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Research Article

Urban Tyres Burning: Sites Mapping and Analysis of Environmental and Health Risks in Abidjan, Côte d'Ivoire

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Abstract

Burning of used tyres is a growing activity in urban areas of Côte d'Ivoire. However, this activity is a source of soil pollution. In this context, this study aims to map the sites where used tyres are burned in the city of Abidjan, to describe this practice and to analyse the associated health and environmental risks. Field observations and interviews were conducted with the local population, garage owners and vulcanisers. In addition, the geographical coordinates of the identified tyres burning sites were recorded using GPS. A total of 50 tyres burning sites were identified in Abidjan, including 12 in Yopougon, 10 in Abobo, 05 in Marcory, 06 in Koumassi, 05 in Port-Bouët, 06 in Attécoubé and 06 in Adjamé. Most of the waste tyres burning sites are located close to economic activities, residential areas and rainwater drainage networks, exposing the surrounding population to risks. Tyres burning is carried out exclusively by men. Most of them are aged between 20 and 40 (59%) and most of them have no formal education (77.15%). This activity produces toxic fumes and ash which contain contaminant, posing significant risks to human health and the environment. This study suggests the importance of regulating informal tyres burning due to its proven risks to public health and the environment. The results of this research should guide public policy promoting environmentally sound alternatives for used tyres management, such as recycling and recovery.

Keywords

Tyres Burning, Environment, Health, Abidjan, Côte d'Ivoire

1. Introduction

Solid waste management is a major environmental concern in the cities of developing countries, due to increased urbanization, economic expansion, the constant search for an adequate lifestyle and galloping demographic [1]. Among these solid wastes, used car tyres are very little discussed in scientific works related to waste management in developing countries. According ADEME [2], 60% of used tyres exports from France, or 38% of global exports, are destined for West Africa. As a result, this zone appears to be the most exposed to use tyres management problems, and Côte d'Ivoire is no exception. In Côte d'Ivoire, expansion of used vehicle and sale of retreaded tyres has led to an increase in the proportion of tyres waste. However, a significant proportion of tyres waste is burned in an uncontrolled manner in the open air for the extraction and recovery of the iron wires it contains [3, 4].

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Yet tyres fires emit toxic black smoke that can lead to respiratory diseases including asthma, chronic obstructive pulmonary disease and lung cancer [5]. In addition, smoke emissions release heavy metals and polycyclic aromatic and aliphatic hydrocarbons, which are potential air, water and soil pollutants [6, 7]. Despite the seriousness of the problem associated with used tyres burning, no studies have yet been conducted in urban areas of Ivory Coast, unlike Nigeria [8] and Ghana [9]. In this context, this study proposes to identify and map tyres burning sites in Abidjan city, describe the practice of tyres burning at the various sites identified, and present the associated health and environmental risks.

2. Materials and Methods

2.1. Study Area

Abidjan is the economic capital of Côte d'Ivoire. It was established as an autonomous district by law n°2001-478 of 9 August 2001 on the status of the Abidjan district [10]. The Abidjan district It is made up of the city of Abidjan, which includes 10 communes (Abobo, Adjamé, Attécoubé, Cocody, Koumassi, Marcory, Plateau, Port-Bouët, Treichville and Yopougon), and the communes of Anyama to the north, Bingerville to the east and Songon to the west (Figure 1). It lies between 4°10 and 5°30 north latitude and 3°50 and 4°10 west longitude. Abidjan has a wide opening to the Atlantic Ocean in its southern part. Its surface area is about 58,000 ha, of which 9,000 ha or 16% are lagoons and 49,000 ha or 84% are land [11]. The city of Abidjan, with a population of 5,616,633 [12], accounts for 88.86% of the population of the Abidjan district. Abidjan is underlain by a soil derived from sedimentary formations of the ferralitic type [13]. Abidjan's climate is sub-equatorial, hot and humid. It has a long rainy season (May - July) and a short rainy season (September - November). The average annual rainfall is 1819 mm [14].

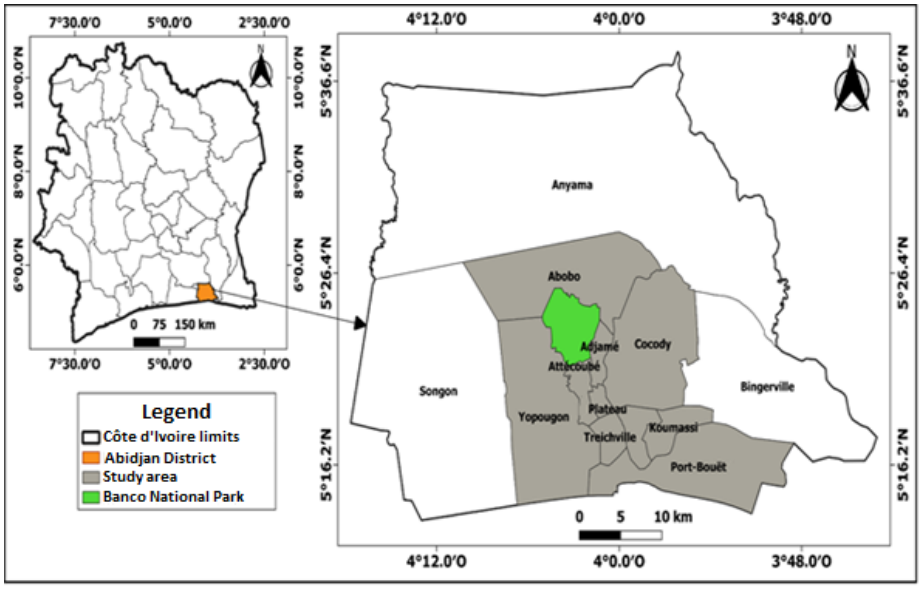

Figure 1. Location of study area.

2.2. Data Collection

The study was carried out between August and December 2023. It consisted in mapping used tyres burning sites, describing used tyres burning activity in the communes of the city of Abidjan and the associated environmental and health risks.

2.2.1. Identification and Mapping Used Tyres Burning Sites in Abidjan City

Tyres burning sites were identified on the basis of field observations. During sites visits, a GPS was used to record the geographical coordinates of the sites. These coordinates were then entered into QGIS 3.14.16 to produce a map of the burning sites. This map was georeferenced using the WGS 84 coordinate system, a worldwide reference system in decimal degrees.

2.2.2. Description of Tyres Incineration Activity and Environmental and Health Risks Associated

Data were collected through field observations and survey. Field observations provided an overview of the tyres burning activity in the communes of Abidjan city and consisted of visiting the sites in question to assess the environment of the sites (presence or absence of commercial activities, drainage net-

work and nearby water points, type of relief of the sites) and to identify the environmental and health risks. The actual survey consisted of filling in the forms provided for this purpose, interviewing and questioning the people involved in the activity of used tyres burning. This made it possible to collect information on the practice of tyres burning (origin of tyres burnt, periods of burning, type and quantity of items sought, fate of these items, etc.). The size of the sample of respondents was determined using the simple random sampling method. This sampling method is characterised by an equal probability of selection for all sample units, with each unit being selected independently of the others [15]. 140 artisans were interviewed, including 20 in each of the surveyed communes.

2.3. Data Analysis

Descriptive statistic such as frequency was employed for data analysis. The descriptive statistics showed the demographic data of respondents (age, gender, level of education), the practices of tyres burning (origin of tyres burnt, tyres burning period, wire selling prices) and the presence of stormwater drainage systems, economic activities and housing near tyres burning sites.

3. Results and Discussion

3.1. Mapping of Tyres Burning Sites in Abidjan City

Investigations carried out in the ten (10) communes of Abidjan revealed used tyres burning sites in seven (07) communes of Abidjan (Abobo, Attécoubé, Koumassi, Marcory, Yopougon, Adjamé and Port-Bouet). These sites number fifty (50), including ten (10) in Abobo, six (06) in Attécoubé, six (06) in Koumassi, five (05) in Marcory, twelve (12) in Yopougon, six (06) in Adjamé and five (05) in Port-Bouet (Figure 2). In the communes of Cocody, Plateau and Treichville, no tyres-burning sites were observed during the survey. The absence of burning sites in Plateau and Cocody can be explained by their standing, which means that their local authorities do not want burning to take place there. Plateau is home to a number of commercial businesses and the town's main administrative buildings and facilities. Cocody, on the other hand, is a prestigious, residential commune renowned for its safe neighbourhoods, luxury homes, large villas and modern infrastructure, home to numerous embassies, international schools, shopping centres and high-end restaurants. The lack of undeveloped land in Treichville to accommodate this activity is the reason for the lack of tyres burning sites.

The higher number of tyres burning sites recorded in the communes of Yopougon and Abobo could be explained by the strong presence of mechanical workshops in these communes, which would favour the wide availability of used tyres. Indeed, the survey showed that mechanical garages are the main source of burnt tyres for artisans in the communes investigated (Table 1). Furthermore, the origin of used tyres, whether collected from garages or from streets and rubbish dumps, is an indicator of the informal organization of this sector. This finding is in line with the observations of Kaza et al. [3], who explain that the absence of regulation in the management of used tyres in developing countries encourages informal and often polluting practices.

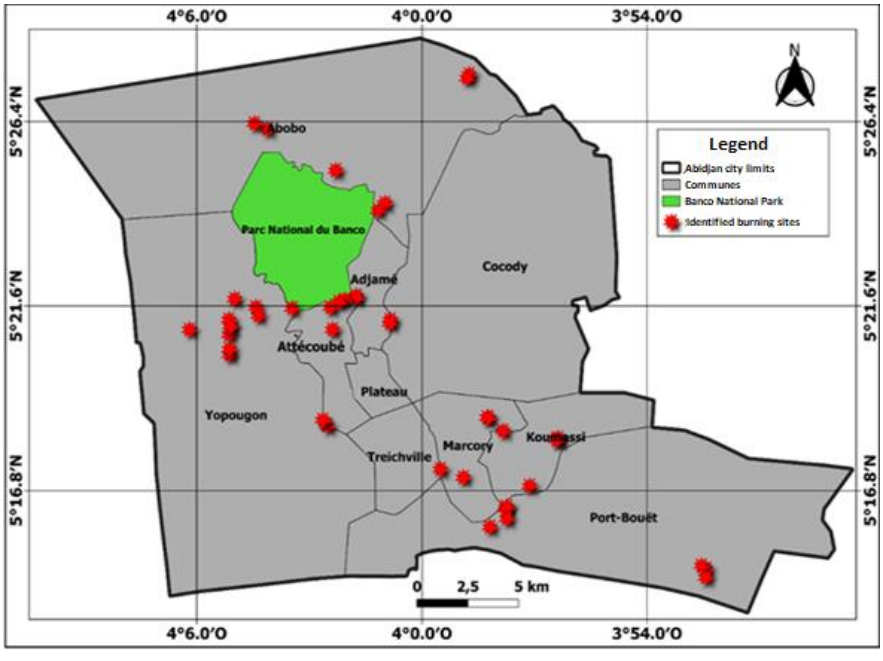

Figure 2. *Location of used car tyres burning sites in the study area.*

3.2. Description of Tyres Burning Activity in Abidjan City

Table 1 show the socio-demographic characteristics of artisans and practices of tyres burning in Abidjan city. This activity is generally practiced by men, most of whom are aged between 20 and 40 (59%) and are no formal education (77.15%). The fact that this activity is largely carried out by young men (mostly aged between 20 and 40) is in line with the observations of Hotou and Wandji [16], who describe tyres burning as an activity mainly carried out by men due to the physical efforts required. As for the artisans' low level of education, this reflects the social situation in which this activity. Indeed, the activity of burning tyres appears to be one of the resilience strategies of these precarious social groups (illiterate and school drop-outs), confirming the findings of [17]. According to the author, this activity is an economic refuge for these illiterate or school-leavers who refuse to give in to defeatism. Burnt tyres mainly come from mechanical garages tyres generally (52.14%). In the absence of a formal tyres waste management system in the country, this waste, which is generally piled up in mechanical garages, is collected by tyres burners to carry out their activity. Used tyres are mostly burnt at night (52.14%) between 8pm and 11pm. This situation can be explained by the clandestine nature of the tyres-burning activity; artisans seek to avoid controls or complaints from local residents that could cause them trouble. In fact, according to article 228 of the Ivorian Environmental Code, anyone who: incinerates household and similar waste, waste electrical and electronic equipment, tyres and plastics outside approved centers and facilities; emits odors that are particularly unpleasant for humans and the environment, is liable to a fine of 50,000 to 1,000,000 francs [18]. Wire (Figure 3) remains the only material recovered from the burning of used tyres in the communes, for resale. These recovered iron wires, which are generally sold for 0.15 to 0.23 € per kilogramme, are used as an additive to charcoal in low-income households, barbecues, grills and baskets. Similar observations were made by Mbiadjeu-Lawou and Hotou, [19] in Bangangté, Cameroon. However, according to Xiao et al. [20], recovered steel wires can be utilized in the production of galvanized steel wires and nails.

Figure 3. *Wire recovered from tyres burning in Adjamé.*

Table 1. *Socio-demographic characteristics of artisans and practices of tyres burning in the study area.*

			Artisans n=140
Socio-demographic characteristics	Gender	Male	100%
		Female	0%
	Age	16-20	17%
		20-40	59%
		40-50	24%
	Level of education	No formal education	77.15%
		Primary school	22.85%
Pratices of tyres burning	Origin of tyres burnt	Garage	52.14%
		Street collection	27.86%
		Garbage dump	20%
	Tyres burning period	Morning	30.71%
		Night	69.29%
	Wire selling prices	0.15 €/kg	52%
		0.23 €/kg	29%
		0.3 €/kg	19%

3.3. Environmental and Health Risks Associated with Tyres Burning Activities

In the city of Abidjan, the practice of burning used tyres poses environmental and health risks due to the proximity of the sites to storm water drainage systems, housing and economic activities and the sites relief, (Table 2, Figure 4). In fact, more than half of the tyres burning sites visited are close to housing and economic activities. The burning of tyres produces large quantities of toxic residues and hazardous gaseous emissions due to the thick black toxic smoke emitted from the open burning of used tyres. These emissions are known to cause respiratory problems, skin irritation and, in extreme cases, chronic diseases such as asthma and lung cancer [21, 22]. This could have an impact on the health of people who visit these sites. In addition, 64% of the burning sites in Abidjan are located close to storm water drainage systems, which could facilitate the dispersion of pollutants such as polycyclic aromatic hydrocarbons and heavy metals in the environment [23, 24]. Although most of the visited tyres burning sites are located on flat land, the significant number of sites on slopes and in low-lying areas may also contribute to the dispersion of pollutants in the environment.

Table 2. *Environmental and health risks associated with tyres burning in study area.*

Environmental and health risks associated with tyres burning		Tyres burning sites n=50
Presence of economic activities and housing in the vicinity of tyres burning sites	Yes	50.24%
	No	49.76%
Presence of storm water drainage systems near tyres burning sites	Yes	64%
	No	36%
Relief of tyres burning sites	Lowland areas	12%
	sloping areas	30%
	Flat areas	58%

Figure 4. *View of tyres burning sites near storm water drainage in Adjam é(A) and housing in Abobo (B).*

4. Conclusions

At the end of this study, we note the existence of 50 tyres burning sites in the city of Abidjan, including 12 in Yopougon, 10 in Abobo, 05 in Marcory, 06 in Koumassi, 05 in Port-Bou ët, 06 in Att écoub éand 06 in Adjam é. Most of the identified tyres burning sites are located on flat land and near rainwater drainage systems and housing. Tyres burning is carried out by men aged between 20 and 40 (59%). The majority of these artisans have no formal education (77.15%). Garages are the largest source of used tyres. Due to their clandestine nature, tyres are burnt in night between 8pm and 11pm. This activity produces toxic fumes and ash which contain contaminant, posing significant risks to human health and the environment.

Soil samples will be taken at tyres incineration sites to determine the level of heavy metal contamination.

Abbreviations

INS	Institut National de la Statistique
ADEME	Agence De l'Environnement et de la Maitrise de l'Energie

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Author Contributions

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Conflicts of Interest

The authors declare no conflicts of interest.

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