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Achievement of Sustainable Development Goals in the Development of the Ranah Minang Silokek Geopark in Sijunjung Regency, West Sumatra

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Abstract:

Background: Geoparks are designated geographical areas that operate within the principles of sustainable development, integrating geological, biological, and cultural heritage with conservation, education, and local economic development. The Ranah Minang Silokek (RMS) Geopark in Sijunjung Regency, West Sumatra, has been developed as part of Indonesia's efforts to promote sustainable regional development and pursue UNESCO Global Geopark (UGGp) status. **Objective:** This study aims to assess the achievement of the 17 Sustainable Development Goals (SDGs) indicators in the development of the RMS Geopark and examine the contribution of its master plan to sustainable development. **Methods:** This study employs qualitative and quantitative descriptive analyses using primary and secondary data obtained from the RMS Geopark Management Agency, Statistics Indonesia, regional government agencies, and the Geopark Master Plan. **Results:** The RMS Geopark was nominated as a candidate for UGGp status in 2026. The findings indicate positive trends in several key SDG indicators. The regional economy grew by 3.80% from 2017 to 2025, while Regional Original Income increased by 6.12% annually. The tourism sector grew by 4.14% per year, although its contribution remained relatively small. Per capita income increased, while poverty declined, accompanied by improvements in social welfare, the Human Development Index, environmental conservation, disaster mitigation, and climate change indicators. **Conclusion:** Twelve of the 17 SDGs—Goals 1, 2, 3, 4, 5, 6, 8, 12, 13, 15, 16, and 17—showed positive trends, indicating that geopark development can contribute to sustainable development through integrated social, economic, environmental, and governance strategies.

Keywords: Geopark master plan; RMS Geopark; UGGp; SDGs

Cite This Article

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1. INTRODUCTION

1.1. Geopark Context and Sustainable Development Goals

A geopark is a vibrant, functioning landscape that showcases outstanding geological heritage and promotes interaction between science and local communities for mutual benefit. The concept of geoparks was first introduced by the United Nations Educational, Scientific and Cultural Organization (UNESCO) in 2004. According to [1], a UNESCO Global Geopark (UGGp) is defined as an integrated geographic area in which sites and landscapes of international geological significance are managed within a holistic framework that emphasises protection, education, and sustainable development.

Presidential Regulation Number 9 of 2019 concerning the Development of Geoparks further defines a geopark as a single or combined geographic area containing valuable geosites and landscapes related to geoheritage, geodiversity, biodiversity, and cultural diversity. This definition emphasizes management for conservation, education, and sustainable economic development of the community, with active involvement from local communities and government. Geoparks play a crucial role in enhancing public understanding and awareness of the Earth and its environment.

The United Nations 2030 Agenda encompasses 17 comprehensive and integrated Sustainable Development Goals (SDGs), and the principle of indivisibility should guide their implementation. However, [3] notes that the 2030 Agenda remains contested regarding the interactions between the SDGs and how these interactions are assessed. As of now, there is no general consensus on an integrated approach to the SDGs. Given that the SDGs provide a holistic, multidimensional perspective on development—encompassing well-being, economic prosperity, and environmental protection—it is essential to identify synergies among SDG indicators. Conversely, negative correlations, in the form of trade-offs, can impede progress toward these goals.

The UGGp serves as an exemplary model for addressing the 17 United Nations Sustainable Development Goals for 2016–2030 (Henriques and Brilha, 2017). Within the global community focused on geological heritage, the UGGp acts as a key mechanism for promoting geological education and conservation (Farsani et al., 2014). The significance of geoparks is closely tied to local economic development and geotourism, which are vital for rural socio-economic improvement (Olafsdottir, 2019). Therefore, UGGps can enhance awareness and understanding of important community issues, such as the sustainable use of Earth's resources, the mitigation of the impacts of climate change and carbon emissions, and the minimization of the risks of natural disasters [1,7].

A study by [8] examining 33 UGGps across 22 European countries showed that these parks contribute significantly—both directly and indirectly—to achieving the 17 SDGs. Strategies that promote sustainable geotourism through community engagement have been crucial in fostering economic activity in Asia and worldwide [5,9], becoming a substantial source of income, especially in rural areas [5,4].

1.2. Geopark Development in Indonesia

Geopark development in Indonesia aligns with the government's efforts to achieve the 17 SDGs outlined in the UN Agenda 2030. The Indonesian government's commitment to advancing geoparks was reinforced by the issuance of Presidential Regulation Number 9 of 2019, which pertains to Geopark Development. To guide the

implementation of geopark development, the Ministry of National Development Planning issued Regulation Number 15 of 2020, which outlines the National Action Plan for the Development of Indonesian Geoparks (2021-2025).

The objectives of this plan include: (1) providing fundamental principles for effective geopark development that aligns with national development planning and the Sustainable Development Goals; (2) offering guidelines for preparing a Geopark Development Master Plan; and (3) serving as a reference for stakeholders involved in geopark development.

Geopark development focuses on conserving three types of natural diversity: geodiversity, biodiversity, and cultural diversity. This aims to promote sustainable regional development through a management approach that emphasizes protection, education, and local economic growth. The development process is conducted using a bottom-up approach, actively involving local communities and supporting the tourism sector's foreign-exchange contributions to the national economy. A Geopark Master Plan is essential for development and must refer to UNESCO guidelines while aligning with at least 11 agreed-upon SDGs. This master plan serves as the foundational reference for geopark development, aiding in the revalidation of UGGp status and the achievement of the 17 SDGs. The Geopark Management Agency will implement this plan and address challenges faced by geopark managers.

Currently, Indonesia has 12 UGGps: Batur Geopark, Gunung Sewu Geopark, Ciletuh-Palabuhanratu Geopark, Rinjani-Lombok Geopark, Toba Caldera Geopark, Belitung Geopark, Merangin Geopark, Jambi Geopark, Raja Ampat Geopark, Maros Pangkep Geopark, Ijen Geopark, Meratus Geopark, and Kebumen Geopark. Additionally, the Indonesian government has designated 11 National Geoparks (GN): Ranah Minang Silokek Geopark, Sawahlunto Geopark, Natuna Geopark, Bojonegoro Geopark, Tambora Geopark, Halimun Salak Bogor Geopark, Sianok-Maninjau Canyon Geopark, Ujung Kulon Geopark, Bayah Dome Geopark, Dieng Geopark, and Yogyakarta Geopark. There are also approximately 110 locations in Indonesia that have the potential to be developed into geoparks [11].

1.3. Research Objectives and Contributions

In the current development of national geoparks, the four-year validation and revalidation process does not specifically include an assessment of the 11 nationally agreed-upon SDGs or the 17 SDGs outlined in UNESCO's 2030 Agenda. Similarly, the four-year validation and revalidation of the UGGp do not yet necessitate the achievement of all 17 SDGs. Validation and revalidation results are categorized by card status: a green UGGp card indicates continued approval for the next four years, a yellow card signals the need for improvement within two years, and a red UGGp status results in revocation.

The purpose of this study is to assess the achievement of the 17 SDGs for the National Geopark (GN Ranah Minang Silokek), based on key SDG indicator data published by the government, including publications from Statistics Indonesia (BPS) and relevant central and regional agencies. Furthermore, this study critically analyses the Geopark Master Plan programme, examining its potential contributions to achieving the 17 SDGs. Despite a search for research references on the role of geoparks in achieving the 17 SDGs, few studies specifically address this topic, often focusing on only limited aspects of the 17 SDGs. Therefore, this research aims to contribute to the development of national geoparks and the UGGp in realizing the 17 SDGs.

National-level studies, such as one conducted by [12] on the Kebumen Geopark, explored the active roles of the government and community in developing the geopark's geotourism potential and its influence on economic growth, thereby providing income opportunities for local residents. A study by [13] focused on the Ciletuh-Pelabuhanratu Geopark in West Java, highlighting that while geoparks support sustainable development, there are weaknesses in regional development related to natural resource exploitation that prioritizes economic growth at the expense of environmental sustainability. This situation underscores the need for capacity building to enhance understanding of geoparks in the context of sustainable development. A case study of the Batur and Gunung Sewu Geoparks by [14] emphasized the importance of coordination and collaboration among all geopark stakeholders for sustainable regional development. Additionally, a study by [15] examined the impact of COVID-19 on both domestic and international geopark tourism in Indonesia, finding that the pandemic led to the closure of all tourist destinations, including geoparks, and significantly affected the economy and job opportunities. The study also highlighted the adverse effects of excessive tourism on environmental and social conditions. A study by [16] on the Kebumen Geopark (UGGp), formerly known as the Karangsambung-Karangbolong National Geopark (GNKK), concluded that its findings complement earlier research, suggesting that the National Geopark and UGGp contribute to the achievement of both the 11 National SDGs and the 17 SDGs established by the United Nations.

At the global level, a study by [9] from the Natural Sciences Sector at the UNESCO Office in Bangkok examined three Geoparks in Asia (Japan, Korea, and Vietnam) to explore how geoparks have contributed to local economic development through sustainable geotourism. A study by [10] involving a sample of 25 strategic geoparks (20 in Europe, 3 in Asia, 1 in Australia, and 1 in South America) found that geoparks serve as an innovative approach for the protection of natural and geological cultural heritage, playing a vital role in fostering geotourism and enhancing rural economies. Furthermore, a case study conducted in India by [17] demonstrated that the benefits of geoparks include creating new job opportunities for local youth and improving the local economy through infrastructure development and advancements in health and education at the village level.

2. METHODS

2.1. Data

The research materials include both primary and secondary data collected from the author's independent study, conducted in collaboration with the Sijunjung Regency Government and the management of the Ranah Minang Silokek Geopark Management Agency in 2025. Throughout the writing process, these materials have been continuously updated through online communication with the geopark management to reflect the latest developments in the field. The data sources are as follows: primary data obtained directly from the Ranah Minang Silokek Geopark Management Agency, and secondary data derived from official publications by the Central Statistics Agency (BPS) and related regional government agencies/Regional Apparatus Organizations (OPD).

2.2. Methode

This study utilized both qualitative and quantitative descriptive analysis methods. The methodological approach incorporated multiple disciplines, including geology, economics, socio-cultural studies, and environmental science. The data collection process involved a literature review, surveys, focus group discussions, and consultations

with the management of the Ranah Minang Silokek Geopark Management Agency and the Regional Apparatus Organizations (OPDs) of the Sijunjung Regency Government.

The UN's 2030 Agenda, which includes the 17 Sustainable Development Goals (SDGs), remains a topic of debate, particularly regarding how these goals interact and how these interactions are evaluated. According to [3], using measurable SDG indicators poses challenges because the SDGs encompass a range of concepts that are still under discussion. Critiques from sociology, anthropology, and sustainability literature highlight the reductive nature of these indicators. Such reductionism can be problematic because it oversimplifies complex, subjective issues [18]. Moving forward, it may be more effective to use primary indicators to evaluate progress on the SDGs, while also considering the development of integrated or composite indicators that capture SDG outcomes at both national and regional levels (Xu et al., 2020). To create an index or composite indicator, it is recommended to use primary indicators. A benchmark criterion of at least 90% representation will enhance the accuracy of selecting the best indicators. In practice, this criterion should be further refined to reflect stakeholder preferences, without focusing solely on the causal relationships among SDG indicators [20].

The analysis of the 17 SDGs will draw on primary and composite indicator data from official government publications that align with the indicators' criteria. This approach aims to address the limited availability of SDG indicator data in such publications. Selecting primary SDG indicators also reduces the risk of research errors [19,20]. Qualitative and quantitative data are employed to meet the requirements for synergistic indicators that exhibit positive characteristics in the final analysis [3]. The established primary and composite SDG indicators will be used to assess progress towards the SDGs. For data analysis, descriptive methods will be employed to explain the data in relation to the concepts being assessed [21]. The data analysis model will follow an interactive method that includes tracking, analysis, imaging, decision-making, and action, while considering the interrelationships among different data types [22].

This study evaluates progress toward the 17 SDGs based on the activities outlined in the Ranah Minang Silokek Geopark Master Plan. The research was carried out in four stages: (1) inventorying the Geopark Master Plan program activities; (2) identifying operational strategies, including funding sources and activity implementers (OPD); (3) reviewing the 17 SDGs; and (4) assessing the achievement of SDG indicators (see **Figure 1**).

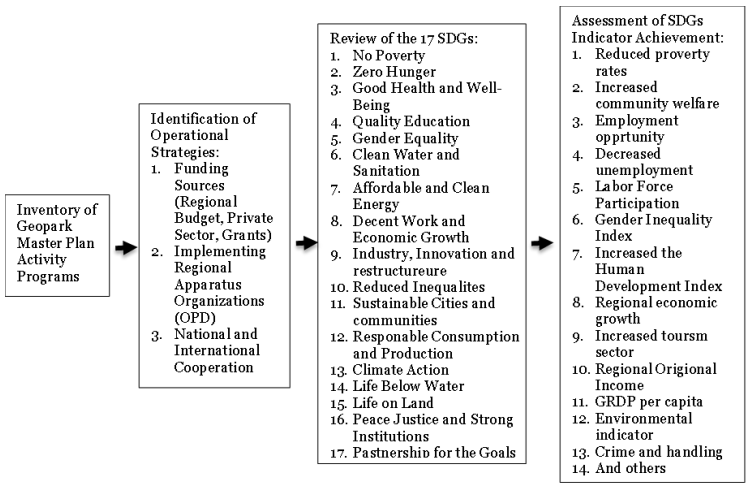
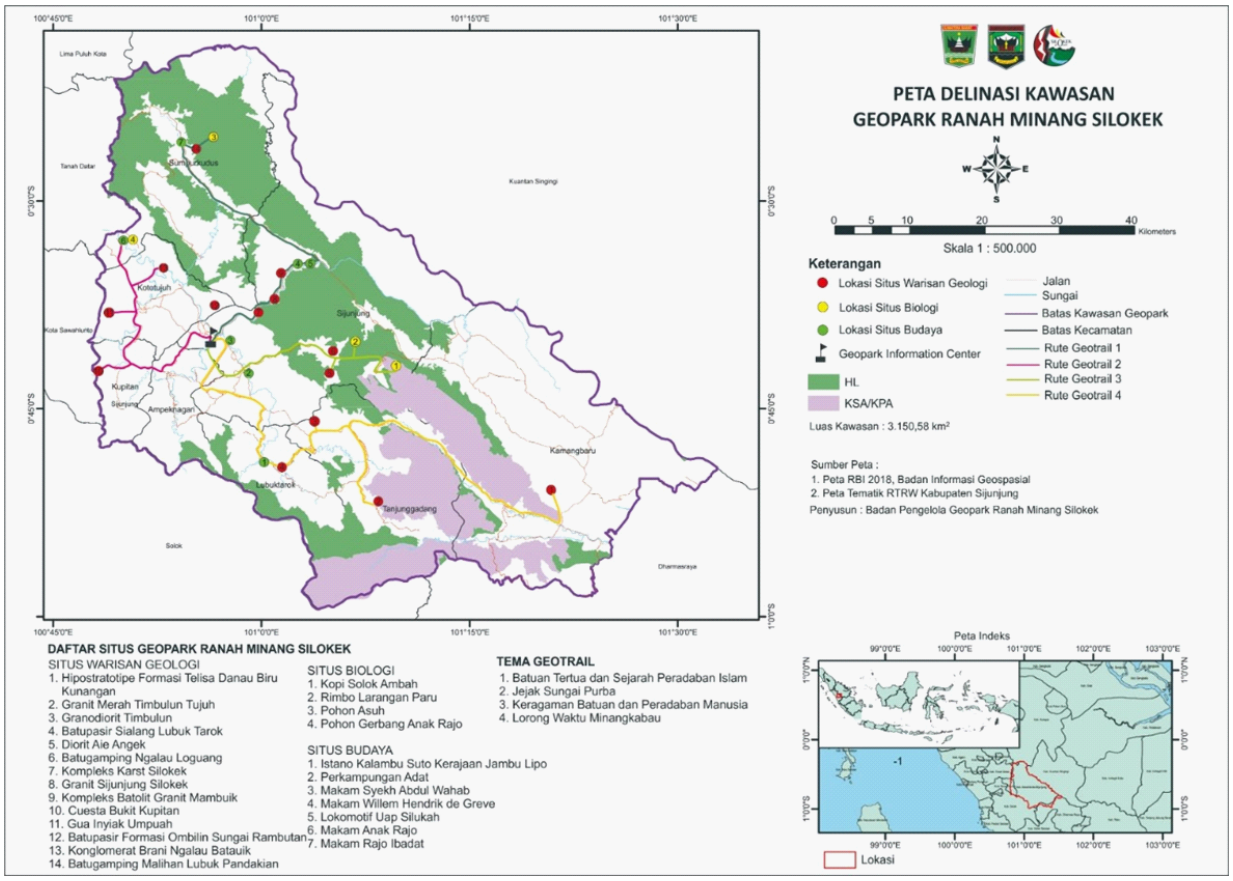


Figure 1. Stages of the Geopark Master Plan Study in Achieving SDGs (4 stages)

3. RESULTS

The Ranah Minang Silokek Geopark was officially designated as a National Geopark on November 29, 2018. It is currently a candidate for the UGGp Project, representing Indonesia alongside the Bojonegoro Geopark. Located in Sijunjung Regency, West Sumatra, the Ranah Minang Silokek Geopark encompasses 14 Geological Heritage Sites, 4 Biological Sites, and 7 Cultural Sites. As specified in Sijunjung Regent Regulation No. 15 of 2023, the geopark spans eight sub-districts within the administrative boundaries of Sijunjung Regency and covers an area of 3,150.58 km² (**Figure 2**).

The distribution of geological heritage within the Ranah Minang Silokek Geopark reveals the geological history behind its 14 geological heritages. The geopark area is divided into two basins: the Ombilin Basin and the Central Sumatra Basin, with geological sites scattered across both regions. The development theme of the Ranah Minang Silokek Geopark is "Hidden Gems that Reveal the Story of the Earth" [23].



Source: Master Plan for the Development of the Ranah Minang Silokek Geopark 2025-2034, Sijunjung Regency, West Sumatra, 2025

Figure 2. Delineation Map of the Ranah Minang Silokek Geopark Area

The development of the Ranah Minang Silokek Geopark is guided by a comprehensive geopark master plan that outlines a funded program of activities. This plan includes a clear vision, mission, and objectives to achieve sustainable development. The Geopark Management Agency (BP Geopark), along with regional agencies and relevant stakeholders such as the private sector, universities, and local communities, implements these program activities. Funding sources include the National Budget (APBN), Regional Budgets (APBD), BP Geopark, Regionally Owned

Enterprises (BUMD), private-sector investments, and other contributions (**Table 1**).

Table 1. Stages of Development of the Ranah Minang Silokek Geopark based on Short and Long Term Programs and Activities 2025-2034

No.	Activity Program/ Action Group/ Indicator	Implementing Agency	Sources of Funding	SDG Targets
1.	Development of Facilities and Supporting Infrastructure for Geopark Areas			
	1.1. Transportation Infrastructure and Facilities, indicators: - Local and/or secondary roads, and - Condition identification, repair, and maintenance	*PUPR Agency*, *Perklim and LH Agency, and others*	State Budget, Provincial and Regency Budgets	SDG 9
	1.2. Development of Geopark Area Facilities and Infrastructure, indicators: - Well-organized area, comfortable tourism, clean environment, - Optimization and efficiency of visiting time, - Regulations on meeting basic needs, - Availability of amenities and new facilities, and - Provision of clean water and water supply.	Bappeda, *Parpora Agency, Perklim and LH Agency*, *PUPR Agency,* BP Geopark, Private, and others	Provincial, Regency, and Regional-Owned Enterprises/ Village/Nagari Budgets	SDG 3, SDG 6, SDG 7, SDG 9, SDG 10, and SDG 11
2.	Protection/Conservation of Geoheritage and Geodiversity			
	2.1. Protection of geological heritage sites and zoning of geosite areas, indicators: - Geoheritage designation, delineation of protected areas, - Academic papers, regulations - Environmental conservation, and - Development of geosites in accordance with their intended use	Bappeda, Badan Geologi, BP Geopark, PUPR Agency, Parpora Agency, Perkim LH Agency, BPBD, and others	State Budget, Provincial and Regency Budgets	SDG 13, and SDG 15
	2.2. Maintenance and preservation of heritage sites and geological diversity, indicators: - Socialization, environmental management, - Tourism areas and geoparks have attractiveness, - References for visitors and tourism managers, - Development of Nagari tourist destinations, and - Disaster-resilient tourism	Bapppeda, Perkim and LH Agency, Parpora Agency, BP *Geopark*, All Districts, and BPBD,	Regency Budgets	SDG 9, SDG 12, SDG 13, and SDG 15,
3.	Protection and Preservation of Bioheritage and Biodiversity			
	3.1. Protection of Heritage and Biological Diversity (Bioheritage and Biodiversity), indicators: - Biosites and biodiversity are maintained and preserved, - Forest areas are maintained and preserved.	Forestry Agency, KPH, BKSDA, Perkkim LH Agency, BP *Geopark*, and BPBD	Provincial and Regency Budgets	SDG 12, SDG 13, and SDG 15
	3.2. Maintenance and Preservation of Heritage and Biological Diversity (Bioheritage and Biodiversity), indicators: - Legal products at the district and village/village levels, - Conservation of existing endemic flora and fauna, and - Availability of information media.	Bappeda, Perkim LH Agency, Agriculture Agency, Forestry Agency, BP *Geopark*, KPLH, and BKSDA	Provincial and Regency Budgets	SDG 12, and SDG 13
4.	Protection and Preservation of Cultural Heritage and Culture Diversity			
	4.1. Protection of Cultural Heritage and Culture Diversity, indicators: - rotection and preservation of cultural heritage, and	Bapppeda, Dikbud Agency, Village/ Nagari, and BP *Geopark*	Regency Budget, Cultural Preservation Center	SDG 11, and SDG 12

No.	Activity Program/ Action Group/ Indicator	Implementing Agency	Sources of Funding	SDG Targets
	- Understanding and adherence to maintaining cultural diversity			
	4.2. Maintenance and Preservation of Cultural Heritage and Diversity, indicators: - Sustainability and development of local culture and traditional institutions - Preservation of cultural heritage - Organization of cultural events/festivals, and - Implementation of the Planning Generation Forum (Genre) and the Youth Counseling Information Center (Pik-R)	Bapppeda, Dikbud Agency, BP *Geopark,* Dagperinkop Agency, BPK, Parpora Agency, and others	Regency Budget, Cultural Preservation Center	SDG 8, SDG 11, and SDG 12
5.	Development of Education, Research, and Scientific Development			
	5.1. Development of Education, indicators: - reparation of teaching materials and curriculum - Integration of Geoparks into the educational curriculum - Geopark socialization and geopark tours to the community - Availability of digital-based educational media - Community participation, and - Ability to accommodate as many local workers as possible	Dikbud Agency, Kominfo Agency, Dagperinkop Agency, BP *Geopark, and others*	APBN, Provincial APBD, Regency APBD, CSR	SDG 4
	5.2. Development of Research and Scientific Development, indicators: - Geosite research - Biosite research - Cultural/intangible site research - Integrated research, and - Annual report	Bappeda, Badan Geologi, BP *Geopark* dan Higher Education, Dikbud Agency, Cultural Institutions, Parpora Agency, and others	Regency Budget, Universities	SDG 13, SDG 11, and SDG 15
6.	Promotion/Marketing of the Ranah Minang Silokek Geopark			
	6.1. Tourism Marketing Branding, indicators: - Participation in domestic and international tourism events - Visitor management - Number of website and social media visitors, and - Number of events held and attended	Ministry of Tourism and Creative Economy, Parpora Agency, PTSP Agency, BP *Geopark*, and BUMD	State Budget, Provincial Budget, Regency Budget	SDG 8
	6.2. Geopark Product Branding, indicators: - Information can be conveyed to visitors, - Branding media: Website, app, social media, and - Information is widely disseminated.	Bapppeda, Kominfo Agency, Parpora Agency; BP *Geopark*, and others	Regency Budget, Private	SDG 8, SDG 9, and SDG 10
7.	Sustainable Economic Development, indicators: - Facilitating business development, - Increasing the role of UPPKA groups in the Ranah Minang Silokek Geopark Area, - Increasing the effectiveness of community empowerment activities in sub-districts, - Community empowerment in sub-districts, and - Developing MSME products to support geopark development	Bapppeda, *Dagperinkop Agency*, Parpora Agency; BP *Geopark*, and others	Provincial and Regency APBD	SDG 1, SDG 2, SDG 5, SDG 8, SDG 9, SDG 10, and SDG 12
8.	Capacity Building for Geopark Management Resources in the Ranah Minang SIlokek			
	8.1. Geopark Management Capacity Development, indicators: - Human resource capacity development,	Bappeda, Parpora Agency, and BP *Geopark*	Provincial and District APBD, and	SDG 4, SDG 12, and

No.	Activity Program/ Action Group/ Indicator	Implementing Agency	Sources of Funding	SDG Targets
	- Number of certifications, and - Number of personnel who have participated in internships/courses and technical personnel exchange programs.		Grants	SDG 16
	8.2. Capacity Development for Tourism Awareness Groups/Customs Organizations/Communities/Youth Organizations, indicators: - Tourism Awareness Group capabilities and capacity - Internship programs and training implementation - Number of workshops and participants, and - Number of outreach activities, tourism expertise guidance, and non-formal training in 8 sub-districts	Bappeda, Parpora Agency, *Kesbangpol Office*, BP *Geopark*, Perkim LH Agnecy, and BKSDA	Regency Budget, CSR, and Grants	SDG 1, SDG 2, SDG 4, SDG 5, SDG 8, and SDG 16
9.	Geopark Network Development, Partnerships, and Institutions			
	9.1. Geopark Network Development, indicators include: - Collaboration in developing geopark networks and partnerships - Establishment of geopark networks - Number of MoUs signed, and - Establishment of business models	Ministry of Tourism and Creative Economy, Bappeda, Parpora Agency, BP *Geopark*, BUMD, and others	State Budget, Provinces and Regional Budget	SDG 4, SDG 12, and SDG 17
	9.2. Partnership and Institutional Development, indicators include: - Provision of leaflets or geopark information and opening routes to tourist destinations, - Development of management, and - Clarity of partnership agreements	Parpora Agency, and BP Geopark	Regency and Private Budgets	SDG 17, and SDG 12
	9.3. Preparation for selection as an Aspiring UNESCO Global Geopark in 2025, indicators include: - Mentoring Activities Implemented - Establishment of Tourism Cooperation and Partnerships, - Establishment of geopark networks	Bappenas (National Development Planning Agency), KNGI), Bappeda, Parpora Agency, and BP *Geopark*	State Budget, Provincial and Regency Budgets, and BP Geopark	SDG 17

Source: Results of Processing the Ranah Minang Silokek Geopark Master Plan, 2025
Information:

Bappeda (Regional Planning, Research, and Development Agency); PUPR Agency (Public Works and Spatial Planning Agency); Perklim and LH Agency (Housing, Settlement Areas, and Environment Agency); Dikbud Agency (Education and Culture Agency); Parpora Agency (Tourism, Youth, and Sports Agency); Dagperinkop Agency (Trade, Industry, Cooperatives, and Small and Medium Enterprises Agency); BPBD (Regional Disaster Management Agency); Forestry Agency; BKSDA (Natural Resources Conservation Agency); Community and Village Empowerment Agency; Population Control and Family Planning Agency; Kominfo Agency (Communication and Informatics Agency); Dagperinkop Agency (Trade, Industry, Cooperatives, and Small and Medium Enterprises Agency); PTSP Agency (Investment and One-Stop Integrated Services Agency); Kesbangpol Office (Office National and Political Unity); Badan Geologi (Geological Agency); BP Geopark (Geopark Management Agency); Regional-Owned Enterprises (BUMD); and KPH (Forest Management Unit)

The development program for the Ranah Minang Silokek Geopark comprises nine key activities outlined in the master plan. Each activity is broken down into action groups, complete with specific indicators for tracking progress. The first activity focuses on the Development of Facilities and Supporting Infrastructure for the Geopark Area, which is further divided into two groups. Program activities 2, 3, and 4 concentrate on the Conservation and Protection of Geological, Biological, and Cultural

Heritage, as well as promoting Geological, Biological, and Cultural Diversity. Notably, program activity 9 aims to enhance Geopark Networks, Partnerships, and Institutions and includes preparations to apply for recognition as an Aspiring UNESCO Global Geopark by 2025.

A detailed table outlines the implementing agencies, funding sources, and SDG indicators for the short- and long-term development stages of the Ranah Minang Silokek Geopark for the period 2025 to 2034. It's important to note that while all SDGs are targeted, SDG 14: Marine Ecosystems has not been addressed in this plan. This is because the Ranah Minang Silokek Geopark area does not include any ocean regions.

The analysis will evaluate progress toward achieving the 17 Sustainable Development Goals (SDGs) using both primary and composite indicators. These indicators are organized into four key pillars of geopark development: the Social Development Pillar, the Economic Development Pillar, the Environmental Development Pillar, and the Legal and Governance Development Pillar, as outlined in Table 2.

Table 2. Indicators of the 17 SDGs based on the Development Pillar Groups in geopark development

Goal	SDGs	Development Pilar	Leading Indicators SDGs
1	Goal 1 No poverty	Social Development Pillar	- Line of poverty (based on income per capita) - Number of poor people - Percentage of the poor population - Poverty depth index, and - Poverty severity index
2	Goal 2 Zero Hunger		HDI- Expenditure per capita
3	Goal 3 Good Health and Well-Being		HDI-Life expectancy
4	Goal 4 Quality education		HDI- Long school expectations
5	Goal 5 Gender equality		Gender Inequality Index (dimensions: reproductive health, empowerment, and economic status)
6	Goal 6 Clean Water and Sanitation	Environmental Development Pillar	Satisfaction of clean and healthy water needs
7	Goal 7 Affordable and Clean Energy		Satisfaction of clean energy needs
8	Goal 8 Decent work and economic growth	Economic Development Pillar	- Economic growth - Tourism growth and contribution for GRD - Unemployment rate - Labor Force Participation - Regional Revenue - GRDP per capita (Indicator of community welfare)
9	Goal 9 Infrastructure, industry, and innovation		
10	Goal 10 Sustainable Cities and Communities		
11	Goal 11 Sustainable cities and settlements	Environmental Development Pillar	Urban planning and residential space
12	Goal 12 Responsible consumption and production		Responsible utilization of available resource
13	Goal 13 Handling Climate Change		Climate change control and management
14	Goal 14 Marine Ecosystems		Maintaining marine sustainability through conservation and protection
15	Goal 15 Land Ecosystem		Spatial planning and sustainable land use
16	Goal 16 Peace, Justice, and Strong Institutions	Legal and Governance Development Pillar	Crime and handling - Crime time lag - Risk of residents being exposed to crime

Goal	SDGs	Development Pilar	Leading Indicators SDGs
17	Goal 17 Partnerships to achieve goals	Economic Development Pillar	Inter-regional, regional, and international cooperation

The Social Development Pillar encompasses Goals 1, 2, 3, 4, and 5, focusing on areas such as poverty reduction, health, education, and gender equality. The Economic Development Pillar includes Goals 8, 9, 10, and 17, which address issues of decent work, innovation, and reducing inequalities. The Environmental Development Pillar comprises Goals 6, 7, 11, 12, 13, 14, and 15, concentrating on clean water, sustainable cities, climate action, and life on land and in water. Finally, the Legal and Governance Development Pillar is represented by Goal 16, which emphasizes peace, justice, and strong institutions.

According to [25], the SDGs comprise 17 goals organised into four interconnected and interdependent pillars. These pillars highlight the necessity of balancing three main dimensions—social, economic, and environmental—with governance serving as the supporting pillar. The first three pillars are closely related and cannot be considered separately. The environmental pillar is particularly vital, as economic growth—reflected in the economic pillar—must align with environmental sustainability. Similarly, social behaviors, represented in the social pillar, must evolve to be more environmentally friendly.

Research by [26] emphasizes that economic development is intertwined with progress in other areas, especially the environment, in the context of sustainable development. A "progress trap" occurs when economic advancement, which aims to enhance human welfare, is pursued without simultaneous development in other sectors, leading to significant social and environmental costs.

In a critical analysis, [27] observed that the scope of sustainable development has expanded considerably, addressing a variety of issues, including poverty, hunger, health, education, gender equality, water and sanitation, energy, economic growth, infrastructure, inequality, urbanization, consumption and production, climate change, and biodiversity. The adoption of the SDGs by the United Nations in 2015 represented a significant milestone, establishing 17 interrelated goals designed to foster a sustainable future for all by 2030. Ultimately, sustainable development is a dynamic and holistic approach that seeks to balance human needs with the planet's capacity to sustain life, ensuring long-term prosperity and well-being for both current and future generations.

5. DISCUSSION

5.1. Growth of the Tourism Sector

The Ranah Minang Silokek Geopark is renowned for its unique and diverse geosites, natural biosites, and cultural sites that reflect the heritage of the Minangkabau people. Since it was designated as a National Geopark, the Ranah Minang Silokek Geopark has undergone various improvements and has demonstrated significant progress, particularly in the tourism sector (see Table 3).

Table 3. Growth of the Tourism Sector in the Ranah Minang Silokek Geopark Area for the 2019-2025 Period

Indicators ofTourism growth	Unit	2019	2020	2021	2022	2023	2024	2025	Growth during 2017-2025
1. Number of hotels	Hotel	17	17	21	24	26	22	25	Growing 4.57% per year
- Hotel Room	Hotel Room	259	236	292	324	281	311	317	Growing 2.61% per year
- Bed	Bed	329	382	467	471	774	732	746	Growing 7.99% per year
2. Number of restaurants	Restaurant	119	139	133	133	259	273	273	Growing 8.06% per year
3. Number of tourism village	Tourism Village	-	-	11	24	27	32	32	Growing 8.33% per year
4. Number of tourism group (Pokdarwis)	Tourism Group (Pokdarwi)	24	30	34	41	46	42	42	Growing 6.12% per year
5. Number of economic actors	Economic Actors	-	153	165	170	170	168	187	Growing 4.44% per year
6. Number of arts organization	Arts Organization	379	225	276	72	75	152	127	Decreasing 9.22% per year, and increasing 25.46% after Covid-19
7. Number of domestic Tourists	Person	14,404	82,674	85,971	209,628	241,236	245,338	243,185	Growing 4.60% per year (2022-2025), 19.43% (2017-2019)
8. Number of foreign tourists	Person	232	6	0	48	57	63	69	Growing 10.14% since 2022 after Covid-19

From 2019 to 2025, hotel facilities, including the number of rooms and beds, grew at an impressive annual rate of 4.57%, with room availability increasing by over 2.61% each year. Similarly, the number of restaurants grew significantly, at a rate of 7.99% per year. Additionally, the number of tourist villages, tourism groups (Pokdarwis), and participants in the creative economy has also risen alongside developments in the tourism sector. Moreover, there was a noticeable rebound in tourist numbers in 2022, following the COVID-19 pandemic. Domestic tourists increased by 4.60% annually, while the number of foreign tourists grew by 10.14%.

5.2. Achievement of the 17 SDGs Key Indicators

The evaluation of the SDGs achievement in the Ranah Minang Silokek Geopark is based on data officially published by Statistics Indonesia (BPS) and the West Sumatra Regional Government. The assessment focuses on the primary SDG indicators, which are organised into four development pillars. These pillars can serve as composite indicators for the development sector, as previously described [24]. Additionally, each composite indicator for the development sector can be further subdivided into several smaller composite indicators, as shown in Table 4.

Table 4. Results of measuring the leading indicators of SDGs in the development of Ranah Minang Silokek Geopark

SDGs Goal	Leading Indicators of SDGs	Unit	Remark Growth during 2020–2025						SDGs Indicator Assessment Results
			2020	2021	2022	2023	2024	2025	
1	e of poverty (based on income per capita)	Rp/capita	433,147	455,346	484,572	529,460	560,5067	574,991	Shows an increase of 7.19% per year
	mber of population	Thousand Souls	235.05	237.31	240.59	243.71	246.78	249.79	Down 0.38% per year
	mber of poor people	Thousand Souls	16.28	16.81	15.07	15.02	14.99	13.55	Down -2.44% (2020-2025)
	centage of the poor population (%)	%	6.78	6.80	6.00	5.88	5.78	5.15	Down -3.74% per year
	erty depth index (P1), and	%	0.79	0.98	0.96	0.85	0.71	0.66	Shows a small decline during 2020-2025, 1.12 to 0.66
	erty severity index (P2)	%	0.17	0.23	0.25	0.20	0.13	0.14	Shows a small decline during 2020-2025, from 0.23 to 0.14
	HDI	Indicator composit	67.74	67.86	68.69	72.30	72.88	73.73	Growing 1.34% per year
2	HDI- Expenditure per capita	Thousand Rp/year	10.361	10.389	10.582	11.018	11.395	11.829,00	Shows an increase of 1.50% per year
3	HDI-Life expectancy	Per year	66.21	71.93	72.27	72.59	72.89	73.30	Shows an increaseof 0.65% per year
4	HDI- Long school expectations	Per year	12.37	12.38	12.64	12.72	12.76	12.99	Shows an increase of 2.15% per year
5	Gender Inequality Index (dimensi: Kesehatan reproduksi, pemberdayaan, dan status ekonomi)	%	0.491	0.527	0.501	0.465	0.491	0.477	The gender inequality index is improving, decreasing by 0.58% per year
6	Satisfaction with clean and healthy water needs	Number of PAM Water Customers	12,780	14,016	15,251	15,885	16,408	17,092	Growing 5.08% per year
7	Satisfaction with clean energy needs	Number of Electricity Customers	39,796	48,303	52,221	53,754	46,100	47,932	Growing 3.39% per year
8, 9, and 10	DP Sijunjung	Billion Rp	6,683.02	6,892.61	7,163.43	7,468.60	7,758.79	8,011.42	Growing 3.82% per year
	DP tourism sector	Billion Rp	636.92	674.46	706.39	749.99	787.52	819.19	Growing 4.17% per year
	tribution of the tourism sector	%	9.81	3.31	3.34	3.51	3.43	3.30	Shows an down of 8.27% per year after Covid-19
	nomic growth	%	-1.10	3.14	3.93	4.26	3.89	3.26	Increased in all down impact covid-19, and growing 0.96 after Covid-19
	rism growth and contribution to GRD	%	-8.88	7.74	6.74	6.94	5.83	4.71	Down impact of Covid-19

SDG sGoal	Leading Indicators of SDGs	Unit	Remark Growth during 2020–2025						SDGs Indicator Assessment Results
			2020	2021	2022	2023	2024	2025	
	employment rate	%	5.30	3.57	4.87	4.71	4.73	4.59	Improving, Down 1.92% after Covid-19
	or Force Participation	%	65.53	68.17	68.51	70.18	71.57	75.33	Growing 1.43% per year
	ional Revenue	Billion Rp	941,763	972,406	1,006,801	100,156	950,198	994,474	Growing 0.80% per year
	ginal Income Regions	Billion Rp	92,474	91,747	99,872	112,701	95,109	112,914	Growing 6.12% per year
	DP per capita	Million Rp	28.43	29.03	29.77	30.65	31.44	32.07	Growing 2.53% per year
11	Urban planning and residential space	Policy and program Spatial and Environ-mental	Environmental programs include geological and other forms of protection, Proklim villages, settlement planning, critical land management, climate change, land use management, and disaster management The Proklim village program is showing results, with four Proklim villages receiving awards from the Ministry of Forestry and Environment (Nagari Paru, Nagari Kumanis, Nagari Guguak, and Nagari Koto Tuo Sijunjung). **Note: The Ranah Minang Silokek Geopark area does not have an ocean** .						Indicators for Goals 11, 12, Goal 12, 13, and 15 program pillars of spatial and environmental development) improved
12	Responsible utilization of available resource								
13	Climate change control and management								
14	Maintaining marine sustainability through conservation and protection								
15	Spatial planning and sustainable land use								
16	Peace, Justice, and Strong Institutions, indicators: - - Crime - - Crime handling	Cases %	315 (65.08)	167 (26.00)	253 (70.35)	248 (72.17)	97 (81.00)	127 (85.04)	Goal 16-Indicator: crime decreased and its handling improved in geoparks
17	Inter-regional, regional, and international cooperation	Trend	Increasing program activities include: - Developing geopark management, - Enhancing national and global geopark networks, and - Establishing national and global geopark collaborations and partnerships.						Goal 17 indicator improved in all geoparks

5.2.1.Pillars of Social Development

The pillars of social development encompass Goals 1, 2, 3, 4, and 5. Goal 1, which focuses on the composite poverty indicator, is evaluated using several key metrics: the poverty line, the number of individuals living in poverty, the percentage of the population that is poor, the poverty depth index (P1), and the poverty severity index (P2). All key poverty indicators have shown small to moderate improvements. Specifically, the poverty line improved by 7.19%, and the number of people living in poverty decreased by 3.74% between 2020 and 2025, translating to approximately 273,000 individuals.

The achievement of Goals 2, 3, and 4 is measured through the composite Human Development Index (HDI). In terms of Goal 2, which is based on the HDI - Expenditure per capita indicator, there has been a slight improvement, with the figure declining from 0.17 to 0.14 between 2020 and 2025. Goal 3 is measured by the HDI related to life expectancy, which recorded an annual increase of 0.65%. For Goal 4, the HDI regarding long school expectations also improved, with an annual growth rate of 2.15%. For Goal

5, the primary measure is the Gender Inequality Index, which encompasses three dimensions: reproductive health, empowerment, and economic status. Data from the Gender Inequality Index indicate an improvement from 2020 to 2025, with a 0.58% annual decrease, reflecting reduced gender inequality.

5.2.2. Pillars of Economic Development

The pillars of economic development include Goals 8, 9, 10, and 17. To assess progress on these indicators for the economic development pillar, a composite indicator that considers the regional economy, employment, and per capita income has been used. From 2020 to 2025, the Gross Regional Domestic Product (GRDP) of Sijunjung Regency grew at an annual rate of 3.82%. Similarly, regional revenue and Local Original Income (PAD) grew by 0.80% and 6.12%, respectively. However, the economic growth of Sijunjung Regency has not been matched by growth in the tourism sector. Although there was a significant increase of 7.74% in early 2021, tourism fluctuated and declined to 4.71% by 2025. The contribution of the tourism sector remains small and has not grown significantly. Data from 2020 to 2025 indicate that the region has yet to recover from the impact of COVID-19.

To assess employment, composite indicators, such as unemployment and labour force participation rates, from 2020 to 2025 have been analysed. Since 2022, the unemployment rate has improved, declining by 1.92% post-COVID-19, while labour force participation has grown by 1.43% annually. Meanwhile, per capita income indicators for the same period showed an annual growth rate of 2.53%.

For the assessment of Goal 17, official published data from the Central Statistics Agency (BPS) is unavailable; therefore, the evaluation is based on the program activities outlined in the geopark master plan. Several of these programs show an upward trend, including: (1) Developing geopark management, (2) Enhancing national and global geopark networks, (3) Establishing national and global geopark collaborations and partnerships, and (4) Increasing the geopark development budget.

5.2.3. Pillars of Environmental Development

The environmental development pillars encompass Goals 6, 7, 11, 12, 13, and 15. Goal 14 is not assessed because the Ranah Minang Silokek Geopark Area does not include a marine zone. For Goal 6, the main indicators for assessment are the number of water customers served by PAM (Perusahaan Air Minum) and their satisfaction with access to clean, healthy water. Between 2020 and 2025, the number of water customers grew by 5.08% annually, indicating that the population's need for clean, healthy water is being met and increasing each year. Goal 7 is evaluated based on the number of electricity customers, which reflects satisfaction with clean energy services. During the same period, the data on electricity customers showed a growth rate of 4.17% from 2020 to 2025. This growth signifies that the demand for clean energy is rising annually and is being satisfied.

The assessment of Goals 11, 12, 13, and 15 relies on policies and programs in the spatial and environmental sectors. Due to the limited availability of government-published data (BPS), we only have access to the main indicators from Proklim villages. The indicators for Goals 11, 12, 13, and 15, which focus on spatial and environmental development, have shown improvement. Environmental programs include geological protection, Proklim village initiatives, settlement planning, management of critical land, climate change responses, land use management, and disaster management. In

2020, three villages—Nagari Paru in Sijunjung District, Nagari Kumanis in Sumpur Kudus District, and Nagari Guguak in Koto VII District—were designated as Proklim Villages by the Ministry of Forestry and Environment. Subsequently, in 2024, another village, Nagari Koto Tuo Sijunjung, received the Proklim Village award.

5.2.4. Pillars of Legal and Governance Development

The pillars of legal and governance development are anchored in Goal 16, which focuses on peace, justice, and strong institutions. This goal is assessed using key indicators, including the number of criminal acts and the number of crimes resolved. Data from 2020 to 2025 show a decrease in the number of criminal cases, an improvement in crime resolution, and an increase in the number of crimes that can be addressed effectively.

6. CONCLUTIONS

The Ranah Minang Silokek Geopark Master Plan has established both short- and long-term activities and funding sources for the period from 2025 to 2034, aimed at achieving the Sustainable Development Goals (SDGs). All programs outlined in the master plan are designed with the SDGs in mind, except for Goal 14, which is excluded because there are no marine areas in the geopark region. Between 2025 and 2026, the RMS Geopark is in the process of becoming a UNESCO Global Geopark (UGGp) candidate, alongside the Bojonegoro Geopark.

An assessment of composite and key SDG indicators across the four pillars of development—social, economic, environmental, and legal/governance—revealed improvements, though generally modest. This growth can be attributed to the geopark's ongoing development, which began in 2019, despite experiencing various challenges.

Under the economic development pillar, the regional economy has grown at an annual rate of 3.82% from 2020 to 2025. Additionally, key indicators of regional revenue and Local Original Income (PAD) have increased by 0.80% and 6.12% per year, respectively. However, this regional economic growth has not been mirrored by the tourism sector. Following a significant 7.74% increase in early 2021, tourism growth has fluctuated and is projected to decline to 4.71% by 2025. Consequently, the tourism sector's contribution remains low and has not demonstrated significant growth. Data from 2020 to 2025 indicates that the region has yet to fully recover from the impact of Covid-19.

On a positive note, per capita income has increased, and the poverty rate has declined, indicating improvements in social welfare and the HDI. Environmental indicators have also improved, particularly in areas such as conservation, disaster mitigation, and climate change. Analysis of key SDG indicators reveals that 12 of the 17 SDGs show an increasing trend: Goals 1, 2, 3, 4, 5, 6, 8, 12, 13, 15, 16, and 17. These findings support previous research highlighting the role of geoparks in achieving the 17 SDGs.

CONFLICT OF INTEREST

The authors declare that the research was conducted without any commercial or financial relationships that could be construed as a conflict of interest.

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DECLARATION OF ARTIFICIAL INTELLIGENCE USE
This study did not use artificial intelligence (AI) tools and methodologies. We hereby confirm that no artificial intelligence (AI) tools or methodologies were utilized at any stage of this study, including during data collection, analysis, visualization or manuscript preparation. All work presented in this study was conducted manually by the authors without the assistance of AI-based tools or systems.

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