Integrated approach in determining priority environmental issues in Medan City North Sumatra Province

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Abstract. Medan City is one of the largest cities in Indonesia. Geographically, Medan City is located between coordinates 2° 27' - 2° 47' North Latitude and 98° 35' - 98° 44' East Longitude. The regional government of Medan is currently carrying out various efforts to overcome environmental problems in Medan City. This study aimed to analyze priority issues that need to be addressed in Medan City. This study was conducted from May to October 2018. The research consisted of several stages of activities, namely: desk review, public consultation with stakeholders, and data analysis. The desk review was conducted to examine various regulations and documents related to the management of Medan's natural and environmental resources and the environmental problems of Medan City. Public consultation with stakeholders was carried out with focus group discussions (FGD), filling out online questionnaires, and auditing with stakeholders. Priority issues were analyzed using the Driving Force, Pressure, State, Impact and Response (DPSIR) approach. Based on an integrated approach, the main issues obtained were the main problems in Medan, namely: Garbage, Water quality and quantity, and Air quality. The three main issues require rapid handling to prevent environmental damage in Medan City.

Keywords: Environment, DPSIR, Medan City, a Priority issue

1. Introduction

Administratively, almost all areas of Medan City are bordered by Deli Serdang Regency, which are West, East and South. Along the northern region the "Medan City" borders directly with the Malacca Strait. The administrative boundaries of "Medan City" are the North bordering the Malacca Strait, the Southern bordering the Deli Tua and Pancur Batu Sub-districts, Deli Serdang Regency, the West bordering the Sunggal Sub-district, Deli Serdang Regency, the East bordering Percut Sub-District, Deli Serdang Regency [1].

Based on regional regulation Number 13 of 2011 about Medan City Spatial Planning (2011-2031) [2], Medan City is dominated by settlements covering an area of 15,471.3 ha (55%), Industry and trade covering an area of 3,000.50 ha (10.54%), other special cultivation areas covering 408.00 (1.43%), Trade and services covering 1,985.60 ha (6.97%), commercial service areas covering 812.35 ha (2.85%),

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mangrove areas covering 453.72 (1.59%), areas local protection area of 1479.43 ha (5.19%) and green open space of 3,767.23 ha (13.32%). Medan City is dominated by Settlement and industry. Green open spaces, mangroves and local protected areas cover only 20.1% in the Medan City area.

Development must consider the sustainability and preservation of natural resources and the environment. In-Law No. 32 (2009) about Environmental Protection and Management Article 1 paragraph 1 [3] explained that the Environment is a unitary space with all objects, power, conditions, and living things, including humans and their behavior, which affect nature itself, survival of life, and human well-being and other living things. As the third-largest city in Indonesia, development activities in various sectors are being carried out. Of course this will provide benefits for the welfare and economic development of the people of Medan City, but on the other hand, it can also have a negative impact on the quality of the environment of the City of Medan.

Therefore, environmental problems will occur if the use of natural resources for the development of Medan City is not accompanied by proper environmental management. As effort to increase public awareness in preserving the environment as mandated by Law Number 32 (2009) about Environmental Protection and Management, the government conducts various activities, such as dissemination to business actors or activities regarding the preparation of environmental documents in a manner routinely carried out every year and prevention of pollution and or environmental damage. The government continues to encourage awareness of business actors or activities to complement its business activities with environmental management documents, such as analysis of environmental impacts, environmental management efforts, environmental monitoring efforts and environmental permits. Based on this, this paper aims to determine priority issues related to environmental issues in the city of Medan and analyze these priority issues based on the Driving Force, Pressure, State, Impact and Response (DPSIR) approach.

2. Materials and Methods

2.1. Study area

This research was conducted in Medan City, North Sumatra, Indonesia (figure 1). The total area of Medan City is 26,510 ha. Medan City has an area of approximately 26,510 ha consisting of 21 Districts. Medan Labuhan District has the largest area, which is 3,667 ha (13.83% of the total area of Medan City) (Central Bureau of Statistics of Medan City, 2018). Geographically, Medan City is located between coordinates 2° 27’ - 2° 47” North Latitude and 98° 35’ - 98° 44’ East Longitude.

2.2. Data collection

This study was conducted from May to October 2018. The research consisted of several stages, namely: desk review, public consultation with stakeholders, and data analysis. There were two kinds of data, namely: primary data and secondary data. Primary data was obtained from Public consultation with stakeholders was carried out with focus group discussions (FGD), filling out online questionnaires, and auditing with stakeholders. The questionnaire prepared by the drafting team refers to indicators of environmental problems [6] related Participants are given time to fill out an online questionnaire for 2 hours. Public consultation activities in the context of formulating priority issues were carried out on September 20, 2018 at the Grandhika Hotel Medan, which was attended by 36 participants coming from representatives of stakeholders in the city of Medan, such as: the Regional Apparatus Organization of the City of Medan, Academics, community representatives, NGOs, private sector and media. Secondary data were obtained from literature and some institutions, such as the environmental office and Regional Development Planning Board. This FGD becomes important because it is an agreement with consideration of various study results in formulating priority problems in Medan City.
2.3. Data analysis
This study uses an integrated approach, namely: a method that integrates stakeholder opinions to determine priority issues and the DPSIR approach to analyze priority issues. This method has also been used in Besitang Watershed and Belawan Watershed [4,5]. The identification of priority issues on environmental issues in Medan City begins with the introduction of the introduction to the discussion, then completes the questionnaire online filled out by all stakeholders. After all the questionnaires are filled in, the data from the questionnaire results are presented in the form of excel data. Analysis of Medan's various environmental documents (such as: Regional Environmental Status, information on the performance of regional environmental management, regional profiles, and other supporting documents), used in analyzing priority issues on environmental issues in Medan in accordance with Law No. 32 (2009) about environmental protection and management (Article 9 and Article 10) and Circular Letter of the Minister of Environment and Forestry No. 5 (2016) about the Preparation of Provincial and Regency / City Environmental Protection and Management Plans (SE.5 / MENLHK / PIA.3 / 11/2016) [7]. From a number of strategic issues obtained, screening of the priority issues of the City of Medan was carried out, which was the result of agreement from all participants.

The desk review was conducted to examine various regulations and documents related to the management of Medan's natural and environmental resources and the environmental problems of Medan City. Priority issues were analyzed using the Driving Force, Pressure, State, Impact and Response (DPSIR) approach.

Figure 1. Map of Medan City, North Sumatra, Indonesia
3. Result and Discussion

3.1. Priority issue of Medan City
Based on the results of the FGD (figure 2), obtained 10 indicators of environmental problems are categorized into 3 priority environmental issues in the City of Medan as shown in table 1.

![Image](image_url)

Figure 2. The implementation of FGD for determination of priority issues in Medan City at Hotel Grandhika Medan

| Nr | Indicator                                                                 | Issue Priority category        |
|----|----------------------------------------------------------------------------|--------------------------------|
| 1. | Flooding during the rainy season                                          | water quality and quantity     |
| 2. | Stagnant water at certain locations during the flood                       | water quality and quantity     |
| 3. | The environment increasingly feels noisy due to transportation and development | air quality                   |
| 4. | Green open space in urban areas increasingly narrow/diminished             | air quality                   |
| 5. | The existence of garbage that disturbs the waterways                       | garbage                       |
| 6. | The condition of rivers and lakes filled with rubbish and waste (polluted by car waste and rubbish) (water quality) | water quality and quantity     |
| 7. | Increased air pollution (smoke, dust, etc.) with an increase in vehicles and factories | air quality                   |
| 8. | Garbage buildup at certain locations and times                             | garbage                       |
| 9. | The appearance of the pungent odor from trash                              | garbage                       |
| 10.| Lots of rubbish littered                                                   | garbage                       |
Strategic issues are environmental problems that occur repeatedly and have a large and broad impact on the sustainability of environmental functions and priority issues are the main issues that become priorities in improving the quality of the environment in the regions based on participatory processes that involve stakeholders in the regions. Based on Table 1 of the 10 indicators of environmental problems in Medan City, three priority issues were obtained according to the agreement at the time of the FGD, which were grouped into Garbage, Water quality and quantity, and Air quality (Table 1).

### 3.2. DPSIR analysis of garbage priority issues

The driver of the problem of garbage in Medan city is an increase in population, an increase in domestic waste due to population growth, lack of public awareness about waste management. Garbage is material or substances, both organic and inorganic, which are produced from every human activity, such as household, industrial, and commercial activities [8]. Garbage becomes a serious problem, especially in urban areas. Garbage is a problem that is quite alarming in Medan City. Sources of garbage were domestic and industrial. One of the Conditions for Garbage Dump in Pringgan Market, Medan City can be seen in Figure 3.

![Figure 3. Condition of a garbage dump in Pringgan Market, Medan City](image)

The predicted garbage heap in Medan per day in 2016 is 1,326.37 kg in 2016 [9]. In 2017, the number of waste generation per day in Medan City is 1,595,000 m³ / day [10]. The Garbage condition raises several problems, such as environmental aesthetics, public health problems due to the proliferation of disease vectors and odors caused by the garbage in the form of methane gas resulting in air pollution. Garbage problems must be carried out in an integrated manner, especially the problem of transporting waste.

The government of Medan city has made various efforts to tackle waste, but there are several obstacles in the implementation of these efforts, namely: 1) lack of APBD provided by the central government, 2) meetings that are only held every six months and get results once a year, 3) difficulty in regulating scavengers who still carelessly burn improper land, and 4) investors who until now have not been there and are urgently needed for waste management consider that the Marelan Waterfall landfill is estimated to only be able to collect waste only in a 3-4 year period [11].

The presence of industrial / trade activities, burning of garbage, and building of public facilities that emit increased air pollutants and methane gas emissions from landfills that continue to increase become pressure on the quality of the environment in the city of Medan. The garbage problem in Medan City can cause some ecosystems to be disturbed, such as river ecosystems (Belawan tributaries), paddy ecosystems, grassland ecosystems, and the Settlement ecosystem [12]. In addition, the function of the ecosystem is also disrupted. At present the conditions in Medan related to the garbage problem were: Limited landfill, no further processing, Difficult / lack of access to solid waste, especially on river banks,
Increased domestic waste due to population growth, lack of public awareness about waste management. Every day around 2 tons of garbage originating from 21 sub-districts throughout Medan were disposed of at the Marelan Falls Landfill. Lacking guidance and support for waste banks, recycling groups, and other waste management efforts, damaging the aesthetics of the environment around the landfill, air pollution (methane gas released from the landfill/rubbish during the summer) and health problems.

Response/Prevention policy is carried out by the Medan City Government by fulfilling pollution control facilities and infrastructure, which include completeness of facilities and infrastructure in the form of domestic wastewater treatment, drainages and waste management infrastructure such as Garbage Containers, Trash Places and Temporary Recycling Place. In addition to completing facilities and infrastructure, the Government is optimizing the existing sludge management system and optimizing the waste service system and waste management.

3.3. DPSIR Analysis of water quality and quantity priority issues
Flood is a problem of excess water quantity that disrupts the activities of the people of Medan, such as causing traffic congestion and damage to infrastructure. Medan City is a city that is geographically prone to flooding. The cause is the position of the city of Medan which is geographically located at an altitude of 2.5 - 50 m above sea level, and is traversed by many flowing rivers and also river conditions mostly broken. This condition is also exacerbated by the lack of synchronization and integration of spatial plans between regions. flooding is also caused by bodies of water getting narrowed, due to the growth of illegal buildings on the banks of the river, and the lack of public awareness not to pollute the river [13].

High rainfall during the rainy season, Lack of water catchment areas due to dense population settlements due to population growth in the city of Medan is quite rapid. Blocked waterways due to the accumulation of garbage in waterways, Canals in Deli do not function optimally. There is no retaining embankment waves are the drivers of flooding. A significant increase in population and settlements, as well as the development of trade centers, hotels, and hospital activities around the river, contributed to the increase in domestic wastewater discharges to the river. Increasing the distribution of large and medium industries which put pressure on the large burden of liquid waste pollution on the rivers body, low public awareness and business behavior to maintain and comply with applicable environmental regulations, Decreased groundwater level due to an increase in the amount of land built and settlements so that groundwater is easily contaminated by household waste, Decreased quantity of groundwater due to lack the reach and capability of PDAM Tirtanadi in meeting the needs of clean water in Medan city resulting in an increase in the amount of underground water extraction [9].

The current condition if there is a flood is an increase in traffic congestion, disruption of community activities, damage to housing infrastructure, an increase in disease events, damage to agricultural land, damage to ponds around the coast, infrastructure damage and mixing of river water and groundwater with seawater, lack clean water, damage to motor vehicles and household furniture due to continuous flooding. The response from the Medan city government is to provide warnings to industries or individuals who dump waste into rivers. Increased public awareness and business behavior to maintain and comply with applicable environmental regulations, Community participation in cleaning rivers, Application of Mayor Regulation No. 8 (2015) [14] about Wastewater Discharge Licenses, Mayor Regulation No. 58 (2009) [15] about Quality Standards for Domestic Business Waste and / or Hotel Activities, Mayor Regulation No. 27 (2009) about Management of Hazardous and Toxic Waste.

3.4. Analysis of Air quality priority issues
In Medan City, there are various types of processing industries that have the potential to pollute the air, including the food industry, the beverage industry, the wood industry, the basic chemical industry, the non-metal mineral industry, the base metal industry, and the textile industry. But a significant source of pollution is from motor vehicle traffic [17]. With the number of motorized vehicles in the city of Medan such as public transportation, private vehicles estimated to reach 781,038 units in 2005, the air pollution burden caused is estimated to be quite significant. The highest air pollution is found in the most congested road sections and prone to congestion. Other sources of pollution are those that originate from
burning domestic solid waste/rubbish by the community, either openly burning or by using stoves or cooking utensils. Air pollution control is carried out by testing and examining motor vehicle emissions in the city of Medan, and air pollution detection equipment.

Sources of air pollution in Medan City were generally caused by types of activities such as the processing industry, transportation, and household daily activities. Increasing the number of vehicles carrying dust particles and other particles as air pollutants Increasing industrial/trade activities, burning garbage, and building public facilities that emit air pollutants increased [18,19]. As a result, the amount of air pollutants has increased, industrial/trade activities, waste burning, and the construction of public facilities that emit air pollutants have increased. Methane gas emissions from landfills have continued to increase.

Current conditions related to air quality are increased risk of disease, disruption of living activities, acid rain and global warming. The long-term effect of pollution that occurs in the air is global warming. If particles in the polluted air are absorbed by plants, this will cause plants to be stunted in their growth and development. In addition, plant diseases will arise [20]. Air quality problems in Medan City can cause several ecosystems disturbed, such as Settlement Ecosystems and Urban Area Ecosystems. The responses from the Medan City government were the promotion of climate village program improvement, periodic motor vehicle Kier Test, together with the community actively involved in driving the Climate Village Program, supervising businesses/activities in accordance with their environmental documents; Monitoring ambient air quality in the Medan City.

Environmental problems, such as garbage, water quality and water quality, as well as air quality which are problems in Medan City, are common problems that almost occur in other cities [21-28]. Several studies have been conducted related to these environmental problems, explaining that community participation is one of the factors that greatly influence the success of environmental management, such as waste, flooding, and water pollution and air pollution [4,17,21,23,28].

4. Conclusion
The main issues obtained were the main problems in Medan, namely: Garbage, Water quality and quantity, and Air quality. The three main issues require rapid handling to prevent environmental damage in Medan City. Several responses from the government, such as the promotion of climate village program improvement, periodic motor vehicle Kier Test, community participation actively involved in driving the Climate Village Program, supervising businesses/activities.

5. References
[1] Central Bureau of Statistics of Medan City 2018 Demografi Kota Medan. https://medankota.bps.go.id/
[2] Regional Development Planning Board of Medan City 2011 Medan City spatial management planning related to regional land uses (2011-2031) No. 13 (2011). Regional Development Planning Board of Medan City, Medan. 41pp.
[3] Ministry of Environmental Republic of Indonesia 2009 Law No. 32 (2009) about Environmental Protection and Management (Undang-Undang Nomor 32 Tahun 2009 tentang Perlindungan dan Pengelolaan Lingkungan Hidup). Jakarta.
[4] Rahmawaty, Villanueva T R and Carandang M G 2011 Participatory Land Use Allocation (Case Study in Besitang Watershed, Langkat, North Sumatera, Indonesia). Lambert Academic Publishing, Germany. 199 pp.
[5] Rahmawaty, Khairat N and Rauf A 2016 Integrated Approach as an Effort to Climate Change Mitigation in Land Use Change Assessment. Prosiding Seminar Nasional Penguatan Pengajaran dan Penelitian Perubahan Ilm: Bridging Gap Implementasi Kebijakan Mitigasi dan Adaptasi di Tingkat Nasional dan Subnasional. Jakarta.
[6] Millennium Ecosystem Assessment (MEA) 2005 Ecosystems and Human Well-Being: Synthesis (Washington, USA: Island Press).
[7] Minister of Environment and Forestry 2016 Circular Letter of the Minister of Environment and Forestry No. 5 (2016) about the Preparation of Provincial and Regency/City Environmental Protection and Management Plans (SE.5 / MENLHK / PIA.3 / 11/2016) (Surat Edaran Menteri Negara Lingkungan Hidup dan Kehutanan No. SE.5/MENLHK/PIA.3/11/2016 tentang Penyusunan Rencana Perlindungan dan Pengelolaan Lingkungan Hidup Provinsi dan Kabupaten/Kota). Jakarta. [in bahasa]

[8] Mifbakhuddin, Saluwati T and Kaswumi A 2010 Gambaran pengelolaan sampah rumah tangga tinja aspek pendidikan, pengetahuan, dan pendapatan perkapita di RT 6 RW 1 kelurahan pedurungan tengah semarang J Kesehatan Masyarakat Indonesia 6(1) 1-14. [in bahasa]

[9] Medan city environmental office 2017 Laporan SLHD Kota Medan Tahun 2016 (Medan: Medan city environmental office).

[10] Medan city environmental office 2017 Laporan SLHD Kota Medan Tahun 2017 (Medan: Medan city environmental office). [in bahasa]

[11] Sari D and Ritonga S 2016 Peran dinas Kebersihan dalam pengelolaan sampah rumah tangga di TPA Terjun kecamatan Medan Marelan Jurnal Ilmu Administrasi Publik 4(1) 65-73. [in bahasa]

[12] Medan city environmental office 2018 Laporan RPPLH Kota Medan Tahun 2018 (Medan: Medan city environmental office). [in bahasa]

[13] Puspitasari DE 2009 Dampak pencemaran air terhadap kesehatan lingkungan dalam perspektif hukum lingkungan (studi kasus sungai code di kelurahan Wirogunan kecamatan Mergangsan hukum lingkungan (studi kasus sungai code di kelurahan Wirogunan kecamatan Mergangsan) Mimbar Hukum 21(1) 23-24. [in bahasa]

[14] Anonim 2018 Mayor Regulation No. 8 the year 2015 about Wastewater Discharge Licenses (Medan: Province of Sumatera Utara Government).

[15] Anonim 2012 Mayor Regulation No. 58 the year 2012 about Quality Standards for Domestic Business Waste and/or Hotel Activities (Medan: Province of Sumatera Utara Government).

[16] Anonim 2009 Mayor Regulation No. 27 year 2009 about Management of Hazardous and Toxic Waste (Medan: Province of Sumatera Utara Government).

[17] Rahmatawaty, Patana P and Latifah S 2017 Spatial analysis on distribution of green belt to reduce impacts of climate change in Medan City, North Sumatra Malays. Appl. Biol. 46(2) 67–76

[18] Purwasi H, Latifah S and Sukmana A 2013 Identification of plant species at a few street green belt of Medan City Peronema Forestry Science Journal 2(2) 108-116.

[19] Banurea I, Rahmatawaty and Afifuddin Y 2013 Green open space capability analysis on reducing concentration of CO2 from motor vehicles at campus USU Medan. Peronema Forestry Science Journal 2(2) 126-129.

[20] Rahmatawaty, Sembiring IEP, Batubara R and Patana P 2018 Mapping of Tree Damage Classification in the Western Part of Medan City, Green Belts Using Geographic Information System IOP Conference Series: Earth and Environmental Science iopscience.iop.org/volume/1755-1315/166

[21] Rahmatawaty, Sitorus NA and Rauf A 2017 Distribution, above-ground biomass and carbon stock of the vegetation in Taman Beringin urban forest. Medan City, North Sumatra Indonesia. Malaysian For 80(1) 73-84.

[22] Damara DY, Wardhana IW and Sutrisno E 2017 Analisis dampak kualitas udara karbon monoksida (CO) di sekitar Jl. Pemuda akibat kegiatan car free day menggunakan program caline4 dan surfer (studi kasus: Kota Semarang) Jurnal Teknik Lingkungan 6(1) 1-14 [in bahasa]

[23] Sulistiyorini NR, Darwis RS and Arie Surya Gutama AS 2015 Partisipasi masyarakat dalam pengelolaan sampah di Lingkungan Margaluyu Kelurahan Cicurug Share Social Work Jurnal 5(1) 71-80 [in bahasa]
[24] Rizal M 2011 Mesin ‘arsitektur ‘elektro analisis pengelolaan persampahan perkotaan (Studi kasus pada Kelurahan Boya Kecamatan Banawa Kabupaten Donggala) Jurnal SMARTek 9(2) 155-172 [in bahasa]

[25] Nevers N 2000 Air pollution control engineering Second Edition. McGraw-Hill: Singapura.

[26] Soedomo M 2003 Kumpulan karya ilmiah pencemaran udara ITB Press: Bandung [in bahasa]

[27] Mahyudin, Soemarno and Prayogo TB 2015 Analisis kualitas air dan strategi pengendalian pencemaran air Sungai Metro di Kota Kepanjen Kabupaten Malang J-PAL 6(2) 105-114 [in bahasa]

[28] Findayani A 2015 kesiapsiagaan masyarakat dalam penanggulangan banjir di kota semarang Jurnal Geografi 12(1) 103-114 [in bahasa]

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