Study of the Environmental Quality Index in an Urban Campus Area

N Listyaningrum1*, T Dewanti, T P Wahyudi1, G R Josiana1, Latifah1, R F Ariefin1 and Slamet Suprayogi1

1Department of Environmental Geography, Faculty of Geography, Universitas Gadjah Mada, Indonesia

*noviyanti.listyaningrum@mail.ugm.ac.id

Abstract. Environmental Quality Index (EQI) has been used as a common measurement for environmental quality in Indonesia. However, EQI is only measured in a wide administrative area. In reality, environmental quality measurement in smaller areas is also needed to formulate the right environmental policy. EQI study at Universitas Gadjah Mada (UGM), as an urban campus, is important because it prioritizes the educopolis vision which commits to create a conducive education environment and be responsive to ecological issues. This research aims to identify the EQI of UGM and analyse the vision of educopolis and open system campus related to EQI. The method which is used is mixed-method of quantitative to obtain the EQI value from Air Pollution Index, Water Pollution Index, and Forest Cover Index, as well as qualitative method to review the educopolis vision and open system campus through analysis of strength, weakness, opportunity, threat (SWOT). The EQI in this study is 50.77, categorized as very less. The vision of the educopolis campus in contrast with the current open system campus. The management strategy to improve the EQI is formulated through the management of vehicles, waste, integrated water in Belik and Code sub-watersheds, and urban green space.

Keywords: EQI, SWOT, educopolis, open campus system

1. Introduction

Our environment play role in providing natural resources and a place for us to live. Changes in land surface occur as a result of the increasing human needs. Amidst the increasing human needs followed by development, environmental quality becomes a crucial issue because it is the heart of the objectives of the planning and design [1]. The Ministry of Environment and Forestry has formulated an index that is able to describe the quality of the environment to make it easier for people and decision-makers to understand the environmental quality in Indonesia [2]. The National Development Agency (Bappenas) of Indonesia also has mainstreamed the sustainable development, that one of the indicator is the Environmental Quality Index (EQI) [3].

The area scope that is formulated by the Ministry of Environment and Forestry is very wide, causing inequality. For example, there are gaps among districts within the province that cannot be captured with the index calculation [4]. It is necessary to study the quality of the environment in a narrower area, for example on an urban campus.

UGM is one of the universities that prioritizes the vision as an educopolis campus [5]. The vision of UGM educopolis refers to the commitment to creating a conducive environment for UGM for the learning process in the context of developing interdisciplinary synergies and being responsive to
ecological issues. Post COVID19 campus activities will be even more challenging as we have seen the contrast between environmental conditions before COVID-19 occurrence and during the pandemic. The decreasing campus activities during lockdown lowers the EQI as there is a drastic decrease in the number of motorcycles and cars and possibly raising the environmental standard for the user (students, college staff, and people who lived around UGM). Therefore, UGM should prepare more to realize educopolis vision seriously to guarantee the environmental quality around the campus area. This is also a challenge for UGM because it has an open system campus that accommodates the general public to pass through the UGM with their private vehicles. This open system can have an impact on the quality of the environment at UGM, coupled with community activities around UGM. The forms of community activities around UGM are domestic activities in settlement areas including Terban Village, Sinduadi Village, and Caturtunggal Village, street vendors on Sunday morning and every night on Jalan Persatuan-Jalan Kaliurang, also operations and mobility in Sardjito Hospital and Soedomo Dental and Oral Hospital. The condition is quite different with other universities in general which have a closed system campus which its environment is exclusive and limited from the general public activities.

The objectives of this study are (1) to identify the Environmental Quality Index (EQI) at UGM and (2) to analyse the vision of educopolis and open system campus related to the EQI. A strategy to improve the EQI of UGM is formulated as recommendation by considering the EQI and the SWOT analysis.

2. Methods
The research was conducted at the UGM campus which is administratively located on the border of two regencies/cities, namely in the city of Yogyakarta (Terban Village, Gondokusuman District) and in Sleman Regency (Sinduadi Village, Mlati District and Caturtunggal Village, Depok District). This research combines quantitative and qualitative methods. The quantitative method is used to identify the EQI. The qualitative method is used to examine the vision of UGM as an educopolis campus and open system campus through SWOT analysis.

The stages of this research is presented in Figure 1. Data which was collected in this study varied from 2014 until 2017. After considering the quality of data collected [5], the parameters in EQI calculation [4], and the previous study [6], only data year 2015 could be used in this study. The selected data of 2015 was the most reliable and previously there was a field survey to validate some data such as green space validation. Water and air quality measurement were conducted too but not to change the data which has been collected by Directorate of Assets UGM [5].

![Figure 1. Research flowchart](image-url)
2.1 Environmental quality index

EQI is a quick fingerprint of environmental quality in an area. In this study, the EQI concept refers to the EQI of Indonesia year 2014. The indicators used in the EQI are the Air Pollution Index (API), Water Pollution Index (WPI), and Forest Cover Index (FCI). The weight of each indicator is API 30%, WPI 30%, and FCI 40%. After the EQI value is obtained, the class is determined based on Table 1. UGM EQI is using EQI in 2015.

\[
EQI = 30\% \text{API} + 30\% \text{WPI} + 40\% \text{FCI}
\]  

Table 1. EQI value range.

| Value range   | Class       |
|---------------|-------------|
| 82 < EQI ≤ 90 | very well   |
| 74 < EQI ≤ 82 | well        |
| 66 < EQI ≤ 74 | moderate    |
| 58 < EQI ≤ 66 | poor        |
| 50 < EQI ≤ 58 | very poor   |
| EQI ≤ 50      | extremely poor (alert) |

source: [2]

2.1.1 Air pollutant index. API was obtained through SO\(_2\) and NO\(_2\) parameters in ambient air quality (Table 2), referring to the API parameter in the EQI document of Indonesia 2014. Data on SO\(_2\) and NO\(_2\) concentrations were obtained through the document of Environmental Management and Monitoring Planning UGM (RKL-RPL) 2015 [5].

Table 2. Ambient Air Quality Standard (μg/m\(^3\))

| Parameter | EU  | National | Regional |
|-----------|-----|----------|----------|
| NO\(_2\)  | 40  | 100      | 100      |
| SO\(_2\)  | 20  | 60       | 60       |

source: [7], [8], [9]

API is calculated through the following formula. AI is the Air Index before being normalized into the API EQI, which is the Air Index adopted from the EU model by adjusting the reference or ambient air quality standard based on [8] and [9]. For one year measurement, a reference or quality standard for NO\(_2\) is 100 μg/m\(^3\) and SO\(_2\) is 60 μg/m\(^3\). This adjustment is based on the relatively high NO\(_2\) and SO\(_2\) values at UGM, which exceeds the EU standard with the quality standards of NO\(_2\) 40 μg/m\(^3\) and SO\(_2\) 20 μg/m\(^3\). If no adjustment is made, the resulting API can be negative.

\[
API = \frac{P_{INO_2} + P_{ISO_2}}{2}
\]  

\[
P_{INO_2} = 100 - \left(\frac{SO}{0.9} \times (IU \text{ NO}_2 \text{ or } IU \text{ SO}_2 - 0.1)\right) \quad P_{ISO_2} = 100 - \left(\frac{SO}{0.9} \times (IU \text{ NO}_2 \text{ or } IU \text{ SO}_2 - 0.1)\right)
\]

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P_{INO_2} = 100 - \left(\frac{SO}{0.9} \times (IU \text{ NO}_2 \text{ or } IU \text{ SO}_2 - 0.1)\right) \quad P_{ISO_2} = 100 - \left(\frac{SO}{0.9} \times (IU \text{ NO}_2 \text{ or } IU \text{ SO}_2 - 0.1)\right)
\]

where:

\[P_{INO_2} = \text{pollutant index of NO}_2\]

\[P_{ISO_2} = \text{pollutant index of SO}_2\]

\[AI = \frac{\text{concentration average of NO}_2 \ or \ SO}_2}{IU} = \frac{\text{concentration average of NO}_2 \ or \ SO}_2}{IU}\]

2.1.2 Water pollutant index. WPI is obtained through the parameters of TSS (Total Suspended Solid), DO (Dissolved Oxygen), and COD (Chemical Oxygen Demand) on the quality of surface water (rivers), referring to the EQI document of Indonesia 2011 [10]. The WPI parameter refers to the 2011 indicator due to limited data, especially fecal-coli and total-coliform used in the EQI document of Indonesia 2014. Data on the concentration of TSS, DO, and COD were obtained from the document of Environmental Management and Monitoring Planning UGM (RKL-RPL) 2015 and refers to the quality standards for
river water quality designations (class II) at the national level, such as the EQI document of Indonesia (Table 3) with the value range as presented in Table 4.

| Parameter | National | Regional |
|-----------|----------|----------|
| TSS       | 50       | 50       |
| DO        | 4        | 5        |
| COD       | 25       | 25       |

source: [11], [12]

\[ P_{II} = \sqrt{\frac{\left(\frac{C_i}{L_{ij}}\right)_M + \left(\frac{C_i}{L_{ij}}\right)_R}{2}} \]  

where:

\( P_{II} = \) water quality index

\( C_i = \) concentration of water quality parameter \( i \)

\( L_{ij} = \) concentration of water quality parameter \( i \) toward the water quality standard \( j \)

\( (C_i/L_{ij})_M = \) maximum value of \( C_i/L_{ij} \)

\( (C_i/L_{ij})_R = \) average value of \( C_i/L_{ij} \)

Table 4. Water Quality Status.

| \( P_{II} \) (range) | Water Quality Status |
|----------------------|----------------------|
| 0 ≤ \( P_{II} \) ≤ 1.0 | meet the standard |
| 1.0 < \( P_{II} \) ≤ 5.0 | slightly polluted |
| 5.0 < \( P_{II} \) ≤ 10.0 | moderately polluted |
| \( P_{II} > 10.0 \) | severely polluted |

source: [2]

In particular \((C_i/L_{ij})\) which has a value greater than 1.0, it is necessary to recalculate the new \((C_i/L_{ij})\) as below [13].

\[ (C_i/L_{ij})_{new} = 1.0 + 5 \log \log (C_i/L_{ij})_{measurement} \]  

The DO parameter has characteristics that are opposite to the general parameters, that the higher the DO, the better the water quality (indications of lower pollution). Thus, the value \((C_i/L_{ij})\) for DO should be adjusted as below [13].

\[ \frac{C_i}{L_{ij}} = \frac{C_{im} - C_i \text{ measurement}}{C_{im} - C_{ij}} \]  

where:

\( C_{im} = \) maximum value of parameter (DO), namely 8.26 mg/l for saturated DO value at normal temperature 25°C (Cole, 1983 in [14]).

After obtaining the \( P_{II} \) and water quality status, the WPI calculation is carried out based on formula (8), referring to Table 5.

\[ WPI = \Sigma \text{ value of each water quality standard} \]  

\[ WPI = \Sigma \left( \frac{\text{weight of water quality index \times number of samples at a standard}}{\text{total number of samples}} \right) \]

Table 5. Weight of Index Values on Certain Quality Status.

| Water Quality Status     | Weight of Index Value |
|--------------------------|-----------------------|
| meet the standard        | 70                    |
| slightly polluted        | 50                    |
| moderately polluted      | 30                    |
| severely polluted        | 10                    |

source: [4]
2.1.3 Forest cover index. FCI is obtained through the parameter of forest area divided by total area, referring to FCI in the EQI document of Indonesia 2014. The formula (9) to calculate FCI does not only involve forest cover area and area, but also the ideal percentage of a maximum number of 84.3% (forest cover condition of Papua 1982) and current regulations. The percentage area of 84.3 will give an index of 100, while forest cover of at least 30% of the area [8], gets a value of 50. The forest cover data at UGM is obtained from the results of tree canopy delineation in the 2015 UGM Earth image. 

\[
FCI = 100 - \left\{ 84.3 - \left[ \frac{FCA}{TA} \times 100 \right] \times \frac{84.3}{50}\right\}
\]  

(9)

where:
FCA = forest cover area (green space)
TA = total area

2.2 SWOT analysis
In addition to quantitative methods to determine EQI, qualitative methods are also used to analyze strengths, weaknesses, opportunities, and threats for UGM as a campus that has an educopolis vision with an open system campus.

3. Results and Discussion

3.1 Components of EQI
3.1.1 Air pollutant index at UGM. Air quality measurements on the UGM campus were carried out at seven points, namely Graphic Street, Faculty of Engineering, Fauna Street, Karangmalang UGM Roundabout, MM UGM Intersection (Kaliurang Street), Purnabudaya Crossroad, and Wisma Kagama. The seven points were chosen because at these points quite a lot of vehicles pass every day, so it is important to measure the air pollution index due to vehicles that pass every day.

Based on the Ambient Air Quality Standards issued by [7] and [8], only one measurement point exceeds the NO\textsubscript{2} quality standard and four measurement points exceed the SO\textsubscript{2} quality standard. The NO\textsubscript{2} content in the Faculty of Engineering far exceeds the quality standard threshold, which is 192.95 \(\mu\text{g/m}^3\). While the NO\textsubscript{2} content in the air of an environment should not exceed 100 \(\mu\text{g/m}^3\) for a measurement period of one year. At other measurement points, the NO\textsubscript{2} content is relatively lower and still meets the ambient air quality standards.

The value of SO\textsubscript{2} content at seven measurement points varied. A total of four location points have SO\textsubscript{2} content that exceeds the ambient air quality standard threshold, including Jalan Fauna, Bundaran Karangmalang UGM, Perempatan (Crossroad) Purnabudaya, and Wisma Kagama. Even on the Jalan Fauna, it is measured to have a very high SO\textsubscript{2} content, which is 381.32 \(\mu\text{g/m}^3\). On Jalan Grafika, Faculty of Engineering, and Perempatan MM UGM (Jalan Kaliurang), the SO\textsubscript{2} content still meets ambient air quality standards.

The high and low content of pollutant parameters cannot be determined from one type of pollutant source. The content of NO\textsubscript{2} and SO\textsubscript{2} in the air is mixed with various pollutant sources. One of the agents that carry particulates and pollutant compounds is wind. Thus, in measuring air quality as a material for calculating API, it is equipped with data on wind direction and speed so that the source of air pollutants can be known with certainty.

| Location                        | NO\textsubscript{2} (\(\mu\text{g/m}^3\)) | SO\textsubscript{2} (\(\mu\text{g/m}^3\)) |
|---------------------------------|------------------------------------------|------------------------------------------|
| Jalan Grafika                  | 39.48                                    | 43.60                                    |
| Fakultas Teknik                | 192.95                                   | 42.12                                    |
| Jalan Fauna                    | 57.96                                    | 381.32                                   |
| Bundaran Karangmalang UGM      | 35.33                                    | 81.56                                    |
| Perempatan MM                  | 55.42                                    | 47.42                                    |
The value of the Air Pollution Index (API) which is calculated at all measurement points is 38.47. This value is lower than the API of Yogyakarta City which is 78.69 [15] and DIY which is 83.65 [2]. Yet, the API value of this study area is higher than in Manado City, which is 30.56 [16]. The EU reference used by DIY was NO$_2$ of 40 μg/m$^3$ and SO$_2$ of 20 μg/m$^3$, whereas in this study, when the EU reference was used, the pollutant indexes of NO$_2$ and SO$_2$ were very small. The low API score at UGM is caused by the high concentrations of NO$_2$ and SO$_2$ pollutants. According to the Directorate of Assets UGM [17], the measurement of air quality at UGM does not represent the condition of the entire UGM campus. This is due to the small number of measurement locations and the selected measurement points are only in locations that are quite crowded by vehicles passing so that the air quality value obtained is low. It is recommended that in the next data collection, the measurement location points at UGM are selected based on grids or stratified sampling so that they are representative of the air quality at UGM.

3.1.2 Water pollutant index at UGM. The surface water quality is presented in Table 7. When viewed from the parameters, the Total Dissolved Solid (TSS) content of the four measurement points, there are three points that have TSS content exceeding the predetermined quality standards, namely upstream and downstream of the Code River and upstream of the Belik River. The excess of TSS levels from the predetermined quality standard is caused by the intensity of the flow being quite fast so that the dissolved solids have not experienced maximum sedimentation. For the Dissolved Oxygen (DO) parameter, two of the four measurement points, namely upstream of the Belik River and downstream of the Belik River meet the quality standards that have been set (above 5 mg/l) but exceed the saturated DO level at 25°C (8.26 mg/l). The high level of DO in the Belik River is caused by a fall along the river which causes turbulence and intensive oxygen exchange in the water. The content of Chemical Oxygen Demand (COD) at the four sampling points meets the quality standards so it is safe for water use with class II quality standards. While in Code River, the downstream is worse than the upstream, following the pattern of WPI in Manado City [16].
The three parameters (TSS, DO, and COD) were used to determine the status of water quality at each sample point (Table 7). Two samples were declared to meet the quality standards and two samples were declared lightly polluted after the water quality status was calculated. In general, the Water Pollution Index (WPI) at UGM has a value of 60 out of 100 which can be interpreted as that the quality of surface water at UGM has a fairly good quality (Table 8). The surface water quality standard at UGM meets the class II water quality standard, i.e. water can be consumed for drinking water purposes but must be treated with special treatment. UGM itself has used the surface water of the Belik River for the supply of Campus Drinking Water Filling Stations (SPAM) which are spread throughout the UGM area and have been processed beforehand to be safe for consumption.

### Table 8. Water Pollutant Index Determination in UGM Area, 2015

| Water Quality Standard | Number of Samples | Contribution (%) | Weight of Index Value | Index Value |
|------------------------|-------------------|------------------|-----------------------|-------------|
| meet the standard      | 2                 | 50               | 70                    | 35          |
| slightly polluted      | 2                 | 50               | 50                    | 25          |
| moderately polluted    | 0                 | 0                | 30                    | 0           |
| severely polluted      | 0                 | 0                | 10                    | 0           |
| total                  | 4                 | 100              |                       | 60          |

Although UGM WPI is quite good, we need to be careful because surface water at UGM is an integral part of the Belik sub-watershed system and the Code sub-watershed. Community activities in locations that are more upstream than UGM will have an impact on the surface water of the Belik and Code Rivers. Surface water management at UGM will not succeed or will not meet the quality standards if it is not integrated with the watershed/sub-watershed system.

3.1.3 Forest cover index at UGM. The forest cover at UGM is approached with a special Green Open Space (RTH) entitled tree. The results of image data processing are shown in Figure 2 and Table 10.
Table 9. Area of Green Space at UGM, 2015

| Type                      | Area       | (%)       |
|---------------------------|------------|-----------|
| Green path                | 111,667.53 | 6.86 %    |
| Park                      | 386,151.44 | 23.73 %   |
| Arboretum                 | 44,687.11  | 2.75 %    |
| Green open space with canopies | 542,506.08 | 33.34 %  |
| Non-green open space with canopies | 1,084,522.63 | 66.66 % |
| Total                     | 1,627,028.71 | 100.00 % |

FCI 53.08

Delineation of forest cover at UGM is a tree canopy that is divided into three classification areas, namely arboretum, green path, and park. Grassland or fields are not included in the delineation so that the area obtained can approach the actual forest cover in the form of tree stands. In addition, the reason grass is not included in the delineation is because the function of the field or grassland at UGM has changed its function to a parking area so that physically it is not like a forest whose plant organ system is complete consisting of roots, stems, and leaves that can carry out activities, photosynthesis perfectly so that it affects the ecosystem and microclimate. Viewed from the aspect of comfort, grassland is not comfortable because it is arid, hot, and does not provide shade. In addition, forest cover delineation ignores areas with single trees or those that have very long distances from surrounding trees because they do not meet the area of one mapping grid (0.4 cm$^2$) at a scale of 1:10,000 with a minimum area of 0.4 ha [19].

The classification of forest cover into three (arboretum, green belt, and park) which is approached with green open space refers to the [19]. The regulation defines green open space as an elongated area/lane and/or clustered, whose use is more open, where plants grow, either growing naturally or intentionally planted. From this understanding, the classification of green open space at UGM is divided into an arboretum which is a natural and grouped space for plants/trees to grow, a garden is a space for growing plants/trees made by humans (artificial) that clumps together, and the green line is an elongated green space or forms a pathway by trees that grow naturally or artificially.

Table 10 shows that 33.34% of the land at UGM is green open space with a tree title and the rest is non-tree open green space, including parking lots [20]. The FCI obtained is 53.08, close to the FCI of the Kraton residential area, Yogyakarta City [21]. This FCI value is greater than 50, indicating that UGM forest cover still meets the minimum requirements for green open space for a city, namely FCI 50 with a percentage of green open space of 30%, but it is not as good as forest cover either in Manado which is 89.60 [16] or in Papua which is used as the highest reference for FCI, which is 100 with the percentage of the total area covered forest 84.3%.

The construction of campus facilities and infrastructure can reduce the number and area of green open space at UGM. The number of new buildings built at UGM leaves the name Bulaksumur which comes from the word bulak which means forest and sumur which means well. In the past, UGM was a shady forest area with dense tree stands. Because of the need and development, the preservation of environmental functions must still be preserved. UGM needs to carry out reforestation policies and restrictions on development and land conversion so that green open space at UGM is maintained. If the decrease in green open space at UGM is not managed, the impacts that can occur are changes in air temperature and microclimate which tend to be hotter, reduced flora and fauna that depend on certain flora, narrow space for shelter and relaxation, and can cause catastrophic urban flooding due to land loss, rainwater catchment.

The concentration of green open space with the highest density is around the lakes and valleys of UGM, the arboretum of Forestry and Biology, and in the western part of the UGM Faculty of Engineering. The existence of green open space that is still quite a lot in these areas has an impact on
the level of the Water Pollution Index and Air Pollution Index. The air will be cleaner because of the large number of particulate and dust settlers, filter CO$_2$, and produce a lot of O$_2$ from the photosynthesis process of plants. With the land covered with dense trees, the amount of runoff and erosion can be inhibited, so that surface water does not accommodate much sedimentation from erosion. This also makes FCI has the highest weight compared to WPI and API that make up EQI.

Green open space treatment also has an important impact on the continuity of its existence. It is necessary to apply selective logging and replacement of old trees to anticipate the dangers around them if an old tree suddenly collapses due to rain and strong winds. The trees inventory is one of the activities that can be carried out to restore the minimum amount of vegetation that must exist. So far, the number of trees at UGM has reached 5,873 trees that are scattered but not including those that grow in both the Forestry and Biology arboretums. The most abundant type of vegetation is *gladokan* (*Polyalthia* sp.), with a total of 975 trees [5], [17]. Making parks and green lanes on every street at UGM can increase the existing green open space. In general, green open space at UGM in 2015 still meets the minimum requirements set, however, UGM needs to preserve and be aware of the decrease in green open space that still exists because the percentage of green open space at UGM is almost close to the minimum limit (30%), which is 33.34% of the total area of UGM.

### 3.2 EQI results

Determination of EQI at UGM is obtained by analyzing each of the constituent parameters such as API, WPI, and FCI spatially. The results of API, WPI, and FCI calculations show the UGM EQI value of 50.77. Based on KLHK [2], this value shows that UGM EQI is in a very poor class, lower than in Manado City [16], similar to the environmental quality of the Kraton residential area, Yogyakarta [21]. Even though it belongs to a very poor class, the score is still better than the EQI of Yogyakarta City in the same year. One of the factors that cause such EQI value is the high level of air pollution. The number of transportation activities that take place around UGM and the nature of the UGM campus which has an open system campus makes it easy for public transportation to enter and exit the UGM area.

\[
\text{EQI} = \left( \frac{20}{100} \times 38.47 \right) + \left( \frac{60}{100} \times 60 \right) + \left( \frac{40}{100} \times 53.08 \right) = 50.77
\]

EQI can be used to measure the achievement of environmental management programs. Law Number 32 of 2004 concerning Regional Government [22], among other things, mandates that environmental affairs are one of the affairs that are left to the regions. With the existence of an environmental quality index, especially regional-based, it is hoped that it can be an input for decision-makers both at the central and regional levels to determine the direction of environmental management policies in the future. EQI can help to sharpen the priority of programs and activities in improving the quality of the environment, especially at UGM. By knowing the environmental media that is still not good, the existing resources can be targeted more precisely so that it will be more effective and efficient. The value of the UGM EQI shows the need for the role of the government, the UGM academic community, and the general public to maintain better environmental conditions and maintain environmental functions in the context of sustainable development [23]. Although the EQI condition is very poor, the condition of understanding and good student knowledge can be an important capital for the government and society to move programs that involve the education sector. This good understanding and knowledge of students are supported by the vision of the educopolis campus.

### 3.3 SWOT analysis of EQI at UGM

SWOT analysis related to EQI at the UGM campus area is shown in Table 11. UGM strength related to EQI is the surface water of the Belik River at UGM which is processed into drinking water through the SPAM system. This encourages UGM to maintain the quality of surface water. One way to maintain the quality of surface water is to control the quantity, namely through pond retention [24]. In addition, every laboratory activity that produces B3 waste is processed first before being discharged into the river, while the rest that cannot be handled will be taken to West Java. In terms of forest cover, UGM has green belts and parks that can be developed and an arboretum that can be preserved. Vegetation in the arboretum, green belts, and parks can hold particulates and other contaminants, absorb CO$_2$ emissions from around
the UGM area, and produce O$_2$ again. The vegetation can also reduce the rate of erosion by surface runoff so that sedimentation in rivers can be suppressed.

The weakness that UGM has regarding EQI is that although vegetation can reduce the rate of surface erosion, most of the land cover is now impermeable (built-up), namely with the presence of blocks and asphalt. Green open space at UGM, especially parks and green lines from time to time, can decrease from time to time, from what was previously called Bulaksumur, initially there was forest, now green open space is approaching 30% of the total area of UGM. As a result, microclimate control and air pollution can be reduced.

The opportunity that will be achieved by UGM related to EQI is that UGM realizes the educopolis vision, namely education that is responsive to ecological issues. The vision of educopolis teaches the importance of learning in a conducive environment, environment-based education and activities, and re-awakens the important role of the environment in life. The vision of educopolis will gradually lead UGM to become a semi-closed system campus, one of which has been realized is the closing of Jalan Olahraga - Jalan Notonagoro at the Karangmalang Roundabout for the general public and the relocation or diversion of the Sunday morning market route from the previous route. The Agro-Socioyustisia Road-Sports Road [25], is now the Agro-East Ring Road-Notonagoro Road. However, further changes to the UGM system to become semi-off-campus will slightly contradict UGM identity as a populist (kerakyatan) university, as stated in the [26]. The semi-closed system campus will also change the function of the environment for cultural elements because the community's space for movement is slightly hampered. UGM's educopolis vision is also supported by the behavior of education personnel who prioritize sustainability [27].

Table 10. SWOT Analysis of EQI at UGM campus

| I n t e r n a l | Strength (S)                                                                 | Weakness (W)                                                      |
|--------------|------------------------------------------------------------------------------|------------------------------------------------------------------|
|              | -SPAM from Belik river                                                       | -green space conversion (especially for green path and park) at campus area, increasing of impermeable land surface |
|              | -Hazardous waste treatment by UGM                                            |                                                                  |
|              | -Arboretum preservation by UGM                                               |                                                                  |

| E x t e r n a l | Opportunity (O)                                                              | Threat (T)                                                        |
|--------------|------------------------------------------------------------------------------|------------------------------------------------------------------|
|              | -Educopolis vision of UGM                                                    | -Open system campus and university identify 'populist or kerakyatan' |
|              | -Merti Code tradition                                                        | -Emission standard of Euro 2 in Indonesia                        |
|              | -Public work service of DIY on Code river riparian                           | -Belik and Code subwatershed arrangement: upstream—UGM—downstream |
|              | -Bank of waste practice by the community of Code riparian                    |                                                                  |
|              | -Movement of river restoration and Code river cleaning                        |                                                                  |
|              | -Measurement of air quality at some points in UGM                            |                                                                  |
|              | -Campus bike and environmentally friendly vehicle fuel                        |                                                                  |

Source: Data analysis, 2017

Another UGM opportunity is the existence of UGM in the sub-DAS Code. Now, efforts have been made to maintain the surface water of the Code River to maintain its sustainability, including (1) relocation of slum settlements to flats built by the DIY Public Works Department, (2) waste bank transaction practices, and (3) river restoration sociopreneurship movement initiated by Civil and Environmental Engineering UGM [28], and (4) river clean-up movement every two weeks by the community. The program is integrated through the Merti Code, which is a form of cultural adaptation that aims to reaffirm the importance of the role of water, rivers, and palaces in growing and maintaining the prosperity and culture of the Javanese people [28].
UGM air quality is also an opportunity, namely the air pollutant index at UGM can be of high value or the concentration of air pollutants at UGM can be of low value. This will happen if air quality measurements are carried out evenly, not only at densely populated points of motorized vehicles. In the future, UGM's next opportunity is optimizing campus bicycles and developing hybrid cars with environmentally friendly fuel.

Threats that disturb UGM related to EQI are the open system campus that applies at UGM and UGM's identity as a populist university. The open system campus accommodates transportation in and out of UGM, although tickets are allowed. There is quite a lot of transportation for the UGM academic community, especially if it is added to the general public. Transportation in the form of motorized vehicles produces emissions that can increase the concentration of air pollutants including SO$_2$ and NO$_2$, especially in Indonesia still using fuel with Euro 2 standards [29] whose combustion results are not yet complete. Another threat is that if UGM's identity as a populist university is maintained, it will be difficult to increase EQI. This happens when the general public around UGM is not aware of the environment, even though UGM has launched environmental education for the UGM academic community. In terms of water quality, UGM will be threatened with water quality degradation if water resource management is not integrated between upstream-UGM-downstream related sub-watersheds, namely Belik sub-watershed and Code sub-watershed.

4. Conclusion

The Environmental Quality Index (EQI) at UGM is 50.77 from API of 38.47, WPI of 60.0, and FCI of 53.08 and is in the very poor category. The status of the future vision of the educopolis campus for UGM is contrary to the current UGM open system campus. On the one hand, the vision of educopolis can increase EQI at UGM which will slowly operate on a semi-closed system campus. On the other hand, the vision of an educopolis that will have a semi-closed system campus will change the function of the environment, especially for the cultural element, because the community space for movement is slightly hampered. This is also contrary to UGM identity as a populist university. The environmental management strategy to improve EQI at UGM is formulated through the management of air, water, and green open spaces: suggesting restrictions on private vehicles or increasing the capacity of campus internal vehicles and closing some roads will be recommended so that UGM does not have a fully open system campus; maintain the quality of groundwater and surface water at UGM by treating waste and water management must be integrated with the Belik sub-watershed and Code sub-watershed; and maintain or increase the tree canopy of green open spaces. For further research, it is recommended to use more data in terms of space and time to compare spatially or temporally.

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