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Analysis of fires at Wildland-urban interface in an observation plot in Hungary

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Abstract

The Wildland- urban interface (WUI) is an area, where houses meet or intermingle with undeveloped wildland vegetation. The identification of these areas is not yet present in all countries. Although scientific research on this topic is still incomplete in Hungary, there are already initiatives and some results to identify WUI areas and analyse their risks. Authors approach the WUI fire risk from two directions. On the one hand, wildland is a combustible biomass, so wildfires pose a direct threat to the built environment. The reason for this threat is that residential buildings are located along the forest, which, as a flammable material, provides an opportunity for the spread of fire. This allows fire to spread from wildland vegetation to the populated area, endangering human life and property. Authors examine the characteristics of WUI fires in Hungary through analysis of observation plots. In the short paper Authors present the direct and indirect interface WUI and analyse the risk of WUI fires by using GIS spatial analyses. Authors also analyse the combustible fuel, the number of fires, and the integrating housing density in the observation plot.

1. Introduction

The Wildland- urban interface (WUI) is an area, where houses meet or intermingle with undeveloped wildland vegetation (Cohen, 2003), (Radeloff, 2005). The concept of WUI is still less known in some part of Europe (also in Hungary), but in the Mediterranean region it is the biggest challenge of fires caused by human negligence. Fires at the WUI are a huge challenge in many countries. One example is the United States, where millions of people and homes on both west and east coasts are at risk from these fires (Radeloff, 2018). In Canada, such areas cover more than 30 million hectares (Johnston 2018). Australia has also WUI fire danger, therefore, a study on fire prevention has been carried out, focusing on priorities and perceptions of wildfire risk (Koksal, 2019). In Europe, countries of the Mediterranean region are especially high vulnerable. In Spain, there are emergency plans against the wildfires (Caballero 2007). In Portugal, the emphasis is also on the prevention, as the risk of wildfires is one of the highest in Europe almost every year (Viegas, 2012). France is also a good example, where a topological matrix has been established to identify WUI areas (Lampin-Maillet, 2009). In Hungary, the national literatures on wildfires focuses less on the prevention of WUI fires and more on the effectiveness of firefighting (Restás, 2018) and the detection (Bodnár, 2018).

2. Methods

During our research we have examined and analysed the relevant literatures in the topic as well as findings of other authors. We present each findings, and in some cases, we discuss or agree with them. In addition, we conducted discussions with international experts on the subject. In order to present the WUI areas developed in Hungary, we made image analyses in an observation plot. Our main observation plot is in South Hungary, in Bacs- Kiskun County nearby the town Kiskőrös. On this observation plot we have made fuel analyses, examined the wildfire statistics from the last 10 years, and examined the integrating housing density along the wildland area. For each risk, we determined the risk of fire hazard. In addition, spatial analyses allowed us to quantify

patterns and relationships in data and display the results as maps, tables, and charts. So we performed GIS Spatial analyses with topoXmap, developed by Hungarian GIS experts. TopoXmap is an efficient, powerful GIS (Geographic Information System) data collection, visualization and processing software which includes GIS tools. It can use and process raster and vector datasets. It possesses powerful GIS visualization tools and supports to build database and to analyse GIS datasets.

3. Results

On the first observation plot (not the above mentioned territory nearby Kiskőrös) we show that in Hungary direct and also indirect interfaces developed. So Figure 1 is a WUI area and the location is part of the village of Nagykovácsi in Hungary (Pest County), but the area belongs to the **urban agglomeration** of Budapest. During the image analysis, we performed a graphical delimitation, where the direct interface of WUI was marked with a red and the indirect interface with yellow. We considered as a **direct interface**, where the areas of wildland and urban environment are adjacent to each other and the distance between them is minimal. **Indirect interface** is where the distance between wildland and residential area is significantly longer, but there are agricultural lands or other combustible materials between the two areas.

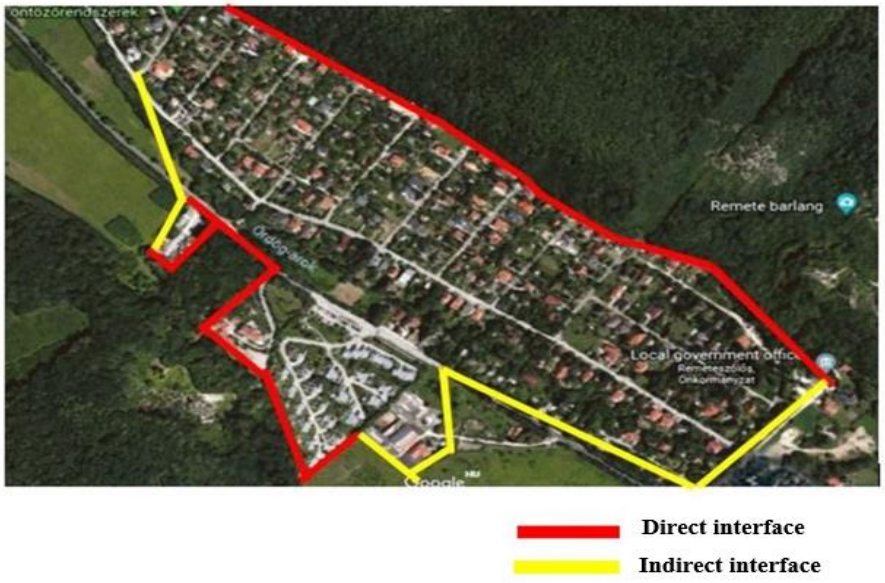

Figure 1- Direct and indirect interface at the WUI.

After that we examined another observation plot for fires at the WUI in 3 steps. We analyse the combustible fuel (first step), the number of fires (second step) and the integrating housing density (third step) in our second observation plot.

In the first step, we **analyzed the combustible fuel** in the observation plot (Bacs-Kiskun County-Kiskőrös) and we distinguished three main groups such as *low dangered forest lands*, *medium dangered forest lands* and *high dangered forest lands* (Figure 2). Pine and juniper vegetation are classified as high endangered forestland (red). Mixed forest and oak forest stands higher than 5 meters are classified as moderately endangered vegetation (yellow). Other native and planted tree species (for example poplar, ash, beech, maple, acacia,) are classified as low endangered forest land (green).

In the second step we **examined the wildfire statistics** in the observation plot from the last 10 years. We distinguished the fires according to their distance from the settlement. We put fires in WUI-1 zone that occurred 500 metres from the residential area. The additional zones were as follows: WUI-2 zone – 1 000 m; WUI-3 zone 1 500 m – WUI-4 zone 2 000 m and WUI-5 zone 2 500 m. In Figure 2, fires in WUI-1 and WUI-2 zones (red and orange hoops) are important for the analysis.

Table 1- Number of wildfires in the WUI zones in the observation plot.

Year	Number of wildfires	WUI-1	WUI-2	WUI-3	WUI-4	WUI-5
2011	103	42	17	9	9	26
2012	278	114	42	25	21	76
2013	66	23	11	8	6	18
2014	78	35	5	5	9	24
2015	50	18	6	2	5	19
2016	69	24	10	12	4	19
2017	145	32	30	21	22	40
2018	45	8	9	10	5	13
2019	180	41	25	22	34	58
2020	85	26	11	8	15	25
2021	123	29	23	20	16	35

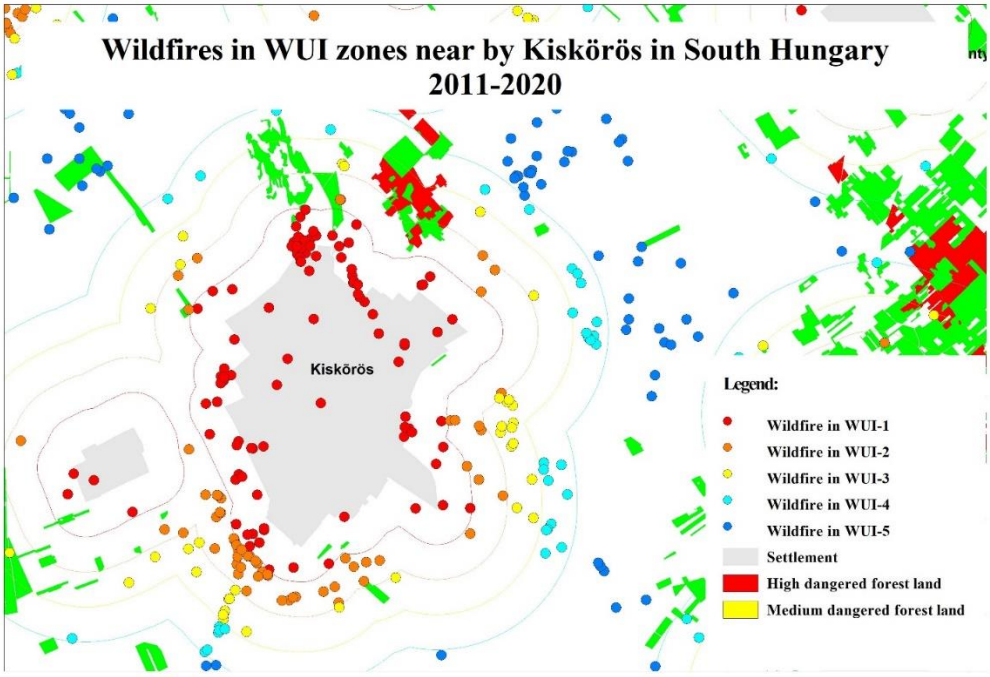

Figure 2 - The distance of fires from the residential area in the observation plot.

We performed GIS Spatial analyses with topoXmap on Figure 2, which presents the fires that occurred in the wildland areas of the settlements in the observation plot. The red colour indicates fires that occur within 500 metres from the residential area (WUI 1 zone) and the yellow those that occur within 1 km (WUI 2 zone). It is clear that a significant part of wildfires occurred close to the residential areas (marked in red and orange). Because of this, buildings were endangered from wildfires. The cause of fires is primarily the human factors.

In the third step of our three-step analysis, we examined the **housing density** along the wildland area at the WUI. Our observation plot is small, so in this case we have examined the integrating housing density of the entire county (Bacs-Kiskun Coutnty). We used Google Earth (open access) for this purpose, where we made an image analysis. We classified the integrating housing densities in three categories. In the first category (green) there are only farms nearby the forest. The second category is where the residential buildings are scattered relative to each other along the forest edge (10 m < >30 m, yellow). We classified the areas into the third category, where residential building very close to each other (<10 m, red).

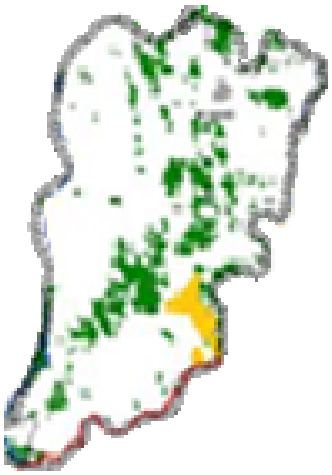

Figure 3- Integrating housing densities at the WUI in Hungary.

After the analysis we determine that there are many farms in the county. So the integrating housing density is low, mainly due to farmlands, and therefore it results in a low fire risk.

4. Conclusion

As a result of our analysis, we prove that WUI areas have developed also in Hungary. As WUI areas endangers human life and and property, these areas must also be identified in Hungary. To summarize our research above, we state that the preventive fire protection of Wildland-urban interface areas is a complex nature, which is still a research gap in Hungary, regardless of the research and guidelines already available in the international references. Taking into account international trends, we examined the risk of WUI fires of a national observation plot. The risk was determined as a result of a three-step analysis. As a result of the analysis, we consider the observation plot, as a high vulnerable WUI area. WUI risk is primarily due to the risk of fuel and fire occurrence. To sum up our results we determined that WUI fires can develop primary due to combustible fuel and number of fires in the observation plot we have analysed. However, they mainly endanger residential buildings and farms at the forest edge, and there is less chance of further residential buildings being damaged from fires.

5. References

Bodnár, L., Restás, Á. 2018: Examination of the forest fires detection: the relationship between the fire and the detection. In: Viegas, Domingos Xavier (ed.) - Advances in forest fire research 2018. Imprensa da Universidade de Coimbra. 995-1001.

Caballero D., Beltrán J., Velasco A. 2007: Forest fires and wildland-urban interface in Spain: types and risk distribution. In: IV Conferencia Internacional sobre Incendios Forestales. Sevilla, Espana, 13 -17 mayo 2007, Organismo Autónomo de Parques Nacionales, Ministerio de Medio Ambiente, 13-17.

Cohen, J. D. 2003: Preventing residential fire disasters during wildfires. In: Proceedings of the international workshop, Forest fires in the wildland-urban interface and rural areas in Europe: an integral planning and management challenge, Athens. Greece. 5-12.

Johnston L., Flannigan M. 2018: Mapping Canadian wildland fire interface areas. *International Journal of Wildland Fire*, XXVII. 1. 1-14.

Koksal K., Mc Lennan J. 2019: - Every Danielle: Australian wildland-urban interface householders' wildfire safety preparations: 'Everyday life' project priorities and perceptions of wildfire risk. *International Journal of Disaster Risk Reduction,* 33. 1. 142-154.o

Lampin-Maillet C., Marielle J., Long M 2009: Mapping wildland-urban interfaces at large scales integrating housing density and vegetation aggregation for fire prevention in the South of France. *Journal of Environmental Management*, XCI. 3. 732-741.

Radeloff C.V., Hammer R. B., Stewart S. I., Fried J. S, Holcomb S. S. and McKeefry J. F 2005: The Wildland-Urban Interface in the United States. *Ecological Application*, XV. 799-805.

Radeloff C.V., Helmers D., Kramer A. 2018: Rapid growth of the US wildland-urban interface raises wildfire risk. *Proceedings of the National Academy of Sciences*, CXV. 3314-3319.

Restás Á 2018: Results of I4F technology making aerial firefighting more effective. In: X. D. VIEGAS: Forest Fire Research Abstracts Book 2018. Coimbra, Portugal: ADAI/CEIF, University of Coimbra, (2018) pp. 115-115. ISBN: 978- 989-99- 0809-3.

Viegas X. D., Figueiredo R., Almeida E. 2012: *Wildland fire report of Tavira/São Brás de Alportel Centro de Estudos sobre Incêndios Florestais*, ADAI/LAETA. Coimbra University. Coimbra.