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# LANDFILL FIRES IN ROMANIA

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Abstract. Landfill fires in Romania. Multiple hazards to human health and the environment are associated with a lacking waste management. Among them, landfill fires suddenly release large amounts of various chemicals, leading to environmental pollution and to potential impacts upon human health in the affected areas. The low level of separate collection and recycling of municipal waste in Romania leads to the accumulation of biowaste and other combustible waste (paper, plastic and textiles) in landfills, increasing the risk of landfill fires. Inventorying and monitoring the effects of such inadvertent events is a necessary step towards a thorough assessment of the environmental pollution at regional level. By using a waste fires database and reviewing press reports on large landfill fires, we have identified the spatial distribution of landfill fires in Romania, between 2016 and 2020. While the national annual average is rather low (around 35 fires per year), we were able to identify several hotspots of frequent landfill fires. Such sites draw attention to the ineffective municipal waste management in Romania and to the need for a better environmental monitoring in areas affected by landfill fires.

Keywords: landfill fire, pollution, waste management, spatial distribution.

## **1. INTRODUCTION**

Fires are part of the natural world, shaping landscapes and ecosystems (Pyne, 2010), while at the same time being hazardous events that impact the environment, economic activities, and human lives (Zhuang et al., 2017). Fire effluents are composed of many compounds and particulates, some of which are known to be harmful to the environment and to human health. Depending on the combustion conditions, the chemical composition of burnt materials and the duration of the fire, various pollutants may be released. The most common fire emissions that may impact human health are carbon monoxide (CO), particulate matter (small particles of unburned, incombustible materials, soot), polycyclic aromatic hydrocarbons (PAHs), volatile organic compounds (VOC), nitrogen oxides (NO<sub>x</sub>), sulfur oxides (SO<sub>x</sub>), polychlorinated dibenzo-p dioxins and dibenzofurans (PCDD/Fs), etc. (Amon et al., 2014).

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Landfilling, open dumping and open burning of the municipal waste are the most common ways of waste disposal at the global level (WB, 2018). From these practices multiple risks to human health (Porta et al., 2009; Ferronato and Torretta, 2019) and the environment (Vergara and Tchobanoglous, 2012; Vaverková, 2019) results, the pollution from landfill fires being one on them.

Living in wildfire smoke-affected areas was associated with increasing respiratory symptoms in the general population, and impaired lung function was reported in cases of firefighters after a full season of working at wildfires sites (Black et al., 2017). However, the cited authors highlight the fact that such symptoms in firefighters were not registered after a single fire intervention, suggesting that repeated exposures are of concern, being more likely to have harmful impacts. Even though landfill fires usually impact much smaller areas than wildland fires, in the case of frequent fire occurrence at the same site, we assume the respiratory health risks for the general population and for firefighters are similar to those of wildland fires, or maybe even higher. The wide variety of materials in the municipal waste ending up in landfills (biodegradable waste, plastic, paper, metal, textile, etc.) contributes to a mixture of chemicals being released into the air during landfill fires. Combustion experiments trying to reproduce such fires revealed worrisome results. Collet and Fiani (2006) found out that PAHs emissions were smaller in laboratory reproduced landfill fires than in laboratory reproduced forest fires, but PCDD/Fs and PCBs releases were ten times higher. Hoffer et al. (2020) determined emission factors for PAHs and  $PM_{10}$  in 12 types of waste and compared them to the emissions from burning dry firewood. They found that under the same conditions, burning different types of plastic waste resulted in 5-40 times more PM<sub>10</sub> emissions, and 50-750 times more PAHs emissions than from burning firewood.

Moreover, landfills are located close to large cities, having a potentially larger impact on human health than wildfires burning in remote, mostly rural areas. After a major fire at the landfill of Palermo city, Mazzucco et al. (2019) investigated the impact of exposure to fire related pollution upon pregnancy outcomes. They found an increased incidence of babies with low weight at birth, and premature delivery in the cases in which women were exposed to landfill fire pollution during conception and early stages of pregnancy. These results were similar to those found in studies investigating the link between living near waste incinerators and human health (Candela et al., 2013). However, large landfill fires and waste facilities fires may impact very wide areas as well. Based on software simulations, Bihałowicz et al. (2021) estimated the PM<sub>10</sub> emissions from 79 large landfill fires in Poland in 2018 and the areas impacted by the increasing PM<sub>10</sub> concentrations in air (increase in 1-hour average concentrations of 1, 10, 100, 1000 and 10,000  $\mu$ g m<sup>-3</sup>). They also calculated that the population exposed to these phenomena (in Poland and in the

neighboring countries) ranged from 35,000 people in the case of the highest  $PM_{10}$  concentration (in areas nearest to the fires), to millions of people living in areas affected by lower concentrations (when assuming the pollutants were diluted into the air and dispersed on larger areas). At the same time, they concluded that large numbers of people were at risk of exposure to increased  $PM_{10}$  concentration in the air originating from more than one landfill fire (e.g., out of the 1,379,000 estimated persons at risk of exposure to increased  $PM_{10}$  concentration of 1000 µg m<sup>-3</sup>, 32% would have been exposed to emissions from more than one landfill fire).

Another way in which fires pollute the environment is by ashes and soot fallout in the surrounding area and accumulation of chemicals into the soil and water bodies. Fajković et al. (2017) measured PCDD/Fs in the air and in aquatic sediments during and after a large fire at an unsanitary landfill in Croatia. During the fire, dioxin concentration measured in the air was 4000 higher than the background levels in the same period of the year without fire. Dioxin in aquatic sediments was measured in samples taken from a lake located 1.5 km away from the landfill. Two sediment samplings were then performed, one year and three years after the fire. The results showed that during that period dioxin accumulated into sediments, suggesting a persistent pollution of the landfill surroundings (however, between the first and the second sampling several landfill fires were reported at the same site).

Part of the chemicals accumulated on soil, water bodies, and plants enter the food chains, bioaccumulates and may end up into human bodies. After a fire at a landfill in Greece (near Thessaloniki) Vassiliadou et al. (2009) analyzed food samples from an area up to seven kilometers away from the fire site, immediately after the fire event and six months after. The results revealed dioxin accumulation in goat and sheep meat, goat and sheep milk, and olives. The measured concentrations exceeded the usual level of dioxin in similar food products in Greece, and in several cases exceeded the maximum levels specified in the EU regulations (mostly in goat milk and goat meat – usually, the goats feed on local vegetation more than sheep, that may rely on other food sources as well). The olives samples revealed a reverse correlation between the distance to the fire site and the measured dioxin levels. Six months later, dioxin concentration has decreased in milk samples, but for several meat samples larger concentrations were measured (an indication of bioaccumulation processes). Similarly, an International Pollutants Elimination Network study (IPEN, 2021) reported on the accumulation of persistent organic pollutants (among which dioxins and furans) in eggs from free-range chicken living nearby waste disposal sites which repeatedly catch fire. The most contaminated samples, largely exceeding the maximum allowed concentrations by WHO standards, were collected from sites near which WEEE had been burnt as a

means of disposing of it or for extracting recyclable parts (mostly landfills in South-East Asia and Africa).

Starting from this rather grim context we wanted to understand how landfill fires impact the environment and human health in Romania. In this study we make the first step towards an assessment of the magnitude of the phenomenon, by inventorying the landfill fires that occurred in the last five years and their spatial distribution.

## **2. METHODOLOGY**

In order to identify the landfill fires in Romania, we used a waste fires database and a survey of reports on fires that we have found in the local media.

The waste fires database resulted from public data from the Romanian Inspectorate for Emergency Situations (Inspectoratul General pentru Situații de Urgență/IGSU) on firefighters' interventions upon fires occurring in the waste management sector. We classified as landfill fires mainly the fires burning large quantities of municipal waste (more than 10 m<sup>3</sup> or 10 tons), AND/OR were affecting areas larger than 50 m<sup>2</sup>. We also included in this category the fires for which there were no specified quantities and areas affected but in which cases the fire description neither mention municipal waste collecting points, nor waste recycling facilities. Moreover, we paid attention to fires for which the firefighting interventions usually lasted more than one hour. Based on the above criteria we identified 174 fires occurring at municipal waste landfill sites and informal dumpsites.

However, the public data provided by IGSU does not specify the exact location of the fires, just the county in which they occurred. So, in order to find more information and be able to pinpoint the fire events, we had to search for media reports on fires. We did this for the counties in which at least 5 fires were listed in the waste fires database. As expected, we could not find media reports for every landfill fire listed in the waste fires database, especially in the case of smaller fire events. However, there were cases in which we found reports on other landfill fires, not listed in the IGSU-derived waste fire database. For the descriptions of fire hotspots in the analyzed counties (landfills where more fires occurred during the analyzed period), we have used information from both sources.

## **3. RESULTS AND DISCUSSION**

Analyzing the waste fires database derived from the IGSU data and looking at the spatial distribution of fires (Fig.1), one can note the increased

frequency of landfill fires in several areas. The counties with at least five landfill fires in the analyzed period are listed in Table nr. 1.

The determining circumstances of such fires were described as selfignition (40% of all fires), "open fire in open areas" (32%), intentional burning (15%) and other circumstances (13%). Self-ignition of landfill fires comes as no surprise considering the deficient waste management in Romania, where 82% of the collected municipal waste gets landfilled (in 2018, Eurostat reported 5007 thousand tons of collected municipal waste out of which 4120 thousand tons were landfilled). There is also a large share of biodegradable materials in the collected waste (more than 50%, according to the National Plan for Waste Management-PNGD). The organic matter decomposing in landfills produces landfill gases with high content of methane. In most cases, the landfill gases emissions are neither monitored, nor collected and removed from the site and this increases the fire risk even more. Moreover, the separate collection of recyclable waste and waste recycling are at very low rates in Romania (in 2018 7.7% of the municipal waste was recycled, and 4.7% composted - 384 thousand tons, respectively 239 thousand tons, according to Eurostat) and as a consequence, the landfills contain a wide range of combustible materials, such as plastic, rubber, paper, textile, etc., that provide extra fuel for the fires.

| based on data noni 1030) |      |      |      |      |      |       |
|--------------------------|------|------|------|------|------|-------|
| Years                    | 2016 | 2017 | 2018 | 2019 | 2020 | Total |
| Area                     |      |      |      |      |      |       |
| București-Ilfov area     | 6    | 3    | 2    | 8    | 3    | 22    |
| Giurgiu County           | 1    | 1    | 2    | 2    | 1    | 7     |
| Mureș County             | 0    | 5    | 1    | 10   | 14   | 30    |
| Cluj County              | 3    | 17   | 7    | 0    | 0    | 27    |
| Suceava County           | 0    | 6    | 1    | 8    | 3    | 18    |
| Galați County            | 0    | 4    | 1    | 4    | 10   | 19    |
| Mehedinți County         | 0    | 2    | 0    | 3    | 1    | 6     |
| Prahova County           | 0    | 0    | 2    | 0    | 4    | 6     |
| Ialomița County          | 0    | 0    | 2    | 1    | 2    | 5     |
| Other counties           | 8    | 2    | 7    | 9    | 8    | 34    |
| Romania                  | 18   | 40   | 25   | 45   | 46   | 174   |

 Table nr. 1. Landfill fires in Romania between 2016 and 2020 (source: own calculation based on data from IGSU)

Almost half of the listed landfill fires were caused by people's actions. Burning as a means of eliminating waste or extracting recyclable parts (mostly from WEEE and used tires) is a widespread practice in Romania (as documented by Ignat, 2013 and Ilie, 2021, among others), and could be the cause for accidental landfill fires. Also, at several waste disposal sites there were suspicions of intentional setting the landfill on fire in order to decrease the volume of the deposited waste on site.

Further research into media reports helped us identify the exact landfills where most of the fires reported by IGSU happened. The hotspots for landfill fires in the 2016-2020 period were the following (Fig. 1):

The Sighişoara landfill. The current municipal waste disposal site near Sighişoara in Mureş County is a sanitary landfill that has been functioning since 1999. It was constructed on top of the old municipal waste disposal site (that had been used since 1977). It has two cells that have already been closed, an active one (operating) and spare space for the construction of a new one. The site has been catching fire periodically, with the highest frequency recorded in September-October 2019. During the studied period, there were 10 large fires at this site, some of them lasting for more than 12 hours. Population alerting messages were sent in the city in several cases because of the high smoke emissions. Two thirds of the fires were caused by self-ignition (many of them as a consequence of the incomplete extinguishing of previous fires).

The Pata Rât site. At Pata-Rât (Cluj County) there are three different landfills. The old landfill, opened in the 1970s and closed in 2015, was rehabilitated in 2019; it was covered with soil and vegetation, and leachate and landfill gas collecting systems were put in place. Alongside, there are two temporary landfills that were opened in 2015, as they were planned as temporary solutions until the new sanitary landfill nearby would be completed (part of an Integrated System for Waste Management/ISWM in Cluj County). However, due to repeated delays, the main landfill is still not functioning in 2021. Waste fires database registered 27 fires at the temporary landfills, with the maximum frequency in July-August 2017. During the analyzed period, there were 10 large fires where substantial waste quantities were burnt and that required the firefighters' interventions for more than 5 hours (and in several cases, for more than 12 hours). Another large fire was due to the self-ignition of the old landfill in April 2016, during its closing procedures; then, the fire lasted for almost one month.

The Fălticeni landfill. In Suceava County most of the registered landfill fires occurred at a waste disposal facility near Fălticeni. In 2013 this site opened as a temporary disposal site because the city's unsanitary landfill, operating since 1978, had to be closed. A new sanitary landfill was projected as part of the county's ISWM, but until its completion this site functioned as a temporary solution. The waste disposal at the site stopped in August 2019 (when the new sanitary landfill start functioning). This temporary landfill had been catching fire each year, recording the worst series of fires caused by self-ignition in August-October 2019. These events prompted the local authorities to

cover it with soil in order to limit the fire occurrence until the site would be properly rehabilitated.

The Tecuci landfill. In Galați County, most landfill fires occurred at the unsanitary landfill in Tecuci (Rateş), with the largest series of fires recorded in 2020. According to the Galați County plan for waste management, this landfill had to be closed in 2021 but it still hasn't.

Other large landfill fires occurred in Mehedinți County, at the Halânga landfill.



Fig. 1. Spatial distribution of landfill fires at county level and the identified hotspots. Counties: CJ (Cluj County), MS (Mureş County), SV (Suceava County), BIF (Bucureşti-Ilfov area), MH (Mehedinți County), PH (Prahova County), GL (Galați County), GR (Giurgiu County), IL (Ialomița Couny). Hotspots: 1 – Sighișoara landfill, 2 – Pata Rât landfill, 3 – Fălticeni landfill, 4 – Tecuci landfill, 5 – Halânga landfill, 6 – Glina landfill, 7 – Boldești landfill (Source: own elaboration based on IGSU-derived landfill fires data base and a media survey in the top 7 counties).

In most analyzed counties there was a single hotspot for landfill fires (e.g., Pata-Rât landfill in Cluj County, Sighișoara landfill in Mureș County, etc.). This may be because of the organization of the municipal waste management in Romania, where an entire county usually relies on one large landfill. However, there were counties where more hotspots were identified, or where a large number of landfill fires resulted from many fires at different locations. It was the case of the București-Ilfov area, Prahova County and

Giurgiu County. The presence of several landfills in the Bucharest-Ilfov area and a large informal recycling sector may explain a more dispersed spatial distribution of waste fires. One of the three landfills located around the city of Bucharest, the Glina landfill (in Popești-Leordeni), the oldest landfill in the area, burned two times in 2016 (in July and in December). Both were large fires, affecting around 5000 m<sup>2</sup>, requiring firefighting interventions of more than 12 hours and multiple crews involved in extinguishing them. In 2020 several fires at illegal dumping sites in the București-Ilfov area were described in the media.

In the analyzed period, in Prahova County there were several fires at three landfills (the sanitary Boldești landfill, operating in 2021, and Bănești and Băicoi, two non-operating landfills, but not properly closed and rehabilitated). The largest fire was in April 2018 at Boldești landfill, lasting more than 12 hours.

In Giurgiu County, the large number of landfill fires registered in the waste database resulted from several informal dumpsites fires.

From the five landfill fires in Ialomița County that were registered in the IGSU database we found related media reports for two of them, one being the sanitary landfill in Slobozia and the other one, an unsanitary landfill in Căzănești.

As seen in the hotspot descriptions, the waste fire risk is high in many counties because of provisory municipal waste disposal solutions left in place for longer than initially planned. These solutions were adopted after old unsanitary landfills had to be closed in order to comply with the European regulations, but the new landfills are still not functioning (in most counties they were only remote projects or are still under construction). Many landfill fires occurred at these sites (e.g., almost all fires in Cluj County), where waste disposal practices do not meet all the requirements for a sanitary landfill. One important such deficiency, increasing the fire risk could be the lack of landfill gas extracting installations. Another one may be not covering the deposited waste on regular basis with inert materials. Hopefully, the completion of the ISWMs at county level, as specified in the PNGD, will provide the muchneeded sanitary landfills, ending the provisory disposal of the municipal waste and, we assume, reducing the landfill fire risk.

Most landfill fires were surface waste fires. However, several deepseated fires occurred in the analyzed period, in already closed landfills, such as the fire at the Pata Rât old landfill in April 2016 or the one at the Fălticeni old landfill (October 2019). Those fires lasted several weeks and were very hard to extinguish. In Pata Rât, the fire was followed by a landslide involving waste and topsoil, and by leachate leaking out of the landfill.

In several cases with high smoke emissions and winds leading the fire plume towards cities, media reports mention air-quality measurements or population alerting messages. In most cases the measurements revealed that the

legal thresholds for measured pollutants were not exceeded. However, looking at international reports we can note that air quality measurements near a deepseated landfill fire in northern Canada revealed increased concentrations of PAHs and PCDD/Fs, exceeding the exposure threshold listed in official guidelines on air quality at points located between 1.2 and 3.8 km from the landfill, while the criteria air pollutants (PM<sub>2.5</sub>, O<sub>3</sub>, NO<sub>2</sub>) remained almost unchanged (Weichenthal et al., 2015). This highlights the need for monitoring more pollutants in order to assess the environmental and health impact of a landfill fire.

## **4. CONCLUSIONS**

The wide variety of materials deposited in municipal waste landfills determines the release of a large number of pollutants during a landfill fire. They may impact human health by direct/instant air pollution and by particle fallout leading to the accumulation of pollutants into the soil, water, and food chains, especially near sites with recurrent fires.

The average number of annual landfill fires in Romania is rather low (around 35 fires per year, occurred between 2016 and 2020). However, they are concentrated in several hotspots of recurrent fires, drawing attention to the need for better pollution/environmental monitoring in the identified areas.

On schedule construction of sanitary landfills and implementation of ISWMs, and better municipal waste management (characterized by the elimination of informal dumping and open burning of waste, and by the increase of separate collection, and diversion of biowaste and recyclable waste away from the landfills), would be indirect measures that could reduce the number of landfill fires in Romania, on medium and long terms Meanwhile, better management of the waste accumulated at the operating landfills (periodic coverage of the waste with inert materials, landfill gas extraction, reducing the open burning of waste on the site, etc.) could be proper direct measures in order to prevent recurrent fires in the identified hotspots.

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