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URBAN WASTE MANAGEMENT SYSTEM IN MAKASSAR CITY: ADDRESSING THE CHALLENGES OFURBANIZATION AND CLIMATE CHANGE

Muh. Syukri[*], Ridha Ramadhany[**], Mulkhaeri Ikram[***], Wina Ayu Giswanti[****], Andi Akbar[*****], Muhammad Isnan Rasyidi[******]

Bosowa University, South Sulawesi, Indonesia[*]
University of Palangka Raya, Palangka Raya, Central Kalimantan, Indonesia[**]
Musamus University, Merauke, South Papua, Indonesia[***]
Bosowa University, South Sulawesi, Indonesia[****]
Bosowa University, South Sulawesi, Indonesia[*****]
Bosowa University, South Sulawesi, Indonesia[******]

Email : muahhmadsyukri@gmail.com[*], ridha.ramadhani@fisip.upr.ac.id[**], ririmulk@unmus.ac.id[***], winaayugiswanti@gmail.com[****], andiakbar@universitasbosowa.ac.id[*****], muhammad.isnan@universitasbosowa.ac.id[******]

ABSTRACT

The rapid pace of urbanization in Makassar City has triggered an exponential increase in solid waste generation, which is further exacerbated by the vulnerabilities of climate change. This study aims to analyze the dynamics of the solid waste management system in Makassar City in facing the dual challenges of rapid urbanization and climate change through a literature review approach. Data were analyzed using bibliometric mapping via VOSviewer to trace the network of literature related to waste management, rapid urbanization, and institutional governance. The results indicate that the solid waste management framework in Makassar City is highly strained by structural barriers, including the overcapacity of the Tamangapa Antang Landfill, low community participation in waste segregation, and weak institutional coordination. Climate change introduces severe disruptions, where high-intensity rainfall accelerates leachate production and floods waste transportation networks, while prolonged dry seasons increase fire risks at landfill sites. The study concludes that navigating these interconnected challenges requires a paradigm shift from a traditional linear governance model ("collect-transport-dump") to a resilient, circular economy framework. This transformation must be supported by cross-sectoral institutional collaboration, infrastructure climate-proofing, and the integration of community-based waste banks (Bank Sampah) into the formal municipal waste system.

Keywords:

Climate Change;
Governance;
Urbanization;
Waste Management.

INTRODUCTION

Makassar City, as one of the largest and most influential metropolitan centers in eastern Indonesia, has experienced significant and sustained population growth over the last few decades. This rapid demographic increase has been accompanied by a corresponding rise in the demand for housing, transportation networks, public infrastructure, and various urban services needed to support the growing population. As a consequence, the city has undergone accelerated physical expansion, often extending beyond its planned development boundaries and contributing to patterns of uncoordinated urban growth.

This phenomenon, widely recognized as urban sprawl, has brought about a range of challenges related to land-use transformation, environmental sustainability, and the changing dynamics of social and economic structures within the city. The conversion of open

spaces and agricultural land into built-up areas, coupled with increasing pressure on natural resources and urban ecosystems, highlights the complexity of managing metropolitan growth. Therefore, addressing these challenges requires the implementation of an integrated and adaptive governance framework that can effectively balance development needs with environmental protection, while preserving the ecological resilience and long-term sustainability of Makassar City.

Table 1.1 Population of Makassar City in 2024

Year	Population
2019	1.53 million
2020	1.55 million
2021	1.46 million
2023	1.47 million
2024	1.48 million

Source: BPS, 2025

Referring to the descriptive data of Statistics Indonesia (BPS, 2025), the total population of Makassar City reached 1.48 million people in 2024. Although the average annual growth rate, or compound annual growth rate (CAGR), experienced a slight slowdown to 0.65% compared with the previous five-year period, which stood at 1.08%, Makassar's population density remains the highest in South Sulawesi Province as well as across Sulawesi Island in general. The demographic characteristics of the city are dominated by the productive-age population, namely those aged 15–59 years, representing 65.74% or approximately 971.48 thousand people of the total population. Meanwhile, the proportion of children aged 0–14 years stands at 23.95%, while the elderly population accounts for around 10.31%.

Theoretically, Wirth (1938) positions urbanization not merely as a spatial phenomenon, but as an orientation toward a way of life, or "urbanism as a way of life," which fundamentally transforms the social behavior of society. In line with this thesis, Yunus (2006) defines this transformation as a structural shift from rural patterns of life toward more complex urban characteristics. The process of rural-to-urban conversion is marked by population agglomeration and the massive concentration of built-up areas (Sadyohutomo, 2008; Garnier, 1984, as cited in Soetomo, 2013). Furthermore, Knox (1994, as cited in Soetomo, 2013) emphasizes that the primary determinants of urbanization include economic restructuring, demographic density, and technological adaptation, which simultaneously generate physical externalities in the form of complex urban environmental problems.

The urban complexity driven by expectations of welfare in urban areas is often not balanced by adequate environmental carrying capacity. One of the most critical impacts of the failure to adapt urban space is the accumulation of poorly managed waste. This waste crisis triggers multisectoral pollution, ranging from the degradation of air quality and contamination of surface water to the decline of soil carrying capacity, which subsequently threatens public health through the transmission of various urban diseases. The realization of a clean and hygienic urban space requires regulatory commitment as well as the integration of collective awareness. Unfortunately, environmental management is often positioned merely as an institutional slogan without consistent implementation in the field.

Environmental preservation movements or the concept of a green city will never reach an optimal level without cooperative synergy from local residents. The presence of ecological pollutants is currently dominated by large-scale industrial waste as well as unreduced domestic household waste (Adi, 2005). The lack of active public participation has

caused the quality of Makassar's urban ecosystem to continue experiencing a significant decline over time.

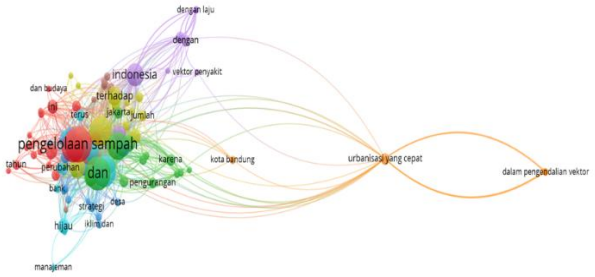

Figure 1. Bibliometric Analysis
Source: Processed by the Author

METHOD

This study was designed using a literature review method with a narrative-integrative approach. The use of this method aims to consolidate, evaluate, and synthesize various previous scientific findings concerning the issues of waste governance, urbanization dynamics, and climate change pressures in metropolitan areas (Snyder, 2019). This approach is considered highly relevant for examining policy overlap as well as identifying research gaps within the domains of public administration and urban ecology.

The secondary data search process was conducted systematically across several reputable scientific databases, including Google Scholar, Scopus, and ScienceDirect, with the publication period limited to 2015–2026. The article search process employed specific keyword combinations, including "Makassar waste management," "urbanization and waste volume," "waste management governance," and "climate change impact on municipal waste." The inclusion criteria required the selected articles to be peer-reviewed scientific journal articles, official statistical reports from Statistics Indonesia (BPS), or spatial planning documents that specifically examine metropolitan urban governance with characteristics similar to Makassar City.

To minimize analytical subjectivity, this study integrated bibliometric mapping techniques (Donthu et al., 2021). Based on a rigorous screening process, 120 relevant articles were extracted into RIS data format. The data were then analyzed using VOSviewer software version 1.6.20 through a keyword co-occurrence network approach. The cluster visualization in Figure 1 serves as a conceptual guide for mapping the causal relationships among the variables of "waste management," "rapid urbanization," "governance," "management," and their implications for the spread of "disease vectors" within the urban environment.

RESULTS AND DISCUSSION

The bibliometric network structure presented in Figure 1 illustrates the division of research clusters into three interrelated thematic groups. The first cluster (green-blue) centers on internal management aspects and waste governance instruments. The second cluster (orange) captures the macro dynamics of rapid urbanization and urban expansion. Meanwhile, the third cluster (red-purple) highlights negative externalities in the form of environmental health threats and the spread of disease vectors resulting from dysfunctions in the waste management system.

The Exponential Relationship between Urbanization and Waste Volume in Makassar City

The population surge in Makassar City, which reached 1.48 million people in 2024, has significantly increased the volume of domestic waste generation. The city's demographic characteristics, dominated by the productive-age population at 65.74%, have directly

transformed patterns of public consumption into more consumptive behavior and contributed to higher carbon emissions (BPS Makassar City, 2025). Referring to Wirth's (1938) framework, population agglomeration in Makassar does not only alter spatial demographics but also creates a concentrated built environment that exceeds the carrying capacity of the area. A tangible consequence of this phenomenon is the city's daily waste production, which is currently estimated to range from 800 to 1,000 tons per day.

The waste generated is largely dominated by household organic food waste and single-use plastic materials. The inability of the city's sanitation service capacity to keep pace with population growth has resulted in unequal waste collection distribution. In peri-urban areas, the limited number of waste collection trucks has led to the proliferation of illegal dumping sites. This condition accelerates the contamination of shallow groundwater sources and undermines the aesthetic quality of urban spatial planning, in line with the concerns raised by Adi (2005).

The Vulnerability of the Waste Management System to Climate Change

Climate change acts as a risk multiplier that exacerbates the fragility of Makassar's domestic waste management system, particularly because the existing system remains conventional, relying on the collect-transport-dump model directed toward the Tamangapa Antang Landfill. This ecological vulnerability manifests in two forms of extreme weather anomalies:

1. High Rainfall Intensity and Flooding: Urban microclimate projections indicate an increasing frequency of extreme rainfall, which often inundates low-lying areas in Makassar. These periodic floods submerge the operational area of the Antang Landfill, disrupt the mobility of waste collection trucks, and drastically accelerate the production of leachate. When leachate retention ponds overflow due to massive rainfall volume, toxic pollutants and heavy metal contents may seep into the Tallo and Jeneberang watersheds, triggering a widespread ecotoxicological crisis (Damanhuri & Padmi, 2016).
2. Heatwaves and Prolonged Drought: On the other hand, prolonged dry seasons triggered by El Niño anomalies increase the internal temperature of waste piles at the Antang Landfill. The accumulation of methane gas (CH_4) from the decomposition of organic waste, without adequate ventilation and gas capture systems, becomes highly reactive and flammable. Large-scale landfill fires not only halt the disposal process but also release hazardous particulates ($PM_{2.5}$) and dioxin gas emissions into the air, directly threatening the respiratory health of urban communities living around the landfill (World Bank, 2021).

Evaluation of Governance and Structural Barriers in Public Service Delivery

From the perspective of Public Administration, the failure to fulfill the principle of service responsiveness in Makassar's waste management stems from an institutional governance model that remains partial, sectoral, and top-down in nature. The Makassar City Government has in fact introduced several pro-environmental policies, such as the operation of the Central Waste Bank and regulations restricting single-use plastic bags. However, the implementation of these regulations at the grassroots level often stagnates due to low levels of civic compliance and weak law enforcement by the relevant authorities.

Table 1.2 Structural Comparative Matrix of Waste Governance

Dimension of Analysis	Current Governance Condition (As-Is)	Adaptive Governance Target (To-Be)
Basic Paradigm	Linear: Collect–Transport–Dispose	Circular: Source Reduction–Recycling–Economic Value
Final Processing Method	Open Dumping / Limited Controlled Landfill	Sanitary Landfill integrated with Waste-to-Energy technology

Community Involvement	Passive, relying on government sanitation workers	Active, with independent waste sorting from the household level
Climate Infrastructure	Vulnerable: conventional trucks and open leachate ponds	Resilient: climate-proofing and automatic methane gas capture systems
Institutional Synergy	Sectoral, dominated by the Environmental Agency	Collaborative, involving cross-sectoral cooperation, private partnerships, and community participation

Source: Author's Analysis (2026)

Cultural barriers in the form of low public awareness—where commitment to environmental sustainability often stops at the level of political jargon without concrete action—remain the greatest challenge in realizing the Green City concept. Waste governance cannot be placed solely on the shoulders of the Environmental Agency (DLH). This issue requires the implementation of collaborative governance capable of integrating the roles of the private sector, academia, local communities, and government bureaucracy from the subdistrict level down to neighborhood associations such as RT/RW (Ansell & Gash, 2008).

CONCLUSION

The waste management system in Makassar City is currently facing a critical point due to the dual pressures of rapid urbanization and high vulnerability to climate change. Uncontrolled urban population growth has triggered a drastic increase in daily waste generation, while extreme weather anomalies such as flash floods and prolonged droughts continue to threaten the operational sustainability of the Tamangapa Antang Landfill. The conventional governance model, characterized by a linear approach and a strong orientation toward final disposal, has proven to be no longer responsive or adaptive in addressing the complexity of modern urban ecological dynamics.

To overcome this degradation, the Makassar City Government must immediately restructure its waste management paradigm toward a circular economy ecosystem that prioritizes waste reduction directly from the source. This tactical step requires the strengthening of local regulations, modernization of waste infrastructure to ensure climate resilience, and the institutionalization of collaborative networks that position civil society as the primary driving actor, rather than merely as the object of public services.

This study has limitations in scope because it relies entirely on secondary data analysis through literature review and macro-level bibliometric mapping. This research has not yet integrated primary quantitative calculations regarding the specific amount of greenhouse gas emissions from the domestic sector in Makassar City, nor has it empirically measured the effectiveness of economic circulation across all Waste Bank units distributed throughout the area. Future researchers are advised to conduct field-based testing using mixed-methods approaches in order to validate the proposed adaptive governance model.

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