

Systems for Disposing of Waste in Addis Ababa, Ethiopia

Hailu Shiferaw^{1,4*}, Fantu Shoamare² and Seifu Legesse³

¹Ex- GIS Expert at Addis Ababa Environmental Protection Authority (AAEPA), Addis Ababa, Ethiopia

²Fantu Shoamare: The late Environmentalist at AA EPA

³Seifu Legesse, Ex Environnemental Education and Legislation Director at AA EPA

⁴Currently working at Water and Land Resource Centre, Addis Ababa University

***Corresponding Author:** Hailu Shiferaw, Currently working at Water and Land Resource Centre, Addis Ababa University, Tel: +251911047022, E-mail: Hailushi31@yahoo.com

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Abstract

Industries have been crucial to the economic growth that has allowed people to build more prosperous lives, higher incomes, and contemporary social structures. However, due to the small number of enterprises and less developed technology, Ethiopia has not reaped the full benefits of the industrial sector. The capital city of Africa, Addis Ababa, served as the site of this investigation. Datasets from 2,204 institutions were gathered via structured interviewing, field research, and GPS locations. Using a relational database system in Visual Basic and an MS Access database environment, datasets were input, cleaned up, and evaluated. Only 18% of industries were found in industry zones, according to the spatial distribution of industries, while 82% were outside of industry zones, with 78% of those being located in residential areas. Industrial wastes are dumped in the closest river or open area. According to the data, just 10% of industries treated and disposed of their effluents, while 90% simply disposed of industrial waste into the environment without any treatment. The primary effects that were noted were harming human and animal health, contaminating air, soil, and groundwater, setting off fires, destroying ditches, obstructing canals, and causing excessive flooding, among other things. In order to create economically vibrant, environmentally suitable, and socially conducive capital city for its citizens, visitors, and businesspeople, significant efforts must be made to reduce and eliminate improper garbage disposal systems.

Keywords: Environmental Challenges; Health Problems; Industrial Wastes; Waste Disposal System

Background

To dispose of waste from both home and industrial sources effectively and sustainably, you need a reliable waste management system. All waste management programs can use waste management data as a comprehensive resource for a critical and instructive evaluation of waste management solutions [1,2]. In developing nations, the necessary evidence for waste management is lacking [3], and even when it is present, it is inconsistent and non-interoperable because it was gathered from secondary sources over a wide time and space range, difficult to validate, and occasionally based on conjecture rather than actual scientific measurements [4].

Pollution has wide-ranging impacts on various sectors, including industries, tourism, property values, and healthcare costs. Understanding these impacts helps emphasize the importance of effective waste management practices. Let's delve into each of these sectors and explore how pollution affects them.

1. **Industries:** pollution can have significant adverse effects on industries. Air pollution, for example, can damage machinery and equipment, leading to increased maintenance costs and reduced productivity. Water pollution poses a threat to industrial operations reliant on clean water sources, impacting production processes, and resource availability, and potentially causing shutdowns or relocation. Additionally, excessive pollution can lead to stricter environmental regulations, which may increase compliance costs for industries.

2. **Tourism:** pollution can have a detrimental impact on the tourism sector. Tourists are often attracted to pristine natural environments, clean beaches, and picturesque landscapes. However, pollution, especially in the form of air and water pollution, can deter tourists and negatively affect their experience. Smog-filled skies, polluted water bodies, and littered tourist destinations can not only discourage visitors but also harm the reputation of tourist destinations, leading to decreased tourism revenue and job opportunities.

3. **Property values:** pollution can significantly impact property values. Areas with higher pollution levels, such as industrial zones with poor waste management practices or regions heavily affected by air and water pollution, often experience a decline in property values. Potential buyers and investors are less likely to purchase or invest in properties located in polluted areas due to concerns about health risks, lower quality of life, and reduced desirability. Property values can decline substantially, affecting homeowners, real estate developers, and local economies. A practical example is observed in the Southwest part of Addis Ababa where domestic waste gathered for decades and the area is affected by pollution resulting in people being less interested in investing and developing the area.

4. **Healthcare costs:** pollution has a direct correlation with healthcare costs. Exposure to polluted air can lead to respiratory problems, cardiovascular diseases, and other health issues. Emissions from industries, vehicular pollution, and poorly managed waste disposal contribute to deteriorating air quality. The healthcare expenses associated with treating pollution-related ailments place a burden not only on individuals but also on public health systems. Increased hospital visits, medication costs, and long-term healthcare requirements further strain healthcare resources, affecting governments, insurers, and individuals alike.

Hence, effective waste management plays a crucial role in mitigating pollution and addressing its adverse impacts on these sectors. By implementing proper waste disposal methods, investing in renewable and clean energy sources, and enforcing environmental regulations, we can reduce pollution levels and promote a healthier and more sustainable environment. It is worth noting that waste management is a complex issue requiring a multi-faceted approach involving government intervention, public awareness campaigns, technological advancements, and collaboration between industries and communities. Implementing efficient waste management practices not only protects our environment but also safeguards the interests and well-being of industries, tourism, property values, and healthcare systems, among others.

Ethiopia and its capital frequently experience cases like this. The African Union's headquarters are located in Addis Ababa, the nation's capital, where a variety of political, social, cultural, and economic activities take place [5]. As a result, these activities are causing various sorts of environmental contamination. Numerous environmental and health issues, such as widespread water and air pollution, noise pollution, waste accumulation, serious air pollution, and a shortage of potable drinking water, have been brought on by population immigration from various parts of the country, rapid industrial sector expansions, and their improper waste disposal management. This is especially true in the lower catchments of the city. Both government representatives and academics agree that Addis Ababa City's sustainable development will be significantly hampered by the dual pressures of resource availability and environmental challenges.

This decade saw the emergence of environmental issues both locally and nationally. Different declarations and regulations were made at different levels (both at national and regional levels) in response to the country's and city's environmental degradation and industrial pollution in order to prevent and control the ongoing environmental crisis and, if possible, restore to their natural systems. Here, it is appropriate to highlight some of the initiatives undertaken in the creation of declarations and rules pertaining to environmental pollution at the local (cities) and national levels. For instance:

1. According to Article 44/1 of the Ethiopian Federal Democratic Republic's Constitution, "every citizen has the right to live in a clean and safe environment." And according to Article 92/1, "the government should work to create a safe and clean environment for all citizens." Additionally, "--- any development intervention ensures the safety of the environmental --- Article 92/2" More environmental ideas can be found in the same article, such as "---both government and the people should take care of their environment --- Article 92/4".
2. Proclamation No. 300/2002 on Environmental Pollution Control. It read, "--- certain social and economic development initiatives may cause environmental harm, which could render the initiatives ineffective. It is appropriate to eliminate or, when that is not possible, to mitigate pollution as a negative impact on social and economic development activities [6]. --the protection of the environment, in general, and the safeguarding of human health and wellbeing, as well as the maintenance of the biota and aesthetic value of nature, in particular, is the duty and responsibility of all.
3. Proclamation requiring an environmental impact assessment: Proclamation No. 299/2002. Environmental impact assessment is used to foresee and manage the environmental effects that a proposed development activity as a result of its designing setting, construction, operation, or an ongoing one as a result of its modification or termination, entails and helps to bring about intended development. An efficient way to harmonize and integrate environmental, economic, cultural, and social considerations into the decision-making process in a way that supports sustainable development is to assess potential environmental impacts prior to the approval of a public instrument. --- environmental impact assessment serves to bring about administrative transparency and accountability, as well as to involve the public and, in particular, communities in the planning of and decision making on developments which may affect them and its environment" [6]. In connection with this National Proclamation, local regulation was also made at the Addis Ababa level, and it is read.
4. City of Addis Ababa Regulation No. 21/2006. In order to lessen and suspend the following negative environmental impacts on the community and natural environment before the work began, it was also stated that "--- it is found necessary to ascertain in advance the examination of those social, and natural environment of negative significant impact to be presumed social and development projects. The need to monitor and check that those carrying out development activities in the City are doing so in accordance with the requirements of the principle of sustainable development and without compromising environmental security has arisen [7].

Institutions that care about the environment and groups of activists have undertaken several awareness campaigns and discussion forums in addition to these declarations and laws [8]. Environmental contamination in the city was being fought by governmental, non-governmental, and civic organizations. The media and news organizations are also paying close attention to environmental issues, particularly pollution in the city.

In order to bring about the anticipated changes in the environment, there is still a larger gap between policies (the rules and proclamations made) and practical settings (what has been happening on the ground). There may be many causes for this, including the level of societal awareness [9,10], the accessibility of disposal sites (disposal systems) to dispose of waste [11,12], and implementation gaps of those policies due to weak institutional and accountability arrangements down to grassroots levels [10]. Furthermore, because they were not geographically separated from other service locations, these companies occasionally made the environment even more polluted [12]. Therefore, there needs to be a lot of work done to put those policies into practice, bringing about environmentally friendly sustainable development as well as maintaining the social, economic, cultural, and aesthetic values of the city that would aid in accelerating economic development and promoting the wellbeing of both the environment and the populace.

To protect the environment and the health of the community living in and around the city, this paper is an initiative that will play a significant role in future study, discussion, and policy development. The three sorts of overall goals for this study are as follows: (1) to create a geo-database for potential pollution sources, with a focus on business sectors and other service providers in the city, (2) to identify and map pollution source points so that researchers and decision-makers can play their respective roles in combating pollution in and around their area of interest, and (3) to provide information on the city's pollution status for business owners and investors, experts, policymakers, and decision-makers so they can visualize the potential sources of pollutants in the city and develop the right technologies and actions to reduce environmental pollution and waste management systems, which will help the city's sustainable socioeconomic development.

Materials and Methods

The Study Area

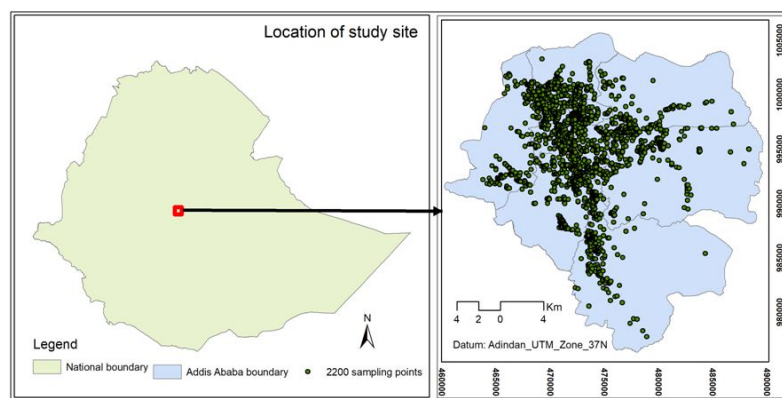


Figure 1: Location of the study area

Data Collection and Analyses

An individual interview with business owners, managers, or technical managers was done using a systematic, closed-ended questionnaire. To gather information across the city, five teams of surveyors, each with five people, were created, along with a coordinator. Between August and November 2007, a thorough census was conducted on every industry and other service-providing organization in the city. We understand that it is a bit older data but the problem is worse than the previous days as there is no management improvement. Along with individual interviews with business owners and managers, personal observations of the industry's effluents and disposal systems and geospatial data were gathered using the Global Positioning System (GPS) for each institution.

After the information was gathered, it was cleaned and entered into a relational database system using Visual Basic (VB6). Different entity relationships were created in order to generate the necessary information. VB6 and MS-Access, ArcGIS 9.1, and Spreadsheet were each used to evaluate and create the organized report (Figure 2). Additionally, many GIS analysis stages were carried out to construct the final maps, and spatial studies were conducted to identify pollution sources and surrounding natural features (such as rivers) that are used as dumping locations.

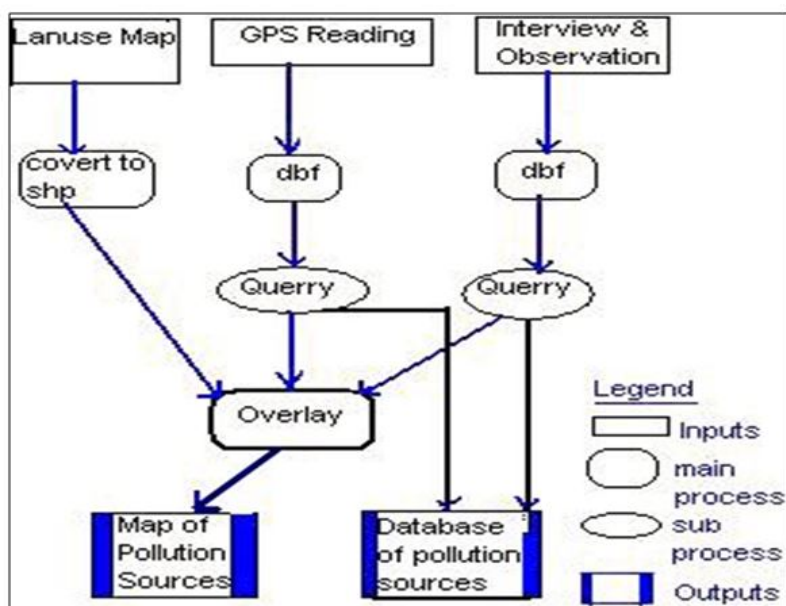


Figure 2: General methodology flowchart

Results and Discussions

Spatial Distributions of Polluting Institutions

More than 2,204 industries and service-providing institutions were found to be registered in the city, according to the findings. Tannery and leather, textile, chemical, plastic, printing, wood pulp and paper, metal, and non-metal are some of the businesses and institutions that provide these services. From the perspective of sound pollution, [9] Mine, [10] Cement, [11] Food and Beverage, [12] Garage and Warehouse, [13] Tobacco, [13] Electronics, [14] Health Facilities (hospitals, clinics, pharmaceuticals, and laboratories), and [15] Religious Centers. These institutions do not appear to be spatially isolated from other forms of land use systems or to be in harmony with designed spatial sites when examining their spatial distributions (Figure 3).

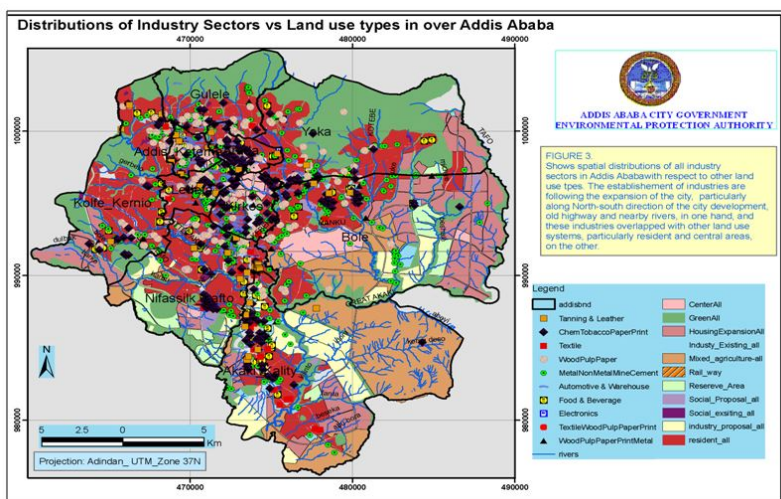


Figure 3: Spatial distributions of all industries by types with respective to other land use plans.

Three findings are shown in Figure 3: [1] Industries were developed after the city's north-south growth; [2] Industries were established following the flow of rivers in the city; and [3] Industries were blended with other land use services, such as residential areas. However, the majority of rivers are the ideal locations for waste disposal, regardless of whether the garbage is from a hazardous industry, a hospital, or a household. In other words, rubbish is dumped into adjacent waterways. According to one of the findings, 45% of companies can be found within 50 meters of the closest rivers and release their effluents into those waters (Figure 4). This demonstrates that these areas (rivers) are both the default and preferred locations for trash disposal.

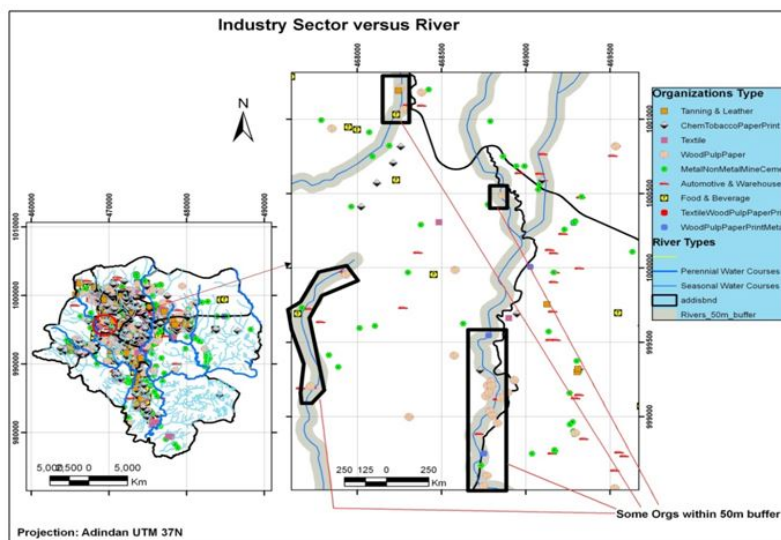


Figure 4: Spatial distributions of polluting industries with respect to rivers in the city and zoomed rivers within 50m buffer.

A further finding from the spatial distribution of the city's industries is that only around 18% of them are located in industry zones, while the remaining 82% are not (Figure 5). Unexpectedly, residential zones are home to 78% of processing enterprises (industries and medical institutions). This shows that the majority of pollution types, such as solid, liquid, noise, and even particulates from various metal and non-metal workshops, are having an impact on society and the environment if these waste products are disposed of haphazardly in and around their immediate surroundings.

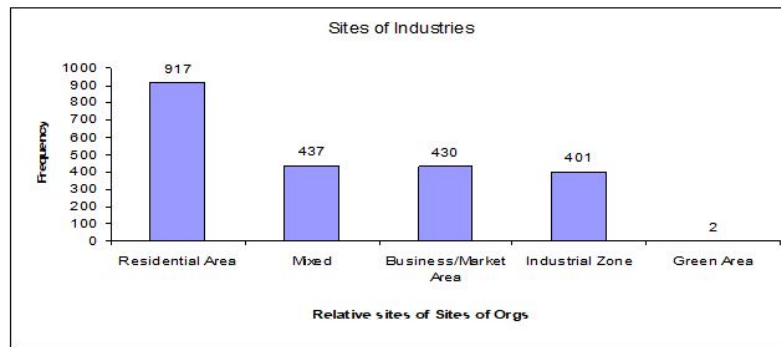


Figure 5: Relative sites of industries in the city as compared to residency and market.

Waste Types and Disposal Systems

It was already noted that the [14] had registered more than 2,204 organizations that provided services, which are thought to be potential sources of pollution in the city. When asked if they treat industrial wastes before releasing them into the nearest river or open field, business owners and managers responded in the affirmative (Figure 6). Only 10% of the requested and visited industries have treatment plants, compared to 90% without treatment plants. Similarly, 42.5% of organizations generated solid trash, while 41.7% of organizations did not specify the type of garbage they generated.



Figure 6: Treatment status of industrial wastes before they were disposed

Some sectors were considered twice when taking waste types into account since their disposal systems required various technologies to dispose of garbage in an appropriate manner. For instance, if a company produced both solid and liquid trash, it would be counted twice because the waste kinds and disposal methods were different. Based on treatment types and status, particularly for liquid and solid wastes, 2,776 industries and service-providing institutions-which handle both solid and liquid wastes-were counted, despite the fact that we had around 2,204 registered. Such institutions produced a variety of wastes, including solid, liquid, particle, noise, and smoke/gas, and sometimes more than one of these (Figure 7). For this analysis, we focused primarily on two major waste types: solid and liquid. The extremely noteworthy conclusion in Figure 7 is that even the biggest percentage of managers of organizations or industries do not have a record of the type of trash that their firm produced, at 30%. They are unaware of the types of garbage that their organization/industry produced, whether they were solid, liquid, or other. These organizations were unable to come up with any prevention or control measures. This also relates to their educational backgrounds and ability to think globally, which will prevent them from competing in both local and international markets.

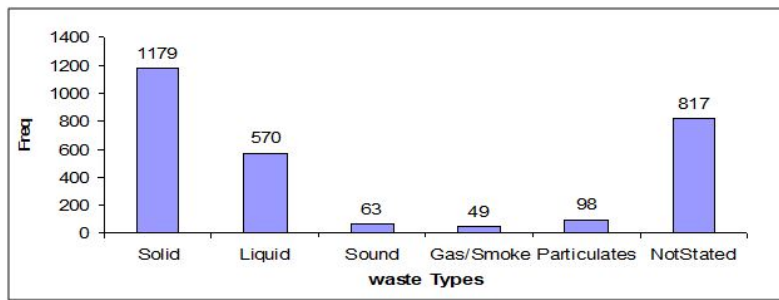


Figure 7: Types of wastes from industries and service-providing organizations in Addis Ababa

Only 31.6% of liquid wastes were released to the municipal sewer system when only solid and liquid wastes were examined [14]. Additionally, only 1.5% of both solid and liquid wastes were recycled and reused, with the remainder being released to the environment untreated. About 30% of the organizations released their solid wastes to open fields. However, there are also institutions that discharged noise (unwanted sound), particles, and other types of pollution (Figure7) in addition to the solid and liquid wastes that are produced by the majority of enterprises. Instead of burning hazardous waste in incinerators, healthcare facilities additionally produced and discharged hazardous waste into neighboring rivers and ecosystems [15]. The poll included hospitals, pharmacies, labs, health centers, and clinics (upper and medium-level clinics) into account (Figure 8).

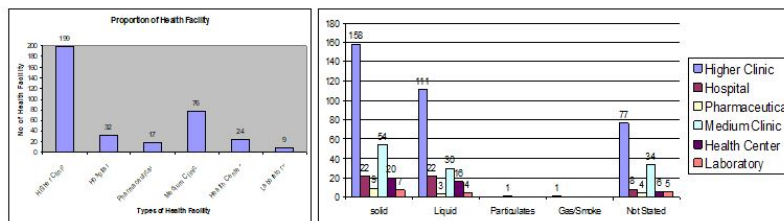


Figure 8: Health facilities surveyed (left) and registered as pollution source (right)

Point sources and non-point sources are the two main sources of pollution. Pollution from both point and non-point (diffuse sources) sources has had a negative impact on the environment's quality of air, water, and soil. For instance, eutrophication (nutrient enrichment) and contamination by toxic organic compounds are at least two significant water quality issues in surface waters [10]. The highest value for ammonia was discovered in Zerfe's study in almost all sites, demonstrating the high risks that the discharge of wastewater causes for the degradation of ecosystem quality. Zerfe explained that almost all industrial effluents discharged into the river system are untreated and that their pollutant loads, both organic and inorganic, are observed to be high. As a result, the city's rivers are often categorized as having "moderate" to "very bad" water quality. The main dangers affecting the water quality for applications like irrigation, swimming, and the maintenance of aquatic ecosystems were discovered to be various ions, heavy metals, and fecal coli forms [10]. Nearly all of the sites along the Kaki Rivers, which are the city's two main rivers at the lower catchments, were found to have degraded water quality and to not fulfill WHO, USEPA, or STN 75 7221 requirements for river water [10].

The pressure on soil quality and the requirement for sustainable soil fertility are both growing as a result of the problems associated with population growth, and soil pollution has become a hot topic [16]. The various types and causes of soil contamination include air deposition, mining, agrochemicals, waste disposal, and industry [16]. These contaminated soils put users' health at risk by causing poor food safety (nutrition). Soil and liquid wastes generated from institutions that provide services have a major impact on our everyday lives and the socioeconomic, environmental, and long-term health of the city.

Environmental Management Systems

An application known as the Environmental Management System (EMS) is used by industries to achieve international standards and ISO 14000 family certification in order to gain access to sustainable manufacturing methods for international market contests. The use of EMS was also taken into account as one method of a "cleaner production" system, or one that is ecologically friendly and sustainable, and industries were evaluated appropriately. Only 1.5% (34/2204) of the organizations was aware of EMS when the EMS application was used, and only 19.5% (429/2204) of the organizations were aware of EMS but took no action (Figure 9). However, according to 78% (1721/2204) of the organizations, they were unaware of EMS [12]. All of these, therefore, suggest that before any legal, real measures are taken against polluters, there should be widespread knowledge of the need for environmentally friendly products and their ability for sustainable development.

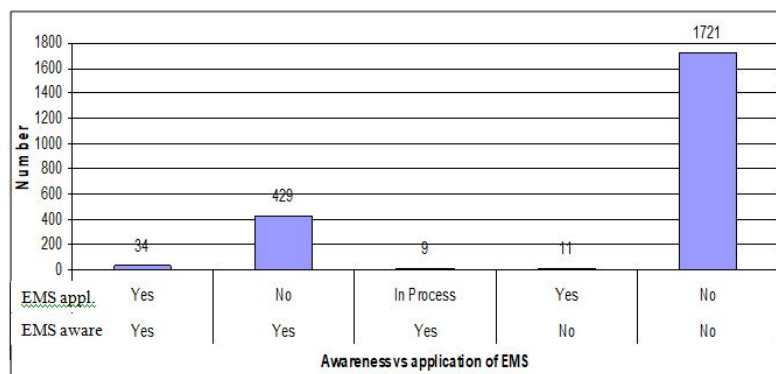


Figure 9: Comparison of industries that have awareness and implementation status of environmental management systems (EMS).

The Effectiveness of Existing Zoning Policies

A number of issues are revealed when the effectiveness of current zoning laws and their enforcement are assessed. Due to a lack of enforcement mechanisms and the existence of outdated service-providing sectors that demand sizable investments to adopt clean or treatment plants, the current pollution control is not as effective as anticipated. Additionally, industrial owners' willingness to put such measures into place is not guaranteed, in part because building treatment plants comes with an added cost. Resources, knowledge, financial backing, competence, and forward-thinking decision-makers are just a few of the variables that need to be taken into account in order to address these issues and increase pollution control.

1. There are weak enforcement measures in place: The success of zoning regulations strongly depends on the existence of enforcement procedures. Industries might not follow pollution control measures if these methods are not reliable or applied consistently. An extensive analysis should pinpoint enforcement weaknesses and make recommendations for enhancing monitoring, inspection, and sanctions for non-compliance.
2. Financial repercussions: Old service-providing industries may face financial hardships if they adopt clean-up or treatment facilities. Industry owners may be discouraged from making these modifications because of the expenses involved in retrofitting existing infrastructure or deploying new pollution control technologies. In order to encourage business owners to embrace more environmentally friendly practices, it is crucial to look into available financial support options, such as grants, incentives, or low-interest loans.
3. Education and awareness: Many business owners may not be aware of the value of pollution control measures or their long-term advantages. The dissemination of information regarding the effects of pollution and the available technology and practices that can reduce them can be aided by educational programs and awareness campaigns that are directed at these stakeholders. Industry owners may be more inclined to voluntarily employ pollution control measures if knowledge is raised.

4. Expertise and technical support: Industries may require specialized expertise to identify suitable pollution control measures specific to their sector. Adoption of cleaner technologies and environmentally friendly behaviors can be facilitated by having access to technical support, such as consultants or expert advice. The required expertise may be provided through collaboration with academic institutions, research centers, and industry associations.

5. Visionary and forward-thinking decision-makers who value environmental protection and sustainability are necessary for effective pollution control. To create and implement policies that promote pollution management and advance sustainable development, these decision-makers should actively collaborate with industrial stakeholders, environmental organizations, and specialists.

As a result, an analysis of current zoning laws and the methods used to implement them shows that more needs to be done in terms of processes, funding, knowledge, and decision-makers who have an eye toward the future. Authorities can improve pollution management, enforce adherence to environmental legislation, and promote the adoption of cleaner technologies and practices across industries by tackling these issues. This all-encompassing strategy will help zoning policies be more successful, leading to better environmental conditions and the long-term viability of both communities and industries.

Summary

According to the research, the city has more than 2,204 registered industries and service providers, the majority of which emit various pollutants. Only 10% of the industries surveyed have treatment plants, compared to 90% without treatment plants. Only around 18% of the city's industries were located in industry zones, according to the spatial distribution of the sector, while 82% were not. About 42.5% of businesses created solid trash, while about 41.7% did not specify the type of garbage their businesses produced. The majorities of river regions were default and preferred sites for waste disposal systems, and 30% of the organizations in the city discharge their wastes to open fields. Approximately 45% of industries are located within 50 meters of the closest river. According to the data examined, only 31.6% of liquid wastes were dumped into the municipal sewage system, and just 1.5% of solid and liquid wastes were recycled or used again, with the remainder being dumped directly into the environment. When the Environmental Management System (EMS) application is taken into account, only 1.5% of business owners are aware of it and have started using it, whereas 19.5% of businesses are aware of it but haven't started using it. But around 78% of the organizations claimed they were unaware of EMS. These all suggest that before taking any legal, concrete action against the polluters, awareness-raising at all levels should be implemented. To bring about environmentally friendly sustainable development and to uphold the social, economic, cultural, and aesthetic qualities of the city, a lot of work needs to be put into implementing such policies, tools, and EMS.

Therefore, sustainable waste management practices can lead to cleaner air, water, and environments, attracting industries, tourists, and investors to environmentally conscious regions. This, in turn, boosts economic growth, preserves natural resources, reduces healthcare costs associated with pollution-related illnesses, and contributes to sustainable and healthy socioeconomic and environmental development. In conclusion, pollution exerts far-reaching consequences on industries, tourism, property values, and healthcare costs. Recognizing the interconnectedness of these impacts underscores the critical need for effective waste management to create a sustainable and prosperous future for all.

Recommendations

Both residential waste and industrial effluents cannot be properly disposed of with current waste disposal methods. This results in the release of waste wherever possible without taking into account its effects on the environment, human health, and overall socioeconomic system. Therefore, we advise enterprises to set up the proper treatment facilities to handle their wastes, ensuring that the effluents meet the necessary standards before being released into the receiving environment or water body.

Up until grass-roots levels, adequate control and management systems from the government's perspective are insufficient; these systems must be improved and facilitated. Setting up realistic ways of actor incentives and/or polluters-pay systems against environmental activities could be one of the tools. Furthermore, as lack of awareness is one of the primary causes of environmental pollution and degradation, it is important to prioritize raising awareness among societies and industry owners and managers. The failure of the locals to remove home waste through the municipal system and instead attaching toilets or septic tanks to the river systems provides a straightforward example for gauging their level of knowledge. Additionally, it is important to promote effective methods of collecting solid wastes, such as composting and the separation of trash from its source. Therefore, in addition to developing and using tools of encouragement or punishment as polluters-pay principles applications to the actors against environmental protection activities, the local government must do more to raise environmental awareness among the general public, especially among business owners/managers and institutions that provide services. The city's efforts to develop in an environmentally friendly and sustainable manner are then supported by appropriate garbage disposal systems. Moreover, updating the data regularly to track progress and identify emerging issues is highly recommended.

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