

Effects of Cement Production on the Environment and Human Health at Sekandji, Benin

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Abstract

Cement is made by grinding several raw materials. The cement industry contributes to the development of any society. Benin has four cement companies, including Sèkandji. Exposure to cement dust can cause a number of ailments. Cement production also contributes to the emission of greenhouse gases (GHGs), which contribute to global warming. The study aims to assess the effects of cement dust on the environment and on the health of the population of Sekandji. This was a cross-sectional study with descriptive and quantitative aims, conducted from May 21 to June 23, 2024. Data were collected using an interview guide from people living in the vicinity of the cement plant, who gave their informed consent to participate in the study. An observation grid was used to assess the environment. Particulate matter was sampled in the immediate vicinity of the cement plant using an AM-4812 anemometer and an air quality monitor. Sampling was non-probabilistic and purposive. Targets were selected for reliability and accuracy of data collection. Data collection was carried out using Kobo Collect software for data collected with the interview guide. Excel 2013 was used for data analysis, tables and graphs, and Microsoft Word 2013 for data entry. A total of 105 residents were selected in the vicinity of the cement plant. The average age of respondents was 35, with a minimum of 20 and a maximum of 50. The dominant age group was between 30 and 39. Males (70) dominated, with a sex ratio equal to 2. The vast majority of respondents (92.38%) said they had noticed or heard about an increase in health problems since the cement plant was set up.

However, 70.48% of respondents claimed to have no information on the effects of cement production on the environment. Few respondents (29.52%) were aware of the effects of cement production on the environment. Respiratory, dermatological and ocular disorders were cited as being linked to cement. PM_{2.5} and PM₁₀ particles were present in very high proportions in the air. The implementation of a serious industrialization policy that takes urbanization into account will guarantee the health safety of the population.

Keywords

Effects, Cement Production, Environment, Health

1. Introduction

Cement is made by grinding several raw materials: clinker, gypsum, slag, pozzolans, etc. [1]-[3]. The cement industry contributes to the development of any society. Benin has four cement companies [4], including Sèkandji. Exposure to cement dust can cause a number of ailments (respiratory, cardiovascular, ocular, dermatological) [1] [3]-[6]. Cement production also contributes to the emission of greenhouse gases (GHGs), which contribute to global warming [4]. Sèkandji is a district in the Agblangandan arrondissement with a population of 57,762 according to the 2013 general population and housing census [7]. Sèkandji, on the outskirts of Cotonou (Benin's economic capital), is home to one of the country's largest cement plants. Cement and limestone are among the main extractive industries with limited industrial potential [8]. The cement plant was set up on April 30, 1976 and began operations on August 16, 1978 in Sèkandji, far from residential areas [9]. Observations of dust and the human presence around the Sèkandji cement plant have prompted the present study, which aims to assess the effects of cement dust on the environment and on the health of the local population.

2. Methods

This was a cross-sectional study with descriptive and quantitative aims, conducted from May 21 to June 23, 2024. Data were collected using an interview guide from people living in the vicinity of the cement plant, who gave their informed consent to participate in the study. An observation grid was used to assess the environment. Particulate matter was sampled in the immediate vicinity of the cement plant using an AM-4812 anemometer and an air quality monitor (see **Table 1**). Sampling was non-probabilistic and purposive. Targets were selected for reliability and accuracy of data collection. Data collection was carried out using Kobo Collect software for data collected with the interview guide. Excel 2013 was used for data analysis, tables and graphs, and Microsoft Word 2013 for data entry.

3. Results

A total of 105 residents were selected in the vicinity of the cement plant.

Table 1. Air quality in the vicinity of the CIMBENIN Sèkandji cement plant in 2024.

Geographics coordinates	Site	Current activity	Hour	T °C	H: %	Concentration of particles $\mu\text{g}/\text{m}^3$			TVOC mg/m^3	HCHO mg/m^3	V/air: m/s		Polluting gases ppm	Observations
						PM1.0	PM2.5	PM10			MIN	MAX	CO ₂	
6°22'14"N 2°30'22"E	In front of the gate 1 of the cement factory	No activity	09:54	31	77	53	223	272	0.008	0.004	0.4	1.3	410	Nothing to report
6°22'14"N 2°30'19"E	In front of the gate 2 of the cement factory	No activity	10:02	33	70	69	265	312	0.006	0.002	0.7	1.3	412	Motorcycle passage
6°22'14"N 2°30'16"E	Entre la sous station et la cimenterie	No activity	10:13	30	79	78	295	349	0.009	0.004	1	1.2	408	restaurant nearby
6°22'14"N 2°30'12"E	In front of the gate 4 of the cement factory	No activity	10:19	30	75	52	219	267	0.009	0.004	2.4	3.2	413	Motorcycle passage
6°22'14"N 2°30'25"E	In front of the pharmacy les chérubins	No activity	10:32	33	66	40	183	223	0.009	0.004	1.7	3.4	412	Vehicles and motorcycles traffic; motorcycle cab parking and shoplifting nearby
6°22'17"N 2°30'25"E	In front of the clinic espérance	No activity	10:41	33	68	58	241	309	0.009	0.004	0.7	1.2	570	Vehicles and motorcycles traffic
6°22'19"N 2°30'23"E	In front of the private school Don de Dieu LASSISSI	No activity	10:46	32	73	41	191	238	0.007	0.002	0.7	1.4	409	Nothing to report
6°22'23"N 2°30'18"E	Behind the cement factory	No activity	10:50	33	69	41	188	235	0.009	0.004	0.6	0.9	413	Nothing to report
6°22'18"N 2°30'08"E	West side of the cement plant	No activity	11:12	31	72	37	174	219	0.006	0.003	0.9	1.5	409	Nothing to report
6°22'13"N 2°30'02"E	New traffic circle of Agblangandan	No activity	11:22	32	86	3	16	21	0.005	0.004	1.4	2.1	403	Vehicles and motorcycles traffic

Source: Data measured in the field, June 23, 2024.

Socio-demographic characteristics of respondents

The average age of respondents was 35, with a minimum of 20 and a maximum of 50. The dominant age group was between 30 and 39. Males (70) dominated, with a sex ratio equal to 2. The majority of respondents (54.34%) had never been to school, but nearly half were artisans.

Sèkandji respondents' knowledge of the effects of cement production on the environment and people's health.

The vast majority of respondents (92.38%) said they had noticed or heard about

an increase in health problems since the cement plant was set up. However, 70.48% of respondents claimed to have no information on the effects of cement production on the environment. Nevertheless, 98.1% of respondents claimed to have information on the effects of cement production on human health. In addition, 63.81% of respondents claimed to have relatives affected by health problems linked to cement production.

Distribution of respondents according to their knowledge of the dominant diseases in Sèkandji in 2024 (see Figure 1).

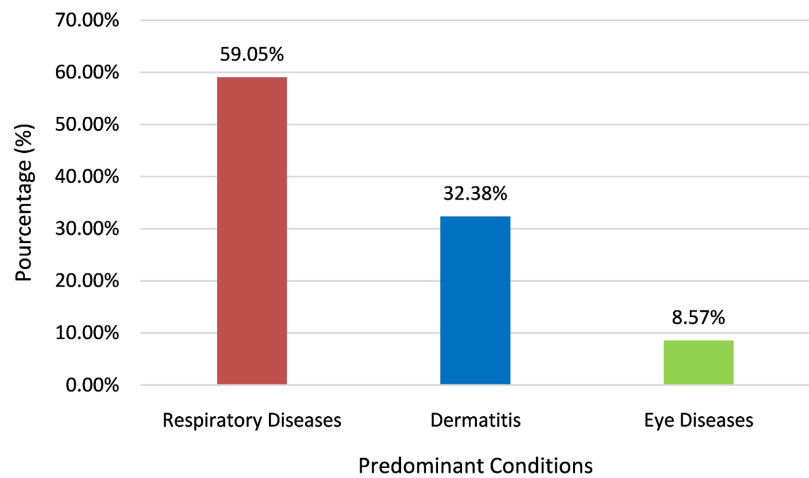


Figure 1. Distribution of respondents according to their knowledge of the predominant diseases in Sèkandji in 2024.

Knowledge and adoption of preventive measures against cement production-related risks by residents surveyed in Sèkandji in 2024.

Few respondents (29.52%) were aware of the effects of cement production on the environment. On the other hand, the majority of respondents (98.1%) were aware of the health effects of cement production. The observation of the presence of dust in the atmosphere, since the installation of the cement plant in Sèkandji, had been affirmed by 96.19% of the subjects surveyed. What's more, 100% of respondents feared developing respiratory illnesses, dermatitis and even eye diseases due to exposure to pollutants from cement manufacturing. Most of the subjects surveyed (38.10%) did not protect themselves. However, some adopted various protective measures, such as wearing protective masks (16.19%), closing doors and windows at all times (30.48%), drinking peak milk (12.38%) at times, and self-medicating (2.86%).

Environment around the CIMBENIN cement plant in Sèkandji.

Numerous dwellings with people living in them had been noticed in the vicinity of the cement plant. In addition, a kindergarten and elementary school had been seen just behind the cement plant, as well as a number of outlets selling goods of all kinds in the vicinity of the plant (see Figure 2).

The surfaces were also covered with a heavy deposit of cement dust, visible to the naked eye and kicking up as vehicles passed by. Items for sale were covered in

cement dust, as were the roofs of the houses. Finally, during the entire observation period, no one was observed using personal protective equipment against the dust (see **Figure 3-5**).



Figure 2. Kindergarten and primary school located behind the cement plant.



Figure 3. Car protected against cement dust.



Figure 4. Cement dust raised by a passing truck on a street in Sèkandji.



Figure 5. Cement dust deposited on a crosswalk outside the cement plant.

4. Data Analysis

- **Temperature and humidity:** Measured temperatures ranged from 30°C to 33°C, and relative humidity from 66% to 86%. These values were typical of a tropical climate.
- **Particulate matter (PM_{2.5} and PM₁₀):** Concentrations measured were very high at almost all sampling points, far exceeding WHO standards. These high levels were a cause for concern, as fine particles can penetrate deep into the lungs and cardiovascular system, causing a variety of health problems.
- **TVOC:** TVOC levels measured were relatively low, but should be monitored as an increase could indicate dangerous chemical pollution.
- **HCHO (formaldehyde):** Formaldehyde levels were below the WHO recommended limit (0.1 mg/m³), so no immediate danger was observed.
- **CO₂:** CO₂ levels were generally within the normal range for outdoor air, with one notable exception in front of the Esperancia clinic, where the level reached 570 ppm, possibly indicating a temporary build-up of CO.
- **Air speed:** Air speed varied from 0.4 m/s to 3.4 m/s, which was fairly typical for an urban area, with local variations due to buildings and vegetation.

5. Discussion

Analysis of the results shows that many people lived close to the cement plant in Sèkandji. In addition, many structures in the vicinity were exposed to cement dust. This dust was more pronounced when vehicles were passing by, as there were numerous points of commerce in the vicinity of the cement plant.

The environment in the vicinity of the cement plant contained a number of particles, notably fine particles PM_{2.5} and PM₁₀, and gases, including CO₂ in places, indicating an accumulation of gases. The concentration of these particles was high in the vicinity of the cement plant, but more pronounced between the substation and the plant. However, further on, at the new Agblangandan traffic circle, the concentration of these particles was lower, within WHO standards (25 µg/m³ 24-hour average; 50 µg/m³ 24-hour average) [10]. Finally, during the entire

observation period, no one was observed using protective equipment against air pollution.

The subjects surveyed (86.67%) claimed to be greatly disturbed by dust from cement production. On the other hand, 70.48% of respondents had no information on the effects of cement production on the environment, while 98.1% had information on the effects of cement production on human health. Cement production causes the emission of greenhouse gases (GHGs), the main GHGs being carbon dioxide (CO₂), methane (CH₄) and nitrous oxide (N₂O) [2]. In addition, 63.81% of respondents said they had relatives affected by health problems linked to cement production. Residents of the production zone were most affected by respiratory infections (90.47%). Coughing, sneezing and nose-blowing are the only mechanisms by which particles are actually eliminated. Other clearance mechanisms lead to particles being redirected to the digestive system, the lymphatic system or the pulmonary vascular network [11]. Exposure to cement dust has been reported to increase the risk of respiratory manifestations [1] [4]-[6] [12] [13]. The pulmonary manifestations of cement exposure can be serious lung pathologies [14]. The subjects surveyed adopted various protective measures such as: wearing protective masks (16.19) closing doors and windows at all times (30.48%). These protective measures should be encouraged and reinforced, as it has been reported by Tedjar L. that cement pollution constitutes a potential danger for local residents [3]. This result runs counter to a study of cement transporters in the Haut-Katanga province of the Democratic Republic of Congo, which found that these transporters do not use protective equipment [15].

Indeed, air quality analyses had shown a high concentration of fine particles PM_{2.5} and PM₁₀ in the air around the cement plant, and these particles were well known for their toxicity [16]. It was reported by Tedjar that the cement extraction and transformation process results in the formation of dust, which is a mixture of limestone, calcium oxide, minerals and partly fired cement [3]. CO₂ values measured in the Sèkandji environment during the study period were within norms. However, it should be noted that CO₂ is a GHG [2], which contributes to global warming in the Sèkandji district.

Concentrations of particulate matter (PM_{2.5} and PM₁₀) were very high at almost all sampling points, far exceeding WHO standards of 25 µg/m³ (24 h) and 50 µg/m³ (24 h) respectively. These particles are known for their toxicity. PM_{1.0}, PM_{2.5} and PM₁₀ affect the central nervous system and reproduction, and cause or aggravate cardiovascular and pulmonary diseases, heart attacks, cancer and premature death. As for their effects on the environment, these particles affect ecosystems, animals and plant growth [16]. This explains the high percentage of respiratory infections reported among people living in the vicinity of the cement production zone at Sèkandji. These results raise the issue of population settlement around industries in general, and cement production in particular. Developing countries must adopt industrialization and urbanization plans that prevent the settlement of populations around industries.

6. Conclusion

This study explored the impact of cement production on the environment and on the health of the population living in the vicinity of the Sèkandji cement plant. Respiratory infections were the most prevalent ailment in the area where the cement plant was located, with a prevalence of 59.05%. The fine particles PM_{2.5} and PM₁₀ present in the vicinity of the manufacturing plant are significant in the environment and could explain the health problems mentioned by the respondents. The implementation of a serious industrialization policy that takes urbanization into account will guarantee the health safety of the population.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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