

A Bibliometric Analysis of research trends in Air Pollution and Environmental Inequalities in Niger

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Abstract

Air pollution is a major public health and sustainability challenge in Africa, where rapid urbanization, population growth, and the diversity of emission sources are contributing to increased exposure among populations. However, scientific knowledge remains unevenly distributed, and the social and spatial dimensions of environmental inequalities have yet to be sufficiently studied. This study aims to analyze the dynamics and structure of scientific research on air pollution, environmental exposure, and environmental inequalities in urban settings, with a particular focus on Niger. A bibliometric analysis was conducted using 1,304 documents extracted from the Dimensions database covering the period from 2000 to 2025. The analysis was conducted using R and the Bibliometrix package. The results show an overall increase in scientific output, marked by peaks in 2008 and 2020. The publications consist of scientific articles, and the collaboration network appears to be fairly fragmented. An analysis of disciplines reveals significant contributions from environmental sciences, public health, epidemiology, and the social sciences.

Keywords: Air pollution, environmental exposure, environmental inequalities, urban environment, Niger, Dimensions.

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I. Introduction

Today, urban air pollution is a major public health issue because of its varying effects on populations depending on where they live, their socioeconomic status, and their ability to adapt (WHO, 2016; Landrigan et al., 2018). Considered one of the great environmental scourges of our time, it affects climate stability, public health, and individual well-being, contributing to increased morbidity and mortality (Ioannis, 2020). Beyond its health consequences, air pollution also raises significant social, economic, and environmental issues, particularly in urban areas where human activities, infrastructure, and emission sources are concentrated.

This issue is of particular concern in cities in developing countries, where rapid urbanization, increased traffic, economic activities, waste burning, and the use of polluting fuels can heighten people's exposure. However, disparities in exposure are not solely linked to pollution levels. They can also depend on residential location, socioeconomic conditions, and people's ability to protect themselves from environmental hazards. Thus, air pollution is also an issue of environmental inequality and environmental justice, as the most vulnerable populations may face both high exposure and limited adaptive capacity (Bullard, 1993; Schlosberg, 2007; WHO, 2021).

In fact, in West Africa and particularly in the Sahel particulate matter concentrations are influenced by anthropogenic emissions and Saharan dust. In Niamey, early studies have already highlighted the significance of this air pollution (Ozer, 2005). It was estimated based on visibility data recorded at Niamey Airport, which showed high concentrations of PM10 and total suspended particulates. A few years later, Barhadje et al. (2024) characterized air pollution based on measurements taken in five areas of the city and observed average PM2.5 concentrations ranging from 75.34 to 162.34 $\mu\text{g}/\text{m}^3$, with variations among the municipalities.

Despite these studies, research on Niger and particularly on Niamey remains scattered across topics such as the characterization of air pollutants, spatiotemporal dynamics, emission sources, seasonal variations, and monitoring methods. While these studies provide a better understanding of certain aspects of air pollution, they do not adequately account for the relationship between pollution levels, population exposure, socio-spatial characteristics, and environmental inequalities. It is therefore important to align scientific research on Niamey and Niger with international, African, and Sahelian trends.

This study therefore aims to provide an overview of the current state of scientific knowledge regarding

the interactions between urban air pollution and environmental inequalities. More specifically, it seeks to: (i) analyze the temporal and disciplinary evolution of scientific output from 2000 to 2025 on the relationships between air pollution, environmental exposure, and environmental inequalities in urban settings; ; (ii) identify the key actors, journals, institutions, and countries; (iii) analyze collaboration networks; and (iv) highlight gaps in the literature and future research directions.

II. Methodology

2.1 Database

The literature review relied exclusively on the Dimensions database. This database was chosen because of the breadth of its bibliographic coverage and the information it provides on publications, authors, affiliations, citations, and publication sources. In summary, the literature review covered the period from 2000 to 2025. The data were exported in CSV format based on three complementary search strategies focusing on air pollution, environmental exposure and the urban context, and environmental inequalities.

2.2 Literature Review Strategy

The literature review was conducted using combinations of keywords in accordance with the fundamental scope of the study. The keywords are air pollution, environmental exposure, and environmental inequalities, with a particular focus on the urban context and Niger. Three search queries were formulated to broaden the scope of the literature review. The search queries are as follows:

Q1 = Air pollution AND Environmental exposure AND Urban
Q2 = Air pollution AND Environmental inequalities

Q3 = Air pollution AND Environmental inequalities AND Niger

The final query is $Q = Q1 + Q2 + Q3$.

Using the final query, 1,304 documents were retrieved.

2.3 Data Extraction and Cleaning

After harmonizing the files and removing 147 duplicates based on the unique publication identifier, the final corpus comprises 1,157 unique publications. The data also underwent a consistency check covering publication years, authors, affiliations, publication sources, citations, and bibliographic information.

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2.5 Bibliometric Analysis

The bibliometric analysis was conducted using the Bibliometrix package in R, which allows for a quantitative examination of scientific output and the mapping of structures and relationships within a research field (Aria et al., 2017). It drew on two main complementary approaches: performance analysis and scientific mapping (Donthu et al., 2021). Specifically, the performance analysis focused on annual trends in publications, the most productive authors and journals, the most cited publications, and the contributions of countries and institutions. Scientific mapping enabled the analysis of collaboration networks among authors, institutions,

and countries, as well as the relationships between key terms and research themes. In particular, co-occurrence analyses of key terms were used to identify the main thematic clusters and their evolution over the period 2000-2025. The figure above illustrates the step-by-step process of this research.

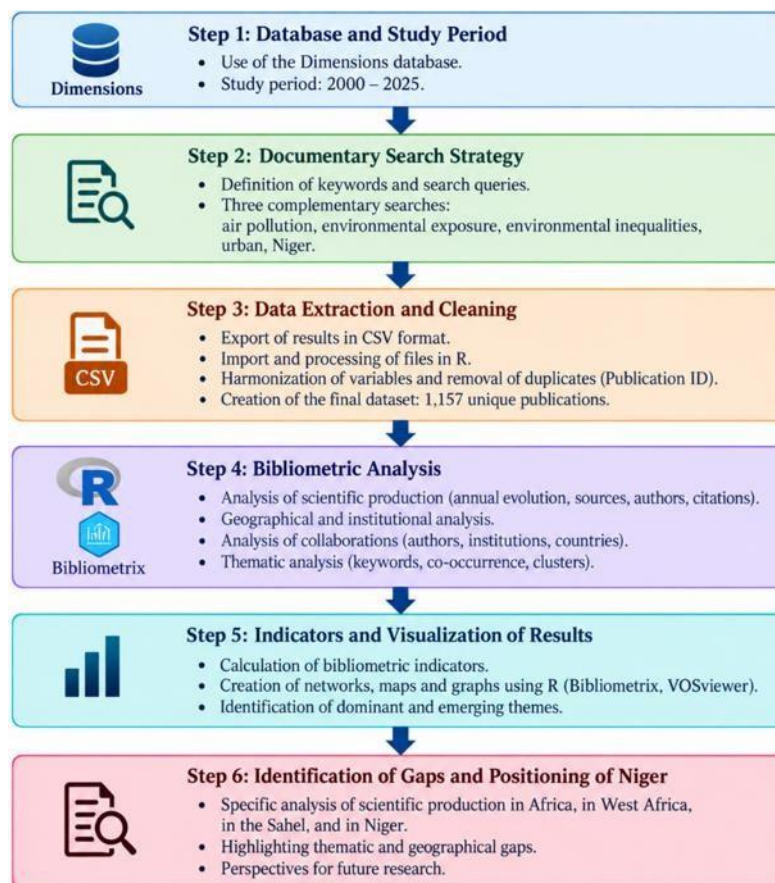


Figure 1: Research Methodology

III. Results

3.1 Annual Trends in the Number of Publications

Figure 1 shows the annual trends in the number of scientific publications on air pollution and environmental inequalities in urban areas from 2000 to 2025. These trends are characterized by significant year-to-year fluctuations. Between 2000 and 2004, the number of publications rose from 12 to 51, before stabilizing at around 33–34 publications between 2005 and 2007. In fact, an initial peak was recorded in 2008 with 120 publications, followed by a decline in 2009 (36 publications). Starting in 2010, output followed an upward trend, reaching 74 publications in 2016. The highest level was observed in 2020, with 123 publications. After this peak, a significant decline was recorded in 2021 and continued through 2023. In that year, only 28 publications were recorded. A recovery was then observed in 2024 and 2025, with 40 and 44 publications, respectively. This trend reflects a growing scientific interest in the topic particularly pronounced during 2008 and around 2020 but the publication output remains irregular.

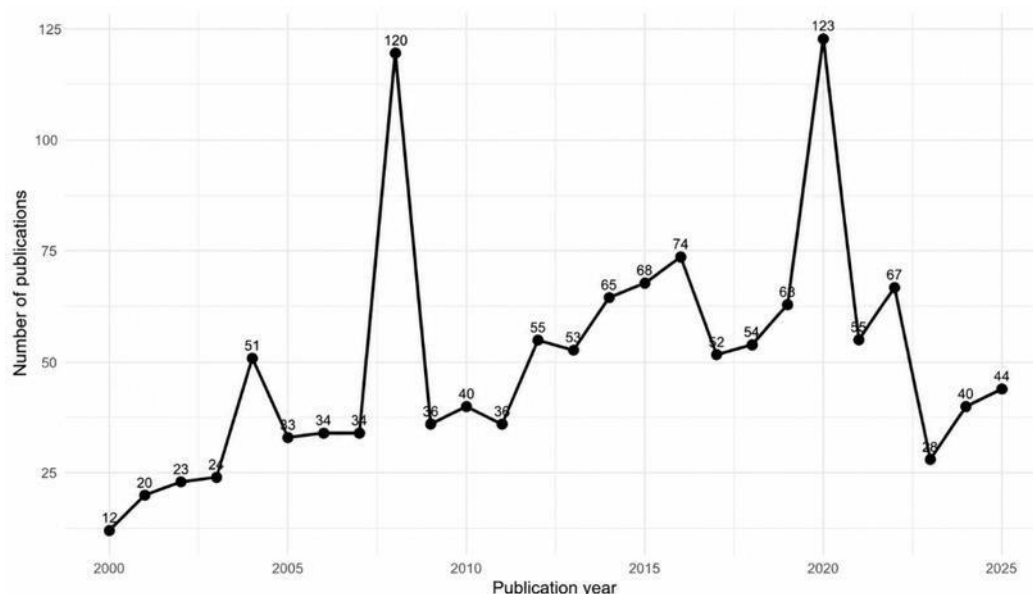


Figure 2: Annual trend in the number of publications

3.2 Types of Publications

Figure 3 shows the distribution of scientific publications by type across the entire analyzed corpus. It reveals a predominance of scientific articles, which constitute the main type of document with approximately 605 publications. Book chapters rank second, with approximately 320 publications, followed by edited volumes with 225 publications. Monographs account for approximately 145 publications, while preprints remain relatively rare, with only a few documents.

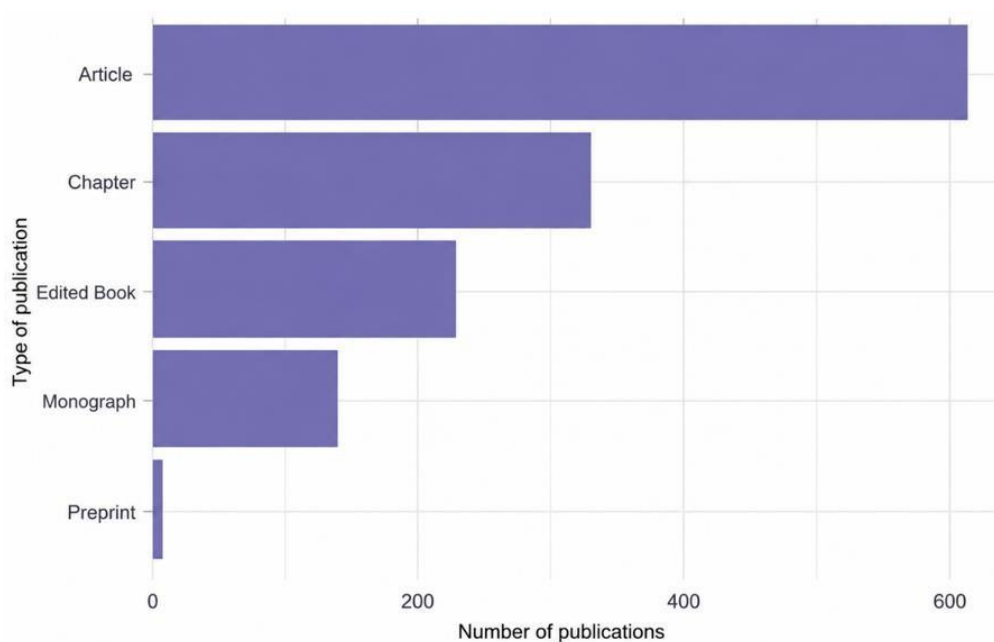


Figure 3: Publication Type

3.3 Main Authors and Contributing Organizations

Figure 4 shows the distribution of the number of publications by the main authors or contributing organizations in the analyzed corpus. It reveals a very high concentration of output among a few actors. The OECD dominates the corpus with approximately 280 publications, followed by the UNDP with 10 publications. Other contributors include the WTO, the United Nations, UNICEF, and several individual researchers, each with a small number of publications ranging from 3 to 6. This distribution reflects the significant influence of international organizations in the corpus studied, while the contribution of individual authors appears more scattered.

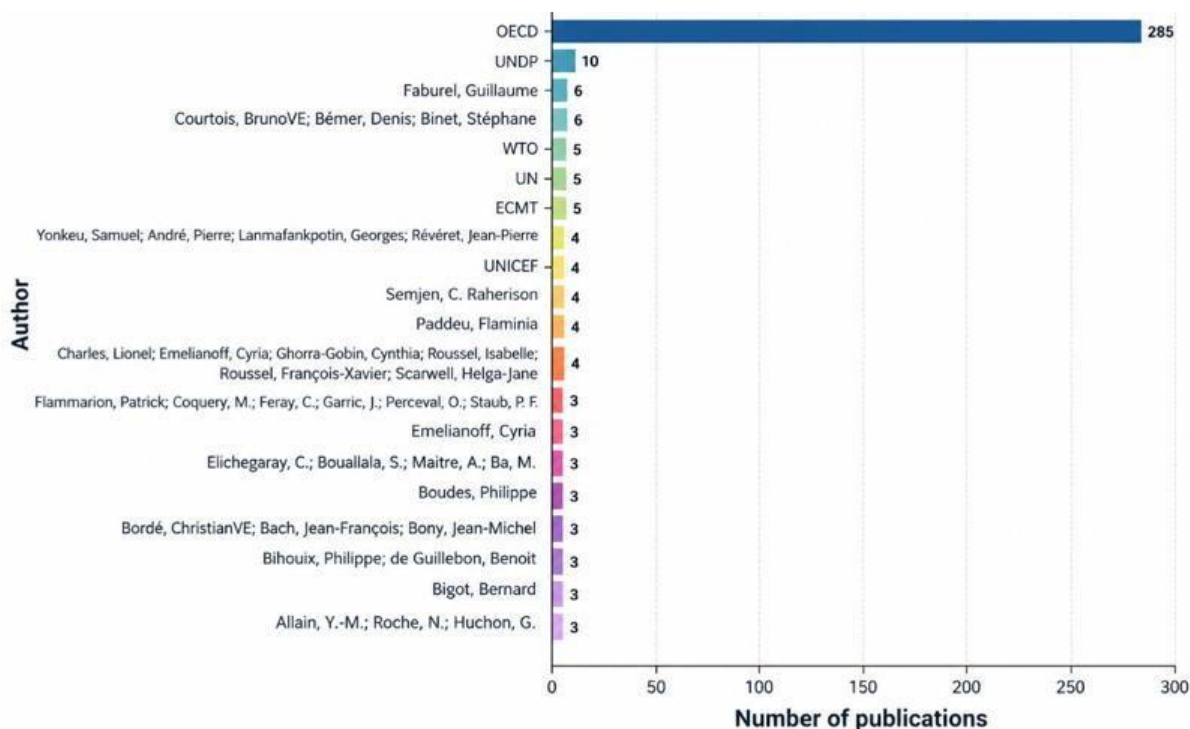


Figure 4: Key Authors and Contributing Organizations

3.4 Collaboration Networks of the Most Productive Authors

Figure 5 shows the collaboration network of the 50 most productive authors in the corpus. The size of the nodes represents the number of publications, and the thickness of the links indicates the strength of collaboration between authors. The network is fragmented, with several small groups of researchers collaborating with one another and a significant number of isolated authors. In fact, the group consisting of Patrick Flammarion, M. Coaquery, C. Feray, and J. Garric forms a relatively dense network with several cross-links. Another significant group comprising Bruno VE Courtois, Stéphane Binet, Denis Bémer, Emlenianoff, Cyria, Isabelle Roussel, and Lionel Charles also exhibit several collaborative links. Other smaller clusters are visible, notably Bordé, Christian VE; Bach, Jean-François; Bony, Jean-Michel; as well as Pairon, J.C.; Charpin; and Caillaud. These groups reveal the existence of a network of researchers who work together. However, several contributors notably UNDP, WTO, UN, UNICEF, and certain individual authors appear isolated or with few connections. This suggests that their presence in the corpus does not necessarily translate into strong integration into co-publication networks.

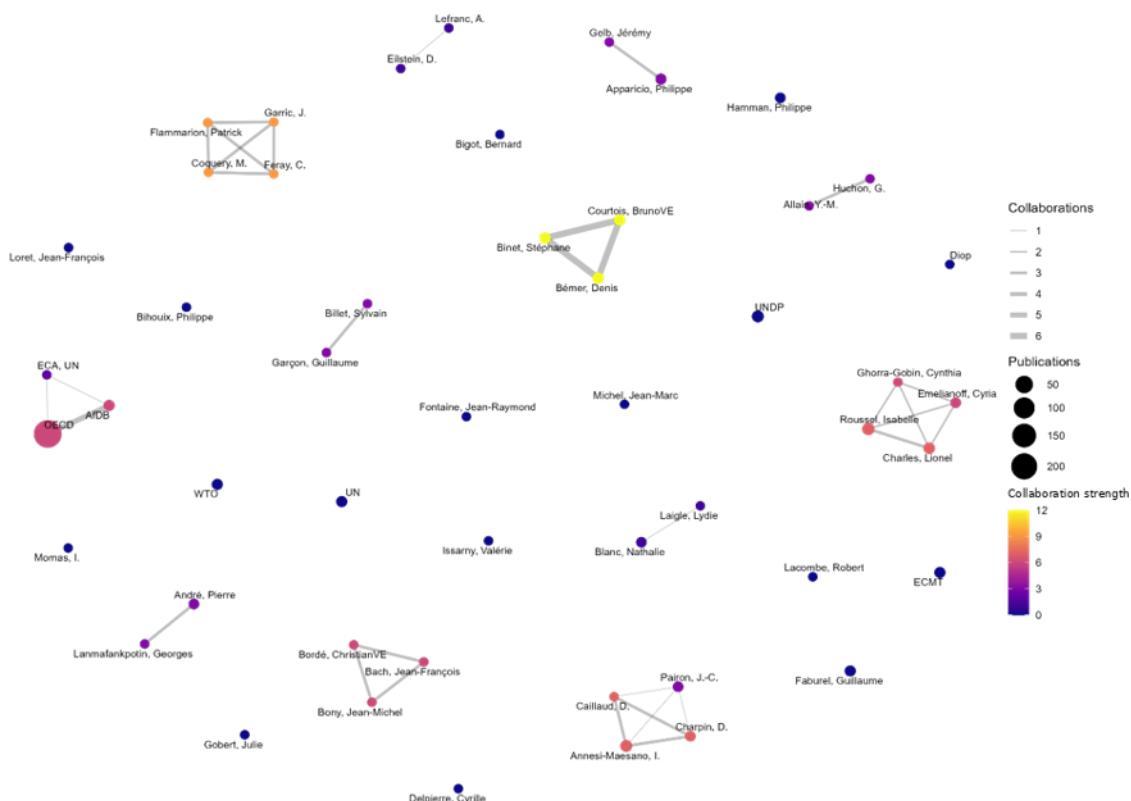


Figure 5: Key Authors and Contributing Organizations

3.5 Main Research Areas

Figure 6 presents the main research areas of the analyzed corpus. The results show a predominance of fields combining environmental sciences and the humanities (30 publications), followed by linguistics (19), public health services and systems, and pollution and contamination (26). Epidemiology and public health account for 12 and 11 publications, respectively. This disciplinary diversity is consistent with the issue of air pollution and environmental inequalities in urban areas, which requires an interdisciplinary approach that integrates environmental, health, and socio-spatial dimensions.

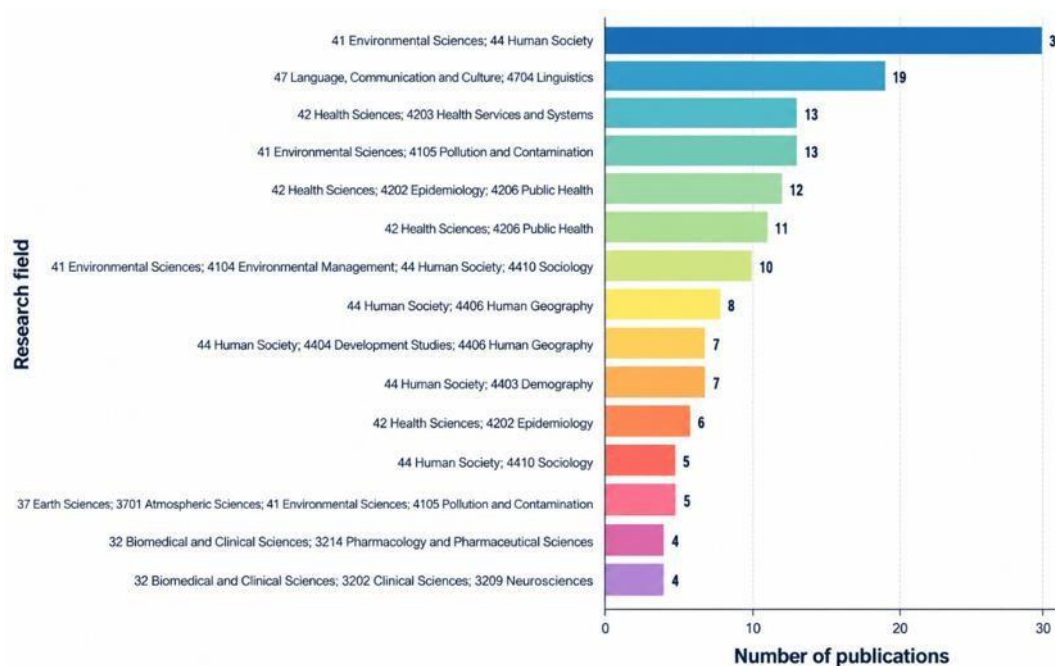


Figure 6: Main Areas of Research

3.6 Top 20 Most Productive Authors

Figure 7 shows the 20 most productive authors and organizations in the corpus. The OECD stands out clearly with nearly 240 publications, followed by Isabelle Roussel with approximately 9 publications. The UNDP and I. Annesi-Maesano each have 7 publications, while several other authors have between 3 and 6 publications. This wide disparity reflects a significant concentration of scholarly output among a few contributors particularly institutional ones while the contributions of others remain more scatter.

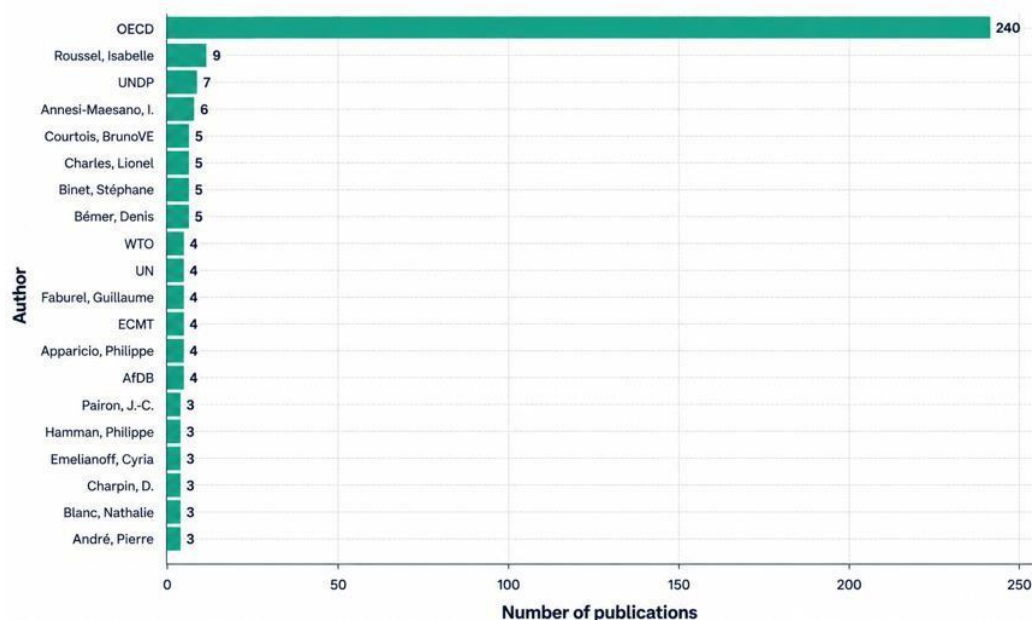


Figure 7: Top 20 Authors

3.7 Distribution of Publications by SDG

Figure 8 shows the distribution of publications by Sustainable Development Goals (SDGs). SDG 3 (Good Health and Well-being) is the primary goal associated with the publications, with 45 documents, followed by SDG 11 (Sustainable Cities and Communities) with 25 publications. SDGs 13 (Climate Action) and 15 (Life on Land) each have 7. This distribution shows that the research lies at the intersection of public health, the urban environment, and environmental inequalities.

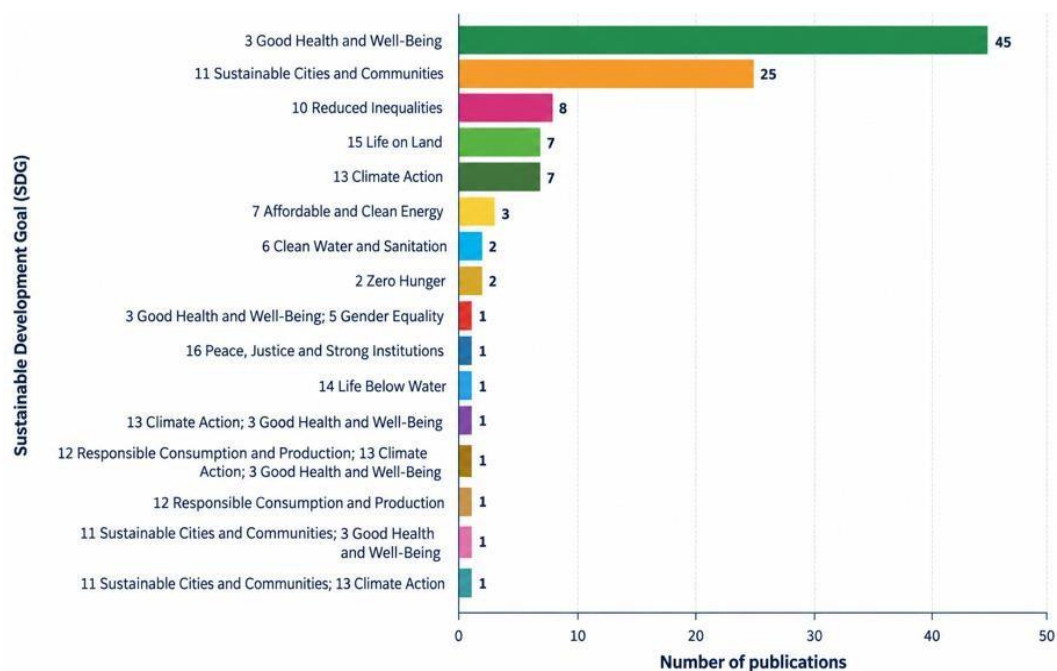


Figure 8 : Breakdown of Publications by SDG

IV. Discussion

4.1 Trends and Dynamics of Scientific Output

Scientific output on air pollution in Africa shows an overall upward trend between 2000 and 2025, despite year-to-year fluctuations. Two peaks stand out between 2008 and 2020. The first is attributable, on the one hand, to the intensification of research on urban air pollution in West Africa, notably through the POLCA2 program, launched in 2007, which enabled measurement campaigns in Dakar and Bamako beginning in 2008 (Adon et al., 2016) and, on the other hand, by the fact that it was during this period that air pollution came to be viewed as a health issue rather than an environmental one. The second peak observed can be explained by the fact that it coincided with the COVID-19 pandemic, which significantly stimulated research on the relationships between lockdowns, reduced human activities, and air quality. In South Africa, for example, the year 2020 accounted for 27% of scientific output on air quality monitoring and management (Matandirotya, 2021).

4.2 Type of Output During the Period Under Review

The scientific output analyzed is largely dominated by scientific articles, while book chapters, books, and monographs play a secondary role. This predominance reflects a gradual shift in the structure of air pollution research in Africa toward specialized scientific work, particularly in the fields of the environment and health. The notable presence of international organizations among the main contributors further underscores the role of these institutions in the production and dissemination of knowledge on air quality and its health and urban implications (Amegah et al., 2019).

4.3 Main Research Focus

The distribution of publications across research fields highlights the highly interdisciplinary nature of scientific output on air pollution in Africa. Environmental sciences play a significant role alongside public health, epidemiology, sociology, human geography, and demography. This disciplinary diversity shows that air pollution is increasingly being addressed as a phenomenon that goes beyond simply measuring pollutant concentrations, by incorporating its social and spatial consequences. This trend is consistent with the work of Malmqvist et al. (2021), who emphasize the need for an integrated approach to air quality in Africa, taking into account the interactions between the environment, urbanization, health, and socioeconomic conditions.

4.4 Research Directions and Consideration of Environmental Inequalities

The distribution of the SDGs shows a strong predominance of SDG 3 (Good Health and Well-being) with 45 publications and SDG 11 (Sustainable Cities and Communities) with 25 publications, reflecting the importance placed on the health effects of pollution and urban sustainability issues. This trend is consistent with the work of Fisher et al. (2021), who highlight the consequences of air pollution on health and human capital. In contrast, SDG 10 (Reduced Inequalities) accounts for only 8 publications, indicating limited attention to the social and spatial dimensions of exposure. This trend is particularly concerning in African cities, where populations are not uniformly exposed to environmental risks. Katoto et al. (2019) notably highlight significant gaps in knowledge regarding the effects of air pollution on African populations. In fact, these findings underscore the need to strengthen research on environmental inequalities, especially in Sahelian cities such as Niamey.

4.4 Contributions of the Niamey Study and Future Directions

The results of the bibliometric analysis highlight that African literature focuses primarily on the health effects of air pollution and urban issues, while the field of environmental inequalities remains largely unexplored. In this context, the choice of Niamey as the study area makes a significant contribution by linking the environmental, spatial, and social dimensions of air pollution. The joint analysis of key pollutants and determining factors—such as population density, vegetation, surface temperature, precipitation, and waste—thus enables an understanding of the spatial variability of exposure. This approach helps to better understand environmental disparities in a Sahelian city that remains under-documented and opens up avenues for further research across major cities in the Sahel.

V. Conclusion

This bibliometric study has characterized the dynamics and main trends in research on air pollution, urban issues, and environmental inequalities in Africa between 2000 and 2025. The results show an overall increase in scientific output, with a particularly marked surge around 2008 and 2020. The corpus consists mainly of scientific articles and reflects significant involvement by international organizations, while collaborative networks remain relatively fragmented.

In the context of Niamey, this study helps to partially fill this gap by combining an analysis of air pollution with the city's environmental and socio-spatial characteristics. It thus highlights the value of

interdisciplinary approaches that make it possible to better identify the most exposed populations and areas. Indeed, strengthening monitoring systems, regional scientific networks, and comparative studies among Sahelian cities appears necessary to improve understanding of exposure inequalities and support air quality management policies.

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