

CLIMATE CHANGE AND RESILIENCE OF INDEPENDENT VILLAGES (IDM), ECOLOGICAL RESILIENCE INDEX (IKL) REVIEW AND NATURE-BASE SOLUTIONS

Arry Retnowati¹, *Dyah Rahmawati Hizbaron², Alia Fajarwati², Muh Isnaini S², Khusnul Intan Fajar³, Gonxha Obed⁴

¹Department of Development Geography – Universitas Gadjah Mada

²Department of Environmental Geography – Universitas Gadjah Mada

³Regional development consultant - Yogyakarta

⁴Student of Development Geography – Universitas Gadjah Mada

Email: arry_retnowati@ugm.ac.id

*Corresponding Author, Received: Aug 28, 2024. Revised: Nov 25, 2024. Accepted: Dec 07, 2024



This is an open access article distributed under the Creative Commons 4.0 Share-Alike 4.0 International License. If you remix, transform, or build upon the material, you must distribute your contributions under the same license as the original. ©2022 by Journal Sjdgge

ABSTRACT: Village Development Index (IDM) classifies the level of village development into distinct categories, such as Independent Village, Advanced Village, Developing Village, Underdeveloped Village, and Very Underdeveloped Village. Each village is guided to improve its social, economic, and ecological quality. A sound ecological quality also supports resilience and sustainability in its socio-economic conditions. Pendoworejo Village in Girimulyo Subdistrict and Pagerharjo Village in Samigaluh Subdistrict were classified as underdeveloped villages in 2016. However, by 2023, according to the Village Development Index (IDM), both villages had achieved the status of independent villages. the development of the tourism sector has become a key driver for diversifying rural community members' incomes, thereby boosting regional economic development. Sustainable management of the natural environment, based on its ecosystem, is an integral component of Nature-Based Solutions.

Keywords: Climate Change, Indeks Desa Membangun, Nature Based Solutions, Sustainable Development

1. INTRODUCTION

The Village Development Index (IDM) is an assessment tool for measuring village progress, developed by the Ministry of Villages, Development of Disadvantaged Regions, and Transmigration Indonesia. The IDM comprises three main components: The Economic Resilience Index (IKE), The Social Resilience Index (IKS), and The Ecological Resilience Index (IKL). The social, economic, and ecological aspects serve as complementary strengths that preserve the potential and capabilities of a village to enhance its well-being. These aspects ultimately determine the level of village development. Villages are categorized into independent villages, advanced villages, developing villages, underdeveloped villages, and severely underdeveloped villages. Village development is based on the Village Legislation and implemented with the support of village funds and complementary financial assistance by the village. This study emphasizes the Ecological Resilience Index (IKL), which focuses on managing ecological quality, disaster mitigation, and disaster

responsiveness to support improvements in the socio-economic and ecological well-being of villages during crises. Beyond the village level, disaster resilience can also be assessed through the availability of the Regional Resilience Index (IKD), which represents provincial or district-level resilience [1]. Generally, environmental resilience analyses are urban-focused; however, the inclusion of the IKL ensures representation for rural areas in resilience evaluations.

Poverty alleviation and environmental improvement contribute to reducing the number of underdeveloped villages and promoting the transition of villages from developing to independent status. The progress of a village can be measured through its Village Development Index, which can also be further analyzed in terms of its social, economic, and ecological resilience. Several arguments suggest a correlation between low economic conditions and ecological degradation. Amid the challenges of poverty and declining environmental quality, sustainable ecological management practices can be implemented through the pillars of Nature-Based Solutions (NbS). This

potential warrants emphasis in this study, as it holds significant promise for enhancing the Ecological Resilience Index and adding value to efforts aimed at improving community well-being [2].

In 2016, Kulon Progo Regency in the Special Region of Yogyakarta (DIY) had the highest number of underdeveloped villages and the lowest number of independent villages in the region. Pendoworejo Village in Girimulyo Subdistrict and Pagerharjo Village in Samigaluh Subdistrict were examples of villages with the lowest Village Development Index (IDM) in DIY at that time. The geographic, topographic, and hydrometeorological conditions of the area posed significant risks of landslides [3]. By the 2020, the IDM status of Pendoworejo Village had improved to "Developing," while Pagerharjo Village had advanced to "Advanced Village." The Ecological Resilience Index (IKL) of Pendoworejo Village in 2017 was high, at 0.93, due to frequent disaster events. However, this value declined to 0.733 by 2020. In contrast, the IKL of Pagerharjo Village showed no significant improvement from 2017 to 2020, as the indicators for natural disasters and environmental quality dimensions remained low [4].

The allocation of village funds to accelerate village self-reliance, when appropriately utilized and supported by adequate human resources and targeted external interventions, has the potential to differentiate the IDM values of these two villages. According to IDM data from 2023, both villages have now achieved "Independent" status. With this status, it is essential to assess the environmental conditions in the study area to ensure they reflect environmental resilience, both physically and non-physically. Independent villages are expected to maintain and manage their resources through creativity, innovation, entrepreneurship, and sustainable networks aligned with the social, economic, and ecological or ecosystem conditions amidst the disaster threats present in their areas.

2. METHODS

This study utilizes secondary data obtained from institutions, organizations, and communities. A qualitative descriptive approach is applied, supported by a literature review. Quantitative analysis is conducted using secondary data from the Village Development Index (IDM) for the years 2016–2023, sourced from the Ministry of Villages, Development of Disadvantaged Regions, and Transmigration. Supporting data are collected and analyzed from various literature or reference sources, including journals, media, relevant research reports, and digital sources on related

themes.

The study focuses on the Ecological Quality Index (IKL), which is a component of the Village Development Index (IDM). In general, IDM is a mathematical formulation consisting of the following components:

$$IDM = (IKL + IKE + IKS)$$

IDM = *Indeks Desa Membangun* or village development index

IKL = *Indeks Kualitas Lingkungan/Ekologi* or environmental/ecology quality index

IKE = *Indeks Kualitas Ekonomi* or economic quality index

IKS = *Indeks Kualitas Sosial* or social quality index

The evaluation of those components is conducted using score values. These scores are determined subjectively by evaluators and are then compiled based on the results obtained, aligned with the IDM classification as previously mentioned.

The Environmental/Ecological Quality Index (IKL) is selected as the focus of this study without disregarding the other two indices. The IKL comprises ecological dimensions, including indicators of environmental quality, disaster risk potential, and disaster responsiveness.

The research location consists of two areas with landslide disaster potential [5], but they are also developed for agriculture and nature-based tourism in the Menoreh Landscape Ecology. Pendoworejo Village is located in Girimulyo Subdistrict, while Pagerharjo Village is situated in Samigaluh Subdistrict. Pagerharjo Village also faces meteorological drought risks, despite having five spring water sources that can be used for domestic needs [6].

Secondary data were synthesized to illustrate the relationship between the characteristics of Independent Villages, as reflected in the Environmental Ecological Index (IKL), and the concept of Nature-Based Solutions (NbS). This study examines how the conceptual framework of the Village Development Index (IDM) can be linked to the NbS concept in addressing global climate change.

3. RESULTS AND DISCUSSION

3.1 Village Development Index (IDM) Kulonprogo Regency, Daerah Istimewa Yogyakarta (DIY) 2016-2023

In 2016, Kulonprogo Regency had the highest

number of underdeveloped villages in the Special Region of Yogyakarta (DIY). Pendoworejo and Pagerharjo Villages, located in Kulonprogo Regency, exhibited low IDM scores in 2016, categorizing them as underdeveloped villages. Since 2016, both Pendoworejo and Pagerharjo have received village budget programs aimed to improve village development. Data analysis reveals

differences in the development and independence status of these villages from 2016 to 2023. These differences are identified using the Village Development Index (IDM) indicators. Table 1 presents a comparison of the IDM and IKL of Pendoworejo and Pagerharjo Villages.

Table 1 Comparison of the Village Development Index (IDM) and Ecological Resilience Index (IKL) of Pendoworejo and Pagerharjo Villages

No	Year	Pendoworejo Village			Pagerharjo Village		
		IDM	IKL	Status	IDM	IKL	Status
1	2016	0,5808	0,6000	underdeveloped	0,5765	0,60000	Under developed
2	2017	0,67889	0,9333	Developed	0,6952	0,66667	Developed
3	2018	0,67889	0,9333	Developed	0,6952	0,66667	Developed
4	2019	0,7012	0,7333	Developed	0,7719	0,9333	Advanced
5	2020	0,7054	0,7333	Developed	0,8151	0,9333	Advanced
6	2021	0,7870	0,9333	Advanced	0,8151	0,9333	Advanced
7	2022	0,8224	0,8667	Independent	0,8373	0,9333	Independent
8	2023	0,8484	0,9333	Independent	0,8502	0,9333	Independent

Source: Results of data analysis, 2023.

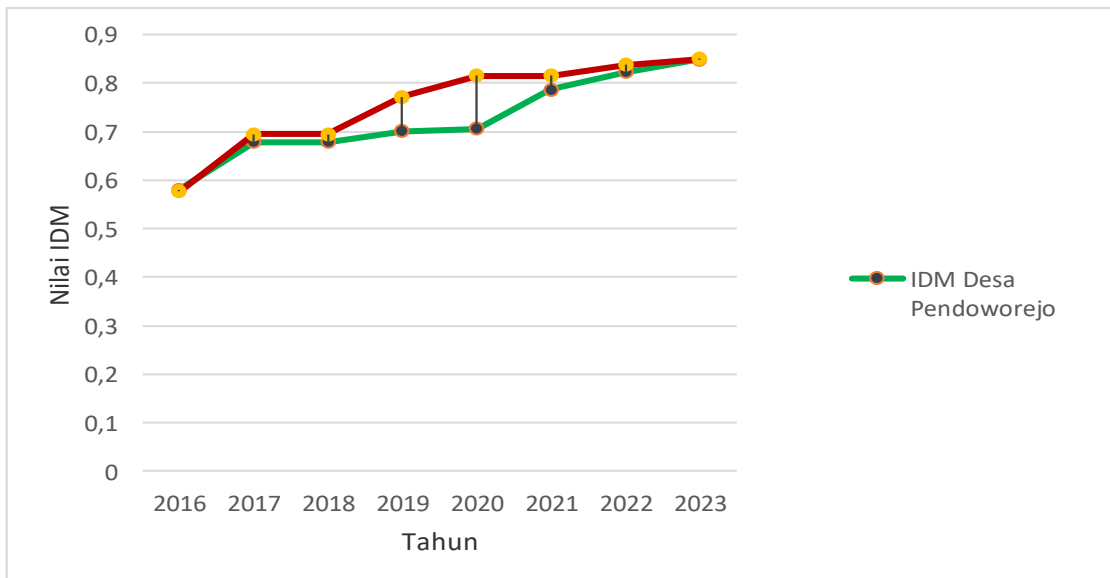


Fig. 1 Village Development Index (IDM) Desa Pendoworejo dan Pagerharjo Growth, 2016 - 2023

The growth of the Village Development Index (IDM) in Pendoworejo and Pagerharjo Villages presents an interesting trend in 2021. As experienced globally, the COVID-19 pandemic, which emerged at the end of 2019, restricted human activities and mobility across all sectors until the end of 2021 or early 2022 [7, 8, 9]. In 2021, Pendoworejo Village saw an improvement in its IDM status, shifting from developing to advanced. Meanwhile, both villages achieved "Independent"

status in 2022. This phenomenon is intriguing and warrants examination from a multidisciplinary perspective.

Generally, the Village Development Index can be analyzed from a socio-political perspective, where public policy studies and planning are of critical importance. This study emphasizes the geographic perspective, in addition to the governance context of the policies implemented in the research area during 2021. The factors that contributed to the shift

in village status require further exploration. Based on the data collected, the composite value of the Ecological Resilience Index (IKL) increased in 2021 compared to the previous year. This indicates that the IKL factor played a significant role in the shift of village status from developing to advanced and independent.

3.2 Ecological Resilience Index (IKL) Pendoworejo dan Pagerharjo Village 2016-2023

Throughout the 2016–2023 period, the Ecological Resilience Index (IKL) of Pendoworejo Village exhibited fluctuations. In 2016, the IKL value of Pendoworejo Village under the Village Development Index (IDM) was 0.60. In 2017, the IKL value rose significantly to 0.93, dominating the IDM components and serving as a key driver for the village's status upgrade to "Developing." However, in 2019 and 2020, the IKL value dropped to 0.73, although the village's IDM status remained "Developing." During this period, the village government focused its budget on social infrastructure projects, aiming for a multiplier effect.

The impact became evident in 2021 when the IKL value increased from 0.73 to 0.93, elevating the IDM status to "Advanced." Nevertheless, in 2022, the IKL value decreased to 0.8667. Despite this decline, Pendoworejo Village's IDM status improved to "Independent." By the end of the period, the IKL value rebounded to 0.93, with the

IDM status remaining "Independent." The fluctuations and progress of IKL and IDM for Pendoworejo Village from 2016 to 2023 are illustrated in Figure 2.

When IDM implementation began in 2016, Pagerharjo Village had an IKL value of 0.60 and was categorized as "Underdeveloped." The IKL value increased to 0.66667 in 2017, remaining stagnant through 2017 while the IDM status improved to "Developing." This stagnation in IKL improvement persisted despite gradual increases between 2017 and 2020. Over the last five years, the IDM value of Pagerharjo Village has risen significantly, aligning with its upgraded village status. Figure 3 provides a visualization of the Ecological Resilience Index (IKL) and IDM for Pagerharjo Village in 2016 and 2023.

The result of the 2023 Ecological Resilience Index (IKL) for Pagerharjo Village in Samigaluh Subdistrict reveals a value of 0.9333, which has remained consistent over the past three years. Similarly, the IKL for Pendoworejo Village in 2023 also stands at 0.9333. However, unlike Pagerharjo, Pendoworejo's IKL has shown fluctuations over the past three years, with a notable decline to 0.8667 in 2022.

These IKL dynamics were further analyzed in relation to the potential application of best practices in Nature-Based Solutions (NBS), which have contributed to improving the index values.

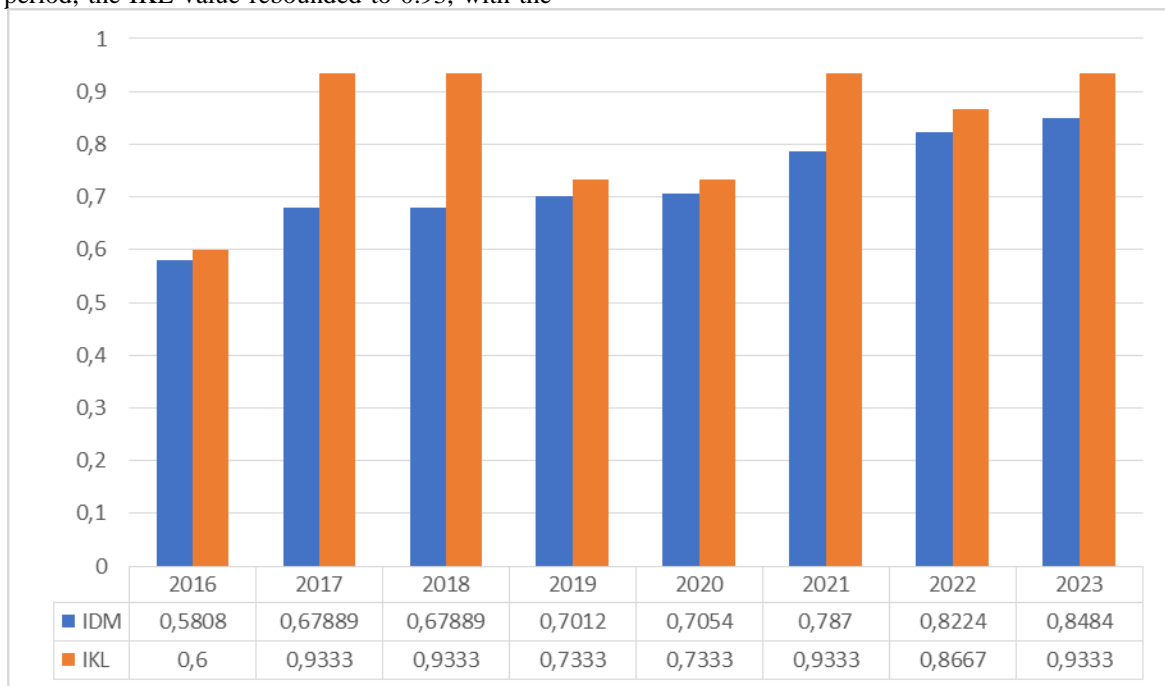


Fig. 2 IDM and IKL in Pendoworejo Village 2016-2023

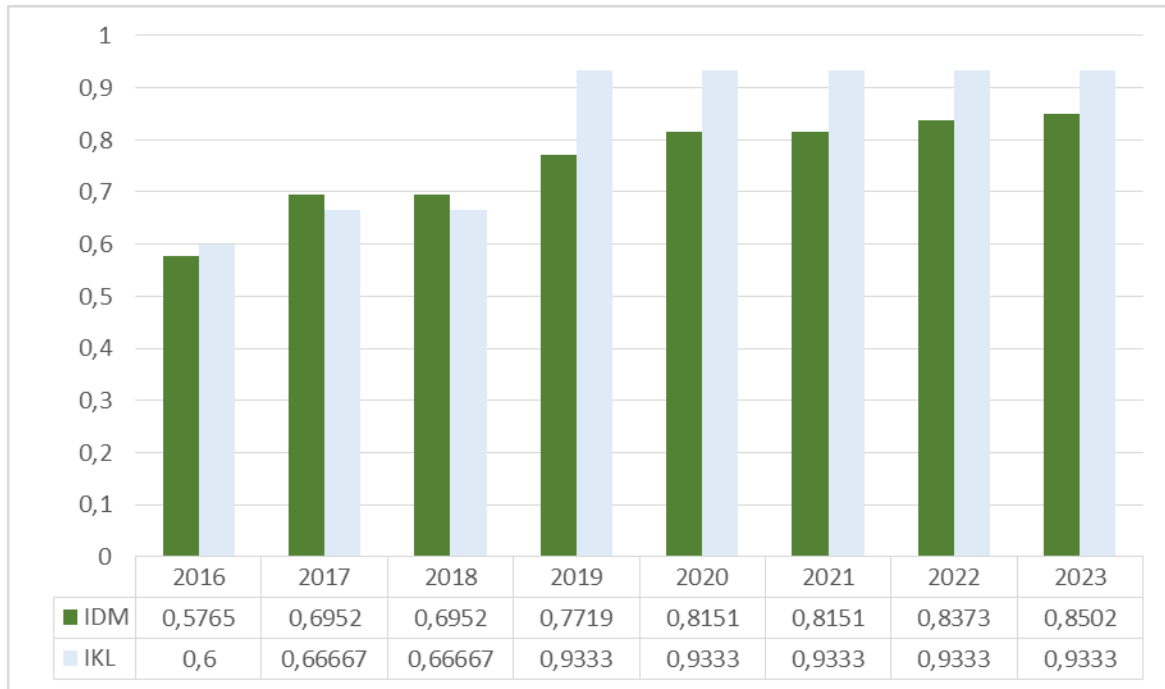


Fig. 3 IDM and IKL Pagerharjo Village 2016-2023

3.2 Nature based Solutions (NBS)

Nature Based Solutions (NBS) are a series of actions designed to address social challenges, such as climate change and disaster risks. These actions are implemented through the sustainable protection and management of ecosystems, allowing natural ecosystems to be restored or modified [10]. The NBS concept has continued to evolve since its inception and is now viewed as a pathway to enhance food security, water security, social and economic development, and public health.

Broadly, efforts to seek nature-based solutions are also referred to as enhancing resilience through nature or the environment itself, leveraging an ecosystem-based approach to address social challenges (Figure 4).



Fig 4. Nature-based Solutions to Address Global Societal Challenges (IUCN, 2016)

Farmers play a vital role in environmental management, as their livelihoods are closely tied to natural conditions. They serve as early observers of

environmental changes within the scope of their daily activities, whether individually or communally. The challenge lies in whether these changes have direct and immediate impacts on their livelihoods. Weather variations, for instance, are crucial factors for farmers and other nature-dependent stakeholders, such as ecotourism practitioners and other environment-based economic actors. The ecosystem services provided by nature are deeply interconnected with the efforts of those who rely on them.

Examples of nature-based management practices can also be observed in the coastal areas of Kulon Progo. These areas offer opportunities for developing activities such as migratory bird watching. Maintaining habitats suitable for these species aligns with the principles of Nature-Based Solutions (NBS). Another example is found in Madigondo Hamlet, Samigaluh Subdistrict, where ecotourism is developed based on the local characteristics of herbal plants, or *empon-empon*, which thrive due to the area's land suitability [11].

Additionally, a noteworthy example of citizen science or community-driven environmental management is the Kulon Progo Women's Farmer Group. This group actively promotes tourism by engaging visitors in observing the environment of the areas they visit. Such educational tourism initiatives aim to foster environmental awareness among both local communities and tourists, inspiring a spirit of disaster mitigation and preparedness.

Statistical data from Pagerharjo and Pendoworejo villages indicate that as of 2020, farming remains the dominant occupation in these areas. The regional economy is primarily based on agriculture, livestock, and plantation activities. This signifies that the livelihoods landscape of these villages is largely shaped by how the community manages its natural resources. Disruptions to the natural or physical environment, whether caused by human activities or natural processes, have the potential to diminish the quantity and quality of cultivated yields.

The connection between the Ecological/Environmental Quality Index and Nature-Based Solutions (NBS) can be understood through the framework of a self-sufficient village as described by the Village Development Index (*Indeks Desa Membangun*, Figure 5). The Ecological/Environmental Quality Index comprises three key indicators: Environmental Quality, Disaster Vulnerability Level, and Disaster Response. These indicators reflect the interactions between humans and nature, encompassing cultivation practices, adaptation strategies, and innovations employed by the community.

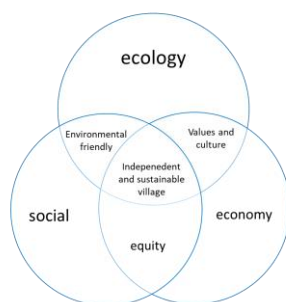


Figure 5. Dimensions of Independent Village Capabilities

Pendoworejo and Pagerharjo Villages, which are prone to landslides, must consistently maintain environmental quality to prevent casualties and losses during periods of heavy or prolonged rainfall. The risk of landslides may increase if village planning does not account for ecosystem and ecological interactions, focusing solely on improving agricultural yields or boosting tourist visits. The vulnerability level can also rise when the management of agricultural land and tourist areas is carried out without considering the ecosystems and environmental ecology being developed.

Community responses to environmental challenges may include managing lands for coffee, tea, or other local commodities that are compatible with soil types, hydrological systems, and

sustainable tourism practices. This includes regulating tourist activities and providing clear guidelines on permissible and prohibited behaviors within homestays or visited areas.

The village government (*kalurahan*) of Pagerharjo has developed local coffee products through coffee shop and roastery enterprises, exemplifying an economic development effort that necessitates attention to ecosystems and ecology. The production chain, from land management to the enjoyment of products by customers, serves as a practical application of Nature-Based Solutions (NBS).

4. CONCLUSION

The findings of this study indicate that changes in the research area occurred between 2020 and 2022, with the peak shift in IDM status observed in 2021, where the Ecological Resilience Index (IKL) emerged as one of the primary factors driving the change. Based on environmental and disaster management practices, the research area demonstrates several community-based Nature-Based Solutions (NBS) practices. This suggests that the role of village funds or other supporting financial allocations in achieving IDM status improvements cannot yet be confirmed by this study as a significant contributing factor. Instead, this research identifies robust community-based social capital as instrumental in enhancing awareness, preparedness, and the willingness of local groups to engage in mitigation efforts while managing regional resources.

The study further reveals that the threats posed by landslides and hydrometeorological hazards faced by the community are not solely barriers to disaster risk reduction efforts. Exposure to climate change also stands out as an aspect of concern among residents. Moreover, the study highlights that IDM and NbS are interconnected, though the specific parameters of this relationship require further clarification to enable more accurate evaluation and monitoring in future assessments.

5. ACKNOWLEDGEMENTS

This research is supported by Universitas Gadjah Mada Yogyakarta under program Academic Excellence (AE) scheme C under assigned paper No.6530/UN1.P1/PT.01.03/2024.

6. REFERENCES

- [1] Hizbaron, D.R., Ismayani, N., Ernawan, F.N., Puspitasari, N.N.A., Yulianda, Y, and Jati, R. 2021. Comparative urban capacity analysis for flood-prone areas: method and a case study of Sidoarjo, Indonesia. Springer
- [2] Setiachyandari, H.K., and Hizbaron, D.R. 2024. Understanding Eco-DRR as a sustainability indicator for mangrove conservation in urbanized area of North Jakarta, Indonesia. *Environmental and Sustainability Indicators*, volume 24.
- [3] Nurapriyana dan Astuti, 2023. Analisis Potensi Longsor Kecamatan Samigaluh, Kabupaten Kulonprogo, DIY, Menggunakan Perbandingan Metode Analytical Hierarchy Process (AHP) Dan Weighted Linear Combination (WLC). *Prosiding Nasional Rekayasa Teknologi Industri dan Informasi XVIII Tahun 2023 (ReTII)*. ISSN: 1907-5995.
- [4] Retnowati, A., Maulya, G.D, Fajar, K.I.D. 2020. Sustainable development from the view of village development index implementation at landslide prone area in Kulonprogo. *IOP*
- [5] Ilham, R. dan Irawan, I.G.B. I. 2017. Karakteristik Geologi Teknik dan Zona Kemampuan Geologi Teknik untuk Pemukiman di Desa Pendoworejo, Kecamatan Girimulyo, Kabupaten Kulonprogo, Daerah Istimewa Yogyakarta. Skripsi Fakultas Teknik, UGM Yogyakarta.
- [6] Nurmasita, L., Asrifah, D., dan Santoso, D.H. 2020. Konservasi Mataair untuk Memenuhi Kebutuhan Domestik di Daerah Desa Pagerharjo, Kecamatan Samigaluh, Kabupaten Kulon Progo, Daerah Istimewa Yogyakarta. *Jurnal Mineral, Energi, dan Lingkungan*; vol. 4, no. 2; UPN Veteran Yogyakarta.
- [7] Ciotti, M., Ciccozzi, M., Terrinoni, A., Jiang, W. C., Wang, C. B., & Bernardini, S. (2020). The COVID-19 pandemic. *Critical Reviews in Clinical Laboratory Sciences*, 57(6), 365–388. <https://doi.org/10.1080/10408363.2020.1783198>
- [8] Rakesh Padhan, K.P. Prabheesh, 2021. The economics of COVID-19 pandemic: A survey, *Economic Analysis and Policy*, Volume 70, Pages 220-237.
- [9] Riccaboni M, Verginer L (2022) The impact of the COVID-19 pandemic on scientific research in the life sciences. *PLoS ONE* 17 (2): e0263001. <https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0263001>
- [10] International Union for Conservation of Nature and Natural Resources (IUCN). 2016. Nature-based Solutions to address global societal challenges. Editors: E. Cohen-Shacham, G. Walters, C. Janzen, S. Maginnis.
- [11] Seliari, T. 2021. Mempertahankan Eksistensi Desa Wisata dengan Kearifan Lokal (Studi kasus: Tracking Terbit Menoreh di Dusun Madigondo, Samigaluh, Kulon Progo). *Khasanah Ilmu: Jurnal Pariwisata Dan Budaya* Volume 12 Nomor 2.