We are IntechOpen, the world's leading publisher of Open Access books Built by scientists, for scientists

6,300

Open access books available

172,000

International authors and editors

190M

Downloads

Our authors are among the

154

Countries delivered to

TOP 1%

most cited scientists

12.2%

Contributors from top 500 universities

WEB OF SCIENCE™

Selection of our books indexed in the Book Citation Index
in Web of Science™ Core Collection (BKCI)

Interested in publishing with us?
Contact book.department@intechopen.com

Numbers displayed above are based on latest data collected.
For more information visit www.intechopen.com

Air Quality and Health in Ethiopia

Tadesse Weyuma Bulto and Birhanu Chalchisa Werku

Abstract

In Ethiopia, people who live in cities with rapid urbanization and high industrialization suffer greatly from air pollutants. These air pollutants, which include particulate matter, sulfur dioxide (SO₂), nitrogen oxide (NO_x), carbon monoxide (CO), and ozone (O₃), often exceed National Ambient Air Quality Standards. When we compared African regions, we found that the population of Eastern and Western Sub-Saharan Africa is greatly affected by air pollution, whereas the population of Southern and Central Sub-Saharan African provinces is less affected by air pollution, specifically through particulate matter. Air pollution is a major issue for both developing and developed countries. The main sources of air pollution in Ethiopia are open burning of refuse, vehicular emissions, and traditional practice. Among these, open burning causes the greatest air pollution in metropolitan cities like Addis Ababa. This chapter examines the effect of air pollution on human health in Ethiopia. In high concentrations, air pollutants can harm both human and ecosystem health. The effect of air pollution on human health includes irritation of the eyes, coughing and breathing difficulties, worsening of existing lung and heart problems, asthma, and increased risk of heart attack. Air quality and health human are directly related. As such, air quality management plans for developed and developing countries are needed to minimize air pollution and reduce risk to human health.

Keywords: air quality, health, air pollution, particulate matter

1. Introduction

Air pollution is the largest single environmental risk to health, responsible for an estimated seven million premature deaths globally every year. Air pollution is an important determinant of health [1]. Air pollution presents a global problem that undermines health and economic productivity. Data from the World Health Organization (WHO) shows that nine out of ten people breathe air containing high levels of pollutants, with low- and middle-income countries (LMICs) bearing the brunt of poor air quality [2]. Principally, open burning of refuse is a major source of high air pollution in metropolitan cities. This chapter identifies pollutant concentration of particulate matter (PM_{2.5}) emission. PM_{2.5} is harmful to people who are unusually sensitive to particulate pollution and have health problems [3]. In addition, vehicle-related particulate matter is a main source of air pollution in the urban environment [4].

Particulate matter contains both solid particles and liquid droplets found in the air's atmosphere. There are artificial (humanmade) and natural sources of air

Figure 1.
Effect of fine particulate matter on human health.

pollution. Sources of fine particles include motor vehicles, power plants, wood burning, and industrial processes. Sources of coarse particles include crushing and dust from paved or unpaved roads [5]. According to different studies, the main sources of primary fine particles are cars and trucks (diesel engines), open burning, wildfires, woodstoves, outdoor wood boilers, cooking, dust from roads and construction, agricultural operations, and coal and oil-burning boilers. The main sources of secondary fine particles are power plants and industrial processes such as oil refining and pulp and paper production.

Knowledge of the effects of air pollutants on human health is a prerequisite for the development of effective policies to reduce the adverse impact of ambient air pollution [6]. Due to the health effects of air pollutants, billions of people and animals die yearly. Fine particulate matter (PM_{2.5}) has been determined to be a serious worldwide air problem during the last several decades. People who live in cities with rapid urbanization and high industrialization suffer more from air pollutants than those individuals living in rural areas. In addition, particulate matter pollution contributes the most to global burden of disease in developing countries. Air pollution can lead to increased risk of lung cancer, heart disease, bronchitis, and other cardiorespiratory conditions (**Figure 1**) [7].

Air quality is a cause for concern in Ethiopia, particularly in cities, and air pollutants including particulate matter, sulfur dioxide (SO₂), nitrogen oxide (NO_x), carbon monoxide (CO), and ozone (O₃) often exceed the National Ambient Air Quality Standards (NAAQS). Daily records of raw concentration of air pollutant and air quality index data acquired at one-hour intervals can be found on the AirNow website of Addis Ababa’s central monitoring station.

2. Effect of air pollution on human and ecosystem health

Air pollution has both short- and long-term effects on human health. Some short-term effects include irritation of the eyes, nose, and throat, and coughing and breathing difficulties. Long-term effects of air pollution can cause cancer and damage to the immune, reproductive, and respiratory systems. In extreme cases, air pollution can even cause death.

A three-year study (2017–2021) of fine particulate pollution in Addis Ababa found that the daily mean (SD) PM_{2.5} concentration was 42.4 µg/m³ (15.98). A

total of 502 deaths (4.44%) were attributable to current air pollution levels referenced to the 35 $\mu\text{g}/\text{m}^3$ WHO interim target annual level and 2043 (17.7%) at the WHO 10 $\mu\text{g}/\text{m}^3$ annual guideline [8]. Another study aimed to identify the major sources of $\text{PM}_{2.5}$ in Ethiopia's capital city and found that 28% comes from vehicular sources, 18.3% comes from biomass burning, and 17.4% comes from soil dust, all of which comprise about two-thirds of total $\text{PM}_{2.5}$ mass, followed by sulfate at 17.4% [9].

Data from a study of particulate matter with aerodynamic diameter $< 10 \mu\text{m}$ (PM_{10}) in Addis Ababa show that maximum emission occurs around 7:00 am daily with secondary peaks in the late afternoon and evening. This suggests that PM_{10} is emitted during periods associated with motor-vehicle traffic, food preparation, and heating of homes. The morning concentration is likely accentuated by stable atmospheric conditions associated with overnight surface temperature inversions [10]. Air contamination influences the human health and environmental wellbeing of the ecosystem. Particulate matter is a series of issues from major air pollutants in the atmosphere [11].

When we compared African regions, we found that the population of Eastern and Western Sub-Saharan Africa is greatly affected by air pollution, whereas the population of the Southern and Central Sub-Saharan African provinces is less affected by air pollution, specifically through particulate matter. Priority should be given to air quality management to improve human and environmental health and reduce the global burden of disease of African provinces [11].

Health risk assessments of air pollution are being developed for a variety of policy scenarios, using different methodologies and spatial and temporal scales [12]. Air pollution is a serious health and environmental problem. Poor air quality has been linked to numerous diseases and is a significant public health issue related to urban planning [13]. Ethiopians face quality of life and livelihood challenges associated with sub-optimal sanitation, dependence on biomass energy, and decreasing agricultural productivity [14]. Detailed knowledge of the effects of air pollutants on human health is a prerequisite for the development of effective policies to reduce the adverse impact of ambient air pollution (Figure 2) [15].

Figure 2.
DPSIR diagram for particulate matter pollution.

3. Conclusion

This chapter discussed air pollution and its effects on human health in Addis Ababa, Ethiopia. It presented data from scientific studies showing the types and amounts of fine particulate matter pollution present in the African city. Air pollution is a transboundary problem that particularly affects vulnerable groups. Many Ethiopian cities face challenges to quality of life and livelihood associated with sub-optimal sanitation, dependency on biomass energy, and decreasing agricultural productivity. As such, the country, as well as other developing and developed countries worldwide, requires an air quality management plan to minimize pollution and mitigate its negative effects on humans and the environment.

A. African provinces exposed to air pollution, total avoided deaths, percent of baseline mortality, deaths per 100,000 population, economic benefits, and avoided life years lost.

S.N	Region and Country	Population Affected	Avoided Deaths (Total)	95% CI	% of Baseline Mortality	Deaths per 100,000	Avoided Deaths (% Population)	Economic Benefits (2011 US)	Avoided Life Years Lost
1	Central Sub-Saharan Africa	40,000,000	9800	7700–12,000	5.6830	24.62	0.0246	4,100,000,000	9500
2	Eastern Sub-Saharan Africa	150,000,000	28,000	22,000–34,000	4.2522	18.53	0.0185	3,400,000,000	28,000
3	Southern Sub-Saharan Africa	37,000,000	7700	6100–9400	5.0706	20.69	0.0207	6,500,000,000	9400
4	Western Sub-Saharan Africa	140,000,000	26,000	21,000–32,000	4.2948	18.22	0.0182	5,300,000,000	21,000

IntechOpen

Author details

Tadesse Weyuma Bulto^{1*} and Birhanu Chalchisa Werku²

1 Department of Environmental Management, Faculty of Urban Development Studies, Kotebe Metropolitan University, Addis Ababa, Ethiopia

2 Department of Rural Development and Agricultural Extension, Shambu Campus, Wollega University, Wollega, Ethiopia

*Address all correspondence to: tadesseweyuma@kmu.edu.et

IntechOpen

© 2022 The Author(s). Licensee IntechOpen. This chapter is distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/3.0>), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

References

- [1] WHO. Air quality and health. 2018.
- [2] WBG. Safe to Breathe? Analyses and Recommendations for Improving Ambient Air Quality Management in Ethiopia. 2021
- [3] Bulto TW. “Impact of open burning refuse on air quality: In the case of ‘Hidar Sitaten’ at Addis Ababa, Ethiopia,” *Environmental Health Insights*. Jan 2020; **14**:1-11. DOI: 10.1177/1178630220943204
- [4] Jida SN, Hetet J, Chesse P, Guadie A. Roadside vehicle particulate matter concentration estimation using artificial neural network model in Addis Ababa , Ethiopia roadside vehicle particulate matter concentration estimation using artificial neural network model in Addis Ababa, Ethiopia. *Journal of Environmental Sciences*. 2020;**101**(September):428-439. DOI: 10.1016/j.jes.2020.08.018
- [5] EPA. Air Quality Index Air Quality and Air Quality Index A Guide to Air Quality and Your Health. 2000. p. 10
- [6] WHO. 20060929_factsheet.pdf.
- [7] Avis W, Weldetinsae A, Singh A, and Getaneh Z. Vulnerability scoping study: Air pollution exposure and public transport in Addis Ababa. 2020
- [8] Kumiea A et al. Fine particulate pollution concentration in Addis Ababa exceeds the WHO guideline value. *Environmental Epidemiology*. 2020;**5**:1-9. DOI: 10.1097/EE9.0000000000000155
- [9] Tefera W et al. Source apportionment of fine organic particulate matter (PM 2.5) in Central Addis Ababa, Ethiopia. 2021
- [10] Etyemezian V et al. Results from a pilot-scale air quality study in Addis Ababa, Ethiopia. *Atmospheric Environment*. 2005;**39**(40):7849-7860. DOI: 10.1016/j.atmosenv.2005.08.033
- [11] Bulto TW. Influence of particulate matter on human health in selected African provinces: Mini-review. *Reviews on Environmental Health*. 2020. DOI: 10.1515/reveh-2020-0013
- [12] WHO. WHO Expert Meeting: Methods and Tools for Assessing the Health Risks of Air Pollution at Local, National and International Level. 2014
- [13] Yan Y. Air pollution in China: A study of public perception. 2016.
- [14] Abadi N, Gebrehiwot K, Techane A, Nerea H. Links between biogas technology adoption and health status of households in rural Tigray, northern Ethiopia. *Energy Policy*. 2017;**101**(November 2016):284-292. DOI: 10.1016/j.enpol.2016.11.015
- [15] WHO. Health Aspects of Air Pollution with Particulate Matter, Ozone and Nitrogen Dioxide. 2003