

CARTOGRAPHIC PRESENTATION AND GIS ANALYSIS OF FIRE RISK ZONES ON THE TERRITORY OF MUNICIPALITY OF BEOČIN (SERBIA)

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Abstract: The territory of Beočin municipality covers north part of Fruška gora in an area between mountain Fruška gora and The Danube river. According to its, that municipality is unique on observed area because the most part of it is covers the area of National Park ‘Fruška gora’ it also, presents an area with the highest concentration of weekend settlements in Serbia. It includes space with most important picnic areas on Fruška gora. Due to large economic recreational, agricultural and residential needs of the residential population, picnickers, owners of cottages, on the territory of municipality stand out fires as an element that influences the living space, which is the aim of the study. The aim of this paper is that on the basis of cartographic review four zones which presents potential fire risk zones are allocated. The four zones are: settlements in municipality of Beočin, weekend settlements, pick nick area, National park ‘Fruška gora’. In this paper the fires for the period 2009-2014 are analysed with the help of the technique of remote sensing, three class classification was made. Overlapping layers determined that the majority number of fires gripped vegetation cover, but just a small outside green space.

Key words: fires, GIS, remote sensing, mapping, analysis, Beočin

Introduction

Human carelessness irresponsible behavior towards nature and processes in nature are often the causes of fire. It can be said that the origin of causes of fire can be anthropogenic (human impact) and natural (solar activity and other). Natural or in other way caused fires have consequences which are often unpredictable and far-reaching. The origin and development of fires in nature, next to combustible materials, depends also of orography and climatic parameters (Živanović i all, 2013). The emergence of fires creates a major environmental problem and the fire is the greatest enemy of vegetation. In Fruška Gora, fires are one of the largest natural problems and dangers. In most cases, the cause of the fire is the human factor. However, a long drought, high temperatures, vegetation composition, terrain, lightning phenomena etc. probably can in certain circumstances cause and dictate the development of fires (Radovanović & Gomes, 2008).

The municipality of Beočin is one of the characteristic municipalities in Serbia which due to its geographical features has a predisposition in fires originated in urban areas, picnic areas, weekend zones and protected natural areas. According to the location, fields of the settlements of Sviloš, Gabrovo and Lug are mountain settlements, fields of settlements of Banoštor and Susek are located in alluvial plain of the River Danube. In alluvial plain of the River Danube Čerević and Beočin (residential area) are located, but the field of this settlement (Novi Rakovac) is located in alluvial plain of the River Danube, and the other part in the mountain area (Stari Rakovac).

The north and central part of municipality are under forests and this part is located in National park "Fruška gora". Mountain Fruška gora with National park, presents one of the most visited tourist destinations in Serbia as the mountain with highly developed excursion tourism (Andrevlje, Testera, Brankovac) and sports-recreational tourism (Bjeljac, and all 2014). In settlement of Beočin is located one of the oldest cement factories in Southern and Central Europe, which also has an impact on the occurrence of fires. On the territory is located a big number of weekend zones, which presents specific municipality in Serbia. The huge concentration of the weekend zones is within the framework of the settlements of Rakovac, Čerević and Banoštor.

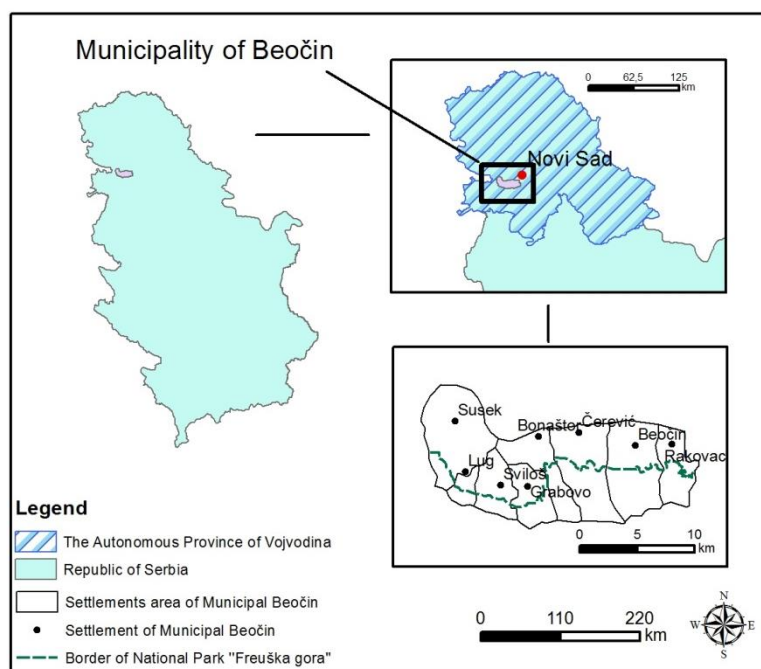


Figure 1 - Location of study area

A natural geographical characteristics

As elements which are important research location and cause of a fire are besides anthropogenic elements the natural conditions of the observed field as well. Therefore, the results of researching altitude, slope and exposition present the basis for zoning and individual climatic elements and defining influence of morphometric characteristics of relief on the recent geomorphological processes, vegetation, land etc., ie agricultural production, tourism, construction, transport, etc. (Đorđević, and all, 1996).

Harmful effects which carry forest fires can not only be considered on the basis of burned wood mass, but as a negative effect on the surrounding area. Combining remote sensing images with GIS tools is a great help in stopping the fires. Images with very large surface on which fires are easily observed can be obtained via satellite (Milanović, M., Lješević M., 2009).

The structure of settlements in Vojvodina (and therefore on the territory of Beočin) is the consequence of the of specific genesis. The pedological composition and geological structure affect directly the choice of location for the construction or expansion of settlements (Kojić, 1961). Thus the settlement of the alluvial plains and river terraces was possible. Modernization and larger possibilities of using the natural conditions and space generally allow the population to inhabit the higher terrains intensively for example the loessial plateau (Bukurov, 1983), as mountain spaces (Figure 1). On the territory of Beočin municipality there are: mountain piedmont, loess plateau of Fruška gora stream valleys and alluvial plain of the Danube (Dobrivojević, 2011). Characteristics of the initial relief expressed in altitudes, slopes, exposures and constitute the primary factor that determines the character and intensity of the work of exogenous forces.

The area of municipality with an altitude of up to 80 m, makes 17,5 km² or 9,4 % of the total area (the area of the Danube alluvial plain). The largest part of the territory of the municipality is at an altitude of 80 to 240 m, 106,90 km² or 57,4 % (area of Fruška gora loess plateau and part of the mountain piedmont). The zone with the altitude from 240 to 400 m is area of 57,4 km² or 30,9% (area of mountain piedmont). The belt with an altitude of 400 to 480 m and over 480 m covers extreme southern parts of the municipality, 4,2 km², or 2,3% of its total territory and presents the peaks of Fruška gora. If we observe climate characteristics, the average temperature (for the period 1991-2006) (Republic Hydrometeorological Service) is 21,6°C. Summer days (tmax C°≥25,0) start from March to November. An average of it is 102.5 summer days during the year. Tropical days (tmax C°≥30) appear from May to September. The monthly average value of tropical

days is highest in July and August. The annual average value of the number of tropical days is 26,7 days. The annual amount of sunshine is 2126.6 hours. The minimum average monthly value in December is 53,9 hours and the highest 294,7 hours in July.

In terms of vegetation Beočin municipality is divided in three biogeographical regions: belt terraces, belt of loess plateau and band valley plains and the Danube alluvial plains. Within these entireties there are differences in the flora, but there are no sharper limits. In addition, the arrangement of the vegetation which has been influenced by natural conditions, significantly changed by social factors. On the terraces vegetation cover is presented by deciduous trees (oak, linden, acacia), and conifers are represented on smaller areas (spruce and fir). The lower areas and a loessial plateau are covered by meadows and pastures. In its composition vegetation on the loess plateau is most similar to the steppe. Valley plains present the grassy landscape. In wetter and deeper landscapes vegetation is of marsh character.

Remote sensing, analysis and reclassification of the surface of Beočin municipality

Remote sensing allows the possibility of comprehensive analysis of the different ecosystems in all geographic latitudes and longitudes. GIS also has extensive capabilities developed for analyzing the available information, provides a way to overlap and combine the data for analysis. Both techniques provide a key technology marrow for the detection and evaluation of forest fire management situation (Jovanović, R., and all 2013).

Due to the large economic recreational, agricultural and residential needs of the residential population picnickers, owners of cottages, on the territory of municipality in this paper fires as an element that influences the living space are separated. We analyzed the period from 2009 to first half of 2014. For the purpose of analysis, four zones are separated: weekend settlements, settlements in Municipality Beočin, picnic area and national park "Fruška gora". In order to determine the locations of the fire outbreak in this paper we started from the hypothesis that the largest number of fires happen in weekend zones and picnic areas (in fact in the most important tourist sites).

Separation of four zones, was done on the basis of field research and locating, by subsequent entering, processing and analyzing data and verifying results on the basis of overlapping with the topographic maps in scale 1: 25 000 and 1:50 000. On the map (Figure 2) orange color represents weekend zones in polygon shape, green color picnic area and while layer of settlements is represented by with shape point. Fourth element presents the border of National Park within which there are four picnic areas and the largest part of forest vegetation and low vegetation is located on the hillsides of this mountain. The other part of area includes urban area all down to the Danube where the marshy land⁸ occurs.

For the purpose of determining vegetation cover remote-detection was accessed using unsupervised classification as the method. One of the common ways of the use of remote sensing is unsupervised classification where on the basis of image classification processing is performed based on the natural groupings of spectral pixels properties - assigning pixels to the same class, because they have similar values. Unsupervised classification gives output image where the number of classes is identified and each pixel is assigned to one of the classes. These classes may or may not correspond with the same types of land cover. This classification is useful when there is no data for existing fields or when the user can't accurately specify type of land cover. This method is commonly used as an initial step before supervised classification (Jovanović and all 2014).

Error of the matrix is a series of numbers categorized in rows and columns which express the number of sample units (pixels, groups of pixels or polygons) assigned to a special category in relation to the actual category. The columns usually represent key data, while the rows represent classification determined by remote sensing. Error of the matrix is a highly efficient method to

⁸In this paper *analysis of* marshy land wasn't used, because *only twice (place Rit) Fire units of Beočin intervened for the analyzed period*

present the accuracy and accuracy of each category is clearly disclosed together with both errors of involvement (commission errors) and errors of exclusion (omission errors), present in the classifications (Russell G., C., 1991).

For the purpose of analysis we used satellite imagery from satellites Landsat Thematic Mapper 4 – 5 made in March 2009 and Landsat 8 Optional Land Image made in March 2014. After detection analysis and data processing using GIS tools were accessed.

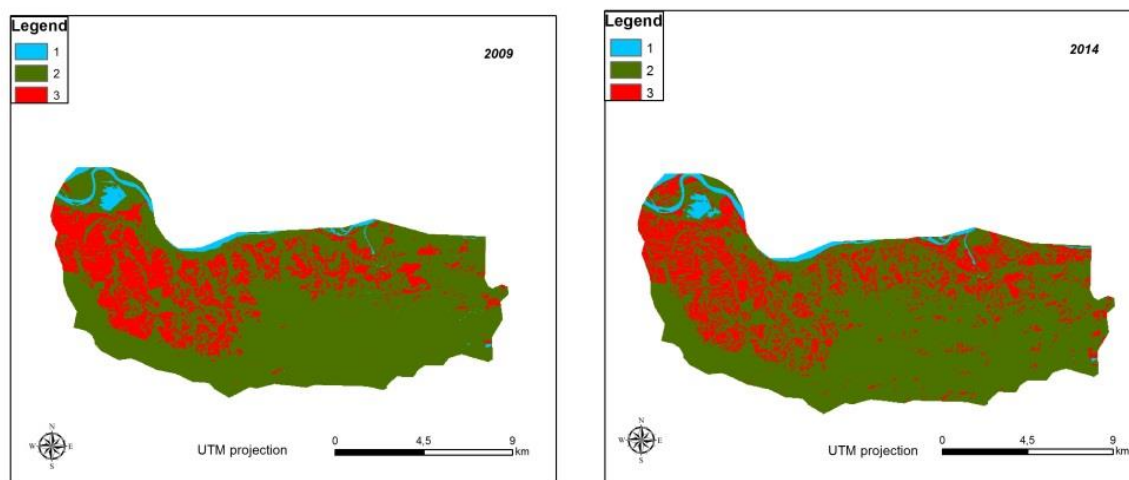


Figure 3 – Reclassification surface Municipality of Beočin
1 – Water, 2 – Vegetation cover and 3 – Urban area

The sum of all pixels within the analyzing territory is 204316, with the maximum value in category 2 (vegetation cover) 152788 for 2009, and 152725 for 2014. This conclusion is foregone because more than half of the Municipal Beočin area is located in the National Park "Fruška gora". The minimum value is category 1 (water area) with 5062 pixels of satellite imagery for 2009, and 5204 pixels of satellite imagery for 2014.

Table 1 – Value of reclassification of surface Municipality of Beočin for 2009

| Value | Count | Per_area |
|-------|--------|----------|
| 1 | 5062 | 2,48 |
| 2 | 152788 | 74,78 |
| 3 | 46466 | 22,74 |

Table 2 – Value of reclassification of surface Municipality of Beočin for 2014

| Value | Count | Per_area |
|-------|--------|----------|
| 1 | 5204 | 2,58 |
| 2 | 152725 | 75,86 |
| 3 | 46387 | 23,04 |

On the basis of map (Figure 2), obtained satellite images and subsequent reclassification (Figure 3), their overlapping and analysis it can be concluded that the largest number of fires gripped of vegetation cover (2). The area of vegetation is for a five-year period increased by 1.06%. Less fire were registered within the urban area, the surface of which was increased by 0.3% of total area of Municipality of Beočin, for the same period.

Fires in the area of municipality of Beočin

On the territory of municipality of Beočin in period from January 2009 to June 2014 580 fires were recorded, where there was need for intervention by the Fire Service (of total 681 interventions).

Of 124 interventions of Fire Services in Beočin in 2009, one intervention of fire fighting was in the settlement Neštin (neighboring municipality Bačka Palanka). Of settlements in the municipality, most fires were in urban areas of Beočin, 67 i.e., 54,47%. In rural areas of the municipality most fires were 22 (Rakovac 11; Čerević 6; Sviloš 3, and Susek 2). In the weekend areas in the municipality there were 21 fires (10 in three weekend zones within settlement Rakovac and 11 fires in four weekend zones within settlement Čerović). In the area of excursion and weekend zones of Beočin Danube there were 7 fires. Within the National Park "Fruška gora", there were seven fires.

In 2010, out of the 97 interventions, 63 were extinguishing fires. The most, 41 (65,08%) were in the settlement Beočin, 14 fires were in rural settlements (Čerević (4), Banoštor (5), Rakovac (4) and Susek (1)). In weekend zones there were 9 fires (Rakovac (6 fires in 3 weekend zones), Čerović and Sviloš, as well as the picnic area of Beočin Danube. Within the settlement Beočin (part of settlement Beočin village), which field is a part of National Park "Fruška gora", there was 1 fire.

During 2011, out of 144 intervention of Fire Services. 138 were extinguishing fires. Out of these the fire brigade Beočin helped (technically and in personnel in extinguishing fires) at the Monastery Đipša (Šid Municipality), in the settlement Ledinci (in Novi Sad) and two in the settlement Nestin (Municipality of Bačka Palanka). Out of 134 fires in the municipality of Beočin, most were in the settlement Beočin 85 (i.e. 63,43%). In rural areas, there were 30 fires (Čerević (13), Rakovac (7); Grabovo (4); Susek and Banoštor 3). In the weekend zones there were 14 fires, in four of weekend zones in the territory of Rakovac (7 fires), in one weekend zone there was 1 fire in the area of Čerević and in Beočin Danube 6. In the area of national park "Fruška gora" there were 4 fires (among other at the most famous excursion sites of Fruška gora: Brankovac and Testera).

In 2012, Fire Services of Beočin had 235 interention, of which there was 135 fires. In the observed year Fire Services of Beočin helped (technically and in personnel in extinguishing fires) in three fires in the municipality of Bačka Palanka (Vizić 2 and Neštin) and the City of Novi Sad (Ledinci). Out of the 131 fires, the highest number was in Beočin 69 (i.e. 51,11%). In rural area 56 (Rakovac 35; Čerević 11, Grabovo 4; Banoštor 3; Sviloš 2; Susek 1), and in weekend zones 6 (in one zone in the area Rekovac there were 3, two zones in the area Čerević (2) and in the area Beočin Danube).

In 2013 Fire Services of Beočin had 91 interentions, out of which there were 57 fires. Only two had extinguishing fires on the territory of Bačka Palanka (Nestin, Vizić). Out of the 55 fires were in the Municipality Beočin, there were 26 (or 47,27%), in the settlement Beočin, 19 in rural areas (Rakovac and Čerević at 7; Lug 3; Susek 2) in weekend zones 8 (in three weekend zones Rakovac (3); in three weekend zones Čerović (4) and one in settlement Susek). At excursion site Brankovac (National Park "Fruška Gora") there was one fire.

The research also involved the activity of Fire Station Beočin From January to July 2014, when were there 60 fires. The majority were in the settlement Beočin 21 (ie 35,00%); rural areas, 12 (7 Čerević; Rakovac 4; Susek 1), weekend zones 22 (Beočin Danube 1, in 4 weekend zones in settlement Čerević 5 fires and in 4 weekend zones in settlement Rakovac 16), on the territory of National Park "Fruška gora" 5 (Brankovac and other excursion sites).

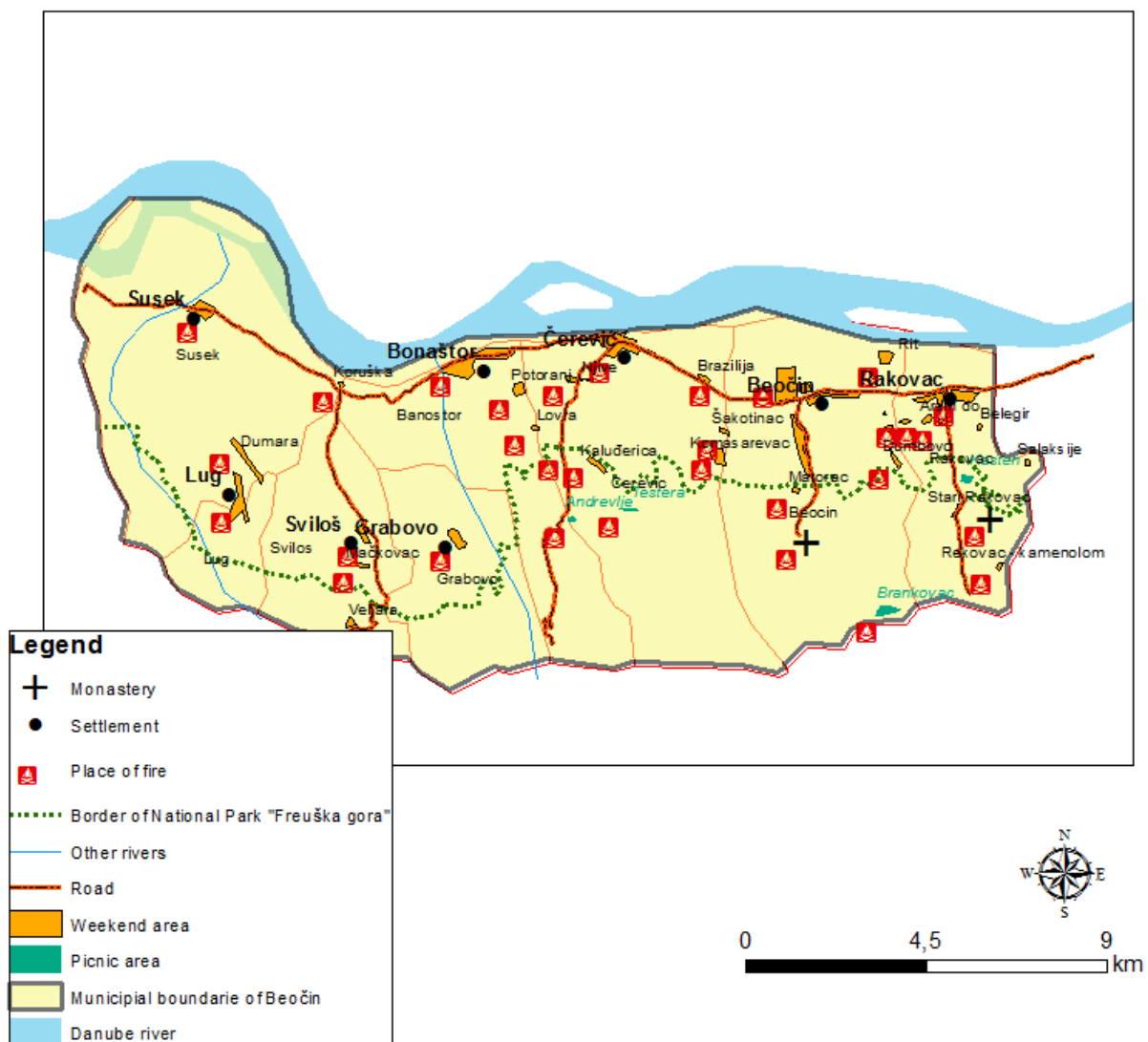


Figure 2 – Map of fire places in study area

Examining year by year, urban area of Beočin represents the area where the highest number of fires was recorded. Although it is the part of the settlement Beočin especially by number of fires part which is called Brazilija allocates (located beside the Lafarge Cement Factory), and the population of this part consists exclusively of members of the Rome ethnic group⁹. In rural settlements, the largest number of fires during the observation period individually was recorded in Čerević and Rakovac¹⁰. According to the analyzed years, in the weekend zones which are located within the settlements Čerević and Rakovac there is the excursion site – weekend zone Beočin Danube¹¹ (Table 1). At 28 sites in the Municipality which represent weekend zones, excursion sites or the part of National Park ‘Fruška gora’ many fires also happened. If we observe the area of National Park ‘Fruška gora’ (space outside urban areas), which is located in the Municipality of Beočin, in the observed period 22 fires happened.

⁹They live in dilapidated houses, several decades old that are not maintained

¹⁰These three settlements make the 84,36% of all residents of the municipality (only in settlement Beočin live 51,32% of the total population of the Municipality), and they make 88,50% of the total territory of the municipality

¹¹Although it belongs to the settlement Beočin, this is a part along the Danube River, where there are public beach and weekend houses

Table 3 - Distribution of fire at the location during the period 2009-June 2014

| Beočin settlement | | Rural area | | Weekend zone | | Excursion site | |
|--|-----------------------------------|--|---------------------|---|---------------------|---|---------------------|
| 274 | | 182 | | 92 | | 20 | |
| Open space | Building structures ¹² | Open space | Building structures | Open space | Building structures | Open space | Building structures |
| 95 | 141 | 100 | 72 | 71 | 20 | 19 | 1 |
| Lokacije požara | | | | | | | |
| Beočin – 268 | | Rakovac – 67 | | Potoranj9 | | | |
| Brazilija 30 | | Čerević – 48 | | Settlement Dunav – 21 | | NP, field Matorac - 4 | |
| Beočin village 1 | | Banoštor -12 | | Stošin do – 11 | | Brankovac – 3 | |
| | | Susek – 10 | | Dumbovo – 11 | | Testera – 2 | |
| | | Grabovo – 8 | | Salaksije – 10 | | Veljara 1 | |
| | | Sviloš – 4 | | Šakotinac – 10 | | Kesten – 2 | |
| | | Lug – 3 | | Arsin do - 3 | | Erdelj 3 | |
| Technical interventions and unknown 38 | | Technical interventions and unknown 10 | | Belegir 3 Koruška 2 Other wekeend zone ¹³ unknown - 1 | | Kaluderica 2 National park unknown 3 | |

Source: Data obtained from the Fire Station Beočin

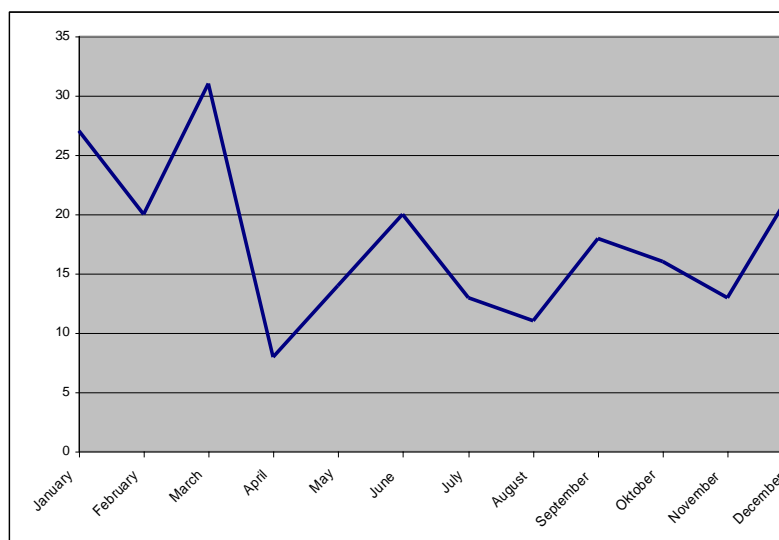
If we observe fires on the fields of the settlements (in the total number of fires), the observed period fires in the settlement Beočin (340) were dominant; settlement Rakovac 107; Čerević 78; Banoštor 13, Susek 12, Grabovo 8, Sviloš 4 and Lug 3. The number of fires for five year period in relation to the location of the excursion sites accounted for more than 5 fire by location, and only one of these fires gripped off an area in excess of 50 a. (a fire that swept through the area of National Park "Fruška gora" in March 2014), and it may be said that the vulnerability of these areas is not great. The most common occurrence of fires is in the densely populated areas, respectively in settlement Brazilija that directly abuts against urban area (30 fires registered) and settlement Danube (the most attractive weekend zone in wider urban area, 21 fires).

Analysis and structure of the fires in the area of the Municipality Beočin

If we observe the number of interventions in a month, they receive the specifics related to season where number of fires or other emergency situations is most present. It is possible to parallel monitoring events by various parameters that may be connected to the time of year, economic activity of specific part of the territory, which including agricultural activities which significantly affect the the number of interventions of the Fire Service.

¹² residential buildings (permanent housing) or objects for rest and recreation (temporary habitation)

¹³ Fields: Litasović, Njive, Keovi, Dobra, Lora, mačevac, Kapuljević, Seča, Dudara i Jaršin po – 1 fire)



Graph 1. Schedule of fires per month, total, in the period 2009-2013

Based on the Graph 1. it can be seen that during the observed period the largest number of fires was recorded during the month of March, then June and September, when there was recorded the highest number of fires in the open space. The secondary maximums were recorded mainly in the areas of permanent and temporary housing, in January and December.

If we observed by year, results of the research show that in 2009 the largest number of fires was in September (23), and secondary maximum was in May and August: It may be concluded that in this year except in the winter months number of fires was balanced, as the third maximum. In 2010, the largest number of fires was in March (14), with secondary maximums in January, May and October. In this year in the summer months and in September minimum was recorded. In 2011, when the highest number of fires in the observed period was recorded, the highest number was in March (26) with secondary maximums recorded in October, August and March (77 or 57,04% of all fires in 2012) and February, with secondary in July, and a minimum of fires were recorded in January and May. The largest number of fires was in 2012, with the maximum in January. In August, September and December, no fires were recorded. In 2013, the largest number of fires was in May (10) and April, with a secondary maximum in August, December and February, and the least were recorded in January, September and November. In the first six months of 2014, most fires were recorded in February and March.

It must be singled out that in the month of March 2012, wherein, with the exception there was the largest number of fires in the stated year there was also the largest number of fires per month in the observed period. For the month there it is characteristic, that in the period from 03rd to 30th of March. The same day, in different places there were several numbers of fires. For example, from 3rd to the 8th of March, there were 16 fires in four settlements (Beočin City, Rakovac Čerević and Gabrovo). Only on the 6th of March 2012 there were eight fires in three settlements. Also from 11th of March to the 20th of March there were 30 fires in seven settlements. Similarly for the period of March 2014 and low vegetation was burning. Given that in the observed period fires that were in the space of settlement fields outside of the urban zone which are state-owned were observed, we can not speak about the anthropogenic factor, but the impact of activities on the Sun. (Radovanović, Gomes, 2008; (Radovanović 2011).

Fires in the open space in the municipality of Beočin

In the observed period a significant share of fires in open space¹⁴ (325 fires, or 56,1%) is present. During this research we exempted fires incurred on construction objects (permanent and

¹⁴The paper research is focused on fires in open space

temporary housing or weekend zones)(205, ie., 35,3%),fires that were related to problems with installations and other objects (fires incurred mostly on the power cables, lamp posts, containers and etc.. (11, 1,9%) as well as a fires incurred because of defects in means of transportation (sevenor, 1,2%), (Table 1).Many of firesthat occurred in the open spece were in the area of residential buildings (permanent residence)or objects for rest and recreation (temporary habitation)(fields, vineyards, pastures, yards, etc..).

We analyzed parts of the Municipalitywhich are categorized as fields and open space(urbanized land, the area along the main roadand other traffic arteries as well asother state owned spaces, and spaces that are in private ownership(such as fields, orchards, pastures, vineyards), weekend zone, excursion sites and forest area (20), wetland (5).As a major of cause fire hazardin the documentation of the Fire Service of Beočin itwas noted that the fire started due to burning low vegetationand garbages, where with the participation of this factoras the cause of the spread of the fire it was 72,4% (it was present in 420 fires). In forest – wetland area, where the major cause was burning, forestamounted to 5.6%, ie., 32 fires.Other fires were created by burning strawand stubble in the fields, orchards and vineyards.

Conclusion

On the basis of distribution of fires, it can be concluded that a small number of fires originatedin zones of excursion sites, and that the largest the number of fires was present in areaswith higher population density,in wider city area and rural areas. The main cause of the fires in the municipality of Beočin is anthropogenic factor due to insufficient attention and ignorance of the local population about the dangers of the origin and spread of fire,as well as measures of fire protection. Consequently, one solution is educationof local population, on one hand and more stringent penalty policy, on the other hand, especially for people who live in the weekend zones.

Remote sensing and GIS as a contemporary tool for modern computer technology, enable monitoring of changing the use of open area.Some of the core elements of GIS in the future where one can make a profit in tourism is planning including and the possibility of manipulating the data and spatial analytes (Sheikh, A.L., Yahiy, A., B., 2012).

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