introduced at national and EC level related to the COVID-19 virus spread.

On some occasions, this also caused a delay in other activities like those planned under Working Package (WP 2) – launching the project website, conduct of workshops and informative school campaigns.

The project website has yet to be designed and launched at the time of this evaluation. According to the project team, many factors impeded the timely achievement of this result. The process of dissemination of project outcomes via an online tool faced some initial delays and ultimately took more time than expected mainly due to the fact that activities

included in WP 5 – Capabilities Analysis of Utilizing the system for Other Purposes than fire Detection and the Fire Risk Assessment, are interconnected to the start-up and pilot work of the wildfire monitoring facility.

Although the investment process (WP3) is a long-term activity related also to legal procedures such as commissioning and operational tests the initially set action plan was kept. Construction works lasted from April till September 2019 ensuring a period of almost a year for the pilot operation of the AOS which is a period more than 7 months longer than the initially envisaged. This is acknowledged to be the main reason that quality and credible reports and management plans have been elaborated under activities in WP 5.

In general, it was found that efficient use was made of financial resources, and that the funds were well spent in a transparent manner. This has been ensured via procurement procedures applied according to national and Programme requirements. The existing internal monitoring system in beneficiary's organization kept a close track on all expenses related to project implementation providing a clear audit trail for all activities.

Under WP 3 **budget** savings occurred after the conduct of the procurement procedure for infrastructure acquisition. In compliance to Programme requirements for budget modifications these discounts have been re-allocated for the purchase of complementarity vehicle – a 1 basket crane that shall be used for the maintenance of the AOS. In this way project outcomes have been enlarged immediately resulting to project objectives.

CONCLUSIONS:

Management capacities are evaluated as adequate to the project content. A clear understanding of the roles and responsibilities by all parties involved in the project is evident.

Project implementation proved that the organizational structure of the team was appropriately designed and appointed. Resources with right skills were available when needed. The inter-structure coordination was good and ensured a comprehensive approach to project implementation.

The project received adequate technical and administrative support from both project partners. Cooperation between project partners has been efficient.

Nevertheless, the project governance should have used more effectively the advisory capacity of the Steering and Technical Committees for facilitating timely results and efficient delivery.

Notwithstanding that the actual project timings were different from the scheduled, the project workplan was not affected seriously mainly due to the investment character of the project which in many aspects enables a range of feasibility for all other activities except for the construction works.

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Effectiveness

It can be stated that the intervention logic "project objectives – activity – result/output" was kept though as described certain deviations from the timeframe and the budget of some activities has occurred.

Although WP 2 obviously faced shortcomings due to the incomplete and delayed completion of planned activities, the successful delivery of outcomes under WP 3, WP 4 and WP 5 determines the project implementation as efficient enough to gain intended long-term impact.

Compared to initially set target values the achievement of project outputs by Municipality of Haskovo is illustrated in **Table 7 "Attained objectives"**.

Table 7 "Attained Objectives"

Main Accomplishments	Indicators
Establishing of high technology forest fire real-time monitoring systems	1 AOS established in Haskovo Municipality 1 System Management Center set into operation in Haskovo Municipality, pilot monitoring conducted for more than 7 months 1 basket crane delivered to Haskovo Municipality
Designing of effective prevention, risk management and project result dissemination plans	1 study "Fire Risk Assessment" developed and adopted for implementation by the specialized disaster prevention unit 1 analysis "Capabilities of Utilizing the System for Other Purposes than Fire Detection" elaborated and brought into execution 1 report "Assessment of the Results Transferability"* elaborated
Rising public awareness on fire prevention and biodiversity protection	5 protected areas indication signboards elaborated and installed in Haskovo Municipality according to a preliminary study for sites definition

**the current report*

Following deliverables planned under WP 2 are not yet fully acquired by the time of the development of the current report though are procured and in a process of implementation:

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Table 8 "Indicators in process of achievement"

Main Accomplishments	Indicators
Rising public awareness on fire prevention and biodiversity protection	Training package with printed materials disseminated in municipal schools in Haskovo Municipalities Awareness rising campaign held in primary schools in Haskovo Municipalities Workshop for presenting project results conducted in Haskovo Project web site launched

Considering the investment nature of the project, the achievement of the results of WP 2 just by the end of the project implementation period is not expected to negatively affect its overall implementation. Even if some of the planned under WP 2 activities are not fully completed by project end it would not contradict its main objectives. Still the funds reimbursement aspect should be considered in case some of activity outputs are not completely attained.

Conducted interviews and the analysis of the answers to the questionnaire clearly show that while at the beginning of the project the benefits of its implementation were not so clearly realized, at its end the contribution to fire prevention and biodiversity protection measures is highly appreciated. There is also a visible upgrade of existing disaster prevention capacity based on the knowledge and experience gained through the developed risk management plans and strategies and the benefits of acquired high-tech equipment.

The training conducted to the employees of the dispatching unit for work with the specialized equipment and software and the establishment of a modern and fast connection to the EMS is considered to be a good prerequisite for the diversified and sustainable use of resources.

CONCLUSIONS:

The evaluation can affirm that the activities were complementary and reinforced the internal coherence of the project.

Nevertheless, the implementation of "soft measures" in parallel with the investment ones would have ensured a more effective achievement of the project objectives.

A wider dissemination of the activities would have increased participation and probably increased the benefits of the project.

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Impact

The extent to which the project has used the available technical, human, and other resources is obviously high as evidenced by the progress made. Programme funds have been effectively used, incl. that savings after public procurement have become an additional contribution to project objectives by the purchase of maintenance equipment.

Under WP 5 essential documents for the beneficiary's organization which would otherwise be met with own funds have been developed. These documents have been already adopted by the institution and set into implementation. This also proves that project objectives were appropriate at strategic and operational level.

The management of the implementation process affirms that project team and coordination structures worked well with governance and disaster prevention authorities during the project. Right after its commissioning the AOS has been introduced as a part of the national EMS. During the pilot operational period envisaged under WP 4 its work has been jointly monitored with the regional civil protection units. In this respect the immediate contribution of the project is apparent, and the impact is promptly transmitted to a wider group of beneficiaries.

Conducted interviews and the analysis of the answers to the questionnaire clearly show that project implementation has catalyzed the potential of the established AOS to be enlarged with additional monitoring towers and even to expand its range of benefits by merging with other AOS into a common interconnected network.

CONCLUSIONS:

Already applied in practice strategic documents developed under the project demonstrate the potential for a long-term impact.

The acquisition of tangible fixed assets under the investment measures has improved the existing disaster prevention infrastructure and has enhanced the capacity for fire detection and biodiversity protection.

Sustainability

In itself, the sustainability of the project is obvious given that the main functions of the municipal administration include activities for prevention and protection of the population from disasters. The municipality maintains and ensures the continuous operation mode as part of a national system of early warning (EMS) of facilities and equipment, dispatch center and teams. In this regard, the implementation of the approved Disaster Prevention and Response Plan, which is provided annually with the corresponding budget funds, is strictly observed.

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"Exit strategy" in this case in the most minimalist version is limited to the provision of operating costs for the operation of the acquired new tangible assets - observation tower, operations center and service vehicle which should be planned in the draft budget for the next calendar year. Given the energy autonomy of the AOC and the low energy consumption of the installed peripheral monitoring devices, it is not expected that the necessary funds will be in an amount that cannot be covered by the own budget.

The warranty terms under the construction contract for the system do not suppose the need for replacement or repair costs in the near future.

Regarding the provision of sustainability, the most important point is the need to maintain a high level of competence of the employees in the dispatch center for working with the specialized software and adequate interpretation of the received information. Minding the intensive development of the IT sector and the alleged update of the early warning software, it is imperative to conduct periodic trainings of operational staff, incl. simulation tasks.

In the long run, as shown by the data from the interviews, the technological capabilities of the system to be extended to all NATURA 2000 sites in the Municipality of Haskovo are already realized. There is a vision for the construction of such observation towers and their connection in a common system also with existing ones on the territory of the Fire Safety and Protection of the Population Directorate in Haskovo District. In this regard, it is recommended to exchange experience and good practices with the duty teams of the previously established system of the same type in the Municipality of Dimitrovgrad.

Regarding the replication of the investment, it is clear that its size exceeds the possibilities of own financing. The type of assets limits opportunities for public-private partnerships to the operation of the system, so that the acquisition cost is unlikely to be of financial interest for any market operators. The most appropriate sources for extending the project remain the EU instruments that provide financial assistance in the form of grants under different programms. At the turn of the two European Union planning terms main priorities of EU support policies should be constantly monitored and the trends for the next programming period should be followed more closely.

CONCLUSIONS:

Project outcomes are supposed to be properly managed after its end. The beneficiary disposes with sufficient financial capacity for maintaining the facilities and ensuring the operation of the early disaster detection system.

There is a clear vision for the replication of the project in other extending and scaling initiatives and a motivated intention to find financial support from grants in the next programming period.

CONCLUSIONS

The analysis of specific positive findings in comparison to faced shortcomings and problems during project implementation are systemized in a way of a SWOT table that highlights the strengths of the project and the opportunities for its replication. A more detailed review for the purposes of this report is made in relation to the transferability of project results. Issues listed in the analysis are considered relevant both to the currently implemented project and any other subsequent initiative/project related to the application of high technology for protection of biodiversity through early fire detection in high significance protected forest areas.

Table 8 "SWOT Analysis"

 **STRENGTHS**	**Introduction of highly efficient early detection IT based systems** The implementation of pilot activities in units that have direct responsibility for disaster prevention and response, as well as maintaining a dispatch center for protection of the population and the environment makes the project highly relevant and effective at local and regional level **Interaction between institutions at regional and CB level** Conditions for effective support of the EMS are created, as well as ensuring a more adequate and interconnected response in cases of emergency **Awareness raising and institutional capacity enhancement** The implementation of "soft measures" for publicity and the creation of strategic planning analyzes upgrades the capacity of the administration and increases the interest of the local community in the issues of biodiversity protection and personal responsibility **Strengthening cross-border cooperation** to solve problems of global importance and creating a vision for the need of joint efforts
 **WEAKNESSES**	**Insufficient coherence** between the implemented investment measures, stakeholder awareness, transfer of know-how and implementation of short-term and long-term strategic plans **Need to attract specialists** with higher qualification and experience in the monitoring and dispatching units to the AOS **Need of additional specialized equipment** for prevention and emergency rescue operations

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OPPORTUNITIES

Structural Funds of the EU

IT technologies

The introduction of modern technologies and use of innovative approaches for environmental protection and biodiversity such as the application of GIS, mapping, maintenance of connected (including cross-border) databases of previous events and threats can be continued

Volunteers

The potential of voluntary structures can be used both at local level and through the implementation of cross-border initiatives to create a connected network that works closely with and supported by municipal and regional structures of environmental and biodiversity protection authorities, prevention and disaster response units

Exchange of experience

THREADS

Change in policies and priorities at local, regional and national level

Lack of funding for the implementation of expensive investment measures and introduction of IT technologies

Insufficient incentives and motivation at management level to extend project activities in other scaling initiatives

RECOMMENDATIONS

As can be seen from the analysis the beneficiary should find a way to develop the project's outstanding work, especially since project activities are highly replicable.

The current report focuses on the transferability of project's results and can be perceived as a plan to enhance the project's sustainability. In particular, it is suggested to support the following components after Fire Detection Project closure:

Recommendation 1:	**Developing replication projects to expand the fire detection network with new facilities**

- Pursuant to this recommendation it should be ensured that future projects involve relevant partners, strengthening synergies. The full involvement of parties should be considered during project design and continued throughout project implementation.
- Projects should be developed based on comprehensive needs analysis and robust

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monitoring and evaluation frameworks should be adhered to during the design and implementation stages. Moreover, clear and well formulated "exit strategies" should also be available in order to enhance the sustainability of future project interventions.

- The search for funding is an essential moment for the replication of the project. The possibilities of grants through the EU instruments should be closely monitored and adequately responded when calls of proposals are launched. In **Table 9 "EU Support"** below brief information on the main grant schemes that support biodiversity protection initiatives during the current period is provided that can add contribution to the efforts for transferability of project results.

- As a part of the measures for development of the project idea it is found necessary a detailed technical study to be developed for outlining the parameters of the network in order all protected NATURA 2000 sites to be monitored.

  Such a study should clarify the range not only of the technical decisions capable to ensure reliable prevention but also the scope of the investment costs. Based on the financial burden of acquisition a prioritized plan for implementation with indicative timeframe should be developed. The Municipality of Haskovo should proactively look for funding for each of the activities, where possible through the EU Programs, through regional and national funds and through partners.

  As part of this report, a study was conducted on the scope of lands of the NATURA 2000 network on the territory of the Municipality of Haskovo. The possibility of installing observation towers in the forest territories and the territories subject to habitat protection was examined. The applied approach was in search of a solution to cover all areas, so that a connection with the already established dispatch center in the municipal administration building in the town of Haskovo to be ensured.

  An interactive map was developed that takes into account the altitude of selected NATURA 2000 sites, the potential for monitoring the largest possible area of the respective protected zone and the provision of a direct air connection between the monitoring facilities and the control center. The map is to be considered a preliminary study whose technical details must be subject to sizing and refinement by experts, designers of IT monitoring and fire detection facilities. The map is presented in Annex 2.

Recommendation 2:	**Enhancing the outreach and results of future fire detection and biodiversity protection projects**

- Municipality of Haskovo should continue exploring the possibility to further adapt the project's approach to other contexts and target groups. In doing so, it should also assess the potential for strengthening the awareness on biodiversity protection at community level and influencing the environment necessary for transferability of the

project results.

- In order to expand the benefits of the current project and any other replication initiative it is suggested to further explore ways of spreading the knowledge and skills obtained. Some possibilities include development and approval of updated municipal rules and plans for biodiversity protection, establishment of a center for conducting trainings and demonstrations of the AOS for the population and know-how exchange with other municipal administrations especially those which have already established similar IT based utilities.

Recommendation 3:	**Working in collaboration with regional, national and CB integration initiatives or mechanisms to enhance sustainability**

- Effective application of the strategic documents developed under the project – the risk analysis and capabilities of the system report, upgrading them through appropriate scaling initiatives with the participation of partnering institutions is a key factors for strengthening the results, dissemination and sustainability

- Partnerships between organizations operating in the field of biodiversity protection increase the benefits of any strategy at national, sub regional and interregional level. Including more collaboration mechanisms in future project activities regardless of project partners' statute of public bodies or NGOs can effectively promote a common vision that, in turn, is able to strengthen results and broaden the dissemination of products.

Table 9 "EU Support"

European Agricultural Fund for Rural Development	By now the main EU financial support for forests come from the Rural Development Policy and the **European Agricultural Fund for Rural Development** (EAFRD). The Rural Development Regulation covers forests and forestry in the majority of six priority areas, which include knowledge transfer and innovation in forestry, promoting sustainable management of forests, restoring, preserving and enhancing ecosystems related to agriculture and forestry, considering Natura 2000 as focus areas and also promoting resource efficiency, low-carbon / climate-resilient economy in agriculture, food and forestry sectors

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European Regional Development Fund& European Social Fund	In addition to the EAFRD, Member States and their regions benefit from the support of the **European Regional Development Fund** (ERDF) and **European Social Fund** (ESF). Some examples that can be linked to forests and the forestry area are investments of the ERDF in Natura 2000 and the promotion of biodiversity and ecosystem services and the support to SME's and innovation. The ERDF also co-finances cross-border, transnational and interregional cooperation programs (**INTERREG**) that support projects which relate to forests and forestry. Projects include fields of intervention such as monitoring and information systems as well as networks linked to forest fires, sustainable land management, information sharing on climate change adaptation, carbon sequestration and risk reduction, biodiversity, policies against depopulation in mountain areas, favoring bio-energy use, cooperation for use of renewables and energy efficiency and sustainable development of regions through SMEs
LIFE	Another important source of funding for forests comes from the **EU LIFE** Instrument which remains to this day the only EU instrument exclusively dedicated to financing environment and climate-related projects. Typical actions under LIFE projects include removing invasive alien species, drawing up management plans and agreeing on appropriate management regimes for forest habitats with local stakeholders, funding restoration projects to improve the structural diversity of forests, kick starting forest-environment schemes under RDP by means of demonstration and best practice projects

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ANNEXES

Annex 1 – Questionnaire Results

Annex 2 – Map of Potential AOS Sites

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nalyan gyudzhen is an independent expert with significant experience in cross-border territorial cooperation programs. She has worked as an investment project's monitoring expert in the Joint Secretariat of the CBC IPA Bulgaria-Turkey Program. As member of the General Directorate "Territorial Cooperation" team in the Ministry of Regional Development of the Republic of Bulgaria she has participated in the project proposals call preparations, projects assessment and selection, Program monitoring.

In previous years, in realization of her professional qualification of a civil engineer, she managed the Construction, Investment Policy and Ecology Directorate in the Municipality of Haskovo and in particular the implementation of the municipal investment program.

By participating in numerous teams both as a member of expert and focus groups and as a project designer with full design qualifications, she has gained experience in evaluating the implementation of investment projects.

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