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THE PERCEPTION OF THE LOCAL COMMUNITY OF THE DEGREE OF POLLUTION GENERATED BY THE TURCENI THERMAL POWER PLANT, ROMANIA

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Abstract: Coal-fired power plants emit large amounts of pollutants. Our study focused on the Turceni thermal power plant, which, while providing significant regional economic benefits through energy supply, also serves as a local source of pollution. Emissions of oxides and ash from the plant negatively impact the environment, public health, and the comfort of local communities. Our research was conducted along several key lines of investigation: residents' perception of pollution levels, the frequency of pollution-related complaints submitted to authorities, the number of individuals receiving financial compensation, the authorities' efforts to reduce pollution, and the intention of some residents to relocate due to pollution. Our findings confirmed the presence of significant pollution and highlighted the need for greater community involvement and awareness in environmental decision-making. Additionally, our study revealed the necessity for improved relations between local authorities and communities, particularly in the context of developing and implementing effective environmental policies.

Key words: environmental pollution, degree of perception, Turceni thermal power plant

1. INTRODUCTION

1.1. Worldwide concerns over pollution generated by coal-fired power plants

Coal-fired power plants generate the largest amount of air pollutants with emissions of carbon oxides, nitrogen, and sulphur, and accidental emissions of heavy metals, such as Hg, Zn, Sb, Pb, Cd, As, Cr, and Mn, as well as ash and $PM_{2.5}$ (Guttikunda & Jawahar, 2018). These emissions have negative effects on the urban ozone (Meawad et al., 2010), affect people's health (Kravchenko & Lyerly, 2018), contribute to the occurrence of acid rain (Bhargava & Bhargava, 2013), and have implications on global climate change (Rashid et al., 2020).

At the global level, regional differences exist in the use of coal as fuel for thermal power plants, imposed by the population's economic interests, strategies, and perception of the degree of pollution. Thus, in 2019, China was considered the largest consumer of coal for energy production, followed by India, the United States of American (USA), Germany, Russia, and Japan (Wang et al., 2020). China has large coal reserves and low exploitation costs; therefore, coal is considered greatly useful in the future (George et al., 2020). Therefore, pollution from coal use affects the atmospheric air quality (Yue et al., 2021). In India, approximately 66% of electricity is produced by coal-fired power plants, which are considered to be the biggest air pollutants that raise the associated mortality rate in India (Sahu et al., 2021). The emissions of polluting noxes have caused premature deaths and approximately 20 million cases of asthma through the exposure to $PM_{2.5}$, which require expenditures of up to 4.6 billion USD (Guttikunda & Jawahar, 2018).

In Europe, the coal used to generate energy is a fossil fuel with the highest degree of pollution compared with other fuels (Carvalho, 2019). Towards the end of the 20th century, the share of coal in electricity production was 30-40% in Ireland, up to 60% in Poland, and 50% in the Netherlands. Other countries also account for a high share of coal use, including Denmark (90%), Greece (72%), and Germany (30%) (Bukowski et al., 2023). The European Union is also facing air pollution, with approximately 49.8% of electricity being produced from power plants using biomass, natural gas, oil, and coal (Kushta et al., 2021).

The most common air pollutants impacting human health are SO_x, NO_x, $PM_{2.5}$, and coal ash (European Environment Agency, 2017). In Poland, where coal is the primary energy source (Glodek & Pacyna, 2009), the most important emitted pollutants are NO_x (14% of Europe's total, Asif et al., 2022), SO_2, CO, and particular matter (PM). In Germany, which predominantly uses lignite for energy production, the primary atmospheric pollutants are CO_2, NO_x (16% of Europe's total, Asif et al., 2022), SO_x, and PM (von Blottnitz, 2006). Other countries contributing significant pollutant emissions to Europe's total are Ukraine, Turkey, Serbia, and Bosnia for SO_2 (27%, 24%, 15%, and 11%, respectively) and Ukraine and Turkey for NO_x (16% and 20%, respectively) (Asif et al., 2022). The use of coal involves still certain economic challenges; however, this is simultaneously contested (Krautz et al., 2017).

In Romania, coal-fired power plants in Oltenia and Hunedoara generate 97% of the country's energy, which is also a major source of pollutant emissions (Nerău, 2021). In this context, the closure of the two complexes would have a limited impact on the elimination of SO_2, NO_x, and $PM_{2.5}$ emissions (Nerău, 2021). High values of CO_2 emissions were registered in the winter months owing to an increase in coal-based electricity consumption (Năstase et al., 2018). Romania is among the countries in the Balkans that have not yet discussed measures to abandon the large-scale use of coal, as in Greece and Hungary, wherein commitments have been made to gradually abandon coal from 2019 (Koltsaklis et al., 2020).

People's perceptions of pollution generated by coal-fired power plants was used in scientific research with the help of questionnaires and interviews. Jardine et al., (2007) used two survey questionnaires and interviews with residents around Wabamun Lake (west of Edmonton, Alberta, Canada) who expressed concern regarding the health impacts of the operation of four coal-fired power stations. Sahay (2008) used a survey to evaluate residents' perceptions of the environmental and health impacts of the Talcher Super Thermal Power Plant, located near Talcher in the district of Angul in Orissa, India. In an extensive report on the Socio-environmental Impacts of Coal and Coal-fired Power Plants in Vietnam, Ha-Duong et al., (2016) used questionnaires and interviews with residents, local authorities, and experts. Using focus group interviews, Chen (2017) highlighted the problem of air pollution and its contradiction with energy production generated by coal-fired power plants in Taiwan; Thomson & Kempton (2018) used interviews to highlight the high degree of pollution from coal-fired power plants compared with that from wind power plants in the USA and Terrapon-Pfaffa et al., (2019) combined interviews with field data from the NOORO ICSP plant in Ouarzazate, Morocco.

Several studies have been conducted on the Turceni Thermal Power Plant (TTPP) regarding the forms of pollution. Căpăţînă (2011) analysed soil pollution in the area of the TTPP; Nica Badea et al., (2022) investigated the contamination of soil by heavy metals, namely, Zn, Cu, Mn, Pb, Ni, Co, Cd, and Hg, in 2010 and Racoceanu et al., (2012) analysed air pollution caused by slag and ash.

The main objectives of our study were to: (i) processing official pollution data, as they constitute the basis of the level of perception of pollution by local communities, and (ii) determining the perception of the local population regarding the degree of pollution of the TTPP using qualitative and quantitative data recorded in the field.

2. METHODOLOGY

2.1. Processing of pollutant values

The concentrations of CO, NO_x, and SO_2 for 2010–2014 and 2018–2019 and for PM_{10} for 2013–2014 and 2018–2019 were obtained from the archive of the Gorj Environmental Protection Agency (GEPA). From this dataset annual averages were calculated.

2.2. Survey and semi-structured interview design

To highlight the local community's perception of the degree of pollution generated by the TTPP, we used the generic method of triangulation to ensure the validity of the qualitative research. In accordance with the specialised literature (Chatterjee et al., 2023), we developed a questionnaire for 200 people, structured with open and closed questions, to highlight the degree of perception of the resident population on the pollution generated by the TTPP. The questionnaire was tested on a sample of 35 participants to ensure data accuracy and eliminate ambiguity. The target participants for the questionnaire were chosen among individuals who lived near the TTPP according to predefined categories. We conducted 21 semi-structured interviews between 1 October and 15 October 2022, as in other cases (Terrapon-Pfaffa et al., 2019) with residents near the TTPP, to determine the degree of generated pollution. The interviews were conducted in the localities of Brăneşti, Cursaru, Ilişeşti, Ioneşti and Turceni, wherein each interview lasted between 40-60 min. We also considered local stakeholders, such as mayors and economists. In accordance with other studies (Evans & Jones, 2011), four of the interviews (19%) were sit-down interviews conducted in the comfort of people's

homes owing to their desire to disclose the pollution problem faced by them. We also used eight (38.1%) walking interviews in the qualitative research (Mason, 2021) as people wanted to show us the heaps of ash and dust on the ground that affect their households. These types of interviews are important as they highlight the connections between individuals and surrounding areas (Evans & Jones, 2011). The remaining interviews were conducted in-person (42.9%). All interviews were digitally recorded, transcribed verbatim, and translated into English. All participants agreed to participate in the study. The characteristics of the questionnaires and interviews are shown in Table 1.

2.3. Mass media - first source of local information

Mass media has been an important tool in public debates on environmental issues since the 1960s (Hansen, 2011) and plays an important role in the distribution of information (Olper & Swinnen, 2013). Mass media is the first source of local information, which helps identify the cause, define social and political problems (Shapiro & Bolsen, 2018), and help citizens defend and promote their opinions during debates (Eskens et al., 2017). To highlight the extent to which the pollution generated by the TTPP was debated in the local mass media, and according to Duncan et al. (2015) we used county newspapers for the period of 2011–2023 as the news archive, and the keywords used were pollution, TTPP, and the Oltenia Energy Complex (OEC). The variables used were the name of the newspaper, article title, and date of publication. We also used national reports on environmental regulations, such as Raport de mediu (2019).

We also used two different scales for the explanatory variables in our database, namely, dichotomous and trichotomous (Bogliacino et al., 2022; İlker et al., 2011), to evaluate the following major directions: the degree of perception of the population on the pollution emitted by the TTPP; the number of notifications sent by respondents to local authorities regarding the pollution arising from the TTPP; the number of people financially compensated by the TTPP; assessment of the degree of involvement of local authorities in pollution reduction in the area of the TTPP and the intention to change residence.

2.4. Photography as a signification of the reality in the fieldwork

To capture the reality on the ground, as this was represented by the answers of the individuals that were questioned and interviewed on the existence of the ash deposit and polluted areas, photography was used as a geographical method of field investigation (Davies et al., 2019). In general photography is a useful resource for analysis, involving a descriptive message and providing very good representation of real-world situations (Rose, 2008).

Table 1. Questionnaires and interviews

Questionnaires									
Period		Sample			No of questions				
April 15-May 15, 2022	200 people							15 close 9 semi-open 1 scaled	
	Gender	Age			Study level				
	104 (52%) male 96 (48%) female	32 people < 40 years old 98 people between 41-65 years old 70 people > 65 years old			35 female - primary education 28 male, 16 female - middle school 63 male, 41 female - high school 11 male, 6 female- university				
Interviews									
21 interviews	face to face sitdown interviews - 4 walking interviews - 8								
Studies/age group									
Period	Age	Primary school		Middle school		High school		University	
June 1 - July 1, 2022	31-40	Male	Female	Male	Female	Male	Female	Male	Female
	41-50						2	1	
	51-60					1	1	1	
	61-70					2	1	2	1
	over 71							2	2
				1		1		2	

2.5. Climatic parameters involved in the spatial spread of ash

To process the speed and frequency of the directions and parameters necessary to evaluate the spread of ash from the Turceni deposit in local communities, we used data from the Meteoblue platform for a period of 30 years (https://www.meteoblue.com).

2.6. Study area

The town of Turceni is located in a subcarpathian region of Oltenia, part of the Getic Piedmont, in the south of Gorj county, at 44° 40' 59.99" N and 23° 22' 0.01" E (Figure 1). According to data provided by the Gorj County Community Directorate for the Registration of Persons, Turceni contains 7,698 houses, 5,120 households, and 8,358 inhabitants. The city is located at an altitude of 122 m and has an area of 7893 ha and a longitudinal shape, imposed by the vicinity of the Jiu River. The TTPP is the largest plant in Romania (Tătar, 2018), and one of the largest in Europe (Gavrilescu & Cioboiu, 2021). Together with the lignite deposits from Rovinari, Jieț Nord, Jieț Sud, and Tehomir, which hold 95% of the coal deposits in Oltenia, it is part of the Turceni Energy Complex (Popa et al., 2018). It started operating in 1978 with an installed power of 330 MW. In 1989, it had an installed power of 2310 MW, which accounted for approximately 10% of Romania's annual electricity consumption, and subsequently reached an installed power of 2640 MW (Popa et al., 2012).

2.7. Study limitations

Our study involves certain limitations that must be acknowledged in the context of a balanced understanding of its results. During the field investigations, some individuals refused to answer our questions due to either convenience or fear of consequences; some were TTPP employees, whereas others had administrative functions. In GEPA, we found no continuous long-term records, which prevents us from analysing the pollution trend over long periods of time, limits the historical context, and hides the correct pollution impact on the study area. In future studies, alternative data sources, such as independent environmental monitoring organisations or remote sensing, could be used to complete the gaps in the records.

3. RESULTS

Our study was conducted in the settlements of Cursaru, Brăneşti, Ilişeşti, Ioneşti, and Turceni, located at distances between 2.5–3.0 and 10–12 km from the TTPP. The vulnerability of these settlements to pollution was highlighted by the overlap of the pollutants emitted by the TTPP with the perception of pollution by the residents and press articles addressing the problem of pollution, (Figure 2).

3.1. General pollution problems resulting from the operation of the TTPP

The TTPP is the main source of NO_2, SO_2, CO, and PM_{10} pollution, and is responsible for landfill ash. Three fixed pollutant-monitoring stations were placed in Gorj County. Among them, we focused on the values of the GJ-3 Turceni station (code RO0152A), located 25 m away from Turceni City Hall. The sources of emissions are large industrial combustion plants, especially for the production of fossil fuel-based electricity (TTPP being

Figure 1. Location of the TTPP: (a) in Romania and Gorj county; (b) TTPP

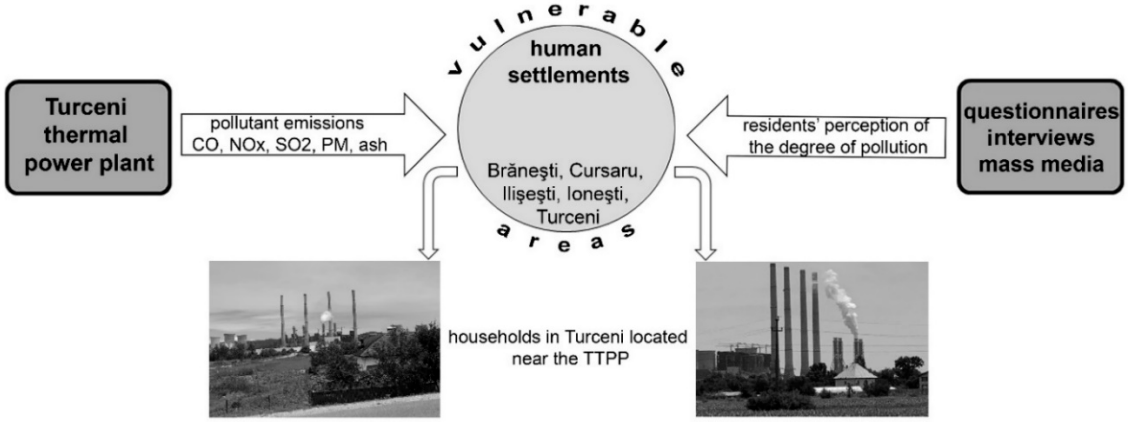


Figure 2. Vulnerable areas where the pollutants emitted by the TTPP overlapped with the perception of pollution by the residents

approximately 2.8 km away). Importantly, the distance between residences and the TTPP was variable: 7% of respondents (n = 14) indicated their residences as being less than 2 km away from the TTPP, 34.5% of them (n=69) indicated distances between 2 and 5 km, and 58.5% of them (n=117) indicated distances slightly over 5 km

3.2. The main pollutants emitted by TTPP

The CO, NOx, and SO_2 pollutants recorded high values in 2010–2014. NO is released and shows a constant increase, similar to NO_2. SO2, after increasing in the first three years of the interval, decreased towards the end of the interval. These values were lower for all pollutants in 2018 and 2019 (Figure 3a). There were no data for the period 2015–2017 and 2020. For PM_{10}, recordings were only made for 2013, 2014, 2018, and 2019. Recordings from other years are missing (Figure 3b). In 2018, at the GJ-3 Turceni station, SO_2 values exceeded the hourly limit value of 350 µg/m^3 in two cases and exceeded the daily limit value (per 24 h) of 125 µg/m^3 in one case. According to GEPA data, no violations of alert thresholds were observed. Air quality thresholds (limit values for the protection of human health) were established according to Law No. 104/2011 regarding the quality of the surrounding air.

3.3. The pollution generated by the ash deposits and the residents' perception of this process

The TTPP has several slag and ash deposits: deposit no. 1 is located in the western part of the plant, with a capacity of 163 million m^3; warehouse no. 2 is located in the southern part of the plant and includes cells 1, 2, and 3, which are already consumed; and cell 4 has two compartments with a capacity of almost 8 million m^3 (www.ceoltenia.ro). Warehouse no. 2 is the main source of ash pollution in the localities and human communities in our study area and is located at distances of approximately 1, 3, and 5 km from the TTPP, city of Turceni, and village of Ioneşti, respectively (Figures 4 a, b). Pollutant emissions from landfills include ash particles entrained from the surface of the landfill, and those dispersed in the air and subsequently deposited on the ground. This process is strongly influenced by the prevailing wind speed and direction. In the summer months, high wind speeds were observed in most hours, which contributed to ash scattering. In June, 14.3, 10.3, and 4.8 days showed wind speeds of above 12, 5, and 19 km/h, respectively; in July, 12.9, 12.8, and 4.7 days showed wind speeds of above 12, 5, and 19 km/h, respectively; and in August, 13.5, 13.1, and 4 days showed wind speeds of above 12, 5 and 19 km/h, respectively (Figure 4c). Thus, the largest amounts of ash were scattered and deposited in the northern directions: in the N direction, wind speeds of above 5 and 1 km/h were observed for 650 and 211 hours/year, respectively; in the NNW direction, wind speeds of above 5 and 12 km/h were observed for 497 and 180 hours/year, respectively; in the NW direction, wind speeds of above 5, 12, and 1 km/h were observed for 361, 168, and 154 hours/year, respectively. The ash spread in these directions affects the Turceni and Plopşoru localities. Additionally, large

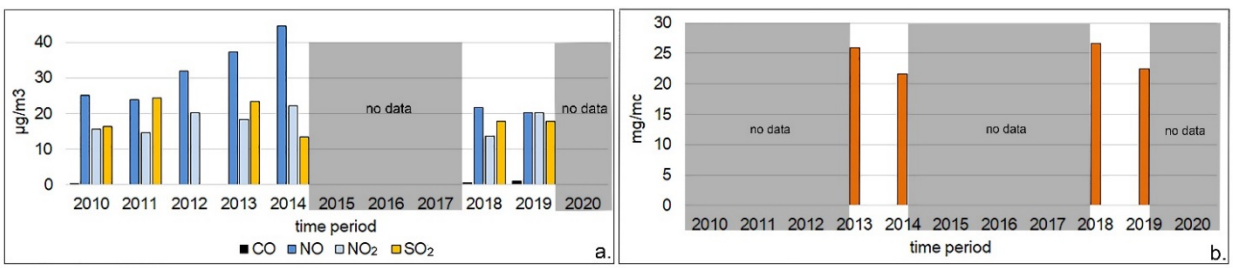


Figure 3. Variations in the emission of CO, NO, NO_2, and SO_2 (a) and PM_{10} in the period of 2010-2020 (b)

amounts of ash were scattered in the eastern direction, affecting the localities of Plopşoru and Aninoasa. Thus, in the ESE direction, wind speeds of above 5, 12, and 1 km/h were observed for 245, 207, and 162 hours/year, respectively; in the NNE direction, wind speeds of above 5, 1, and 12 km/h were observed for 419, 181, and 40 hours/year, respectively (Figure 4d). In December 2013, an accident occurred at the Turceni branch of the Valea Ceplea ash deposit. There was a spill of water with ash (Figure 5), and the mixture flooded approximately 15 ha of agricultural land and 10 households in the Submaidane area of Turceni and Ionești localities. The Environmental Guard of the Gorj County Commissariat (EGGCC) observed damage to the environment, ordered measures to rectify the situation, and imposed contravention sanctions on the OEC. The pollution generated by ash dumps affects the health of inhabitants and damages their living conditions and the environment.

These effects were evident in the study area. The residents told us that the pollution affects their health and harvests at the same time. They sent hundreds of notifications and pictures regarding ash pollution to the EGGCC, and TTPP was fined tens of thousands of lei for pollution. Some residents mentioned that as employees of TTPP, they know that when the wind blows, the ash is deposited everywhere. The pollution generated by the TTPP was also highlighted by the mass media, and a series of articles were published (39.1% of the total articles dedicated to the TTPP in the period of 2011-2023) emphasizing this problem (Table 2). The episodes of

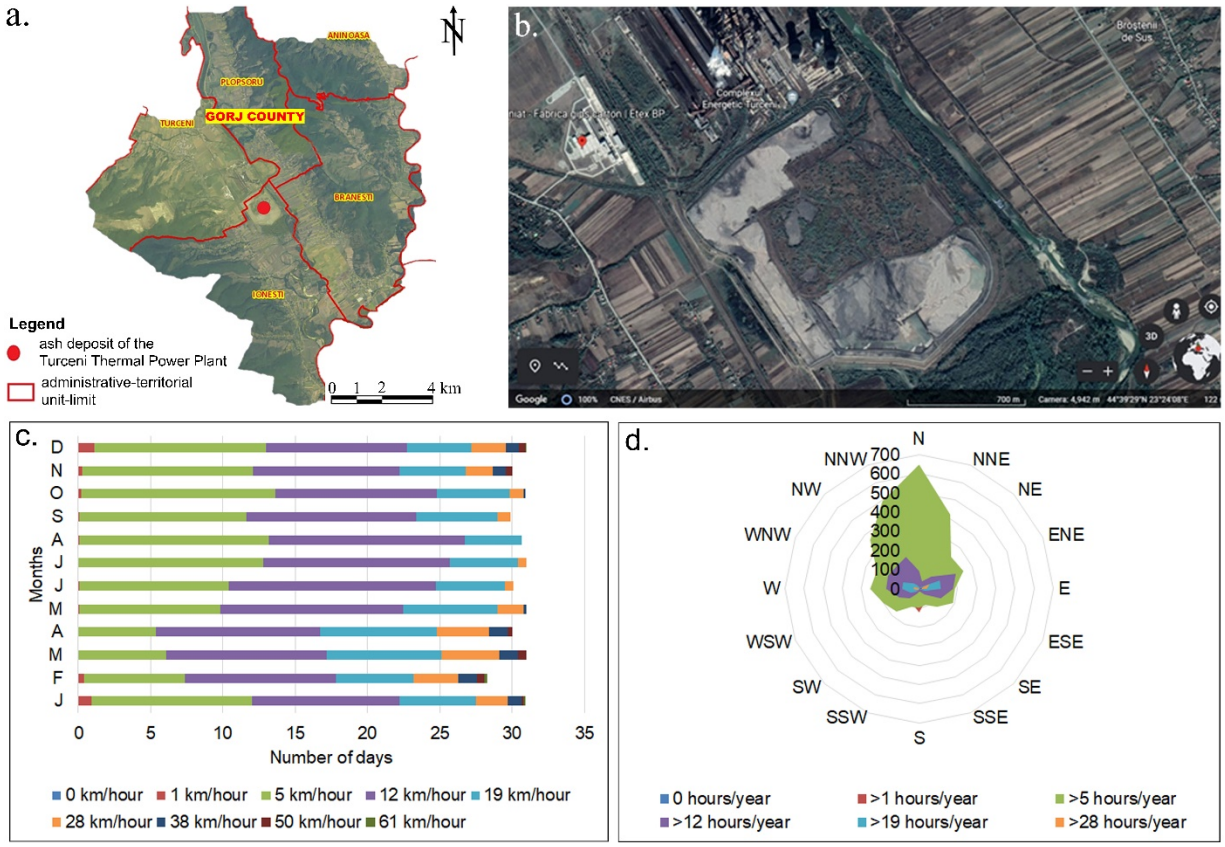


Figure 4. Location of ash deposit no. 2 of the TTPP: (a) facing neighbouring human settlements; (b) details of ash deposit no. 2 (source: www.google.earth.com); and (c) number of days with winds of different speeds; (d) number of hours per year of wind frequency in all directions at different blowing speeds.

Figure 5. Dust and ash pollution (marked in red) originating from deposit no. 2 of the TTPP (a., b); pollution of some agricultural land and 10 households in the Submaidane area of the Turceni and Ionești localities (c) (*Cornescu, 2021*)

Table 2. Local press presenting the pollution problems caused by the TTPP

Data	The title of the article
19.06.2023	OEC checks the level of pollution at thermal power plants
18.05.2023	OEC wants to reduce dust pollution in the area of the TTPP
18.05.2022	OEC takes measures to reduce dust pollution in Turceni
21.02.2022	OEC, two fines for pollution
18.05.2022	OEC wants to reduce dust pollution in the TTPP area
18.02.2022	Massive pollution in the Turceni area! Ash cloud
15.12.2021	Polluted air breathed by the residents of Rovinari and Turceni
28.05.2021	TTPP fined 50,000 lei for pollution
07.05.2021	Clouds of ash around the TTPP
25.09.2020	OEC cuts down forests and pollutes the air to produce an energy of the past
11.05.2020	The pollution from Turceni and Ordinary caused by ... technical unemployment!
07.04.2020	OEC fined for pollution
04.02.2020	Risk huge fines for ash from TTPP
29.07.2019	New requests regarding the monitoring of air pollution - Turceni and Rovinari thermal power plants, again to the attention of the European Commission
02.06.2019	Pollution from TTPP brought to the attention of the Ombudsman
30.04.2019	A cloud of ash covered the TTPP
29.04.2019	Pollution, from SE Turceni! The cloud of dust for several kilometres
15.09.2016	On hunger strike for a plot of land under the Ceplea ash pit
09.09.2014	The gray life in Submaidane to the attention of the Bankwatch Association
11.12.2013	TTPP in the top of the biggest polluters. Aurel Medințu (OEC): It is natural, we produce the most!
29.11.2011	TTPP, leader in pollution in Europe

intense pollution with the ash from this deposit are also reflected by the four fines imposed by the EGGCC from 2020, and by the verification of the level of pollution and specific measures implemented to reduce pollution in recent years, namely, in 2022 and 2023

3.4. Residents' perception of the degree of pollution generated by the TTPP

Among all the surveyed individuals (n=200), 132 (66% of the total) were residents of Turceni, 30 (15% of the total) were residents of the village of Ioneşti, and the remaining 38 (19% of the total) were residents of another village. The degree of perception of pollution emitted by the TTPP was differentiated by categories of perception. The highest value of the perception of the degree of pollution is highly appreciated. High values were also observed for the high and medium perceptions (Figure 6).

For the last 10 years, only two people (1% of the total) made a single notification, 17 people (8.5% of the total) notified the authorities several times, and 171 people (90.5% of the total) never notified the authorities or TTPP representatives in relation to problems arising from its operation (Figure 7).

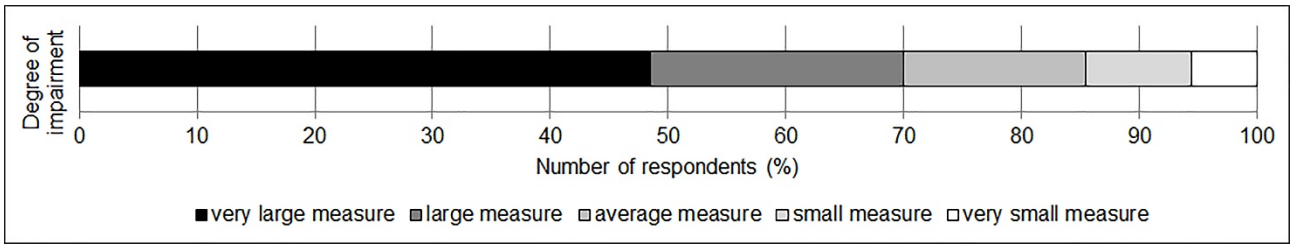


Figure 6. The degree of perception of the population on the pollution emitted by the TTPP

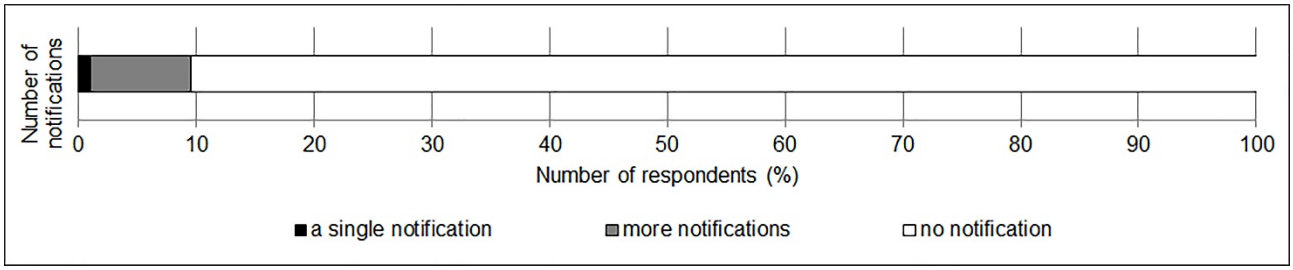


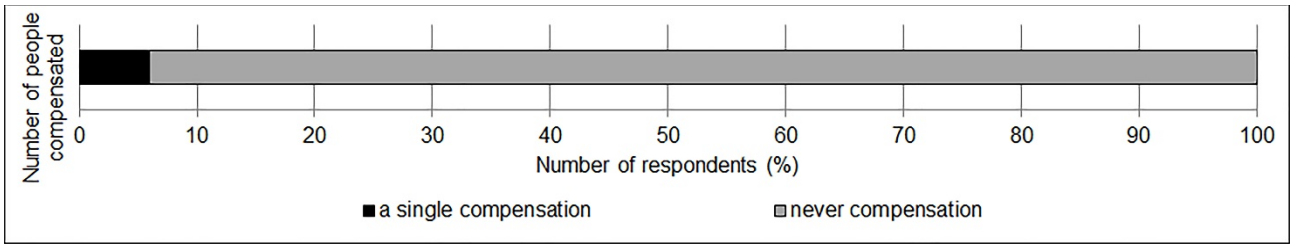
Figure 7. The number of notifications sent by respondents to local authorities regarding the pollution arising from the TTPP

The respondents' responses highlight the fact that the local authorities and TTPP representatives were notified of the issue of ash pollution and delay in the greening of the lands covered by the ash, which also resulted from the annual reports of the GEPA. Some of the respondents did not consider that reporting to the local authorities or the OEC could resolve conflicts, interfere with job security, and rectify the feeling of mistrust. The surveyed population indicated the existence of environmental conflicts owing to the operation of the TTPP, but the majority of the analysed answers showed that they had never participated in these meetings.

Thus, on the one hand, regular meetings are not organised by local authorities, GEPA, or other non-governmental organisations, and conversely, residents may not be informed about these meetings or do not want to participate, which amplifies conflicts. Often, residents of a community provide accounts of their perceptions and emotions, and the emotional aspect is influenced by a lack of trust or fear. The TTPP has provided little compensation to people affected by pollution over the last ten years. Thus, 24% (n=12) of the respondents mentioned that they benefited from such compensation only once, whereas 76% of the total respondents (n=188) mentioned that they never received compensation (Figure 8).

Regarding the involvement of local authorities to reduce pollution in the TTPP area, only the surveyed people living in the city of Turceni appreciated the involvement to a very high extent, whereas the residents of the village of Ionești appreciated the involvement to a small and very low extent (Figure 9). In this regard, the former mayor of the village Ionești told us that there are no studies about the impact of pollution on cereals and vegetables. It was also observed that, for example, the life span of elms is considerably shorter, and the pines on Dealul Bisericii have been affected by drying in the last 7-8 years.

The location and operation of the TTPP induced changes to the quality of environmental components owing to an increased level of pollution, especially dust and ash. The alteration of the environmental conditions identified by the respondents and the consideration of the high degree of impact owing to the location and operation of the TTPP can be correlated with the intention to change residence in the area of the TTPP. Thus, 96 (48%) respondents stated that they never intended to change their domicile, 94 (47%) respondents stated that they sometimes thought about it, and 10 (5%) respondents declared that they would change their domicile soon (Figure 10).



Figures 8. The number of people financially compensated by the OEC

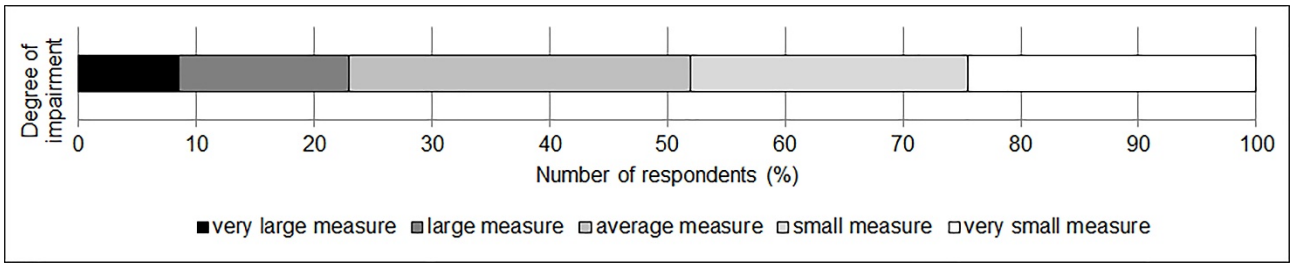


Figure 9. Assessment of the degree of involvement of local authorities in pollution reduction in the area of the TTPP

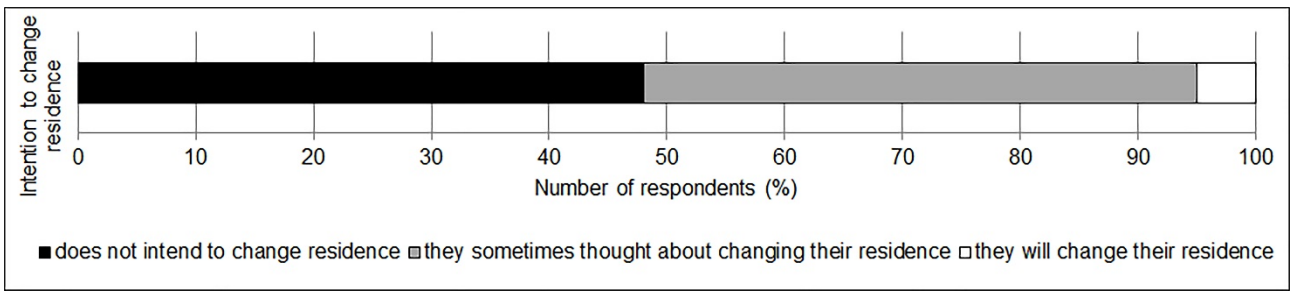


Figure 10. Intention to change residence

Even in this context, the majority of respondents (84%) stated that compared with the communist period, the current living conditions were better, and 32 (16%) respondents specified that the conditions were worse. However, the unanimous perception of the local community is that information of the elimination and mitigation of pollution is insufficient. This fact is highlighted by the residents. It is mentioned that there was no involvement of the community in the implementation process of certain projects, that the residents were not informed regarding the decisions and implemented plans, and that there are no known studies on the environmental or socioeconomic impact on the health of the population in the area. It is said that everything is political and that those at TTPP do not care about the people. On the other hand, it is recognized that the influence of the thermal power plant on the socio-economic development of the city is major because TTPP pays taxes and levies monthly and quarterly to the local budget, is the main entity providing jobs, and is the primary source of income for many of the residents in the area, thus highlighting the socio-economic benefit of TTPP.

4. DISCUSSIONS

The demands of urban communities for quality living spaces are increasing and residents' opposition to large sources of pollution can be attributed to the "Not In My Backyard" syndrome (Sun et al., 2016). This is also the case for the TTPP, one of the most polluting installations in Romania and Europe, according to the European Environmental Agency (Istrate & Bănică, 2016), which generates discontent and social conflicts. The use of coal by the TTPP is perceived as harmful to human health and the environment by the residents questioned and interviewed, as mentioned in other cases (Thomson & Kempton, 2018). Air pollution control policies remain current in the TTPP area. Our area faces pollution with various oxides and ash. As in other situations (Zhao et al., 2017), the most cited pollutants with a high degree of pollution by the inhabitants were NO, SO_2, and PM. Ash from the incomplete combustion of coal is the most important pollutant generated by thermal power plants and endangers human health (Guttikunda & Jawahar, 2018; Kravchenko & Lyerly, 2018).

Wind plays an important role in the distribution of ash (Bajpai et al., 2010), an aspect that we made sure to emphasise. Conversely, Shahzad Baig & Yousaf (2017) mentioned that ash can be transported to long distances, i.e. 40–50 km even at low wind speeds, and Feng et al., (2013) stated that the average ash scattering distance is approximately 3.2 km. In this context, we can say that ash—the pollutant with the greatest impact on our study area—falls within these distances, with the average distance being 3.5 km, and that wind plays an important role both in the warm and cold seasons.

However, there are few regulations regarding ash transport and storage, and few studies have examined the impact of ash on human health (Zierold et al., 2020). Although air quality is permanently monitored by the GJ-3 station (Lazăr et al., 2014), the same major problems of ash pollution are faced by the TTPP, which affects the environment and generates social problems (Gămăneci et al., 2011). Estimating particulate emissions from ash deposits is a complex process, because scattering depends on the properties of the ash and the state of the atmosphere at the time of analysis. Therefore, it is almost impossible to identify a functional relationship that allows the estimation of short- or long-term particle emissions (Racoceanu et al., 2012). As mentioned previously, during the summer months, with more intense winds, ash is scattered on agricultural land, vegetation, roads, and human settlements. This process occurs also in winter—particularly in January—when the wind is more intense and temperature inversion occurs during depression relief (Palarz & Celiński-Mysław, 2017), similar to that occurring at the depression location of the Paroşeni thermal power plant (Tătaru & Tătaru, 2016).

As mentioned in the Raport de mediu (2019) around the slag and ash deposits, with the increase in wind speed and due to the lack of wetting measures for the dumps, suspended dust causes pollution, which exceeds the maximum allowed daily concentration of 50 $\mu g/m^3$. Coal combustion results in large amounts of ash, with values of approximately 1.25 million t reported in 2019, and 1.48 million t in 2018. In this context, for January–June 2021, residents addressed four complaints to the Global Economy and Governance, with the energy company being sanctioned several times for pollution, with fines exceeding 100,000 lei. Although ash from coal combustion has multiple uses (Senapati, 2011) in the manufacture of construction materials, cement industry, ceramics, road construction, and as fertiliser in agriculture, only a part of the ash from the TTPP is used in the production of gypsum plaster by Siniat.

Thermal power plants are major sources of energy with a strategic role in the economic development of countries (Istrate Bănică, 2016). They are cheap and reliable and have an inverse relationship with environmental systems (Das & Mahadeb, 2015). The active perception of local communities regarding the economic development represented by coal plants is a necessary element to consider (Allen et al., 2008). The economic impact of the TTPP is important and has regional significance for Oltenia, whereas the consequences on the environment are local and spatially

variable, affecting local communities. This contrast was highlighted by the field investigations. The economic value of the TTPP also emerged from the answers of the interviewees, who mentioned that the TTPP helped the economic development of the area through the payment of fees and taxes and offered jobs to some of the residents of the local communities (n = 43; 21.5% of the total number of people questioned), similarly to other cases (Ha-Duong et al., 2016). Conversely, regardless of the level of education (60.5% of all respondents had high school and university training, and 39.5% of them had only primary and middle education), gender (52% were men, and 48% were women), and implicitly of the awareness of environmental issues in their communities that they still know very well (70% of all respondents), a series of answers of the respondents highlighted their critical and conscious attitude towards the pollution generated by the TTPP. Zhao et al., (2017) mentioned a similar situation in China's coal-fired power plant industry. In this sense, the locations for establishing coal-fired power plants should be chosen by considering primarily the associated environmental costs and to a lesser extent the economic costs associated with the proximity to human communities (Barrows et al., 2018), as in the case of the TTPP. The siting of energy projects causes conflict, which is usually expressed through disapproval, thereby requiring local community consultation (Petkova et al., 2002) to reduce the sense of concern of the residents (Richardson & Razzaque, 2005). Public participation is important for avoiding conflicts between the local population and the administration of power plants (Chompunth, 2012). In this context, field surveys, which form the basis of a population's perception of the degree of pollution, represent a key concept (Kelly & Vlaenderen, 1995) and effective participatory tool for local-level debates. Undoubtedly, the questionnaire and interview survey we conducted validated the reality of the pollution generated by the TTPP.

As mentioned in the literature (Chatzimouratidis & Pilavachi, 2008), people affected by the operation of power plants due to pollution should be compensated. The compensation process is part of the socio-environmental liabilities (Cardoso, 2015) that we evaluated using field surveys to highlight the pollution that affects residents' health. Although the amount of compensation was based on specific agreements and protocols, in our case, the residents were compensated only once in a small proportion (24% of the respondents), and the majority were never. The compensation rate refers to the funds provided to restore the environment and compensate for the negative effects of power plant operation. The calculation of compensation rates is based on the external costs specified by market rules, international agreements, and protocols. In this case, pollution was part of an externality process (Chatzimouratidis & Pilavachi, 2008). This is a concept in which a first actor, in the present case the TTPP, has a negative effect through the pollution process on the health and well-being of another actor, in the present case the residents of Brăneşti, Cursaru Ilişeşti, Ioneşti and Turceni. Thus, the first actor fails to satisfactorily reward the other actor. Only through full compensation will environmental pollution no longer be an externality (Bertel & Fraser, 2002). Although one could invoke the precautionary principles and "polluter pays," (Sahu, 2010) the financial compensation offered by the TTPP may lead to some social conflicts, given the small number of people compensated.

Almost half the respondents mentioned that local authorities have a low or very low degree of involvement in pollution reduction. In the same context, the interviews highlighted that information regarding the methods for eliminating and mitigating pollution was deficient. The respondents' answers were likely influenced by their lack of information regarding the values of the measured parameters, particularly the maximum allowed values. Normally, there are public information sessions for residents and hearings as part of the information process (Jae-hyuck et al., 2022) that would allow decisions to be made based on the residents' opinions (O'Faircheallaigh, 2010). Public participation is essential as long as it is not formal and is still considered. However, the impossibility of recording continuous values by the GJ-3 station due to technical failures directly results in an increase in the distrust of the local population by the local authorities. The only sources of information on the pollution generated by the TTPP were articles from the local press and non-governmental organisations, such as the Bankwatch Association, which stimulated the attention of the local community, as in other cases (Nakayama & Fujikura, 2001). News and reports from mass media and statements by certain NGOs strongly influence public opinion because of their broad exposure and large audience (Nakayama & Fujikura, 2001). In this way, the press becomes an authorised source and newspaper actor in the significant debate process (Rizzoli et al., 2024).

An immediate effect of pollution is represented by a change in residence, in which more than half of the respondents surveyed were involved. This process is similar to those in other cases. For example, the pollution generated by a thermal power plant in northeastern Italy is responsible for increasing the incidence of lung and bladder cancers in people who live near it (Collarile et al., 2017), and a small community in Sri Lanka had to be relocated because of the construction of a thermal power plant nearby

(Jayasinghe, 2024). In our case, the change of residence was identified following field surveys, considering the overlap of the area with the highest frequency of ash pollution over the residence of the respondents from Turceni and Ionești localities, especially.

Considering the above, the OEC Restructuring and Decarbonization Plan (2023) has become of great interest for a clean environment and Romania's energy transition. It was approved by the European Commission through Decision C (2022) 553 (final of 26.01.2022) and included in the country's energy strategy for 2020–2030. By 2030, Romania has proposed to reduce emissions by almost 40% compared to 2005 levels. These objectives will be translated into policies and government decisions at the central level, as is the case with the OEC restructuring plan, which proposes the construction of three photovoltaic parks by 2025, with panels to be located on the closed ash deposits of the TTPP, and an energy block to be built based on natural gas in Turceni.

5. CONCLUSIONS

In our study, we focused on pollution problems arising from the generation of oxides of NO, NO_2, CO, SO_2, PM, and landfill ash by the TTPP, which affect people's way of life and health. Our approach had two directions; the identification of communities vulnerable to pollution, and the development of a comprehensive methodological framework. This is represented by the processing of the pollutant values and the ash scattering directions driven by the prevailing winds, and our research was validated using the generic triangulation method, represented by survey questionnaires, interviews, mass media analysis, and dichotomous scales and trichotomics that validated the reality in the field. These are valuable tools used to address the problems faced by the inhabitants of the area, such as pollution reports to the authorities, the degree of authorities' involvement in solving pollution problems, the need for financial compensation, and the tendency of residents to change their residences. We believe that our study can present a new understanding of the relationship between humans and the environment in which they live and work, and of their conscious integration in the participatory and decision-making process. In the same context, this study can be beneficial for considering environmental factors and developing environmental policies.

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