

# PROMOTING ENVIRONMENTAL EDUCATION FOR ELEMENTARY SCHOOL STUDENTS AROUND LIMESTONE MINING AREA, GUNUNGGKIDUL REGENCY, INDONESIA

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## Abstract

Indonesia has many environmental problems, especially those related to mining. It becomes essential to provide environmental education to the younger generation. However, the environmental education curriculum has not been explicitly found in the body of formal education in Indonesia. The study area is in Gunungkidul Regency, Indonesia where the limestone mining industry has expanded in almost all areas. The purpose of this study is to assess the environmental impacts of limestone mining activities and align the possible integration of environmental education in the study area. To gather data about the environmental impacts of limestone mining activities, a desktop study, field investigation, and interviews with local communities were conducted. Analysis of the Indonesian curriculum and interviews with elementary school teachers were conducted to align the possible integration of environmental education. The environmental impacts of limestone mining activities in the study area include air pollution, water contamination, drought, soil erosion, and road damage. We provide some suggestions for learning materials including an Introduction to environmentally friendly mining activities (Science subjects, grade 4, thematic 3), an Introduction to air pollution impacts in the mining area on human breathing (Science subjects, grade 5, thematic 2), and Introduction about mining activities impacts on the air, water, and soil (Science subjects, grade 5, thematic 8). It is recommended that teachers not only teach theory but also practice and environmental observation.

**Keywords:** Environmental Impact, Environmental Education, Limestone Mining, Elementary School, Curriculum

## Abstrak

Indonesia memiliki banyak masalah lingkungan, terutama yang berkaitan dengan pertambangan. Menjadi penting untuk memberikan pendidikan lingkungan kepada generasi muda. Namun, kurikulum pendidikan lingkungan hidup belum secara eksplisit ditemukan dalam badan pendidikan formal di Indonesia. Daerah penelitian berada di Kabupaten Gunungkidul, Indonesia dimana industri pertambangan batu kapur telah berkembang hampir di semua wilayah. Tujuan dari penelitian ini adalah untuk menilai dampak lingkungan dari kegiatan penambangan batu kapur dan menyelaraskan kemungkinan integrasi pendidikan lingkungan di wilayah studi. Untuk mengumpulkan data tentang dampak lingkungan dari kegiatan penambangan batu kapur, dilakukan studi desktop, investigasi lapangan, dan wawancara dengan masyarakat setempat. Analisis kurikulum

Indonesia dan wawancara dengan guru sekolah dasar dilakukan untuk menyelaraskan kemungkinan integrasi pendidikan lingkungan. Dampak lingkungan dari kegiatan penambangan batugamping di wilayah studi antara lain pencemaran udara, pencemaran air, kekeringan, erosi tanah, dan kerusakan jalan. Kami memberikan beberapa saran untuk materi pembelajaran antara lain Pengantar kegiatan pertambangan yang ramah lingkungan (mata pelajaran IPA kelas 4, tematik 3), Pengantar dampak polusi udara di area pertambangan terhadap pernapasan manusia (mata pelajaran IPA kelas 5, tematik 2), dan Pengenalan dampak kegiatan pertambangan terhadap udara, air, dan tanah (Mata pelajaran IPA, kelas 5, tematik 8). Disarankan agar guru tidak hanya mengajarkan teori tetapi juga praktik dan observasi lingkungan

**Kata Kunci:** dampak lingkungan, pendidikan lingkungan, pertambangan batu kapur, sekolah dasar, kurikulum

## Introduction

According to geomorphological considerations, the southern part of Daerah Istimewa Yogyakarta Province, Indonesia, is primarily composed of limestone karst areas, one of which is located in the Gunungkidul Regency. The local people are highly reliant on karst groundwater as a result of this situation, particularly during dry seasons. However, water is abundantly contained in this landscape's hardly usable underground flow system. As a result, drought is a constant threat in karst area<sup>1</sup>. People fight, survive, and cope with hard conditions as a result of an annual water shortage, which requires them to research and utilize knowledge, skills, and available resources to sustain their livelihoods and live in harmony with the karst climate, particularly during the dry season<sup>2</sup>.

The mining industry has expanded in almost all areas of Gunungkidul Regency. It has always been a mining center, whether modernized with heavy machinery or done the traditional way. Mineral mining has driven more productive activities, increasing revenue through taxation, creating employment, and reducing poverty<sup>3</sup>.

<sup>1</sup> Widyastuti, M., I. A. Riyanto, M. Naufal, F. Ramadhan, and Novita Rahmawati. "Catchment Area Analysis of Guntur Karst Spring Gunung Kidul Regency, Java, Indonesia." In *IOP Conference Series: Earth and Environmental Science*, vol. 256, no. 1, p. 012008. IOP Publishing, 2019.

<sup>2</sup> Retnowati, Arry, Esti Anantasari, Muh Aris Marfai, and Andreas Dittmann. "Environmental ethics in local knowledge responding to climate change: An understanding of seasonal traditional calendar pranotomongso and its phenology in Karst Area of Gunungkidul, Yogyakarta, Indonesia." *Procedia Environmental Sciences* 20 (2014): 785-794.

<sup>3</sup> Kholil, Rahma Octaviani, A. Tyagi, S. Chatterjee, H. Langhals, T. Schmid, M. Herman, M. Zwiener, A. Hofer, N. S. M. Tahiruddin, and N. A. M. Ya'akub. "Application of AHP Method for selecting the best strategy

However, mining contributes to a variety of environmental issues, including biodiversity loss, deforestation, and soil and water<sup>4,5,6,7</sup>. Unregulated mining can trigger environmental damage such as holes in the post-mining soil, air pollution, and the possibility of landslides throughout the rainy season. In addition, roads will be destroyed due to vehicles being overweight<sup>8</sup>. Toxic heavy metals from mining activities also pose health hazards and have negative consequences for humans<sup>9</sup>, for example, chronic exposure to arsenic causes

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to reduce environmental damage caused by non metallic mining Case study in Gunungkidul Regency, Yogyakarta, Indonesia." *International Journal of Environmental Engineering Science and Technology Research* 1, no. 7 (2013): 98-109.

<sup>4</sup> Tansengco, Myra, Judith Tejano, Fe Coronado, Carmel Gacho, and Joven Barcelo. "Heavy metal tolerance and removal capacity of *Trichoderma* species isolated from mine tailings in Itogon, Benguet." *Environment and Natural Resources Journal* 16, no. 1 (2018): 39-57.

<sup>5</sup> Trisnaning, P. T., A. Zamroni, O. Sugarbo, H. N. E. Prasetya, S. T. Sagala, and M. Y. Hardiansyah. "Quality of surface water due to sand mining activity: a case study from the Progo River, Daerah Istimewa Yogyakarta Province, Indonesia." In *IOP Conference Series: Earth and Environmental Science*, vol. 1098, no. 1, p. 012031. IOP Publishing, 2022.

<sup>6</sup> Nolos, Ronnel C., Akhmad Zamroni, and Kathleen Faith P. Evina. "Drivers Of Deforestation And Forest Degradation In Palawan, Philippines: An Analysis Using Social-Ecological Systems (SES) And Institutional Analysis And Development (IAD) Approaches." *GEOGRAPHY, ENVIRONMENT, SUSTAINABILITY* 15, no. 4 (2023): 44-56.

<sup>7</sup> Zamroni, Akhmad, Paramitha Tedja Trisnaning, and Fajar Rizki Widiatmoko. "Karst landscapes in Indonesia: Potential disaster and mitigation." In *AIP Conference Proceedings*, vol. 2482, no. 1, p. 080001. AIP Publishing LLC, 2023.

<sup>8</sup> Kholil, Rahma Octaviani, A. Tyagi, S. Chatterjee, H. Langhals, T. Schmid, M. Herman, M. Zwiener, A. Hofer, N. S. M. Tahiruddin, and N. A. M. Ya'akub.

<sup>9</sup> Asih, Andrea Sumarah, Akhmad Zamroni, Wahyudiansyah Alwi, Saurina Tua Sagala, and Adam Sukma Putra. "Assessment of heavy metal concentrations in seawater in the coastal areas around Daerah Istimewa Yogyakarta Province, Indonesia." *The Iraqi Geological Journal* (2022): 14-22.

reproductive, respiratory, hematological, cardiovascular, hepatic neurological, and diabetic effects. More dangerously, ingestion of arsenic can cause many kinds of cancer, including bladder, skin, and lung cancer<sup>10</sup>. Mining pits offer considerable environmental risks since they are filled with rainwater during the rainy season, and it flows around the residence wells, where it becomes a source of water for the surrounding population for whatever purposes, especially during the dry season<sup>11</sup>.

Dredging the karst region for mining purposes is consuming the majority of the water storage in the karst hills and causing damage to the current hydrological system. In the region of land conversion, the effect is a rise in the quality and quantity of water demand as well as a decrease in water supply in terms of quality and quantity<sup>12</sup>. Aticho et al.<sup>13</sup> said that environmental knowledge and the views of the community determine how natural resources should be used and managed responsibly. Education can contribute to improvements in everyday life that are more environmentally friendly. Environmental education is defined as a means of reconsidering our ties with the biosphere as well as a tool for long-term societal change toward sustainability. As a result, environmental education could be crucial in addressing two unavoidable challenges.

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<sup>10</sup> Giang, Pham Quy, Kanchana Nakhapakorn, and Achara Ussawarujikulchai. "Effectiveness of different spatial interpolators in estimating heavy metal contamination in shallow groundwater: a case study of arsenic contamination in Hanoi, Vietnam." *Environment and Natural Resources Journal* 9, no. 1 (2011): 31-37.

<sup>11</sup> Zamroni, Akhmad, Paramitha Tedja Trisnaning, Haris Nur Eka Prasetya, Saurina Tua Sagala, and Adam Sukma Putra. "Geochemical Characteristics and Evaluation of the Groundwater and Surface Water in Limestone Mining Area around Gunungkidul Regency, Indonesia." *The Iraqi Geological Journal* (2022): 189-198.

<sup>12</sup> Sari, Avellyn Shintya, Sari Bahagiarti, Suharsono Suharsono, and C. Prasetyadi. "Groundwater quality in Ponjong Karst, Gunungkidul Regency, Special Region of Yogyakarta." *Journal of Earth and Marine Technology (JEMT)* 1, no. 1 (2020): 7-11.

<sup>13</sup> Aticho, Ababayehu, Dessalegn Obsi Gemed, Tariku Mekonnen, Tamiru Chalchessa, Deresa Abetu, Kerry Morrison, and George Archibald. "Assessment of community knowledge and perception on environmental issues in Jimma Zone, Southwest Ethiopia." *Journal of Degraded and Mining Lands Management* 6, no. 2 (2019): 1635.

First, there is the ecological challenge, which aids in the training of not only young people and children but also managers and planners to direct their beliefs and attitudes toward a harmonious relationship with nature. Second, there is a social imperative that requires us to fundamentally alter the management and allocation of the earth's wealth<sup>14</sup>. Furthermore, environmental education aims to change people's actions to be more environmentally sustainable to reduce the environmental effects of human activities<sup>15</sup>.

Environmental education refers to initiatives that promote environmental awareness, encourage sustainable practices, and disseminate particular types of environmental information in schools or protected natural areas<sup>16</sup>. To address the various environmental issues, it is necessary to create public awareness and encourage people to take action to improve the environment and its state. Environmental education is a critical instrument for instilling environmental responsibility and a long-term perspective in individuals. There should be a plan in place to incorporate environmental topics and studies into educational institutions' curricula<sup>17</sup>. In line with the urgency of maintaining the environment, support from society is essential. This awareness needs to be built from childhood on, and formal education plays a crucial role. Effective environmental education represents more than a unidirectional transfer of information but also involves a positive environmental attitude and action. This issue in Indonesia is identified as a crucial challenge within the country and globally.

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<sup>14</sup> Varela-Candamio, Laura, Isabel Novo-Corti, and María Teresa García-Álvarez. "The importance of environmental education in the determinants of green behavior: A meta-analysis approach." *Journal of cleaner production* 170 (2018): 1565-1578.

<sup>15</sup> Ilma, Silfia, and Fitri Wijarini. "Developing of environmental education textbook based on local potencies." *JPBI (Jurnal Pendidikan Biologi Indonesia)* 3, no. 3 (2017): 194-201.

<sup>16</sup> Kopnina, Helen, and Andreea Cocis. "Environmental education: Reflecting on application of environmental attitudes measuring scale in higher education students." *Education Sciences* 7, no. 3 (2017): 69.

<sup>17</sup> Esteban Ibáñez, Macarena, Isabel Victoria Lucena Cid, Luis Vicente Amador Muñoz, and Francisco Mateos Claros. "Environmental education, an essential instrument to implement the sustainable development goals in the university context." *Sustainability* 12, no. 19 (2020): 7883.

However, environmental education is not considered a priority yet in Indonesia's educational system. Until now, the environmental education curriculum could not be found explicitly in the body of the formal education curriculum<sup>18</sup>. It is essential for the Indonesian government to provide environmental education for local people and children in the mining areas, especially about air and water pollution due to mining activities<sup>19</sup>. Therefore, the purpose of this study is to assess the environmental impacts of limestone mining activities and align the possible integration of environmental education in Gunungkidul Regency.

### Method

Figure 1 shows the methodology of this study. This study used natural and social science frameworks to gather two kinds of data, namely the environmental impacts of limestone mining activities (natural science) and the urgency of environmental education (social science). This method followed the method of Sulaeman et al.<sup>20</sup>, who conducted research on the air quality index and the urgency of environmental education. To gather data about the environmental impacts of limestone mining activities, a desk study and field investigation was conducted<sup>21</sup>. In addition, interviews with local people around mining areas were also conducted to get supporting data on the environmental impacts of limestone mining activities<sup>22</sup>. To review available data and literature sources, a desk study was conducted on the particular geographic area that the proposed

projects could affect. A field investigation was carried out to confirm data from the desktop report, as well as to assess air and water quality, erosion potential, road condition, and relevant on-site activities<sup>23</sup>. In addition, a thorough grasp of this case study necessitates a review of some past research<sup>24</sup>. As a result, paper titles and abstracts were reviewed to exclude any records that were not relevant. Reading abstracts to grasp the main idea of the previous study completed the selection of references (articles). For clarification and in-depth knowledge, it is important to read the complete text<sup>25</sup>.

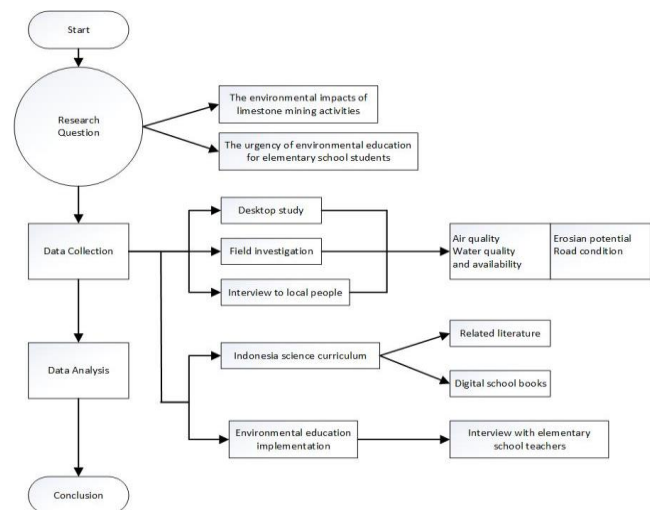


Figure 1. The method of this study.

Interviews with local communities were also conducted to get information about air and water quality, and water availability. Meanwhile, the previous research on environmental education and the Indonesian curriculum for elementary school students were examined to determine the urgency of environmental education for elementary school students<sup>26</sup>. To begin, these

<sup>18</sup> Sulaeman, N. F., A. Nuryadin, R. Widyastuti, and L. Subagiyo. "Air quality index and the urgency of environmental education in Kalimantan." *Jurnal Pendidikan IPA Indonesia* 9, no. 3 (2020): 371-383.

<sup>19</sup> Rachmawati, Yeni, and Akhmad Zamroni. "How Indonesian Governments Care for Local People's Education in the Mining Area: Experiences from other Countries." *Psychology and Education Journal* 57, no. 9 (2020): 5924-5934.

<sup>20</sup> Sulaeman, N. F., A. Nuryadin, R. Widyastuti, and L. Subagiyo.

<sup>21</sup> FARM, P. H. W., NEAR, A. I., and MOORREESBURG, W. C., (2017). Environmental impact assessment.

<sup>22</sup> Nguyen, Nhi, Bryan Boruff, and Matthew Tonts. "Fool's gold: Understanding social, economic and environmental impacts from gold mining in Quang Nam province, Vietnam." *Sustainability* 10, no. 5 (2018): 1355.

<sup>23</sup> FARM, P. H. W., NEAR, A. I., and MOORREESBURG, W. C.

<sup>24</sup> Zamroni, Akhmad, Ayu Candra Kurniati, and Haris Nur Eka Prasetya. "The assessment of landslides disaster mitigation in Java Island, Indonesia: a review." *Journal of Geoscience, Engineering, Environment, and Technology* 5, no. 3 (2020): 124-128.

<sup>25</sup> Suprpto, N., A. Zamroni, and E. A. Yudianto. "One decade of the "lusi" mud volcano: physical, chemical, and geological dimensions." *Chemistry: Bulgarian Journal of Science Education* 26 (2017): 615-29.

<sup>26</sup> Sulaeman, N. F., A. Nuryadin, R. Widyastuti, and L. Subagiyo.



documents were chosen and labeled to identify meaningful and specific sections. The documents discovered during the first process were then used to justify the need for environmental education in Gunungkidul Regency. Furthermore, an analysis of the Indonesian curriculum was conducted to identify potential topics for strengthening environmental education in Gunungkidul Regency, especially in the area of the environmental effects of limestone mining activities.

According to Parker <sup>27</sup> and Sukma et al. <sup>28</sup>, science is a subject that can be best integrated with environmental education. Therefore, we explored topics in the science subject of elementary school for grades 4 and 5. We chose some basic competencies that might be possible to integrate into environmental education from the digital school books <sup>29</sup>(Table 1). To align the procedure and result with possible integration in Indonesia's environmental education, three elementary school teachers (Desi, Esteria, and Jumiati) were interviewed in this study. Interviews were semi-structured and focused on the following topics: a) implementation of environmental education in the current elementary school curriculum; b) the link between environmental education and science subjects; c) how teachers teach environmental education; d) teachers' challenges in teaching environmental education; and e) advice and recommendations for implementing environmental education.

**Table 1.** The basic competency in the Science curriculum of elementary school.

Grade	Thematic	Basic Competency
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4	3	Explain the importance of balancing and preserving natural resources in the environment
5	2	Describe the respiratory organs and their functions in animals and humans, as well as how to maintain the health of the human respiratory organs
5	8	Analyze the water cycle and how it affects events on the planet as well as the existence of living creatures.

<sup>27</sup> Parker, Lyn. "Religious environmental education? The new school curriculum in Indonesia." *Environmental Education Research* 23, no. 9 (2017): 1249-1272.

<sup>28</sup> Sukma, Elfia, Syahrul Ramadhan, and Vivi Indriyani. "Integration of environmental education in elementary schools." In *Journal of Physics: Conference Series*, vol. 1481, no. 1, p. 012136. IOP Publishing, 2020.

<sup>29</sup> Buku Sekolah Digital., 2017. *Kurikulum 2013 Edisi Revisi 2017*. <<https://bsd.pendidikan.id/data/2013/>>. Accessed 3 May 2021.

## Finding and Discussion

### Finding

In this section, the environmental impacts of limestone mining activities results were presented, followed by the urgency of environmental education results. The results of the environmental impacts of limestone mining activities, it is included air quality, water quality and availability, erosion potential, and road condition. As a continuation of the urgency of environmental education results, the qualitative data were explicitly discussed to explore the possible integration of those results in environmental education.

### Discussion

#### a. Environmental Impacts of Limestone Mining Activities in Gunungkidul Regency

The mining industry has expanded in almost all areas of Gunungkidul. Mining activities have some environmental impacts on air quality, water quality and availability, erosion potential, and road conditions. Figure 2 shows one of the limestone mining areas in Semin District, Gunungkidul Regency. The surroundings nearby are covered in dust from limestone mining and processing operations. Air quality testing, which includes the values of SO<sub>2</sub> and NO<sub>2</sub>, has been carried out annually in Patuk and Wonosari districts in Gunungkidul Regency. In Patuk District, the SO<sub>2</sub> was 34.29 µg/m<sup>3</sup>, and the NO<sub>2</sub> was 73.48 µg/m<sup>3</sup>. Meanwhile, in Wonosari District, the SO<sub>2</sub> was 32.32 µg/m<sup>3</sup>, and the NO<sub>2</sub> was 74.37 µg/m<sup>3</sup> (Department of Environment and Forestry, 2019). The Environmental

Protection Agency (EPA) issued a decision to retain the existing primary National Ambient Air Quality Standard (NAAQS) for sulfur dioxide (SO<sub>2</sub>). The EPA's conclusion is predicated on the belief that the present NAAQS protects public health, particularly the health of asthmatic at-risk populations, with an appropriate margin of safety.

The value of the SO<sub>2</sub> standard was 75 parts per billion (ppb) or 196.5 µg/m<sup>3</sup> based on the 3-year average of the 99th percentile of the yearly distribution of 1-hour daily maximum concentrations<sup>30</sup>, the NAAQS for nitrogen oxides is a 1-hour standard of 100 ppb based on the 3-year average of the 98th percentile of the yearly distribution of 1-hour daily maximum concentrations, and an annual standard of 53 ppb or 99.64 g/m<sup>3</sup> based on the 3-year average of the 98th percentile of the yearly distribution of 1-hour daily maximum concentrations<sup>31</sup>. According to this limit value, the air quality of SO<sub>2</sub> and NO<sub>2</sub> in both districts is permissible. Although in general some of the air component standards in Gunungkidul Regency are still safe, it must still be a concern for residents around mining areas where air pollution tends to be high in the area. Many groundwater aquifers and surface waters are polluted due to several human activities such as mining, agriculture, industry, and household activities<sup>32</sup>.



**Figure 2.** Mining limestone area in Semin District, Gunungkidul Regency.

The equilibration with the carbonate rocks has a significant impact on the hydrochemistry of all water sources in Gunungkidul. All subterranean water sources are clearly dominated by matrix flow during the dry season, as seen by the comparatively high mineralization. During the rainy season, heavy rainfall causes a large amount of surface water to enter the subsurface karst system, causing turbidity to rise and water quality to deteriorate in many cave rivers and springs. During the dry season, the water quality is well below any guideline thresholds for inorganic contaminants. Dissolved Al concentrations are regularly over the Indonesian guideline standard during the wet season<sup>33</sup>. Variations in precipitation have an impact on the underground river's discharge, which has its catchment region in Gunungkidul. Because of the low precipitation rates, water scarcity will likely become more of a problem in Gunungkidul throughout the dry season. Gunung Sewu, a karst area south of Gunungkidul, has very little surface runoff and reservoirs, and a reduction in precipitation is exacerbating the inadequate water supply. Despite this, there are still plenty of water reserves in the limestone's soluble rocks. Therefore, an enhanced water delivery infrastructure that ensures a constant supply of water for the local Village Tambakromo represents an area with a lack of water supply, while villages Kenteng and Karangasem have a sufficient water supply. The

<sup>30</sup> Buku Sekolah Digital, 2017. *Kurikulum 2013 Edisi Revisi 2017*. < <https://bsd.pendidikan.id/data/2013/>>. Accessed 3 May 2021.

<sup>31</sup> United States Environmental Protection Agency, 2018. "Primary National Ambient Air Quality Standard (NAAQS) for Nitrogen Dioxide". < <https://www.epa.gov/no2-pollution/primary-national-ambient-air-quality-standards-naaqs-nitrogen-dioxide>>. Accessed 2 June 2021.

<sup>32</sup> United States Environmental Protection Agency, 2018. "Primary National Ambient Air Quality Standard (NAAQS) for Nitrogen Dioxide". < <https://www.epa.gov/no2-pollution/primary-national-ambient-air-quality-standards-naaqs-nitrogen-dioxide>>. Accessed 2 June 2021.

<sup>33</sup> Eiche, Elisabeth, Maren Hochschild, Eko Haryono, and Thomas Neumann. "Characterization of recharge and flow behaviour of different water sources in Gunung Kidul and its impact on water quality based on hydrochemical and physico-chemical monitoring." *Applied Water Science* 6 (2016): 293-307.

difference in water availability is assumed to give an overview of how people behave in relation to water and wastewater. Meanwhile, the areas within the catchment area with an abundance of water are the villages of Umbulrejo and Sumbergiri, which have an abundance of surface water. The existence of surface water and fish ponds is assumed to give different inputs on how people manage their water and wastewater<sup>34</sup>.

Based on field investigations and interviews with local communities, local communities around the limestone mining area in Semin District often use water from wells with a depth of 40–60 meters for daily needs, including drinking water. Besides that, the water is also traditionally used by local communities for limestone mining activities. Shallow wells that have a depth of less than 10 m, often have no water during the dry season. The well water consumed by local communities often contains limestone deposits. This condition also makes some of them buy clean water for drinking from outside the area. In addition, the rivers around the limestone mining area are also dry during the dry season (Figure 3).

The major causes of erosion are human activities and physical parameters. Human activities such as mining and building development affect physical parameters such as waves, tides, wind, and vegetation<sup>35</sup>. The Karst Gunung Sewu area, which has a high incidence of ground subsidence, includes the districts of Ponjong, Rongkop, and Semanu in Gunungkidul Regency. Subsidence can occur naturally as a result of ground movement caused by external causes such as water. Sinkholes can modify the spatial distribution of soil moisture due to water stagnation in floodplains, or changes in the spatial

distribution of air temperature and humidity, as well as the depth of the soil in the karst zone<sup>36</sup>. Some caves in the karst areas of the Gunungkidul Regency have the potential to collapse, especially on the roof of the cave<sup>37</sup>. In addition, the hole from the former limestone mining in Ponjong District that was not maintained was also a potential collapse<sup>38</sup>.



**Figure 3.** The river around the limestone mining area is dry during the dry season.

As a result of clearing marginal land for agricultural production to meet the requirements of a growing population, deforestation, and land degradation were widespread in the Gunungkidul region by the 1950s. However, starting at least 50 years ago, the Gunungkidul region's agriculture has been revolutionized by the widespread adoption of agroforestry through the construction of a tree-based agricultural system practiced by smallholder farmers<sup>39</sup>. Based on field

<sup>36</sup> Haripa, Rijali Isnain, Astrid Damayanti, and Tito Latief Indra. "Property index and hydrophysical conditions of soils at subsidence in Ponjong, Rongkop and Semanu subdistricts, Gunungkidul district." *GEOMATE Journal* 19, no. 73 (2020): 242-249.

<sup>37</sup> Nugroho, B., P. A. Pranantya, and R. Witjahjati. "Potential collapse due to geological structures influence in Seropan Cave, Gunung Kidul, Yogyakarta, Indonesia." In *IOP Conference Series: Earth and Environmental Science*, vol. 106, no. 1, p. 012007. IOP Publishing, 2018.

<sup>38</sup> Sariandi, Fajar, G. V. Putra, GAVARIA VENZIO Setyorini, and Singgih Saptono. "Stope stability analysis of limestone ex-mined area at Ponjong sub-district Special Region of Yogyakarta using finite element method." In *IOP Conference Series: Earth and Environmental Science*, vol. 212, no. 1, p. 012037. IOP Publishing, 2018.

<sup>39</sup> Sebastian, Gerhard, Peter Kanowski, Digby Race, Emlyn Williams, and James M. Roshetko. "Household and farm attributes affecting adoption of smallholder timber

<sup>34</sup> Nayono, Suwartanti, M. Singer, H. Lehn, and J. Kopfmüller. "Sustainable sanitation as a part of an IWRM in the Karst Area of Gunung Kidul: Community acceptance and opinion." *Water Practice and Technology* 5, no. 4 (2010).

<sup>35</sup> Thepsiriamnuay, Hiripong, and Nathsuda Pumijumnong. "Modelling Assessment of Sandy Beaches Erosion in Thailand." *Environment and Natural Resources Journal* 17, no. 2 (2019): 71-86.



investigations, soil erosion was found in several locations near limestone mining areas in Semin District (Figure 4). It has the potential to cause landslides.



**Figure 4.** The soil erosion near limestone mining areas in Semin District.

Based on field investigation, road damage was found around the connecting roads of Semin District, Gunungkidul Regency, and Sukoharjo Regency (Figure 5). The road damage is probably due to trucks carrying limestone quarries passing on the road (Figure 6).



**Figure 5.** The road damage around the connecting roads of Semin District, Gunungkidul Regency, and Sukoharjo Regency.



**Figure 6.** The truck carrying limestone quarries passed on the road.

## b. Implementation of Environmental Education in the Current Elementary School Curriculum

From previous explanations about the environmental impacts of limestone mining activities in Gunungkidul Regency, it looks essential to integrate environmental education for the students around the limestone mining areas in Gunungkidul Regency. In 2013, the previous curriculum was updated once again in order to increase the standard of the national education system. The revisions aimed to address three specific concerns: preparing Indonesia's massive youth population for future labor markets, increasing students' understanding and appreciation of Indonesia's social, cultural, and environmental problems, and enhancing Indonesian students' performance on international comparative assessments<sup>40</sup>.

Environmental education is something that can be incorporated into the educational process. For incorporating environmental education into the learning process, science learning has the highest presentation. Environmental literacy has evolved into a central theme in science education over time. Since the structure is so broad, environmental education can be incorporated into science classes. Science is one way to solve human problems with nature, and education will provide knowledge and raise awareness. As a result, studying natural science and environmental education can easily be combined<sup>41</sup>. After exploring some basic competencies in the Science curriculum of elementary school, we determined that environmental education for elementary school students around mining areas can be implemented in grades 4 and 5. The basic competencies in the science curriculum of elementary school are shown in Table 1.

“Environmental education has been applied to students since grade 1. For example, on

<sup>40</sup> Faisal, and Martin, Sonya N. "Science education in Indonesia: past, present, and future." *Asia-Pacific Science Education* 5, no. 1 (2019): 1-29.

<sup>41</sup> Sukma, Elfia, Syahrul Ramadhan, and Vivi Indriyani.

management practices by tree growers in Gunungkidul region, Indonesia." *Agroforestry systems* 88 (2014): 257-268.



the theme "Living Creatures", students were taught about the importance of loving animals and plants. In addition, in grade 3, students learned about the life cycle of animals and plants so that they could understand ecosystems and how to preserve them. Even in the previous curriculum, environmental education has also been taught." (Desi).

"Environmental education has been implemented in elementary school students by applying environmental practices and observations in several subject chapters. For example, the teacher taught students how to clean the surrounding environment and how plant trees. Another example was environmental observations. The teacher asked students to observe the condition of some well water in their area. Then, the teacher explained that if there was a well with yellow water, it must be filtered so that the water becomes clearer." (Esteria).

"Environmental education has been implemented in the 2013 curriculum, even in the special curriculum for the pandemic period." Some examples include: 1) Learning in grade 2, in the subject of Sports Education, in Basic Competency 3.6, namely "Understanding how to keep the environment clean (bed, house, classroom, school environment, etc.); and for its application, in Basic Competency 4.6. namely "Telling about how to keep the environment clean (bed, house, classroom, school environment)". 2) Learning in grade 4, in the subject of Science, in basic competency 3.7, namely "explaining the importance of efforts to balance and preserve natural resources in the surrounding environment," and for its application, in basic competency 4.7, namely "conducting activities to preserve natural resources with people in the surrounding environment"." (Jumiati).

Schools have implemented environmental education from grade 1. Environmental education was implemented in several subject chapters through theory, practice, and environmental observations. Even though schools have implemented environmental education, it is important to know whether the students are also ready or not to receive environmental education.

"Elementary students are ready to learn about environmental issues. In my opinion, studying environmental issues early will help them understand how to preserve the environment. In addition, by learning environmental education earlier, they have prepared a good environment for their future. Grade 1 students are ready to receive environmental education, all subjects are very sustainable with the implementation of environmental education, especially with the current thematic system." (Desi).

"Students are ready to learn about environmental issues in grade 1. However, environmental issues taught must still exist around their environment, for example, air pollution. So that students can be taught how to protect the environment, such as not smoking indiscriminately and keeping the environment clean in their schools." (Esteria).

"Elementary school students are ready to learn about environmental issues because environmental issues must be introduced to children at an early age. It may start with simple things because students have also been dealing directly with their environment." (Jumiati).

Elementary students are ready to receive environmental education from teachers. Environmental issues taught by teachers in environmental education can help them be more concerned about protecting the environment. Teachers can give simple examples of environmental issues and how to protect the

environment by looking at their own environment.

### **c. The Link between Environmental Education and Science Subject**

“Environmental education in science subjects can form a person who voluntarily preserves the environment. In addition, environmental education is useful to prepare them for higher education in their field of interest. Actually, other subjects are also closely related to environmental education; for example, in citizenship education, students are taught how to behave towards the environment. The thematic system makes it easier to convey material related to environmental education.” (Desi).

“Science subjects are closely related to environmental education. Science subjects relate to the earth and the environment on the earth. Teachers will find it easier to relate environmental issues in science subjects such as how to protect springs.” (Esteria).

“Science subjects are very suitable for environmental education because some of the scopes of these subjects include living things and life processes, namely humans, animals, and plants, and their interactions with the environment, as well as health.” (Jumiati).

Environmental education is related to science subjects because it includes learning about natural resources and the interaction of living things with the environment.

### **d. How Teachers Teach Environmental Education**

“It is flexible. If possible, students were involved directly to see how the environment related to the learning material. In addition, I also often make simple experiments, such as the process of a volcano erupting, or the process of plant reproduction.” (Desi).

“If there is a theory that is very difficult to understand, then I will provide an example through students' experiences. I also invited them to watch a video or picture related to environmental issues. In addition, I also taught hands-on practices such as making fertilizer from fallen leaves from trees.” (Esteria).

“I taught environmental education through theory and practice. Examples of practical activities that I taught include planting plants through hydroponic media, planting medicinal plants, using rice washing water to water plants, and caring for pets.” (Jumiati).

Teachers taught environmental education to students through theory, experiment, and practice. Theories in environmental education can be more easily understood by students through practical activities, experiments, and visual examples such as watching videos related to environmental issues.

### **e. Teachers' Challenges in Teaching Environmental Education**

“Sometimes I did not master the learning material, so it often made students less interested if I only delivered learning material in the form of lectures without practice or experimentation. Teachers were used to the previous curriculum, where each subject stood alone, and parents also found it difficult to help their children learn online at home. In addition, school learning facilities were still very limited. Sometimes teachers asked students to make their own learning media to make it easier for them to understand the learning material—for example, the practice of simulating a volcanic eruption. This activity required students to spend a budget, and I worried it would be hard for their parents. Schools receive learning media from the government, but usually in grades 4, 5, and 6, while grade 3 does not. But on the other hand, I gained convenience because I teach at an

elementary school in the village. Environmental education is easier to teach through outdoor learning, for example, in parks or on walks around the school.” (Desi).

“Not all students can easily understand learning materials, for example, understanding climate change, so I have to play learning videos to make it easier for them to understand. They would not even know about air pollution if they had not been shown a learning video. Parents must contribute to teaching environmental education. Especially during this pandemic, there was homework that involved parents and students, for example, making videos of students and parents planting trees.” (Esteria).

“My challenge in providing environmental education to elementary school students was that students did not have the awareness to implement environmental education actions, they were just waiting for the teacher's orders. They did not have the awareness to reduce the use of plastic. In addition, the land in the school was not large enough to be used to plant trees.” (Jumiati).

The challenges of teachers in teaching environmental education are learning media for experimentation activities in schools, theories about the environment that are sometimes difficult for students to understand so teachers must provide examples by using videos, and the lack of awareness of students in implementing environmental education that has been learned in daily life.

#### **f. Advice and Recommendations for Implementing Environmental Education**

“The government should provide learning media for experimental activities so that students will be more interested and understand learning materials easier.” In addition, because the number of books for

teachers was very limited, the government should add more books for teachers to use as references in teaching. Teacher human resources must also be considered in order to teach better.” (Desi).

“Teachers and parents not only teach students about theory but also real-world practice, students are involved in joint discussions to find solutions to environmental issues. In addition, the government should add more pictures to textbooks. The government can provide CDs containing videos on learning materials, especially about the environment. The video should be standardized by the national government.” (Esteria).

“Teachers and parents train children to get used to implementing environmental education through character education, such as by watering plants regularly, disposing of garbage in its place, sorting garbage according to its types, recycling garbage into a craft, not throwing waste cooking oil in the gutter, and reducing the use of plastic.” (Jumiati).

The government should add learning media for hands-on activities, hire more teachers, update learning books with more pictures, add more books for teachers to use as teaching guides, and give out CDs on nationally standardized environmental education. Also, parents must help their kids get used to putting environmental education into practice through character education.

Based on an analysis of the elementary school curriculum and interviews with elementary school teachers, it is likely that elementary school students will get environmental education. The subjects most related to environmental education for elementary school students around mining areas in Gunungkidul Regency are science subjects, especially in grades 4 thematic 3, grades 5 thematic 2, and 8. It is recommended that teachers not only teach theory but also practice



and environmental observation. Teachers can explain environmental issues around mining areas, such as air pollution, water contamination, drought, soil erosion, and road damage, through environmental observations. Teachers and parents can teach students to deal with environmental issues around them, including not playing near mining sites, not playing in rivers polluted by mining activities, not using polluted well water for drinking and bathing, being wise in using water and not being wasteful, and planting trees around the house to reduce the impact of air pollution. In addition, we provide some suggestions for learning materials that can be applied to elementary school students around the mining areas (Table 2).

**Table 2.** Learning materials suggestions for elementary students around mining areas.

Grade	Thematic	Learning materials suggestions
4	3	Introduction to environmentally friendly mining activities
5	2	Introduction about air pollution impacts in the mining area on human breathing
5	8	Introduction about mining activities' impacts on the air, water, and soil

According to Table 2, there are three learning materials that can be taught by teachers to elementary students around the limestone mining area related to environmental education, namely, Introduction to environmentally friendly mining activities at grade 4 - thematic 3, Introduction about air pollution impacts in the mining area on human breathing at grade 5 - thematic 2, and Introduction about mining activities' impacts on the air, water, and soil at grade 5 - thematic 8.

**Conclusion**

Limestone mining in Gunungkidul Regency has caused air pollution, water pollution, drought, soil erosion, and damage to roads, among other things. It looks essential to integrate environmental education for the students around the limestone mining areas in Gunungkidul Regency. The subjects most related to

environmental education for elementary school students around mining areas in Gunungkidul Regency are science subjects, especially in grade 4 thematic 3 and grade 5 thematic 2 and 8. We provide some suggestions for learning materials, including an introduction to environmentally friendly mining activities (grade 4, thematic 3), an introduction to the impacts of air pollution in the mining area on human breathing (grade 5, thematic 2), and an introduction to the impacts of mining activities on the air, water, and soil (grade 5, thematic 8). It is recommended that teachers not only teach theory but also practice and environmental observation. Teachers and parents can teach students to deal with environmental issues around them, including not playing near mining sites, not playing in rivers polluted by mining activities, not using polluted well water for drinking and bathing, being wise in using water and not being wasteful, and planting trees around the house to reduce the impact of air pollution.

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