Journal of Natural Resources and Environmental Management
12(4): 720–728. http://dx.doi.org/10.29244/jpsl.12.4.720–728
E-ISSN: 2460-5824
http://journal.ipb.ac.id/index.php/jpsl

Analysis of the factors that influence the environmental quality index in Bekasi Regency

Nurul Iswari, Arief Budi Kusuma

Master Program of Natural Resources and Environmental Management Science, Graduate School, IPB University, IPB Darmaga Campus, Bogor, 16680, Indonesia

Article Info:
Received: 02 - 09 - 2022
Accepted: 15 - 09 - 2022

Keywords:
Bekasi Regency, delphi, EQI

Corresponding Author:
Nurul Iswari
Master Program of Natural Resources and Environmental Management Science, Graduate School, IPB University;
Tel. +6281384421147
Email:
nuruliswari@apps.ipb.ac.id

Abstract. *Environmental quality index (EQI) is needed to describe the initial indication of the environmental conditions of an area in a certain period. Bekasi district, the largest industrial area in Indonesia and Southeast Asia, faces environmental damage that can threaten the quality of human life. Local governments need the determination of the environmental quality index of Bekasi Regency to get quick conclusions from environmental conditions in Bekasi Regency. Many factors can affect the environmental quality index in Bekasi Regency, both direct driving factors and supporting factors. Twenty-four assessment instruments must be assessed by nine expert panelists from several regional agencies. The Delphi method was used to obtain consensus from two rounds of interviews with expert panelists. Changes in land cover, type of land cover, household solid waste pollution, household liquid waste pollution, industrial air pollution, and industrial liquid waste pollution are the direct driving factors that most influence the environmental quality index in Bekasi Regency. Meanwhile, population growth and population migration are the supporting factors that most influence the environmental quality index in Bekasi Regency.*

How to cite (CSE Style 8th Edition):
Iswari N, Kusuma AB. 2022. Analysis of the factors that influence the environmental quality index in Bekasi Regency. JPSL **12**(4): 720–728. http://dx.doi.org/10.29244/jpsl.12.4.720–728.

INTRODUCTION

According to the Regulation of the Minister of Environment and Forestry of the Republic of Indonesia Number 27 of 2021 concerning the Environmental Quality Index, the Environmental Quality Index (EQI) is a value that describes the environmental quality of an area within a particular time. EQI is obtained compositely from the values of the Water Quality Index (WQI), Air Quality Index (AQI), Land Quality Index (LQI), and Sea Water Quality Index (SWQI). The EQI of each region contributes significantly to the calculation of national EQI, whereas national EQI is obtained from the sum of each provincial EQI multiplied by the weight of the province. The area in the province of West Java that has the most significant number of industrial estates in Indonesia is Bekasi Regency. Bekasi Regency, the most significant industrial area in Southeast Asia (Agustina 2021), is now facing the threat of environmental damage. This condition is to the results of research by Ahmed *et al.* (2022) in the Asia-Pacific region that industrialization plays a role in economic growth but contributes to the impact of environmental damage and threatens the quality of human life.

Bekasi Regency is one of the outermost zones of the Jakarta metropolitan area, which is directly affected by the metropolitan core area (Indraprahasta 2013 and Pravitasari *et al.* 2015 in Kurnia *et al.* 2020). Given the high population of Bekasi Regency, which is 3.157.962 people, and the population growth rate of 1,93% based

on the results of the interim population projection for 2020-2023 (Bekasi Regency in 2022), the pressure on the carrying capacity of the environment and the quality of the environment should be a concern. Therefore, it is necessary to describe the environmental conditions of Bekasi Regency in a certain period, which is also an instrument for the success of the local government in protecting and managing the environment, namely through the determination of the environmental quality index. In responding to the results of the environmental quality index, information is needed on the factors that have the most influence on the environmental quality index. These factors are related to each index (AQI, WQI, LQI) in the aggregate and can affect the fluctuation of EQI. Information on the factors that affect the environmental quality index can be used as study material for local governments in protecting and managing the environment.

METHODS

Research Location and Time

This research was conducted in Bekasi Regency, with the duration of the research being six months, from July to December 2021. Interviews with the first round of expert panelists were conducted in September 2021. Interviews of the second round of expert panelists were conducted in October 2021.

Methods of Collecting Data

This research is descriptive and quantitative. The type of data collected to identify the factors that influence the Bekasi Regency EQI is secondary data with data sources from interviews and literature studies. Interviews were conducted with nine expert panelists, six expert panelists from the Bekasi Regency Environmental Service, two expert panelists from the Bekasi Regency Cipta Karya and Tata Ruang Office, and one expert panelist from the Bekasi Regency Regional Development Planning Agency. Meanwhile, secondary data collection in the form of water quality and air quality in the Bekasi Regency was obtained from the Bekasi Regency Environmental Service. Land cover data were obtained from SPOT-6 image processing using ArcGIS to obtain land cover area data.

Data Analysis Methods

The analytical method used in this research is the Delphi method. According to Massaroli *et al.* (2017), this method is carried out through a systematic communication structure controlled by the researcher. The Delphi method also allows expert panelists to receive feedback on the opinions submitted and revise their opinions while responding to points raised by other participants so that an agreement or consensus can be reached at the end of the round. Referring to Zatar *et al.* (2016) and Rum and Heliati (2018), the stages of the Delphi method carried out in this study are as follows:

a. Identification of expert panelists who refer to the experience, expertise, and research conducted in their field to the certification obtained. Expert panelists are also based on their knowledge of the environmental quality index in Bekasi Regency;
b. Asking the expert panelists' willingness to be involved in the panel or discuss the topic;
c. Presentation of information related to assessment instruments that will be assessed by expert panelists while at the same time aligning the perceptions of all resource persons. A total of 24 assessment instruments were used in this study, as follows local government policies, national policies, local government supervision, national strategic projects, population migration, population growth, education level, public awareness for healthy living, and conception of community cultural values industrial wastewater pollution, industrial solid waste pollution, industrial air pollution, household liquid waste pollution, household solid waste pollution, number of motorized vehicles, soil type based on sensitivity, soil slope, vegetation type based on function, type of land cover, green open space, unclear tenure and land ownership, land cover change, and drainage

systems based on water flow (Susmarkanto 2002; Kurniawati *et al.* 2017; Firman 2009; Putri and Pamungkas 2014; Sitorus *et al.* 2012; Trinanda and Santoso 2013);

d. Interviews with expert panelists. In this study, two rounds of interviews with expert panelists were conducted, which according to Rowe and Wright (1999 in Skulmoski *et al.* 2007), aimed to enable participants to improve their views regarding the progress of group work from round to round; and
e. Opinion drawing and consensus measurement. In drawing the opinion of the expert panelists, a survey was conducted using a questionnaire. The weighting of each factor uses a Likert scale to obtain the influencing factor with the highest weight value (Taluke *et al.* 2019). The scale used in the weighting has a value of 1 to 9 based on the level of influence; namely, a scale of 1 indicates not very influential, and a scale of 9 indicates very influential. The questionnaire form consists of the dependent variable in the form of 24 assessment instruments and the independent variable in the form of driving factors and supporting factors for the assessment instrument.

The expert panelists gave a scale (from 1 to 9) based on the level of importance of each assessment instrument in influencing the environmental quality index in Bekasi Regency. The answers from all expert panelists were then analyzed statistically using the standard deviation and interquartile range approach. The final result of this statistical analysis is in the form of consensus or convergence of opinion, as well as the final result of the Delphi Method procedure.

RESULTS AND DISCUSSION

After going through two rounds of interviews using a questionnaire form to 9 expert panelists, the results were obtained from the expert panelists' responses to the questionnaire given. The following is the order of the expert panelists who became respondents in the interviews that were conducted:

a. The first expert panelist : Expert from the Environmental Service of the Bekasi Regency
b. The second expert panelist : Expert from the Environmental Service of the Bekasi Regency
c. The third expert panelist : Expert from the Environmental Service of the Bekasi Regency
d. The fourth expert panelist : Junior expert planner from the Development Planning Agency of the Bekasi Regency
e. The fifth expert panelist : Junior expert planner from the Department of Human Settlements and Spatial Planning of the Bekasi Regency
f. The sixth expert panelist : Spatial junior expert from the Department of Human Settlements and Spatial Planning of the Bekasi Regency
g. The seventh expert panelist : Environmental impact controller junior expert from the Environmental Service of the Bekasi Regency
h. The eight-expert panelist : Environmental impact controller junior expert from the Environmental Service of the Bekasi Regency
i. The ninth expert panelist : Environmental supervisor junior expert from the Environmental Service of the Bekasi Regency

The assessment instrument used in the questionnaire form is obtained from the literature study results and is open if additional instruments are from expert panelists. However, in this research, as many as 24 instruments were obtained, and there were no additional new assessment instruments from expert panelists. The following results of the expert panelists' answers in the first round of interviews (Table 1) are presented. The results of the answers from all rounds of interviews were then statistically analyzed to see conclusions or consensus. Reliable consensus is the expected result of the Delphi method procedure derived from expert opinion groups (Niederberger and Spranger 2020). To determine whether the assessment instrument has reached consensus,

statistical analysis is used with indicators of reaching consensus if the standard deviation is < 1,5 and the interquartile range is < 2,5.

Table 1 Results of expert panelists' answers in the first round of interviews

No	Instruments	Expert panelists								
		X1	X2	X3	X4	X5	X6	X7	X8	X9
1	Local government policy	7	8	8	9	9	9	9	9	8
2	National policy	6	7	7	8	9	7	7	9	7
3	Local government supervision	6	8	7	8	9	8	7	9	9
4	National strategic project	7	7	7	6	7	9	8	9	8
5	Population growth	6	9	8	8	6	8	9	8	9
6	Population migration	8	7	8	8	7	9	8	8	8
7	Level of education	8	6	6	4	9	4	5	8	5
8	Public awareness for healthy living	8	8	6	7	8	7	9	9	7
9	The conception of community cultural values	5	4	6	7	8	3	6	9	5
10	Industrial liquid waste pollution	9	9	8	5	9	8	7	9	8
11	Industrial solid waste pollution	7	5	9	5	7	5	6	3	7
12	Industrial air pollution	7	8	9	8	6	6	9	9	8
13	Household liquid waste pollution	8	8	8	9	9	9	9	8	8
14	Domestic solid waste pollution	7	8	8	9	8	9	9	7	8
15	Amount of motor vehicles	8	6	9	8	6	9	7	9	6
16	Soil types based on sensitivity	7	6	7	3	7	2	4	7	5
17	Land slope	8	8	6	8	7	7	8	7	8
18	Types of vegetation based on the root system	6	5	7	3	4	8	5	7	4
19	Types of vegetation based on function	5	5	7	3	5	4	6	7	5
20	Types of land cover	8	8	9	7	9	7	8	9	8
21	Green open space	7	8	8	8	7	6	9	9	9
22	Indistinct land tenure and ownership	7	6	7	5	7	4	7	1	6
23	Land cover change	9	7	9	6	9	8	9	9	8
24	Drainage system based on water flow	8	5	6	6	6	3	6	6	8

The standard deviation and interquartile range were statistically calculated after getting the findings of the first round of interviews using 24 assessment tools. It is clear from the results of the calculation of the standard deviation and interquartile range when compared to the findings of the first round of interviews (Table 2) that 15 assessment instruments, specifically those with a standard deviation value of < 1,5 and an interquartile range value of < 2,5, have been mutually agreed upon. Local government policies, national policies, local government oversight, national strategic projects, population growth, migration, public awareness of healthy living, industrial air pollution, household air pollution, household solid waste pollution, land slope, land cover type, green open space, and land cover change are the assessment tools that will be used to the second round of the interviews.

In the initial round of interviews, no agreement was reached. Based on the standard deviation and interquartile range of the 24 evaluation tools used in the initial round of interviews, it is developed. Therefore, to verify and balance perceptions, expert panelist interviews were repeated in the second round. Table 3 displays the responses provided by the expert panelists during the second round of interviews. The outcomes of the expert panelist interviews in the second round were not significantly different from those in the first. The expert panelists argued that the number of national strategic projects in Bekasi Regency was still small

and did not alter the environmental quality index, but the interview results from the national strategic project assessment instrument and the slope of the land changed. However, because the terrain in Bekasi Regency has a flat (3 - 7%) slope, this element of the ground does not influence the environmental quality score. The standard deviation and interquartile range calculations for the outcomes of the second round of interviews are performed to see whether consensus has been attained. To find the agreed-upon and non-agreed-upon assessment instruments, use this calculation. Table 4 displays the results of calculating the standard deviation and interquartile range from the outcomes of the second round of interviews. During this second round of interviews, the expert panelists were required to select each assessment tool into the direct driving elements or supporting factors impacting the environmental quality index in the Bekasi Regency.

From the results of the second round of interviews, 13 assessment instruments were agreed upon by the expert panelists, namely local government policies, national policies, local government supervision, population growth, population migration, public awareness for healthy living, industrial wastewater pollution, industrial air pollution, sewage pollution, household liquid waste pollution, household solid waste pollution, types of land cover, green open space, and land cover changes. While the results of determining the direct driving factors and supporting factors in the environmental quality index in Bekasi Regency can be seen in the data presented in Figure 1, the determination of the direct driving factors and supporting factors are carried out on 13 assessment instruments that have been agreed upon by the expert panelists.

Table 2 Standard deviation and interquartile range from the results of the first round of interviews

No	Instruments	ROUND 2	
		Standard deviation	Interquartile range
1	Local government policy	0,73	1
2	National policy	1,47	1
3	Local government supervision	1,21	2
4	National strategic project	1,38	1
5	Population growth	1,31	1
6	Population migration	0,84	0
7	Level of education	3,08	3
8	Public awareness for healthy living	1,30	1
9	The conception of community cultural values	3,31	2
10	Industrial liquid waste pollution	1,40	1
11	Industrial solid waste pollution	3,12	2
12	Industrial air pollution	1,39	2
13	Household liquid waste pollution	0,53	1
14	Domestic solid waste pollution	0,86	1
15	Amount of motor vehicles	1,63	3
16	Soil types based on sensitivity	3,83	3
17	Land slope	1,29	1
18	Types of vegetation based on the root system	3,59	3
19	Types of vegetation based on function	3,66	1
20	Types of land cover	0,86	1
21	Green open space	1,21	2
22	Indistinct land tenure and ownership	3,66	2
23	Land cover change	1,12	1
24	Drainage system based on water flow	3,00	0

Table 3 Results of expert panelists' answers in the second round of interviews

No	Instruments	Expert panelists								
		X1	X2	X3	X4	X5	X6	X7	X8	X9
1	Local government policy	7	8	8	9	9	9	9	9	8
2	National policy	6	7	7	8	9	7	7	9	7
3	Local government supervision	6	8	7	8	9	8	7	9	9
4	National strategic project	7	6	7	5	6	9	8	9	8
5	Population growth	6	9	8	8	6	8	9	8	9
6	Population migration	8	7	8	8	7	9	8	8	8
7	Level of education	8	6	6	4	9	4	5	8	5
8	Public awareness for healthy living	8	8	6	7	8	7	9	9	7
9	The conception of community cultural values	5	4	6	7	8	3	6	9	5
10	Industrial liquid waste pollution	9	9	8	5	9	8	7	9	8
11	Industrial solid waste pollution	7	5	9	5	7	5	6	3	7
12	Industrial air pollution	7	8	9	8	6	6	9	9	8
13	Household liquid waste pollution	8	8	8	9	9	9	9	8	8
14	Domestic solid waste pollution	7	8	8	9	8	9	9	7	8
15	Amount of motor vehicles	8	6	9	8	6	9	7	9	6
16	Soil types based on sensitivity	7	6	7	3	7	2	4	7	5
17	Land slope	8	8	6	8	7	6	7	7	7
18	Types of vegetation based on the root system	6	5	7	3	4	8	5	7	4
19	Types of vegetation based on function	5	5	7	3	5	4	6	7	5
20	Types of land cover	8	8	9	7	9	7	8	9	8
21	Green open space	7	8	8	8	7	6	9	9	9
22	Indistinct land tenure and ownership	7	6	7	5	7	4	7	1	6
23	Land cover change	9	7	9	6	9	8	9	9	8
24	Drainage system based on water flow	8	5	6	6	6	3	6	6	8

Table 4 Standard deviation and interquartile range from the results of the second round of interviews

No	Instruments	ROUND 2	
		Standard deviation	Interquartile range
1	Local government policy	0,73	1
2	National policy	1,47	1
3	Local government supervision	1,21	2
4	National strategic project	1,90	2
5	Population growth	1,31	1
6	Population migration	0,84	0
7	Level of education	3,08	3
8	Public awareness for healthy living	1,30	1
9	The conception of community cultural values	3,31	2
10	Industrial liquid waste pollution	1,40	1
11	Industrial solid waste pollution	3,12	2
12	Industrial air pollution	1,39	2
13	Household liquid waste pollution	0,53	1
14	Domestic solid waste pollution	0,86	1

No	Instruments	ROUND 2	
		Standard deviation	**Interquartile range**
15	Amount of motor vehicles	1,63	3
16	Soil types based on sensitivity	3,83	3
17	Land slope	1,62	1
18	Types of vegetation based on the root system	3,59	3
19	Types of vegetation based on function	3,66	1
20	Types of land cover	0,86	1
21	Green open space	1,21	2
22	Indistinct land tenure and ownership	3,66	2
23	Land cover change	1,12	1
24	Drainage system based on water flow	3,00	0

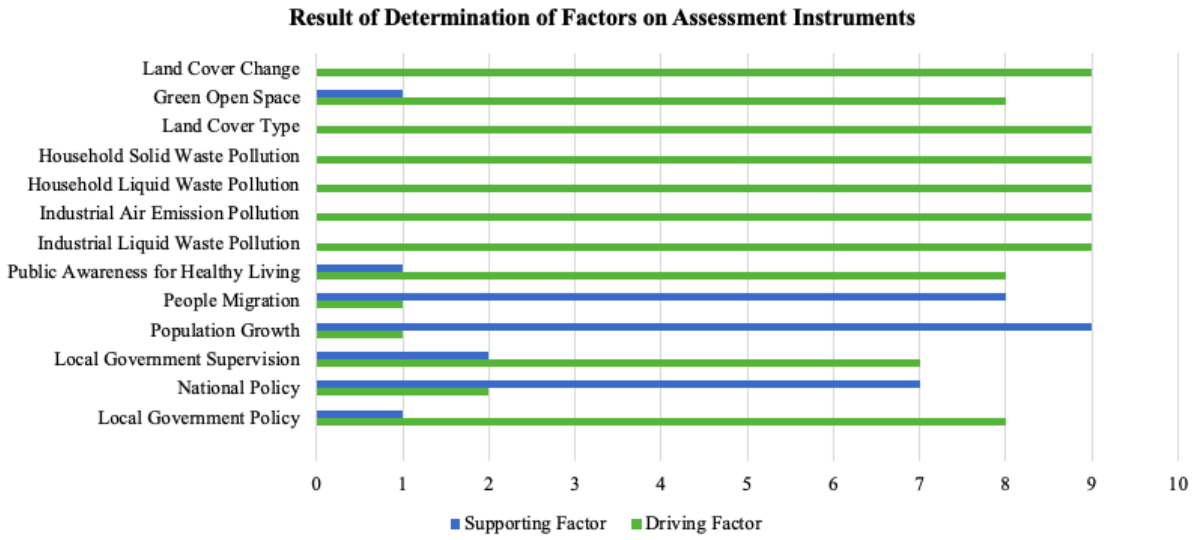

Figure 1 Result of determination of factors on assessment instruments on the environmental quality index in Bekasi Regency

From the results of determining the direct driving factors for the assessment instruments agreed upon by the expert panelists, all assessment instruments are direct driving factors for the environmental quality index in Bekasi Regency. Changes in land cover, type of land cover, household solid waste pollution, household liquid waste pollution, industrial air pollution, and industrial liquid waste pollution are the direct driving factors that most influence the environmental quality index in Bekasi Regency. Any element, natural or artificial, that directly or indirectly alters an ecosystem is known as a driver. Ecosystem processes are undeniably influenced by a direct driver. An indirect driver modifies one or more direct drivers to work more subtly (Nelson *et al.* 2006).

Schafers (1998 in Warlina and Listyarini 2022) stated that the amount of waste created may be impacted by rapid population growth. Large-scale trash production in the industrial and residential sectors becomes a problem that is frequently seen in urban areas. This issue is highly intricate and challenging to solve. Another significant problem to address, particularly in emerging nations, is the lack of land utilized for final garbage disposal (landfill) (Warlina and Listyarini 2022). Meanwhile, population growth and population migration are the supporting factors that most influence the EQI in Bekasi Regency. Six assessment instruments do not support the determination of the environmental quality index in Bekasi Regency, namely land cover changes, land cover types, household solid waste pollution, household liquid waste pollution, industrial air pollution, and industrial liquid waste pollution.

The result is comparable to several previous studies. Rahaman *et al.* (2020) found that the expansion of built-up land harmed all aspects of the environment. Waste pollution, both solid and liquid waste, also harms the environment and human health. Based on research by Abul (2010) conducted in Swaziland, waste pollution causes severe problems for the environment, and the health quality of 82% of the population living close to pollutant sources has decreased. Anthropological factors such as population growth and population migration play an important part in environmental quality, per the opinion of Alnour *et al.* (2022), that population growth and urbanization play a critical role in shaping environmental sustainability in any country.

Nelson *et al.* (2006) mentioned that anthropogenic drivers have a strong relation to economic drivers, such as consumption, production, and globalization. Humans' efforts to enhance their well-being have a knock-on effect on economic activity. Natural resource endowments, including ecosystem services (natural capital), the availability of labor and human capital (labor and human capital), the stock of built resources (manufactured capital), and the character of formal and informal human institutions all influence the activity's results (social capital). Aside from the planned outcomes, economic activity can sometimes have unintended consequences or externalities, which are typically detrimental to ecosystems.

CONCLUSION

Based on the research that has been done, 24 assessment instruments are assessed by expert panelists to determine the factors that affect the environmental quality index in Bekasi Regency. Of the 24 assessment instruments, there are 13 instruments agreed upon by expert panelists to determine the direct driving factors and supporting factors that affect the environmental quality index in Bekasi Regency. The assessment instruments are local government policies, national policies, local government supervision, population growth, population migration, public awareness for healthy living, industrial liquid waste pollution, industrial air pollution, household liquid waste pollution, household solid waste pollution, types of cover land, Green Open Space (RTH), and land cover changes. All of these agreed assessment instruments directly influence the environmental quality index in Bekasi Regency.

However, changes in land cover, type of land cover, household solid waste pollution, household liquid waste pollution, industrial air pollution, and industrial liquid waste pollution are the direct driving factors that most influence the environmental quality index in Bekasi Regency. Population growth and population migration are the supporting factors that most influence the environmental quality index in Bekasi Regency.

ACKNOWLEDGEMENT

We thank the Environmental Service of the Bekasi Regency for their assistance in providing research materials and facilities to produce this paper. We also thank the Environmental Service of the Bekasi Regency, the Development Planning Agency of the Bekasi Regency, and the Department of Human Settlements and Spatial Planning of the Bekasi Regency for their willingness to become expert panelists who contributed to defining the influencing factors in the environmental quality index in Bekasi Regency.

REFERENCES

Abul S. 2010. Environmental and health impact of solid waste disposal at Mangwaneni dumpsite in Manzini: Swaziland. *Journal of Sustainable Development*. 12(7):64–78.

Agustina IH. 2021. Study of flood-prone areas in Bekasi Regency. *Jurnal Geografi Gea*. 21(2):180–187.

Ahmed F, Ali I, Kousar S, Ahmed S. 2022. The environmental impact of industrialization and foreign direct investment: empirical evidence from Asia-Pacific region. *Environmental Science and Pollution Research*. 29:29778–29792. doi:10.1007/s11356-021-17560-w.

Alnour M, Ali M, Abdalla A, Abdelrahman R, Khalil H. 2022. How do urban population growth, hydropower consumption, and natural resources rent shape environmental quality in Sudan?. *World Development Sustainability*. 1(2022):1–16. doi:10.1016/j.wds.2022.100029.

Firman T. 2009. The continuity and change in mega-urbanization in Indonesia: A survey of Jakarta-Bandung Region (JBR) development. *Habitat International*. 33:327–339.

Kurnia AA, Rustiadi E, Pravitasari AE. 2020. Characterizing industrial-dominated suburban formation using quantitative zoning method: The case of Bekasi Regency, Indonesia. *Sustainability*. 12(8094):1–19. doi:10.3390/su12198094.

Kurniawati ID, Nurullita U, Mifbakhuddin. 2017. Indikator pencemaran udara berdasarkan jumlah kendaraan dan kondisi iklim (studi di wilayah Terminal Mangkang dan Terminal Panggaron Semarang). *Jurnal Kesehatan Masyarakat Indonesia*. 12(2):19–24.

Massaroli A, Martini JG, Lino MM, Spenassato D, Massaroli R. 2017. The Delphi method is a methodological framework for research in nursing. *Texto Contexto Enferm*. 26(4):2–9. doi:10.1590/0104-07072017001110017.

Nelson GC, Bennett E, Berhe AA, Cassman KG, DeFries R, Dietz T, Dobermann AR, Dobson A, Janetos A, Levy M, *et al.* 2006. Anthropogenic drivers of ecosystem change: an overview. *Ecology and Society*. 11(2):29

Niederberger M, Spranger J. 2020. Delphi technique in health sciences: A map. *Front Public Health*. 8(457): 1–10. doi:10.3389/fpubh.2020.00457.

Putri AMS, Pamungkas A. 2014. Menentukan faktor yang berpengaruh dalam persebaran pencemaran industri migas. *Jurnal Teknik* POMITS. 3(1):20–23.

Rahaman S, Kumar P, Chen R, Meadows ME, Singh RB. 2020. Remote sensing assessment of the impact of land use and land cover change on the environment of Barddhaman District, West Bengal, India. *Frontiers in Environmental Science*. 8(127):1–15. doi:10.3389/fenvs.2020.00127.

Rum IA, Heliati R. 2018. *Modul Metode Delphi*. Sumedang: Universitas Padjadjaran.

Sitorus SRP, Leonataris C, Panuju SR. 2012. Analisis pola perubahan penggunaan lahan dan perkembangan wilayah Kota Bekasi, Provinsi Jawa Barat. *Jurnal Tanah Lingkungan*. 14(1):21–28.

Skulmoski GJ, Hartman FT, Krahn J. 2007. The Delphi method for graduate research. *Journal of Information Technology Education.* 6(2007):1–21.

Susmarkanto. 2002. Pencemaran lingkungan perairan sungai: salah satu faktor penyebab banjir di Jakarta. *Jurnal Teknologi Lingkungan*. 3(1):13–16.

Taluke D, Lakat RSM, Sembel A. 2019. Analisis preferensi masyarakat dalam pengelolaan ekosistem mangrove di pesisir pantai Kecamatan Loloda Kabupaten Halmahera Barat. *Jurnal Spasial*. 6(2):531-540.

Trinanda RA, Santoso EB. 2013. Penentuan faktor-faktor yang mempengaruhi ketertinggalan kawasan Kabupaten Pamekasan. *Jurnal Teknik POMITS*. 2(2):149–152.

Warlina L, Listyarini S. 2022. The study of estimation of landfill capacity through a dynamic system approach. *Scientifica*. 2022:1–8. doi:10.1155/2022/1068111.

Zatar A, Katili PB, Suparno. 2016. Penentuan kriteria kualitatif penentu dalam pemilihan objek audit internal menggunakan metode Delphi (studi kasus: Dana pensiun PT. X). *Jurnal Teknik Industri*. 4(1):1–6.