

# Organizing the Participation of Population in Preventing Forest Fires: International Experience

## Organizando la participación popular en la prevención de incendios forestales: La experiencia Internacional

Tuan Anh NGUYEN [1](#)

Received: 05/10/2017 • Approved: 29/10/2017

### Content

[1. Introduction](#)

[2. Role of Voluntary Fire Guard in Ensuring Fire Safety in Forestlands](#)

[3. Methods. Analysis of Opportunities to Monitor Forest Fires for Organizing the Population to Participate in Preventing Them](#)

[4. Results](#)

[5. Discussion](#)

[6. Conclusion](#)

[References](#)

#### ABSTRACT:

The modern society cannot exist without meeting the essential ecological needs related to the preservation (protection) of the natural environment and its components, rational use of natural resources, and person's defense (protection) from unfavorable state of the natural environment, including forest fire hazard. The goal of the article is to analyze the international experience of organizing the participation of the population in preventing forest fires and possibilities to use it in Russia. The article considers the current problems on organizing prevention and extinguishing forest fires. The role of voluntary fire guard in ensuring fire safety in the forestland is analyzed. It has been offered to create a wireless sensor network on controlling forest fires as a means of monitoring forest fires to organize the participation of the population in preventing them. The authors make the conclusion that since the problem of fire safety of forests is a component of the national safety it requires to take primary measures. To fulfill the latter, local state

#### RESUMEN:

La sociedad moderna no puede existir sin satisfacer las necesidades ecológicas esenciales relacionadas con la preservación (protección) del medio ambiente y sus componentes, el uso racional de los recursos naturales y la defensa (protección) de las personas del estado desfavorable del entorno natural, incluido el peligro de incendios forestales. . El objetivo del artículo es analizar la experiencia internacional de organizar la participación de la población en la prevención de incendios forestales y las posibilidades de utilizarla en Rusia. El artículo considera los problemas actuales para organizar la prevención y extinción de incendios forestales. Se analiza el papel de los guardafuegos voluntarios para garantizar la seguridad contra incendios en el bosque. Se ha ofrecido crear una red de sensores inalámbricos para controlar los incendios forestales como un medio para monitorear los incendios forestales y organizar la participación de la población para prevenirlos. Los autores concluyen que, dado que el problema de la seguridad contra incendios de los bosques es un

administrations have to develop programs on preventing forest fires in the forestland taking into account offers of the self-governing authorities in interest.

**Keywords:** forest fire, fire safety, forest protection, forestland, voluntary fire guard, monitoring of forest fire, population notification, forest fire prevention

componente de la seguridad nacional, se requiere tomar medidas primarias. Para cumplir con esto último, las administraciones estatales locales tienen que desarrollar programas para prevenir los incendios forestales en las tierras forestales teniendo en cuenta las ofertas de las autoridades autónomas interesadas.

**Palabras clave:** incendio forestal, seguridad contra incendios, protección forestal, tierras forestales, protección voluntaria contra incendios, monitoreo de incendios forestales, notificación a la población, prevención de incendios forestales. Traductor de Google para empresas: Google Translator Toolkit Traductor de sitios web

## 1. Introduction

The forest fire is an uncontrollable multistage process of forest product burning in the open space on the area covered with wood. At least two conditions are required for the forest fire to start. They are a dead forest fuel (not more than 6-25% of humidity) and a source of fire. In 10-15% cases the forest fire reasons remain undefined. They can be both of natural and anthropogenic origin. The forest fire is the destruction of not only the forest but also flora and fauna, and worsening of the ecological situation and human health.

Based on statistical data about the causes of forest fires over the recent years, the researchers state that the most negative factor in this regard is the human factor (above 90%). This analysis makes it possible to make the conclusion that the majority of forest fires can be prevented because their main causes are the human factor – the violation of regulations on fire safety in the forest (Kanitskaya 2013; p. 34-46).

Now the following issues on organizing the prevention and liquidation of forest fires remain problematic:

Untimely notification of territorial bodies of the Ministry of Emergency Situations about fires by forest users,

Insufficient work of local and self-governing authorities on organizing fire prevention,

Land that has undue anti-fire state maintained by its owners, lack of adequate responsibility for the damage incurred to the environment as a result of fires,

Village and township councils, agricultural (farm) enterprises, organizations and citizens do not comply with the requirement about forbidding to burn dried grass,

The formed rural fire teams do not duly function, and actually only subdivisions of Ministry of Emergency Situations extinguish fires of dried vegetation on the territories of agricultural enterprises and private households,

Inability of local authorities to provide the process of extinguishing forest fires with the required amount of fuels and lubricating materials, and to solve issues related to dwelling and catering of the involved manpower.

In order to improve the coordination in preventing and fighting forest fires, first of all those characterized by the transboundary effect, a global early fire detection system is being developed under the UN auspices. It is based on the satellite monitoring, forecasting, and modeling forest fire risks and centralized informational system of notification (Fire management working paper 17, 2016; Carvalheiro, Bernardo, Orgaz and Yamazaki, 2010). The creation of this system is scientifically assisted by Canadian and US researchers cooperating with the Global Fire Monitoring Center.

In order to maintain a constant high level of readiness of control forces, today many countries establish national training centers on preparing personnel to extinguish forest fires. In particular, such center was created within the Forestry Ministry of Turkey. The Center was being created during several years in the cooperation with the US Forest Service and other partners.

It is equipped with the most modern training systems to work out the actions of helicopter and airplane pilots when extinguishing fires, fire engines' drivers and extinguishment managers. The training package includes theoretical studies of the forest pyrology, mastering models of fire conduct, basics of forecasting the fire safety, study of modern technologies and equipment to extinguish natural fires, strategies and tactics of extinguishing. It gives practical skills of making preventive fires and burns. Based on it, the Turkish government offers to establish the European Center for Training Forest Fire-fighters where fire-fighters will be trained for countries of the region (Bouabdellah, Nouredine and Larbi 2013).

The urgency of the defined problem causes the need to develop the forest fire policy for Russia. Its principles must be based on taking into account the main challenges for forests in the XXIst century that were mentioned at global forest summits: global changes of the climate, growth of the population, decrease in the biodiversity, and change of the land use, as well as regional peculiarities of forests (Baranovskiy 2011, p. 221).

In the world a flexible approach to fire in the forest becomes more and more wide-spread. It is called "integrated management of fire in natural ecosystems", and has been implemented during several decades in the USA and other countries. Essentially, the national legislation can define a different pyrologic mode: from complete prohibition (for example, forests with a high class of fire danger, valuable forests that are not stable to fires, etc.) to the limited and controllable use of fire to decrease the accumulation of forest combustion materials or increase in the biodiversity or contribution to the natural recovery of old forests. It must be proceeded by comprehensive forest and pyrology researches and zoning of forests (Litschert, Brown and 2012; Hansen and Naughton, 2013).

Top priority areas of the further development of forests protection in Russia like in other countries of the world must become the implementation of modern complex systems of early detection of fires, improvement of the readiness of anti-fire forces, modernization of technical means of fire extinguishment and carrying out anti-fire propaganda by using modern informational technologies. Depending on the priorities of forestry in a region, peculiarities of the forest fund and anthropogenic impact, the system of forest protection from fires must be optimized (Vorobev 2015, p. 42).

For example, in such region as Marseille, which is characterized by climatic conditions that are similar to the southern coast of the Crimea or the Black Sea coast of Caucasus, the intensive recreation and construction, frequent periods of extreme fire danger with the wind at a speed of up to 100 km per hour, and a high natural fire danger of vegetation, the system of early detection of fires, quick reaction (15-20 minutes) by involving air means of fire extinguishment are of top priority. Within this approach Marseille developed a modern innovation system of early fire detection that combines a network of towers with extrasensitive sensors of smoke, forest anti-fire system that includes models of combustive materials, models of fires' conduct, models and forecasts of weather causing fires, space observation and other latest technologies. Such system allows 24/7 observation detecting burning on the level of barbecue heap within 30 seconds and automatically defining the shortest way to deliver anti-fire forces and means. The system of supporting decisions on fire extinguishment is based on meteorological and pyrological models and calculates an approximate quantitative and qualitative composition of anti-fire brigades required to extinguish a fire as on the moment of arriving at the place of fire. It also estimates the need to involve air means, the level of expansion and mobilization (Vilar, Camia, San-Miguel-Ayanz, and Martín 2016).

An important direction in improving the efficiency of anti-fire protection of forests and organization of the population to prevent forest fires can be modern telecommunication opportunities. Over the recent years, social networks have become considerably important in the society. In Russia such social networks as V Kontakte, Facebook, Twitter, YouTube and other can be used to improve anti-fire propaganda. The placement of anti-fire videos, pictures of fires, information about negative ecological and social consequences of fires can become an efficient tool to decrease a number of forest fires as a result of careless fire treatment.

Protection of tropical forests from fires in Southern regions of China, India and South-Eastern Asian countries – Vietnam, Thailand, Myanmar, Laos, Indonesia and others – is especially urgent. It was in the late 1990s when forest fires in Indonesia were an acute problem for the region countries. Due to it, the long-term program “ASEAN Vision 2020” (1997) specified in the Hanoi Action Plan set the tasks to improve the efficiency of monitoring forest fires, to create a system of early notification, as well as to create the ASEAN Regional Research and Educational Center for Managing Forest Fires.

Speaking about the fire situation in Vietnam, it is necessary to keep in mind that forests are extremely important as a natural potential used in industry and agriculture, construction, production and services provision. At the same time they are highly valuable natural ecosystems that contribute to the protection of biodiversity. Moreover, it is necessary to remember that forest fires are an increased danger for the country population because of their high frequency. According to the researchers, the population transfer from the rural to urban area that has been observed over the recent decade, the refuse from traditional land use in the rural environment, increase in the recreation use of forestlands, and imperfection of the system managing forestry have become key factors of the increase in risks of forest fires, the number of which is about 700 per year. At the same time technogenic forest fires make up about 80% from their total number (Minaev, Topolskiy and Dao An Tuan 2016).

---

## **2. Role of Voluntary Fire Guard in Ensuring Fire Safety in Forestlands**

The foreign experience shows that the most rational means of organizing the participation of the population in preventing forest fires is the organization of the voluntary fire guard (VFG). In order to attract the local population to preventing and extinguishing forest fires, Russia also adopted a law on creating voluntary fire brigades that will cooperate with forest fire-fighters.

All countries created VFG to unite efforts of citizens (non-professionals) to extinguish fires. It is necessary to note that by their size voluntary fire teams exceed professional fire-fighters and together with them create a rather efficient system of fire safety.

Thus, in Germany there is no any unified fire guard. The responsibility for the fire safety in Germany (both on the legislative and executive levels) is imposed on every federal state separately. All organizations existing on the territory of Germany and specializing in fire protection can be divided into three basic groups: personnel (professionals), voluntary brigades, and appointed teams. In some German communities there is also an obligatory service in the fire guard (Voluntary Fire Guard: History of VFG in Germany).

In Sweden the VFG makes up above 80% of the fire protection of the country. At the same time, the responsibility for the organization and activity of VFG is imposed on municipalities. In Austria VFG is organized according to the professional units’ model, and its size considerably exceeds the number of professional subdivisions. The Austrian VFG is peculiar by the large reserve that has got initial training and obtained basic skills of extinguishing fires. In addition to extinguishing fires, volunteer firefighters perform active work on preventing fires by using means of anti-fire propaganda and organizing public events (Creating Voluntary Fire Guard in Developed Countries).

Voluntary fire society of Poland includes 16,380 voluntary fire-fighting teams that unite above 700,000 members. General scheme of financing voluntary fire-fighting teams is as follows: 70-60% of the funds for annual keeping of voluntary teams (providing fuel, purchasing protective clothes, small repair of buildings and equipment, paying for public services, paying the remuneration for liquidation fires and participation in trainings, etc.) come from the budget of local executive authorities. Additionally, about 2% from the budget of the area, 1.8% from the budget of the region, and 6% from the central body of VFG are granted for every rural fire-fighting team on an annual basis. About 4% comes from the Environmental Protection Fund. 10% of voluntary teams financing make up own funds of teams that are granted as charges

from members of local units of the society (from PLN 10-30 per year). Besides, voluntary teams can obtain funds as charity (sponsorship). VFG units actively use opportunities of territorial communities to attract grants from various European funds used to purchase machines and equipment, repair and construct sheds, organize public events, etc. The main source of financing the purchase of machines and value rescue gears for voluntary fire-fighting teams is also local authorities (Bartczak, Chilton and Meyerhoff 2015).

In accordance with the Law of the People's Republic of China (PRC) about fire safety dated April 29, 1998, in China voluntary fire teams were created in districts and villages. Besides, the law obliges every organization and every adult citizen to participate in the organized events on extinguishing fires (Gudoshnikov and Troschinskiy 2012). In some Asian countries, for example, in Japan and Singapore the fire protection service entirely consists of volunteers.

According to the 2014 data, the Socialist Republic of Vietnam had above 870 thous. volunteer fire-fighters in various economic entities and above 380 thous. in villages (Yung 1997). According to the researchers, the VFG of the Socialist Republic of Vietnam is the main force of fire extinguishment based on the total number of fire-fighters (professionals and volunteers) that makes up 98% of them. However, VFG units independently extinguish only 2% of the total number of fires and jointly with professional fire-fighters participate in extinguishing only 9% of fires. At the same time, the main tasks of VFG in the system of fire safety in the Socialist Republic of Vietnam include fire prevention, rescue of people and property during fires, recovery operations and providing injured people with the first aid, participation in fire extinguishment and recovery operations (Nguen and Prokushin 2015). However, taking into account the fact that volunteer fire-fighters are equipped with power pumps and water engines, the maximum water discharge of which is not more than 10 l/s (Semikov and Nguen 2015), the readiness of volunteer fire-fighters to extinguish forest fires in the Vietnam rural area remains on a low level.

The first step in creating the network of voluntary fire formations in Russia was Order of Alexander II dated August 18, 1860 "On Forming Public Fire-Fighting Brigades from Citizens in Cities". However, in Russia the VFG activity on ensuring fire safety in forestlands was not so efficient because it was related first of all to the VFG work in rural settlements, the organization of which had a number of problems including the population passiveness, insufficient anti-fire propaganda among peasants by local authorities, difficult financial and economic position of the majority of rural communities, and lack of qualified fire-fighting personnel to train peasants how to extinguish fire.

With time a number of problems of VFG were not solved, first of all, those related to interrelations of volunteers with heads of provinces, police, and city halls. Unfortunately, similar disadvantages are observed today, too. And although the situation, particularly related to forest fires, troubles the world community, in general the implementation of efficient measures by the state including those on involving the community is not sufficient yet.

Due to this, today for the purpose of fire safety of forestlands as an integral part of the ecological safety system, it is necessary to create an algorithm of interrelation and cohesion of actions made by public authorities and VFG.

In particular, researchers (Halvorsen, Almklov, and Gjørund, 2017) define the following characteristics of the interrelation of fire-fighting bodies and state institutions: cooperation (on-site and distance), mutual aid (direct and indirect), cooperation of power and funds, and strengthening management parameters of the system. The following organizational forms of such interrelation were defined: information exchange, advanced experience, joint development of training and methodic materials, propaganda work by using mass media, and eliminating drawbacks in the statutory regulation. Forms of the interrelation of state fire-fighting service and population include teaching rules of fire safety to the population and specialists of mass professions, joint inspections, mass fire preventive examination of settlements and industrial and household facilities, selecting members of voluntary fire-fighting formations, training VFG heads, participation of the population in preventing work on non-admittance of fires,

organization of fire-fighting propaganda and creation of voluntary fire-fighting formations and rural fire-fighting teams.

One of the most important drawbacks of statutory regulation of joint activity in various areas is the lack or imperfection of enactments on cooperation of governmental and non-governmental organizations. One more drawback is also related to the relevant joint activity of state fire-fighting service, its voluntary subdivisions, and law enforcement bodies, including state forest protection bodies, in terms of ensuring fire safety on forestlands.

It is necessary to note that the efficiency of any body's work depends, above all, on large and detailed regulatory activity as a whole, accurate defining of, firstly, inter-departmental steps to make in a specific situation. This is such detailed regulation of joint activity that characterizes the developed Western countries.

In this regard we have to follow and impellent the relevant experience in the national system, too, particularly, in interrelation of ensuring fire safety in forestlands. Consequently, there is intensive need to adopt a number of joint inter-departmental instructions, including to regulate the interrelation of state fire-fighting service and subdivisions of voluntary fire-fighting guard with one another, population, and with state forest protection body in terms of ensuring fire safety in forestlands.

---

### **3. Analysis of Opportunities to Monitor Forest Fires for Organizing the Population to Participate in Preventing Them**

Over the recent decade, due to the brisk worsening of the ecological situation, the problem on forest fires has acquired special acuteness. That is why there is an urgent task to create a reliable system of notifying the population based on the early detection and control over forest fires. Such system must monitor and control the fire safety in the forest under various weather conditions, and monitor the state of forest combustive materials, sources of fire and forest fires to timely develop and take measures on preventing forest fires and decrease damage from them.

The following approaches are now used to detect forest fires (Loret, et al. 2009):

1. Space monitoring – the fire is detected when analyzing images made by satellites. The main disadvantages include low operational efficiency, insufficient imaging precision, impact of meteorological factors, high initial cost for creating and implementing the system,
2. Aircraft monitoring – systematic flights by using inhabited aircrafts and air drones above the monitored territory. Main disadvantages: operational efficiency of detecting a fire depends on the flights schedule, high cost of exploitation.
3. Terrestrial monitoring – based on using cameras and sensors. Main disadvantages: high cost and complexity of assembling the system, need in constant power supply and high-speed communication channel. The main advantage of the systems under consideration is a large area of monitoring.

To take timely and optimal decisions, modern systems of monitoring forests must provide information about the state of the territory under control online (Hariyawan, Gunawan and Putra, 2013).

One of the possible solutions is terrestrial monitoring systems (TMS). A promising solution for TMS is a network infrastructure that unites a wireless network system of sensor monitoring (WNSSM) and wireless sensor network.

Thus, this is an urgent task to develop a system that would monitor forest fires and quickly notify the population including rural VFG in case of fires for emergency services to timely react and eliminate the problem.

Due to the above, a goal was set to develop architecture of a wireless sensor network to control



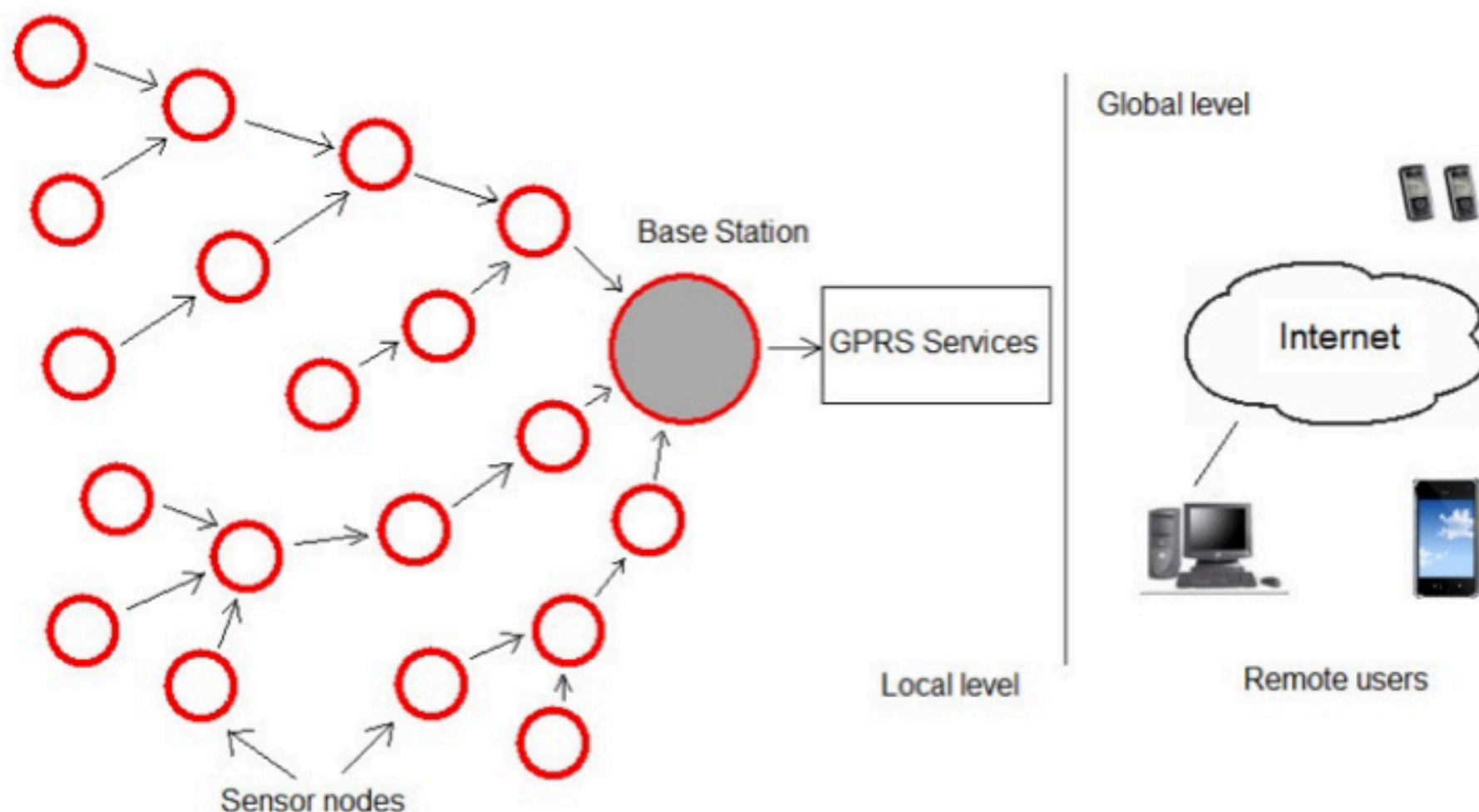
forest fires with the possibility to transmit messages to the interested parties (service of the State Emergency Ministry, VFG, and the population, as a whole).

## 4. Results

The wireless sensor network on controlling forest fires is a wireless system that is a distributed, self-organizing network sustainable to refuses of separate elements for data transmission and processing. The developed wireless sensor network on controlling forest fires consists of wireless modules that are equally located on the whole territory of observation (Fig. 1). To transmit data from sensors to the base station, the ZigBee technology is used. To transmit data between the microcomputer and the base station (operator), the GSM technology is used.

To detect a fire, stand-alone units of the wireless sensor network, as a rule, are equipped with the following sensors: temperature, open fire, carbon dioxide, smoke, etc. In order to extend the functional possibilities of the forest monitoring system, the wireless unit is equipped with the sound sensor. The use of the sound sensor will allow improving the reliability of detecting an event, as well as extending functional possibilities of the monitoring system, including revealing facts of unsanctioned deforestation online.

**Figure 1**  
General Structure of the System (Doolin and Sitar, 2005)



Wireless sensor modules are equally located on the whole territory of observation. Using the ZigBee technology, data is transmitted to the base station. To transmit data from the base station to emergency operations services, the GSM communication channel is used. Wireless units are made on the basis of wireless microcontrollers. Microcomputer is used as a controller of the base station.

Since wireless units function from the independent power supply, an actual task of monitoring systems based on wireless sensor network is to decrease the flow of data transmitted to the base station. The research (Bouabdellah, Nouredine and Larbi 2013) makes a comparative analysis of methods on decreasing volumes of messages. According to it, the approach based on calculating the fire index decreases the volume of data transmitted to the base station.

However, to calculate the fire index, it is necessary to collect additional data about the meteorological situation in the control zone.

To decrease the volume of data transmitted from the sensor to the base station, it is offered to divide the changed indicators of every sensor into three states: normal, pre-emergency and emergency. If indicators of all sensors of the unit are normal, the base station gets the code of the unit that corresponds to the normal state of sensors. If the indicator of one of the sensors is in the pre-emergency or emergency state, the base station gets a package that contains a sensor number and its state. This approach will allow increasing the duration of the network functioning from the independent power supply.

Thus, the developed structure of system on controlling and observing forest fires provides for the monitoring of forests in terms of fires and quick informing of emergency services, VFGs, and the population in case of activation of the involved sensors. The use of the wireless sensor networks' system will allow monitoring large areas of forest by the minimum use of various types of equipment required for it, and decreasing the system cost by that.

---

## **5. Discussion**

In addition to monitoring and notifying the population and VFG about forest fires, there are also other measures on organizing the population to participate in preventing forest fires.

Thus, the due fire safety in forests is guaranteed by a number of protective and preventive measures. The most important of them include the explanatory anti-fire propaganda among the population, correct arrangement of forests for mass leisure of the population, preventive forest work, and compliance with the anti-fire regulations during deforestation.

As stated above, the main cause (90-100% cases annually) of forest fires is the careless handling of fire and violation of fire safety regulations by the population when going to the forest. The most frequent causes of fires include marches, stubs, shooting wads from incompletely burning materials, sparks from engines of working cars, exposed fireplaces, etc. The greatest number of forest fires occurs in forest regions with the largest size of population during a warm period of the year when the forest is visited for resting, hunting, fishing in forest lakes and rivers, picking up non-woody forest food and enjoying wonderful forest landscapes.

In order to minimize the number of forest fires, it is necessary to essentially change the consumer-oriented outlook of citizens and their attitude to the forest. It is necessary to perform explanatory and upbringing work on correct organization of using all values and benefits of the forest, and, above all, careful conduct with fire in the forest, which can be harmful.

In European countries, particularly, in Finland, Italy and others, such explanatory and preventive work has been performed since the XXth century. It is necessary to involve not only forest guard employees in this important business but also forest protectors from local citizens, teachers, and state officers. The more forest protectors are mobilized, the less threat of fires there will be.

At the same time it is reasonable to involve public organizations into this work and use all possible mass media, including printed press, radio and television, etc. In order to perform such explanatory work in the form of lectures or talks with the population, it is possible to use community centers, clubs, schools, libraries, sanatoriums, health resorts, and enterprises hostels. It is possible to consider meetings of members of the Hunting and Fishing Societies, "green" societies and other organizations as efficient forms of communication.

An important form of the propaganda on forest protection from fires is to publish relevant materials in the local mass media and small-circulation newspapers of enterprises and organizations. State forest enterprises on roadsides of forest roads, in leisure area must place bright name plates and boards that warn about the fire danger in the forest, the need to carefully treat forest plants. During the period of the increased fire danger, when vacationers come to resorts, sanatoriums, health and recreational resorts, etc., it is reasonable to use local



radio and TV networks, loud-speakers, megaphones, and other equipment to warn about the fire danger in the forest and inform about measures to prevent forest fires.

The preventive anti-fire work with the population continues during the whole year. Especially, it is intensified during the summer and autumn period. This is when citizens from cities and settlements leave their cities and villages for the forest to rest. Usually they visit those places in the forest they know best of all. Above all, these are places with drinking water. Forest rest of one group lasts from two days to two weeks.

The task of employees from the forest management is to create the elementary conditions for living and rest of such groups in the forest, i.e. to prepare separate areas of the forest fund for the organized rest. The best variant is when the state forestry enterprise cooperates with a certain enterprise (enterprises), the employees of which always rest on its territory. In this case the state forestry enterprise that owns the forest fund and the enterprise conclude an agreement that the state forestry enterprise will arrange a certain forest area for the organized rest of the enterprise employees and their families according to the established procedure.

Compliance with the anti-fire regulations of conduct in forests by the enterprise and providing the arranged areas by the forestry enterprise are obligatory provisions of the agreement. Above all, it is related to preparing and arranging paths at stops. In order to preserve forests from destroying them by tourist groups, the administration of state forestry enterprises and forest districts must be aware about constant tourist routes and stops, demand their orderliness from tourist organizations, and simultaneously perform their own work on creating leisure areas and parking lots in these places where possible.

---

## **6. Conclusion**

Protection of the forest from fires as a part of the general problem on protecting the environment has an important individual meaning because of the growth of the anthropogenic loading on the environment and considerable increase in the number of forest fires.

Every year the problems related to the fire safety in forestlands become more and more critical. Bad situation with fires and their consequences say about the need to solve the problem on protecting people's lives, national wealth, and environment, which requires strengthening the anti-fire protection of forestlands.

The VFG is important in ensuring forests fire safety. Fire-rescue subdivisions of the VFG can quickly reveal and extinguish fires in forestlands. Besides, functioning of voluntary subdivisions contribute to preventing fire in forests because they occur locally.

At the same time it is necessary to pay special attention to improving the prevention system, creating and improving the material and technical basis of economic entities and self-governing body that in their turn create and delegate the relevant powers to voluntary fire-rescue subdivisions.

Today many issues related to the anti-fire conduct of the population remain undetermined. Perfect methods of forecasting the fire hazardous situation that would take into account both meteorological and other natural, and anthropogenic factors have not been developed. All the above says about the further prospects in the research of the participation of population in forest fire prevention.

---

## **References**

Baranovskiy N. V. (2011). Kontseptsiya razvitiya rossiyskoy sistemy prognoza lesnoy pozharney opasnosti [Concept of Developing Russian System of Forecasting Forest Fire Hazard]. Bulletin of the HNTU. Informational Technologies, 44(2), 220–225.

Bartczak, A., Chilton, S. and Meyerhoff, J. (2015). Wildfires in Poland: The impact of risk preferences and loss aversion on environmental choices. Ecological Economics, 116, 300-309

- Bouabdellah, K., Noureddine, H. and Larbi, S. (2013). Using Wireless Sensor Networks for Reliable Forest Fires Detection. *Procedia Computer Science*, 19, 794-801
- Bouabdellah, K., Noureddine, H., and Larbi, S. (2013). Using Wireless Sensor Networks for Reliable Forest Fires Detection. *Procedia Computer Science*, 19, 794-801.
- Carvalheiro, L.C., Bernardo, S.O., Orgaz, M.D.M. and Yamazaki, Y. (2010). Forest Fires Mapping and Monitoring of current and past forest fire activity from Meteosat Second Generation Data. *Environmental Modeling & Software*, 25(12), 1909-1914
- Dobrovolnaya pozharnaya ohrana Germanii: istoriya DPO Germanii [Voluntary Fire Guard: History of VFG in Germany]. Date View September 17, 2017  
<http://www.igps.ru/component/content/article/68-2011-01-19-06-30-23/777-2012-03-05-06-38-22.html>
- Doolin, D. M. and Sitar, N. (2005). Wireless sensors for wildfire monitoring. In: *Smart Structures and Materials*. International Society for Optics and Photonics. Proc. SPIE 5765, 477-484
- Fire management: voluntary guidelines. Principles and strategic actions: [Fire management working paper 17]. (2016). Rome, pp. 61.
- Gudoshnikov, L.M. and Troschinskiy, P.V. (2012). Sovremennoe pravo Kitayskoy Narodnoy Respubliki (obzor zakonodatelstva 1978–2010 gg.) Chast 1 1978–2001 gg [Modern Law of People’s Republic of China (1978 – 2010 Legislation Review) Part 1 1978 - 2001]. Moscow: IDV RAS, pp. 200
- Halvorsen, K., Almklov, P. G. and Gjørund, G. (2017). Fire safety for vulnerable groups: The challenges of cross-sector collaboration in Norwegian municipalities. *Fire Safety Journal*, 92, 1-8
- Hansen, W. D. and Naughton, H. T. (2013). The effects of a spruce bark beetle outbreak and wildfires on property values in the wildland–urban interface of south-central Alaska, USA. *Ecological Economics*, 96, 141-154
- Hariyawan, M. Y., Gunawan, A. and Putra, E. H. (2013). Wireless Sensor Network for Forest Fire Detection. *Telkomnika*, 11(3), 563- 574
- Kanitskaya L. V. (2013). Lesnaya pirologiya [Forest Pyrology]: manual. Irkutsk: Publishing House of the BGUEP, pp. 206.
- Litschert, S. E., T. C., Brown and D. M. (2012). Theobald. Historic and future extent of wildfires in the Southern Rockies Ecoregion, USA. *Forest Ecology and Management*, 269, 124-133
- Loret, J., et al. (2009). A wireless sensor network deployment for rural and forest fire detection and verification. *Sensors*, 9(11), 8722-8747.
- Minaev V.A., Topolskiy N.G. and Dao An Tuan. (2016). Problemy i osnovnyie faktory otsenki pozharnyh riskov vo Vetname [Problems and Basic Factors of Estimating Fire Risks in Vietnam]. Internet Journal “Technologies of Technosphere Safety”, 1 (65). Date View September 17, 2017  
<http://agps-2006.narod.ru/ttb/2016-1/32-01-16.ttb.pdf>
- Nguyen B. T. and Prokushin A.V. (2015). Problemy dobrovolnoy pozharnoy ohrany vo Vetname [Problems of Voluntary Fire Guard in Vietnam]. *Technologies of Technosphere Safety*, 5 (63). Date View September 17, 2017  
[https://elibrary.ru/download/elibrary\\_26249898\\_38223550.pdf](https://elibrary.ru/download/elibrary_26249898_38223550.pdf)
- Opyt sozdaniya dobrovolnoy pozharnoy ohrany v razvityh stranah [Creating Voluntary Fire Guard in Developed Countries]. Date View September 17, 2017  
[http://26.mchs.gov.ru/upload/site41/document\\_file/QWQV7oiO8K.pdf](http://26.mchs.gov.ru/upload/site41/document_file/QWQV7oiO8K.pdf)
- Semikov V.L. and Nguyen B. T. (2015). Dobrovolnye pozharnye formirovaniya vo Vetname [Voluntary Fire Formations in Vietnam]. *Modern Technologies of Providing Civil Defense and Liquidation of Consequences of Emergency Situations*. Moscow, pp. 183-185.
- Vilar, L., Camia, A., San-Miguel-Ayanz, J. and Martín, M. P. (2016). Modeling temporal changes in human-caused wildfires in Mediterranean Europe based on Land Use-Land Cover interfaces.

Forest Ecology and Management, 378, 68-78

Vorobev Yu. L. (2015). Lesnye pozhary na territorii Rossii: sostoyanie i problemy [Forest Fires in Russia: State and Problems]. Moscow: DEKS- PRESS, pp. 312.

Yung D. et al. (1997). Modeling Concepts for the Risk-Cost Assessment Model FiRECAM and its Application to a Canadian Government Office Building, Fire Safety Science: Proceedings of the Fifth International Symposium, International Association for Fire Safety Science, pp.619-630.

---

1. The university of fire fighting and prevention. 243, Khuat Duy Tien street, Thanh Xuan district, Ha Noi city, Viet Nam.  
E-mail: [tuan\\_moskva@mail.ru](mailto:tuan_moskva@mail.ru)

---

Revista ESPACIOS. ISSN 0798 1015  
Vol. 39 (Nº 06) Año 2018

[Index]

[In case you find any errors on this site, please send e-mail to [webmaster](mailto:webmaster)]

©2018. revistaESPACIOS.com • ®Rights Reserved