

Surabaya Strategy to Answer Air Pollution Improvement

Intan Ayu Pratiwi¹ and Rusdiana Puspa Ayu²

¹*Biology Department, Airlangga University, Surabaya, Indonesia*

²*East Java Province Environmental Agency, Indonesia*

(Received 27 September, 2019; Accepted 1 March, 2020)

ABSTRACT

Surabaya as metropolitan city and 2nd biggest city in Indonesia has a challenge especially in air pollution. Increasing population, mass transportation, industry and regional economic give bad result in air pollutant. Increasing population from 2014 to 2017 goes up until 7.75%. Increasing the population can also increase the level of air pollution. Problems in this research is to present of result and analysis of management of green open space Kota Surabaya to achieve air pollutant control. Focus of this research is not only on biology and environment but also on economic, population and climate in Surabaya. This research was conducted using qualitative methods from observation and official documents of related instance. This research concludes that green open space management in 2014 and 2017 that are managed by DinasKebersihan dan Pertamanan (Park and Sanitary Office) Kota Surabaya has good strategy in plant selection to increase the quality of air. Although area of green open space had minor reduction and increase in population as well as economic sector. In 2017, Surabaya can archive 90.26 value of air pollution index or increase 6.83% from 2014. This condition present the quality of green open space can be reached beyond plant selection.

Key word : Surabaya, Air, Pollutant, Index, Green

Introduction

Surabaya is located in the Northern Coast of East Java Province. Surabaya city borders with Madura Strait in the north and east, Sidoarjo Regency and Gresik Regency for the south and west sectors respectively. Surabaya has river estuary of Kalimas as part of the fraction of Brantas River. Surabaya administratively is divided into 163 districts and 31 sub-districts and central of East Java capital. Surabaya as the metropolitan city for second place after Jakarta, had changed to be infrastructure growing city. Development in strategic area already finished such airport, expansion of port, interconnecting highway and the biggest bridge between Surabaya-Madura. As the most crowded city and

central economy in East Java Province, Surabaya metamorphose as the target of migration with having various activities and very dense population (Pratiwi, 2012). Complexity in Surabaya as economic, migration, population, industry city creates some issues.

One of Surabaya's issues is the environment is air pollution. Air Pollution is spooky problem in big city, and Surabaya faced this problem as main objective government agenda to mitigate pollution issues. Gulia *et al.* (2015) investigated through the view of satellite record (Aerosol Optical Thickness) for Surabaya and other big cities. They concluded that the human population will relate to pollution. Air pollution is contributed to human activities, such as transportation, industry, economic/com-

mercial and domestic sector (Gusnita *et al.*, 2015). Approximately 70% of urban air pollution has been caused by vehicle emissions in urban as well as in the central city (Ikhlas *et al.*, 2017; Islam *et al.*, 2013). Firdaus *et al.* (2016) studied distribution SO₂ and Respiratory Infection cases in Rungkut, as industrial area in Surabaya. The result give a positive correlation that higher SO₂ increases higher human respiratory infection exposed. The higher CO₂ emission in air also can disturb the balancing system and, in the end, will affect the environment and human well-being. Maulana *et al.* (2014) reported that the type of housing in Surabaya gives different results of CO₂ emission.

Indonesia government regulations no 41/1999 is created to control air pollution (Akhadi, 2009). Air pollution has a direct relation with Respiratory Infections (Arifin and Sukoco, 2009). The parameters to indicate air quality is the Air Quality Index (AQI). AQI as an indicator of air quality not only for the government to consider for the green decisions but also for getting awareness in society because reaching the good air quality can be applied with a combination of all Stakeholders to improve air quality (Gulia *et al.*, 2015). Air quality index in Indonesia refers to Regulation of Minister of Environment no 41/1999. This study is devoted to review the air quality from 2014 to 2017 in Surabaya. Presenting interface data between open green spaces, regional economic, population, raining days and number of transportations in Surabaya to get a clear picture of air pollution factor and lesson to learn of Surabaya strategic to increase air quality index.

Table 1. Information of Primer Data

| Data | Source | Type | Note |
|--|--|-------------------|---|
| No. of Open Space and Area | Development Planning Agency of Surabaya | Official Document | Proceed by Environmental Services of Surabaya |
| Population Density, Gross Regional Domestic Product at Current Market Price by Industry, and No. of Industry (Big and Medium Enterprise) | Statistics Indonesia (Surabaya and East Java) | Official Document | |
| Air Quality Index | Environmental Services of Surabaya | Official Document | |
| Number of Vehicle | Regional Revenue Agency East Java and Surabaya Dept. of Transportation | Official Document | Proceed by Environmental Services of Surabaya and Surabaya Mayor Regulation 76/2016 |

Research Procedure

This research conducted through the qualitative method. Data collective has been done with data statistics and official literature. Following the objective of the research with data taken from 2014 until 2017 in Surabaya as below.

Air quality index refers to Table 1 has been calculated with the adoption of the Program European Union Model and converted to be Air quality index as Eq. 1. AQI is an air quality index as a unitless value. IEU is European Union Index from a combination of SO_x and NO_x.

$$AQI = 100 - \left(\frac{50}{0.9} \times (IEU - 0.1)\right) \quad .. (1)$$

Regulation of Indonesian Minister of Environment notice about range and category for air quality index as Table 2 below.

Table 2. Range Value of Air Quality Index

| Category | Range Value of AQI |
|-----------|--------------------|
| Excellent | AQI > 90 |
| Very Good | 82 < AQI ≤ 90 |
| Good | 74 < AQI ≤ 82 |
| Enough | 66 ≤ AQI ≤ 74 |
| Less | 58 ≤ AQI < 66 |
| Very Less | 50 ≤ AQI < 58 |
| Alert | AQI < 50 |

Results and Analysis

Surabaya gives a big effort to increase space for open green areas. Although Surabaya already crowded city, from 2015 continuously until 2017,

area for green space has been enlarged to be 7286.56 ha from 6840.02 ha. The conversion area to be open green space increased only by 6.53%. Hakim, (1987) separated open green space to be active and passive which depends on the activity in this area. Table 4 shows the number of green open spaces. In 2017, the total active garden increased to be 120% and 5.56% for the passive garden from 2014.

Table 3. Percentage of Green Space in Surabaya Area

| Year | Open Green Space (ha) | Percentage |
|------|-----------------------|------------|
| 2014 | 6840.02 | 20.45% |
| 2015 | 6853.09 | 20.49% |
| 2016 | 7268.45 | 21.73% |
| 2017 | 7286.56 | 21.78% |

The increasing population in Surabaya as well as regional value, the number of the vehicle in Surabaya has a positive trend statistically as shown in Table 7. Famoso *et al.* (2015) concluded base data in Veneto, one of heavy traffic in Italy. That traffic jam contributes to air pollutant as well. Some papers have a typical pattern that higher vehicles will affect air pollutants (Gualtieri *et al.*, 2017; Battista, 2017). Table 7 will indicate that the potency of air pollutants in 2017 will be higher because of the higher of number of vehicles.

For total industry in Surabaya already reduced to be 8.6% from 2014 to 2017 as Table 8. If compared with the total population, it roughly can speak that only 8.6% may already eliminated or merge into others and become bigger.

Table 9 explains for percentage of rainy days every year. The percentage of rainy days increases by 4.2% in 2014. Mishra *et al.* (2012) studied that rain can reduce air pollution. The maximum values of pH, chloride, and carbon dioxide were recorded as 7.39, 17.04 mg/L and 9.2 mg/L during the initial rains and decreased to 24, 5.98 mg/L and 2.2 mg/L. High values found earlier indicate the washout of the air pollutants. Second opinion by (Kwak *et al.*, 2017). The research conducted in Seoul, South Korea using path analysis. They reported that heavy rainy

Table 4. Number of Green Open Spaces in Surabaya

| Year | Active | | | | | Passive | | | | |
|------|---------|-------|-------|------|------|---------|-------|-------|------|------|
| | Central | North | South | East | West | Central | North | South | East | West |
| 2014 | 10 | 9 | 10 | 20 | 5 | 62 | 49 | 41 | 79 | 39 |
| 2017 | 15 | 15 | 23 | 42 | 24 | 65 | 52 | 49 | 83 | 36 |

Table 5. Dense Population in Surabaya

| Year | Man | Woman | Total |
|------|-----------|-----------|-----------|
| 2014 | 1,430,985 | 1,422,676 | 2,853,661 |
| 2015 | 1,473,640 | 1,469,888 | 2,943,528 |
| 2016 | 1,507,474 | 1,509,179 | 3,016,653 |
| 2017 | 1,534,438 | 1,540,445 | 3,074,883 |

Table 6. Gross Regional Domestic Product at Current Market Price by Industry

| Year | GRDP (In Billion) |
|------|-------------------|
| 2014 | 365,350.94 |
| 2015 | 406,223.50 |
| 2016 | 451,383.24 |
| 2017 | 495,026.30 |

Table 7. Number of Vehicles in Surabaya

| Year | 2014 | 2015 | 2017 |
|--------------------|-----------|-----------|-----------|
| Number of Vehicles | 2,285,382 | 2,361,250 | 2,777,739 |

Table 8. Number of Big and Medium Industries in Surabaya

| Year | Number |
|------|--------|
| 2014 | 942 |
| 2015 | 957 |
| 2017 | 867 |

Table 9. Percentage of Rainy Days in Surabaya

| Year | Station | | | |
|------|-----------------------|-----------------------|--------|---------|
| | Perak 1 st | Perak 2 nd | Juanda | Average |
| 2014 | 44.66% | 39.73% | 42.19% | 42.19% |
| 2017 | 46.03% | 45.75% | 47.40% | 46.39% |

Table 10. Air Quality Index in Surabaya

| Year | AQI |
|------|-------|
| 2014 | 84.49 |
| 2015 | 83.85 |
| 2016 | 89.57 |
| 2017 | 90.26 |

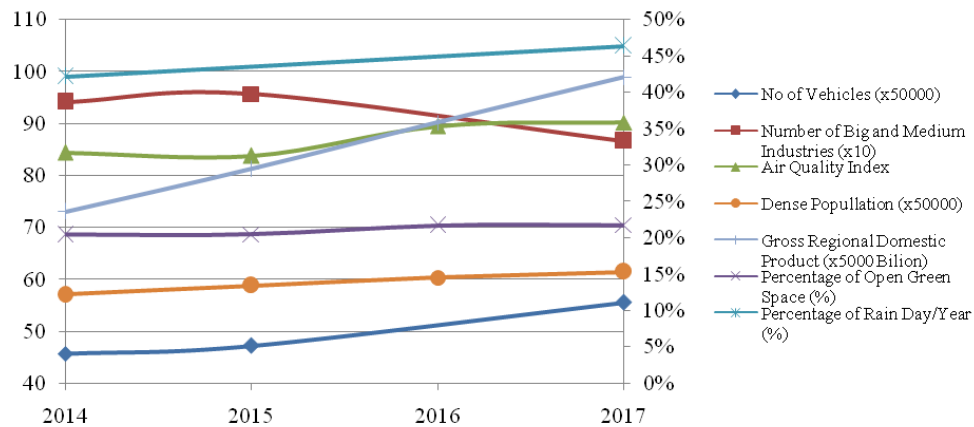


Fig. 1. Interface of Air Quality Index with Other Parameters

can trigger of pollutants decreasing acceleration because of low visibility.

Air Quality Index is recorded from 2014 to 2017 in Table 10. The positive trends until 90.26 in 2014 can be categorized as “Excellent” as Table 2.

All data are shown in Fig. 1. Although the number of industries reduces but the capacity of the cash flow of industries in Surabaya may increase. It can be seen in the higher gross regional domestic product. The impact of this condition makes a dense population in Surabaya higher (Tjiptoherijanto, 1999). The dense population will increase the number of vehicles for transportation higher (Gusnita *et al.*, 2015). Although for the percentage of open green space and rainy percentage every year is relatively constant, the air quality index can increase to 90.26 or 6.8% higher than 2014 data.

The selection of trees and public contribution may have big portion to increase of air quality index in Kota Surabaya. Sukmawati, *et al.* (2015) found that *Polyalthelongifolia*, *Pterocarpus indicus*, and *Cerberamanghas* are dominant in their survey on some green space areas such as as Taman Flora Bratang, Bundaran Waru, and Kebun Bibit Wonorejo). They conclude that emission can be reduced in green open space. Santoso *et al.* (2018) recommended the kind of trees in 2010 to challenge emission reduction in Surabaya and Susanto *et al.* (2018) suggest trees selection in green belt area between industry and city. Surabaya may already implement the quality of green open space beyond trees selection. Fu’adah *et al.* (2016) concluded that the strategy of green open space has good administrative and execution. In terms, Surabaya invites the public and private sectors to optimize of green open

space. Fu’adah *et al.* (2016) also reported that public contribution to support Surabaya program “Green and Clean” with education and action to manage and control waste.

Conclusion

Air quality index from 2014 to 2017 increased by 6.83%. Interface data that will reduce air quality index prediction such as increase dense population, economic domestic, number of vehicles and constantly new green open space have been broken in 2016 and 2017 because of air quality index is higher than 2014. These phenomena may be played by trees selection and public contribution in Surabaya. Further research shall be conducted to investigate the base trees population in Surabaya and specific investigate impact program for air quality improvement in Surabaya.

References

- Akhadi, 2009. Ekologi Energi Mengenal Dampak Lingkungan Dalam Pemanfaat Sumber-Sumber Energi. Yogyakarta, Graha Ilmu.
- Arifin and Sukoco, 2009. Pengendalian Polusi Kendaraan Bandung, Bandung. Alfabeta.
- Battista, G. 2017. Analysis of the Air Pollution Source in the city of Rome (Italy). *Energy Procedia* (126) : 392-397.
- Famoso, F., Lanzafame, R., Momforte, P., Oliveri, C. and Scandura, P. F. 2015. Air Quality Data for Catania: Analysis and Investigation Casestudy 2012-2013. *Energy Procedia* (81) : 644-654
- Firdaus, Aris Putra and Sulistyorini. 2016. Kadar SO₂ and Kejadian ISPA di Kota Surabaya menurut Tingkat Pencemaran yang berasal dari Kendaraan

- Bermentor. Simposium I Jaringan Perguruan Tinggi untuk Pembangunan Infrastruktur Indonesia.
- Fu'adah, Anny Maftuqatul, Setyowati and Rr. Nanik, 2016. Aktivitas Partisipasi Masyarakat Kelurahan Jambangan dalam Kegiatan Green and Clean Kota Surabaya. *Kajian Moral and Kewarganegaraan*. Vol 2.
- Gualtieri G., Camilli F., Cavaliere A., De Filippis T., Di Gennaro F. Dini F., Gioli B., Matese A., Nunziati W., Rocci L., Toscano P., Di Lonardo S., Vagnoli C., Zaldei, A. 2017. An Integrated Low Cost Road Traffic and Air Pollution Monitoring Platform to Assess Vehicles Air Quality Impact in Urban Area. *Transportation Research Procedia*. 27 : 609-616.
- Gulia, S. M. Shiva Nagendra, Khare, M. and Khanna, I. 2015. Urban air quality management-A review. *Atmos. Pollut. Res.* 6(2) : 286-304.
- Gusnita, Dessy and Suaydhi, 2015. Emission Estimation of Fuel Consumption and CO₂ Absorption by Green Open Space in Jakarta. *Proceedings of the IConSSE FSM SWCU*, pp. SC. 21-29.
- Hakim, Rustam. 1987. Unsur Perancangandalam Arsitektur Lansekap. Bina Aksara. Jakarta.
- Ikhlas, Nurani, Abdullah, Taufik and Boedisantoso, Rachmat, 2017. Calculation Method of Green Open Space Based on Carbon Emission from Transportation Sector in Surabaya. *The Journal for Technology and Science*. 28 2.
- Islam, J.H., Harianto, M.C. and Wibowo, 2013. Rancang Bangun Alat Pendeteksi Gas CO, CO₂, and SO₂ Sebagai Informasi Pencemaran Udara. *Jurnal Stikom*. 2(1).
- Kwak, H.Y., Ko, J., Lee, S. and Joh, C.H. 2017. Identifying the correlation between rainfall, traffic flow performance and air pollution concentration in Seoul using a path analysis identifying the correlation between rainfall, traffic flow performance and air pollution concentration in Seoul using a path analysis. *Transportation Research Procedia*. 25 : 3552-3563.
- Maulana, Affan Sani; Setiawan, Rulli Pratiwi. Keterkaitan Tipe Huniandengan Emisi CO₂ di Kota Surabaya. *Jurnal Teknik POMITS*. 3. 2014.
- Mishra, A., Singh, A.K., Singh, K. A., Pandey, P., Yadav, S., Khan, A.H. and Barman, S.C. 2012. Urban Air Pollution and Their Effects on Rain Water Characteristics In Lucknow City, India. *Journal of Environmental Research and Development*. 6(4).
- Pratiwi, S.R. 2012. Adequacy Analysis of Private Residence Green Space in Adsorbing CO₂ Emission and Full filling the Human Needs of O₂ in North Surabaya (Case Study : Kenjeran District). Scientific Conference of Environmental Technology IX-2012: 1-6.
- Santoso, Kurniawan Budi; Hakim, Lukman; Ningrum, Esya Racha; Widyatmanti, Wirastuti. 2018. Studi Temporal Pertumbuhan Ekonomi dan Polusi Udara. Studi Kasus: DKI Jakarta, Semarang, dan Surabaya pada Tahun 2005-2015. *Jurnal Meteorologi Klimatologi dan Geofisika*. 5(2).
- Sukmawati, Tria, Fitrihidajati, Herlina; Indah, Novita Kartika. 2015. Penyerapan Karbon Dioksida pada Tanaman Hutan Kota di Surabaya. *Lentera Bio* 4: 1.
- Susanto, Joko Prayitno; Komarawidjaja, Wage. Pembangunan Green Belt sebagai Antisipasi Pencemaran Udara Industri Pupuk di Kalimantan Timur. *Jurnal Teknologi Lingkungan*. 19. 2018.
- Tjiptoherijanto, Prijono, 1999. Urbanisasi and Pengembangan Kota di Indonesia. *Populasi*. 10(2).