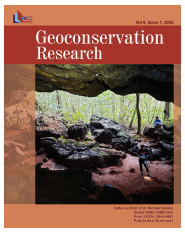

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Strengthening Collaborative Governance: Implementing the Pentahelix Approach to Address Challenges in the Toba Caldera UNESCO Global Geopark, Indonesia

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Abstract

The Toba Caldera UNESCO Global Geopark (TCUGGp), renowned for its exceptional geological and cultural significance, holds great potential to catalyze regional development and community empowerment. However, the TCUGGp received a warning status (yellow card) for revalidation of its status from the UNESCO Global Geoparks Council (UGGpC) in 2024. Here, we explore the shortcomings and challenges in developing, managing, and promoting the geopark using primary and secondary data. We find that the TCUGGp faced significant challenges, including insufficiencies in human resources, financial constraints, low levels of community engagement, infrastructure gaps, and governance issues, which contributed to the warning status. We propose adopting a collaborative governance model based on the Pentahelix approach, integrating academia, business, community, government, and media (ABCGM) to address these challenges. We suggest how to involve the five stakeholders, and practical implementation for future actions for each stakeholder. By these means, we expect the TCUGGp to reverse its warning status and retain its UGGp status while building a better managerial team and sustainable geopark.

Keywords: Geoparks, Collaborative governance, Pentahelix model, Toba Caldera UNESCO Global Geopark, UNESCO Global Geoparks

Introduction

As part of the endeavors to promote awareness of the global geo-environment by UNESCO (The United Nations Educational Scientific and Cultural Organization), geoparks focus on conserving, educating, and promoting geological heritage with the involvement of local residents. Since their inception in 1998 (Patzak 1998), geoparks have contributed significantly to raising awareness about the importance of protecting geodiversity, biodiversity, and cultural diversity around geopark areas (Dowling 2011; Farsani *et al.* 2012; Farsani *et al.* 2014; Lin & Su 2019). Through their bottom-up approach, geoparks have advanced the involvement of local communities in managing these areas. Such involvement not only promotes geological conservation but also contributes to the economic well-being and sense of pride of the people around the geoparks.

Studies have shown significant progress in the geoparks movement (Dowling 2011; Ng 2014; UNESCO 2014; Farsani 2018; Herrera-Franco *et al.* 2021). There are 213 UNESCO Global Geoparks (UGG) worldwide, spread over 48 countries (UNESCO 2024a).

UNESCO Global Geoparks are subject to a comprehensive revalidation process every four years to assess their functionality and quality. This process includes a field mission conducted by two evaluators who reassess the geopark's adherence to UNESCO standards. Based on the evaluators' report, the geopark may receive one of the following designations (UNESCO 2024b):

a. Green card: The geopark continues to fulfill all the required criteria. It will maintain its status as a UNESCO Global Geopark (UGG) for another four years.

b. Yellow card: The geopark no longer fully meets the criteria. The management body is notified and given a two-year window to implement necessary actions for improvement and revalidation.

c. Red card: If, after receiving a yellow card, the geopark still does not fulfill the criteria within two years, it will lose its status as a UNESCO Global Geopark.

Indonesia, known for its rich and diverse geological heritage, has been part of this movement since the 2000s. Despite the input of proactive endeavors, several shortcomings in geopark management persist including segregated and ambiguous development plans (Coordinating Ministry for Maritime and Investment Affairs 2019), inadequate development of townships around the geoparks, connectivity issues to the geopark locations (Kementerian PPN/BAPPENAS 2019), and other problems such as ineffective management bodies (Kompas 2023a), and lack of local community involvement (Marbun *et al*. 2019).

This article aims to explore the Toba Caldera UNESCO Global Geopark (TCUGGp), which received a warning status (yellow card) from the UNESCO Global Geopark Council (UGGpC). Although the yellow card was delivered in 2024 following the decision by the UGGpC in 2023, the warning status had already become known in Indonesia shortly after the visit of the UNESCO evaluators in August 2023 following a media report, and before the UGGpC meeting in September 2023. Local and national media covered the issue widely even before the formal announcement, and this highlighted the urgency of addressing the concerns raised by the evaluators, especially by the TCUGGp Management Body and other stakeholders.

According to the media, the yellow card issued to the Toba Caldera UNESCO Global Geopark is based on seven reasons (Bisnis Indonesia 2023):

d. The mapping of geological heritage is insufficient according to UGG standards.

e. Cultural and intangible heritages are inadequately mapped.

f. The Management Body is not representative and needs reorganization.

g. Signage visibility about the geopark is suboptimal.

h. The UGG logo is underutilized in promotional materials such as maps, books, and brochures.

i. Partnership activities are weak.

j. Networking efforts are lacking, particularly with other UGGs in Indonesia and other countries.

These seven problems seemed straightforward, and we argue that the Management Body should come up with a solution. Therefore, we aim to explore the shortcomings and challenges in the Toba Caldera Geopark development, management, and promotion. We propose solutions based on the Pentahelix approach to address these challenges and improve its future management.

Collaborative Governance

Collaborative governance emerged as an alternative to traditional, government-centric systems that are often conflict-oriented and adversarial (Stoker 1998; Ansell & Gash 2008). It promotes cooperation between government and non-government actors (Murdoch & Abram, 1998), involving open public discussions, consultations, and stakeholder forums (Ingles *et al*. 1999). This approach includes various public agencies at different government levels, the private sector, local communities, academia, and NGOs in planning and decision-making processes (Emerson *et al*. 2012; Lin & Su 2019; Nadjib 2016; Pomeroy 1995).

While this collaborative process can be time-consuming, it leads to more inclusive governance, particularly when local capacities are strengthened (Hung Kam *et al*. 2011; Koutra & Edwards 2012), and ensures that policies are inclusive and aligned with local traditions, strengthening the role and sense of belonging of local communities (Nadjib 2016). However, effective local involvement requires prioritizing the capacity-building of stakeholders, as their abilities and intensities in management can vary (Hung Kam *et al*. 2011; Koutra & Edwards 2012). Keyim (2018) identifies three determinants for satisfactory collaborative governance: broad and equitable collaboration, a legitimate and skilled convener, and adequate resources. Similarly, Nadjib (2016) emphasizes fair representation, inclusive policies, and shared authority in management as critical factors. Furthermore, Emerson *et al*. (2012) highlighted the importance of shared motivation and capacity when collaborating.

The Pentahelix Model

Helix thinking aids in identifying stakeholders and their interconnections, evolving from the Triple Helix model of university–industry–government relations (Etzkowitz & Leydesdorff 1997) to the Quadruple Helix, which adds media (Carayannis & Campbell 2010; Leydesdorff 2012; Ivanova 2014). The Pentahelix model further expands this framework by including additional stakeholders, making it more comprehensive for collaborative efforts (Carayannis *et al*. 2012; Campbell *et al*. 2015; Calzada & Cowie 2017).

Typically, the Pentahelix model comprises:

1. Academia: providing research and expertise (Etzkowitz & Leydesdorff 1997).
2. Business: offering innovation and economic development (Etzkowitz & Leydesdorff 1997).
3. Community: representing local interests and cultural values (Nadjib 2016).
4. Government: supplying regulatory support and resources (Keyim 2018).
5. Media or NGOs: facilitating communication and advocacy, depending on the field of collaboration (Awaluddin *et al*. 2016; Calzada 2016; Nadjib 2016; Sudiana *et al.* 2020; Windiani 2020.

Collaboration among these stakeholders can enable the achievement of governance that is participatory, consensus-oriented, accountable, transparent, responsive, effective and efficient, equitable and inclusive, and that follows the rule of law (Geopark Management Toolkit 2024).

Against this background, we analyze the necessity of collaborative governance in managing the Toba Caldera UGGp in North Sumatra, Indonesia, by utilizing the Pentahelix approach to explore how it could be implemented to address shortcomings and manage challenges in the Toba Caldera UGGp.

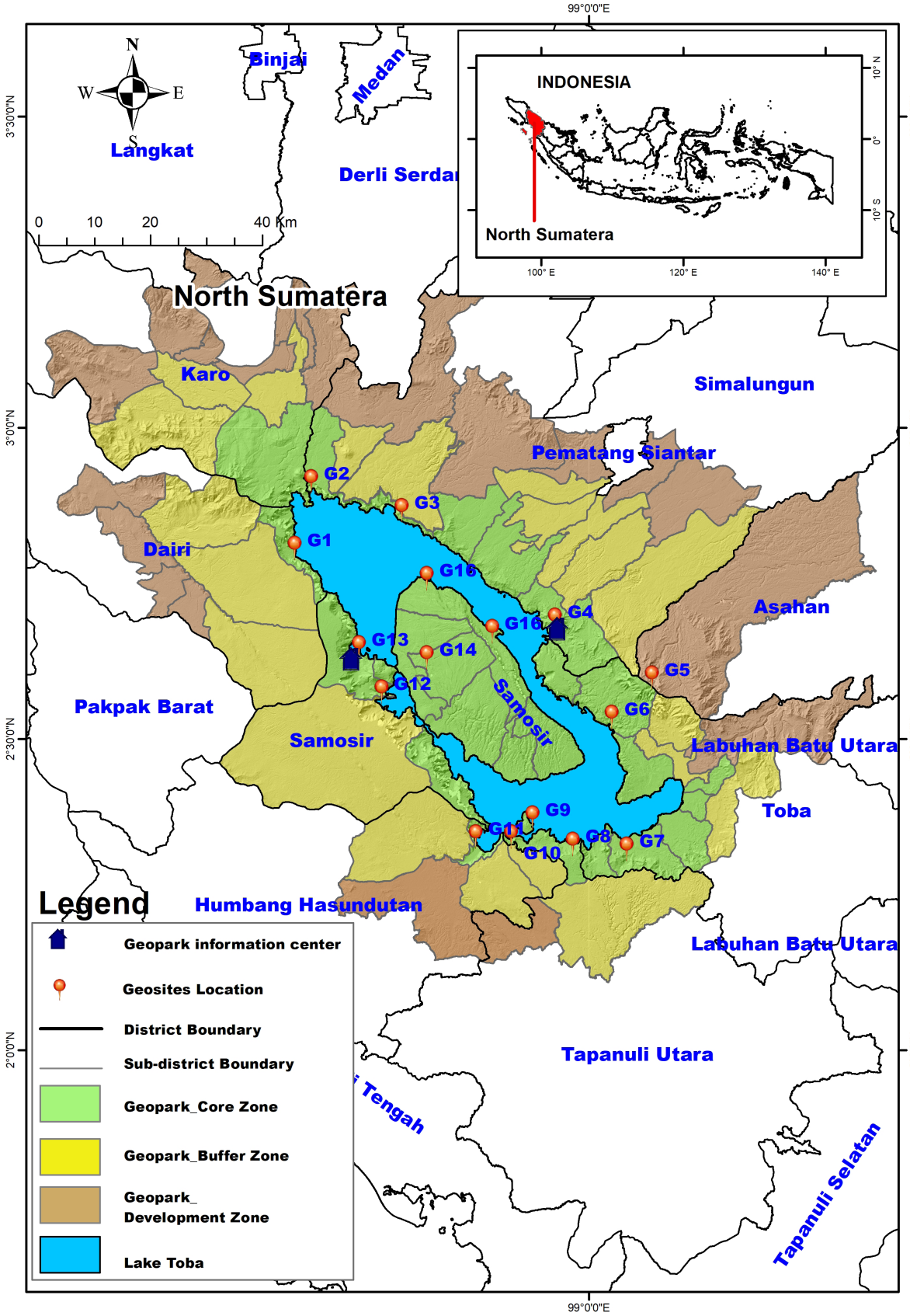

Figure 1. Map of the zonation of the Toba Caldera UGGp and the names of districts where the geosites are located. Source: Geospatial Information Agency of Indonesia (BIG 2017) with modification based on Toba Caldera Geopark (2021) and Kastawan (2021)

Methods

Study Area: The Toba Caldera UGGp, North Sumatra, Indonesia

Until 2020, Indonesia had six UNESCO Global Geoparks (UGGp) (Pardede 2021), thirteen National Geoparks, and 110 potential Aspiring Geoparks (The Ministry of National Development Planning [Kementerian PPN/BAPPENAS] 2020). In 2023, UNESCO certified and designated four additional Indonesian geoparks as global geoparks, bringing the total to ten. These geoparks include the Ijen UGGp in East Java (2023), the Maros Pangkep UGGp in South Sulawesi (2023), the Merangin Jambi UGGp in Jambi (2023), the Raja Ampat UGGp in West Papua (2023), the Toba Caldera UGGp in North Sumatra (2020), the Belitong UGGp in Bangka-Belitung (2020), the Rinjani-Lombok UGGp in Lombok (2018), the Ciletuh-Palabuhanratu UGGp in West Java (2018), the Gunung Sewu UGGp (2015), and the Batur UGGp in Bali (2012).

The Toba Caldera UGGp is the fifth UGG of Indonesia. Located 176 km west of Medan, the provincial capital of North Sumatra, it encompasses the area within the walls of the Toba Caldera (caldera rim) and Samosir Island (Fig. 2). The geopark centers around the geological theme of a super-volcano, resulting from a massive volcanic eruption approximately 74,000 years ago (Van Bemmelen 1929, 1939, 1949, 1970; Chesner 2012). This incident created a giant volcanic mountain range (volcano-tectonic caldera) that forms the largest lake in Indonesia, approximately 100 x 30 km² in size, situated at an elevation of 904 meters above sea level, with the deepest part of the lake being 505 m (Kementrian Lingkungan Hidup dan Kehutanan [Ministry Environment and Forestry] 2019). The brim of the Toba Caldera exhibits a morphology of undulating to steep hills and valleys, forming plains with the caldera rim watershed of Lake Toba covering an area of 3,658 km² and a lake surface area of 1,103 km². This watershed area consists of hills (43%), mountains (30%) with peak

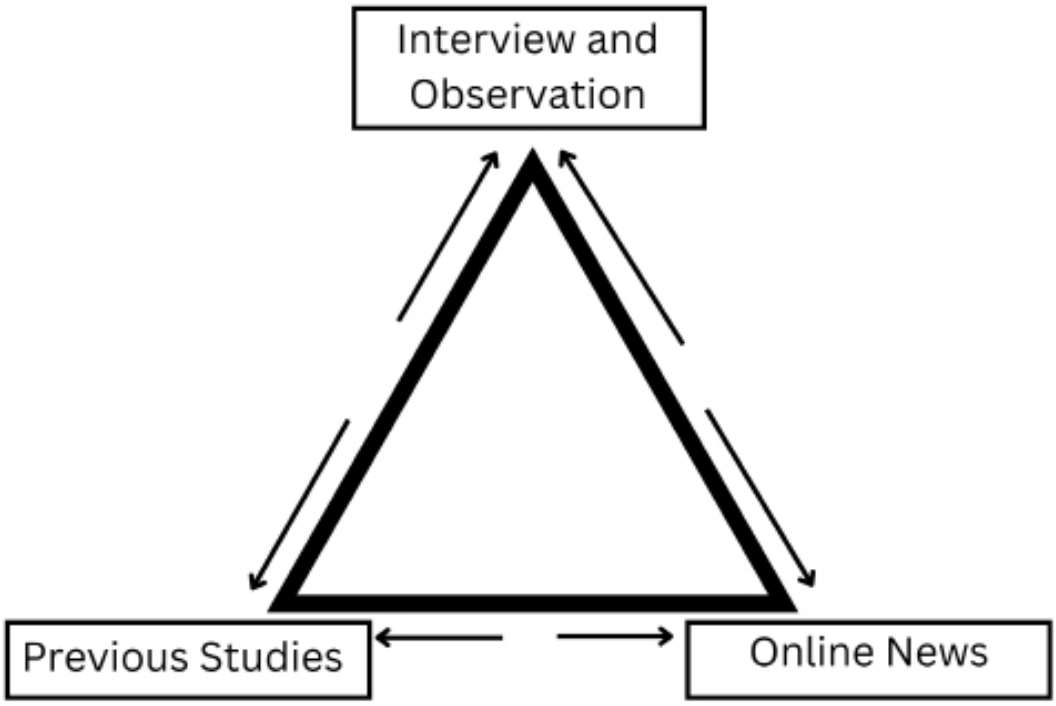

Figure 2. The three different sources of data used in the study as data triangulation techniques.

Table 1. Distribution of the geosites of the Toba Caldera UGGp based on the county location (Source: Toba Caldera Geopark 2021

No.	County	Names of Geosites
1	Dairi	G1. Silalahi – Sabungan
2	Karo	G2. Sipisopiso – Tongging
3	Simalungun	G3. Haranggaol – Simalungun
		G4. Parapat – Sibaganding
4	Toba	G5. Eden Botanical Garden
		G6. Balige – Liang Sipege – Batu Basiha – Meat
		G7. Situmurun – Uluan Block
5	North Tapanuli	G8. Hutaginjang
		G9. Tapian Nauli – Muara – Sibandang
6	Humbahas	G10. Sipinsur
		G11. Bakkara – Tipang – Baktiraja
7	Samosir	G12. Pusuk Buhit-Sianjur Mulamula
		G13. Tele – Efrata – Sihotang
		G14. Hutatinggi – Sidihoni
		G15. Batak Museum Simanindo – Batu Hoda – Stone Tombs
		G16. Ambarita-Tuktuk-Tomok

elevations of 2,000 m above sea level, and plains (27%) (Kastawan 2021).

The Toba Caldera UGGp comprises four geo-areas and 16 geo-sites distributed across seven districts [*kabupaten*, the third level of administrative level in Indonesia, below the province] in North Sumatra Province (Table 1). The geopark is home to approximately 263,900 people with a population density of 29 persons/km^2 (Kastawan 2021) of four Batak ethnic groups: Toba Batak, Simalungun Batak, Karo Batak, and Pakpak Batak. These four ethnic groups share similarities in cultural expressions, although there are more specific variations—architectural styles, textiles, and the kinship system known as *marga* (clan system). *Dalihan Natolu* (Toba Batak), *Tolu Sahundulan* (Simalungun Batak), *Daliken Sitelu* (Karo Batak), and *Sulang Silima* (Pakpak Batak) describe the essential pillars of social relationships that exist within these societies (Toba Caldera Geopark 2021).

In particular, the Toba Batak people mostly still embrace the traditional governance system called the *Bius* system. The *Bius* consists of a combination of several *horja* (councils), and each horja comprises several *huta* (villages), which are units of place/territory as well as shared interests and thus are no longer bound by lineage or clan ties. A *Bius* encompasses a geographical area that is not too large but still represents a community with a shared sense of solidarity (Siahaan 2005). The *Bius* is responsible for resolving issues such as distributing land; conducting the election of the *Bius* leader (*Raja Bius*); regulating the distribution of irrigation water; resolving disputes within the *Bius*; collaborating with other *Bius* to build an *onan* (market); forming family bonds based on religious or secular matters with several *Bius* located far apart, known as a *janji* (pact) (Pelita Batak 2021). However, with the existence of the mod-

ern government system, such as the Village Head, the *Raja Bius* system's influences are diminished, mainly related to traditional land distribution and dispute, as well as traditional ceremonies. Nevertheless, the *Raja Bius* are still respected figures in the village and can influence the villagers.

Economic activities in the Toba Caldera Geopark area are supported by 71 percent of agricultural commodities, including rice, onions, beans, chilies, corn, various vegetables, mangoes, and candlenuts (Kementrian Lingkungan Hidup dan Kehutanan [Ministry Environment and Forestry] 2019; Kastawan 2021). The remaining activities include livestock farming (buffalo, pigs, fisheries), tourism and service industries (transportation, hotels, restaurants), and trade activities such as small and medium enterprises (Kementrian Lingkungan Hidup dan Kehutanan [Ministry Environment and Forestry] 2019; Kastawan 2021). The seven districts each have local public and private schools, from kindergarten to senior high schools, added with small-scale local colleges (Kementrian Lingkungan Hidup dan Kehutanan [Ministry Environment and Forestry] 2019). However, for quality reasons, many families with better economic conditions prefer to send their children to urban areas, ranging from junior high school to university.

The journey of the TCUGGp to become a UNESCO-level geopark was marked by significant challenges and complexities. The initiative was started in 2009 (Mongabay 2023). It was initially named Toba Geopark in 2011, but then it changed to Toba Caldera Geopark in 2013 following its most unique heritage, the caldera being formed by supervolcano eruptions (Sumutprov 2024). It became a national geopark in 2014 (Indonesian Geoparks Network 2024). The attempt to join the Global Geopark Network (GGN) in 2014 failed as the application was rejected (UNESCO Global Geoparks 2018). In 2018, although the UGGp Council acknowledged that most of the former recommendations from 2014 had been fulfilled and should be highly commended, the application was deferred based on several shortcomings, such as that some of the proposed UGGp sites were unconnected, there being no master plan, and many of the sites having geoconservation issues that need to be improved (UNESCO Global Geoparks 2018).

Finally, in 2019, the application was accepted unanimously during the UGGp Council meeting. The Council acknowledged that the Toba Caldera Geopark had fulfilled the recommendations from the evaluation of 2018 and, with its exceptional geological and cultural significance, fulfilled the criteria to be a member of UGGp (UNESCO Global Geoparks 2019). The Toba Caldera Geopark was inaugurated as the Toba Caldera UNESCO Global Geopark (TCUGGp) in 2020.

Additionally, during the meeting in 2019, the UGGp Council gave several recommendations for the TCUGGp as follows (UNESCO Global Geoparks 2019 p.39):

1. Develop links between geological and other territorial heritages (i.e., natural, biotic, cultural, and intangible) through interpretation, education, and tours. Train local guides, tourism operators, and local people about the links between geology and ecology to enable knowledge sharing with visitors.

2. Develop a partnership strategy with a clear methodology and criteria for becoming a partner, outlining the agreements with Geopark. This applies to accommodation, catering, transport providers, activity providers, and producers of local products but is not restricted to those identified.

3. Strengthen involvement in the activities of the Global Geoparks Network and the Asia

Pacific Geoparks Network, promoting the international value of the territory through the partnership with Global Geoparks under the umbrella of the UNESCO Global Geoparks.

4. Develop an education strategy by working in partnership with other UGGps. Geopark teaching should occur in schools within the geopark territory, and the management should facilitate the development of learning programs and interactive tools for the students.

5. Improve educational strategies and activities to facilitate the mitigation of natural hazards and climate change in schools and for the local population.

6. Strengthen the involvement of the UGGp in research, conservation, and promoting the local indigenous population and their culture and language.

However, even with strenuous endeavors to become a global geopark, the TCUGGp received a yellow card in 2024. This yellow card serves as a strong indicator that there are several shortcomings in the management of the TCUGGp. Although the TCUGGp could still retain its UGGp status for two years after the warning was given, it may be unable to retain its UGG status if it fails to fix the problems and shortcomings raised by the UGGpC.

The 2023 UGG Council also raised concerns about the management team change following the UGGp's acceptance by UNESCO, noting that the new team needs further training to implement the recommendations effectively (UNESCO Global Geoparks 2023). Further, the UGG Council gave several recommendations for the TCUGGp as follows (UNESCO Global Geoparks 2023 p.59):

1. *Geological heritage and interpretation*: Diversify the geological narrative by conducting a broader survey to identify more accessible geological sites showcasing the basement rocks, major eruptions, and structural features of the Toba Caldera. Promote these sites with scientifically meaningful explanation panels and feature them on a comprehensive map, the website, and other media. Ensure the content is clear and easily understood by the public and school students.

2. *Other heritages*: Identify and catalog the non-designated natural, cultural, and intangible heritage within the geopark and integrate them into a cohesive narrative that connects all aspects of the geopark's story.

3. *Visibility and partnerships:* Increase the overall visibility of the Geopark by adding more interpretation panels, especially at key partner sites like the monkey and elephant preservation areas and Toba Caldera resort. Regularly update social media and improve the website, ensuring accurate content in multiple languages without relying on automatic translation. Use panels, brochures, and other materials to explain the regional and global geopark networks alongside the UGGp and Geopark logos. Ensure all communication is scientifically and grammatically correct. Develop a clear branding policy with partnership criteria and regularly provide partner training and idea exchange opportunities.

4. *Networking and training*: Strengthen collaboration with Indonesian geoparks while increasing involvement in regional (APGN) and global (GGN) networks. Establish partnerships with other UGGps and ensure management and site managers attend national and regional training for better geopark management. Stay connected with

APGN/GGN and the UNESCO Secretariat, including the Jakarta office, for guidance and updates.

However, there are discrepancies between the official UGG Council's recommendation, as written on the meeting report, and the recommendations reported by the media based on the statement of the government's or the TCUGGp's representative (Bisnis Indonesia 2023) (see introduction).

Data Collection

Our research began in a 2017 study before the Toba Caldera Geopark was inaugurated as a UGG in 2020, following its unsuccessful earlier attempt to join. The research aims to explore the situation of the geopark before and after the inauguration as a UGG, particularly focusing on the development, management, and promotion and how they might have contributed to the warning status given by the UGG Council after the 2023 evaluation.

The data used in this study consists of primary and secondary data. Primary data were obtained through insider and non-insider interviews, including in-depth semi-structured and short unstructured in-person interviews, online in-depth semi-structured interviews (Zoom video calls), and direct *in situ* observation. Here, 'insider' refers to people directly involved in the geopark Management Body. In contrast, 'non-insider' refers to local people living around the geosites who might have been part of the organization or facilitating geopark's management or development in certain ways but, unfortunately, are not engaged in the geopark affairs, thus avoiding the term 'outsider.'

Both the 'insiders' and 'non-insiders' were selected based on non-probability sampling. In particular, the 'insider' interviewees were chosen based on a purposive sampling technique, first by visiting the information center directly to meet the manager, and second by contacting people from the Management Body. The 'non-insider' interviewees were chosen based on the convenience sampling technique by going directly to the geosite and asking people randomly for an interview (Saunders *et al.* 2009). Table 2 depicts the timeline of the observation and data collection.

We also utilized data triangulation (Clark *et al.* 2021) to ensure the data's broad scope and validity by employing the qualitative textual analysis of previous studies and online news for secondary data (Fig. 2).

Triangulation is a method used to enhance validity and minimize bias, offering confirmation and completeness (Arksey & Knight 1999). The research examines the issue from different perspectives by incorporating multiple data sources, leading to more robust and comprehensive results (Arksey & Knight 1999). As part of the data triangulation, qualitative textual analysis (Kuckartz 2019) of previous studies and online news was employed to analyze perceptions by scholars, the public, and the media of the geopark's management, promotion, and development conditions.

It is important to note that previous studies included here are limited to those related to the development, management, and promotion of the Toba Caldera Geopark before or after its inauguration as the UGGp. Publications are from 2023 and earlier when sources for this article were gathered. In addition, the analyzed online news was all news published in 2023 related to the 'yellow card' of the TCUGGp. These were then compared to the results of our interviews and observations during the fieldwork in the geosites areas. The results are categorized based on their sources, as shown in the result section.

Table 2. Timeline of observation and data collection.

Time	Fieldwork location	Activity	Respondents with initial
2017	Hutaginjang geosite (G8) Sianjur Mula-Mula geosite (G12)	observation interview	**A** (Manager of the Geopark Information Center, male, over 50s) **B** (member of Raja Bius, male, over 70s) **C** (farmer, female, over 30s)
2019	Haranggaol geosite (G3) Paropo Silalahi (G1)	observation random and short interview	**D** (farmer, female, over 50s) **E** (farmer, male, over 20s)
2020	Sianjur Mula-Mula geosite (G12)	observation interview	**B** (the same Elder interviewed in 2017 **F** (operator of a community learning center in the village, male, over 20s)
2021	virtual	in-depth online interview through a zoom video-call	**G** (insider of TCUGGp, male, over 60s) **H** (insiders of Youth Geopark Forum of the TCUGGp, female, over 20s)
2022	Simanindo geosites (G15) Meat geosite (G11) Bakkara-Tipang Baktiraja geosite (G11) Parapat-Sibaganding geosite (G4)	observation	none
2023	Merek geosites (G2)	observation random and short interview	**I** (farmer, female, over 60s) **J** (farmer, male, over 20s) **K** (farmer, female, over 30s)
2024	Desk review, qualitative textual analysis of previous studies, and online news		

Results

Shortcomings Related to the Development, Management, and Promotion of TCUGGp

Findings from Previous Studies

Based on a Google search, we found eight peer-reviewed articles about the Toba Caldera Geopark related to development, management, and promotion published before 2024. Two were published in 2018, three in 2019, two in 2020, and one in 2023. These studies highlighted several shortcomings related to the development, management, and promotion of the TCUGGp:

- Lack of board direction (signage) to the geosites (Ginting & Sasmita 2018).
- Low public awareness about the Toba Caldera Geopark (Gultom *et al*. 2019; Fahrizal *et al*. 2020).
- Low involvement of the local people (Marbun *et al*. 2019).
- Low participation of young people (Hutauruk *et al*. 2018).
- Shortcomings in fulfilling the UGG assessor team's requirements (Simatupang & Purba 2019).
- Lack of commitment and integration among the local government of the 16 geosites in supporting the management of the Toba Caldera Geopark (Bangun &

Junita 2020).

- the importance of inter-regional cooperation in the development of the UNESCO Global Geopark Toba Caldera's tourist area (Kennedy *et al*. 2023)

The shortcomings highlighted by previous studies mainly focus on the lack of public awareness about the Toba Caldera UGG and the lack of coordination between the TCUGGp Management Body and the seven districts' local governments. We argue that the lack of public awareness arises from insufficient participation by the general public, particularly the youth and local community, and ineffective promotion and socialization by the management. Our argument is supported by some of the online news cited in this study (CNN Indonesia 2023; Detik 2023a), interviews with the local community, and observations of eight geosites we visited during fieldwork.

Findings from Interviews and Observations

We interviewed four insiders and seven local people as non-insiders related to the development, management, and promotion of the TCUGGp. We synthesize the results of the interviews as follows:

Insiders:

- Insufficient funds for daily operations to implement the annual work plan

(interviews in 2017 and 2021)

- Low budget allocation from the government (interview 2021)

- Lack of human resources, the geosites are spread in 16 locations, where each

geosite is supposed to have at least one Manager, but in reality not all geosite

managers were active due to insufficient operational funds (interview 2021)

- Disinterest or low interest of the local people to participate due to the lack of

economic benefit (interview 2017 and 2021)

- Lack of interest or low interest of young people to participate (interview 2021)

- Lack of networking and collaboration of the geopark management body with other

institutions (interview 2021).

Non-insiders (Local people):

- Low involvement of the local people (interviews 2017, 2020, and 2023)

- Low promotion to the general public causes them not to be aware of the geopark (interview 2017, 2020, 2023)

- Low awareness of the benefit of geopark to the general public (interview 2017, 2020,and 2023).

The interviewed locals expressed dissatisfaction with how the geopark management involved them (**B, C, F** interviews 2017, 2020) in planning and managing the site, disregarding their complaints. One interviewee (**B** 2017), with the status of *Raja Bius* (see above), questioned the origins of the staff at the geopark information center in Geosite Sianjur Mula-Mula (G12), stressing that only insiders were aware of recruitment or events related to geopark activities.

Furthermore, locals from Geosite Paropo Silalahi (G1) indicated confusion when asked about the geopark, either by its popular term or the Indonesian term "*Taman bumi*." The interviewees only knew that their area was becoming more popular and receiving more visitors without understanding its connection to the geopark (**D**, **E** 2019). In random interviews conducted in 2023 at Geosite Merek (G2), three locals (**I**, **J**, **K** 2023) echoed the

sentiment of exclusion, doubting they would benefit from the geopark as they were not involved and lacked the means to participate. They noted that only those with close contact with the insiders or those with enough capital to establish tourism businesses would benefit.

Findings from the Online News

The news was released in 2023 about the yellow card (warning status). Based on a Google search, around 30 different portal news (mass media) reported about the evaluation result of the TCUGGp. However, as most news content was generally the same, we only cite several of them in this article, particularly the popular portal news that mentioned the reasons for the yellow card, particularly shortcomings related to the development, management, and promotion of the TCUGGp.

Following the "warning status," most news portals discussed the Management Body's ineffectiveness and failures, lack of action, and unrepresentativeness. Over 30 news articles reviewed in this study echoed this sentiment. One outlet even linked the current issues to a corruption case involving one of the top management personnel, though the case predated the establishment of the geopark. Nonetheless, the media highlighted this as indicative of broader management failures. In addition to criticizing the Management Body, the media reported the need to reorganize the Management Body and the government's plans to reorganize it. A senator expressed dissatisfaction with the result of the yellow card and suggested investigating all management personnel. Through media channels, the government also expressed its commitment to fulfilling the recommendations the UGGp Council gave. However, implementing these plans remains to be seen, as the new Management Body for the Geopark has not yet been announced.

The following are our findings from the online news:

- One of the top Management Body embroiled in a corruption case caused a decline in geopark progress (Kompas 2023a).
- Ineffective Management Body (Kompas 2023b).
- Management failures (Detik 2023a).
- Lack of action in promoting the TCUGGp (VOA Indonesia 2023; VIVA 2023; MetroTVNews 2023).
- Lack of action of the management body of the TCUGGp. This includes issues related to community empowerment, the cleanliness sector that needs attention, and economic challenges in the Lake Toba area (CNN Indonesia 2023; Detik 2023b; Trans7 2023).
- The provincial government planned to reorganize the geopark management body after getting the warning (yellow card) from the UGGpC (Antaranews 2023; CNN Indonesia 2023).

Despite not being included in the official recommendations, it is interesting that the geopark representatives who talk to the media highlighted that improved management is one of the recommendations of the UNESCO Evaluator Team.

> "So far, there are four recommendations that require follow-up, namely: the management body's organization, geological maps, visibility, and the geopark theme with its application in the field. Among these four recommendations, the organization of the Toba Caldera management body is the top priority for immediate action." (The Head of the Communications Bureau of the Ministry of Tourism and Creative Economy of the Republic of Indonesia (Kemenparekraf), Kompas, October 2023c).

> "One of the recommendations for the yellow card is management. According to the evaluators who visited the Toba Caldera area, the management, in this case, the Management Body, is not sufficiently representative. Therefore, it requires changes. There are coordination issues that are not handled properly, leading the evaluators to recommend that the Management Body be restructured or reorganized." (General Manager of the Management Body of Toba Caldera UNESCO Geopark, North Sumatra & the Head of the Department of Culture, Tourism, and Creative Economy of North Sumatra Province, Bisnis, October 2023).

> "The UNESCO team also assessed that the management – in this case, the Management Body – is not sufficiently representative and therefore requires a management restructuring." (Head of the Management Body of Toba Caldera UNESCO Geopark, North Sumatra & the Head of the Department of Culture, Tourism, and Creative Economy of North Sumatra Province, VOA Indonesia October 2023).

The secretary of the Management Body of TCUGGp, who attended the UGGpC meeting in Moroko in September 2023, also stated the reasons for the yellow card.

> "There are at least seven points of UNESCO's recommendations that need to be implemented at the geosites in the Lake Toba area to improve its status. These points are related to geological mapping boundaries, biological and cultural heritage, strengthening the management body, education, partnerships, visibility, and networking." (Secretary of the Management Body of Toba Caldera UNESCO Global Geopark, RadioDelFM October 2023; BPODT October 2023).

Moreover, criticism of the management of the TCUGGp, dominated by bureaucrats and allegedly influenced by political interests, surfaced in the mass media in 2021 when the new Management Body was announced. It was also stated that individuals involved in the initiation of the Toba Caldera Geopark (TCG) until it became a UGGp appeared to have been sidelined after the TCG achieved the UGGp status (Medanbisnisdaily 2021). It aligns with the concerns expressed by the UGGp Council at the 2023 meeting, raising issues regarding the change in the management team following the UGGp's acceptance by UNESCO (UNESCO Global Geoparks 2023).

Challenges of the Management Body

Findings from interviews with local people, previous studies, portal news, and direct observations highlighted the shortcomings in the development, management, and promotion of the TCUGGp. However, it is also essential to consider the perspectives of the Management Body. Although their efforts were insufficient to meet the standards of a UGGp, they have valuable insights into the challenges faced in managing the geopark.

Interviews with insiders revealed significant challenges in managing the geopark. Two representatives of the Toba Caldera UGGp from different positions in the Management Body pointed to insufficient human resources, limited operational budgets, difficulties in convincing local people to participate, and the extensive spatial spread of the 16 geosites as primary obstacles.

The First Representative explained that irregular budget allocations hampered their ability to carry out work or hire staff for daily operations and for work to be conducted systematically. Initially, attempts were made to employ local people, but irregular payment and low wages discouraged the hired people. Consequently, the Management Body had to hire outsiders willing to compromise

on wages and payment irregularities, as their responsibilities were limited to daily labor rather than managerial tasks. Additionally, finding individuals knowledgeable in geopark management and willing to accept unsatisfactory salaries in a remote area proved challenging. The First Representative also highlighted a misconception among local people about geoparks. During socialization efforts, geoparks were consistently associated with UNESCO and the benefits for local communities, which led to misunderstandings. The locals focused primarily on immediate economic gains and ceased participating in activities when these were not realized later (**A** 2017).

An interview with the Second Representative in 2021 revealed similar, albeit slightly improved, conditions. This person noted that achieving UNESCO status for the Toba Caldera UGGp required more activities and collaborations than in 2017. Lobbying for collaboration and signing memoranda of understanding (MOU) with other institutions required operational funds and social capital. The Management Body had signed MOUs with several schools and universities for research and promotion, but these collaborations take time and funding to achieve results (**G** 2021).

As the geopark areas spanned across seven districts, the geopark authorities fell into the provincial government. The provincial government then established a special agency to manage the TCUGGp. Figure 3 shows the organizational structure of the Management Body of the TCUGGp based on North Sumatra's Governor Regulation No. 48/2020 on 'The Management Body of Cal-

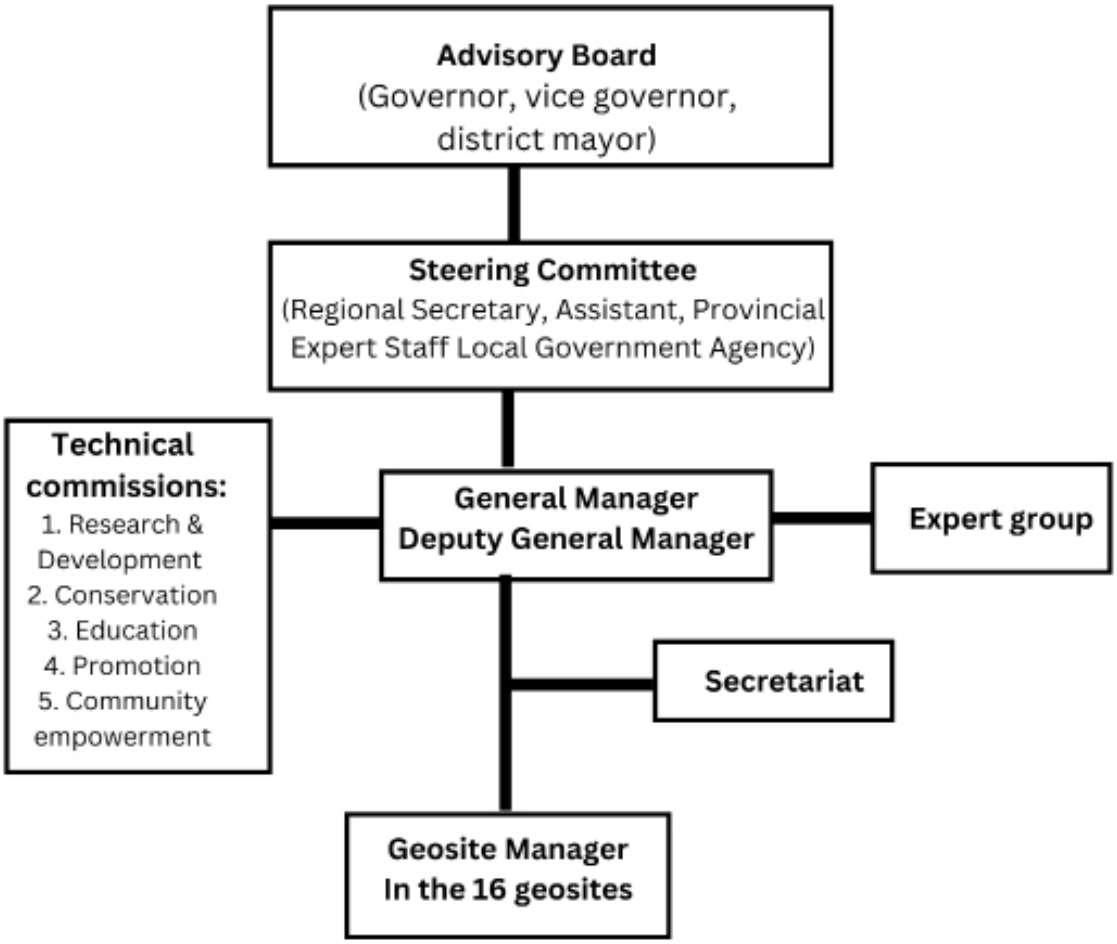

Figure 3. Organizational structure of the Management Body of the TCUGGp based on North Sumatra's governor's regulation.

dera Toba UNESCO Global Geopark of North Sumatra Province' (PERGUB No. 48 2020).

In comparison, Figure 4 shows the actual structure of the Management Body of the TCUGGp based on North Sumatra's Governor's Decree No. 188.44/630/kpts/2020 on "The appointment of Personnel for the Management Body of Toba Caldera UNESCO Global Geopark." (SK GubSu No. 188.44/630/Kpts/2020).

Some differences exist between the governor's regulation and the governor's decree, such as the divisions/commissions and the expert group. However, both structures included the governor and the seven district mayors as part of the Advisory Board and other high-ranking officials as part of the Steering Committee. The General and Executive Manager coordinate with four divisions, each led by one personnel with several members. However, according to the mass media report, the coordinator of the Conservation and Environment division and the Empowerment, Economy, and Community division resigned not long after they were appointed (Medanbisnisdaily 2021). The Second Representative also stated that although the Governor's Decree appointed 16 people as geosite managers, not all are active due to a lack of funding (**G** 2021).

When questioned about the top-down initiative and low local engagement, the Second Representative echoed the First Representative's sentiment that involving locals without offering direct eco-

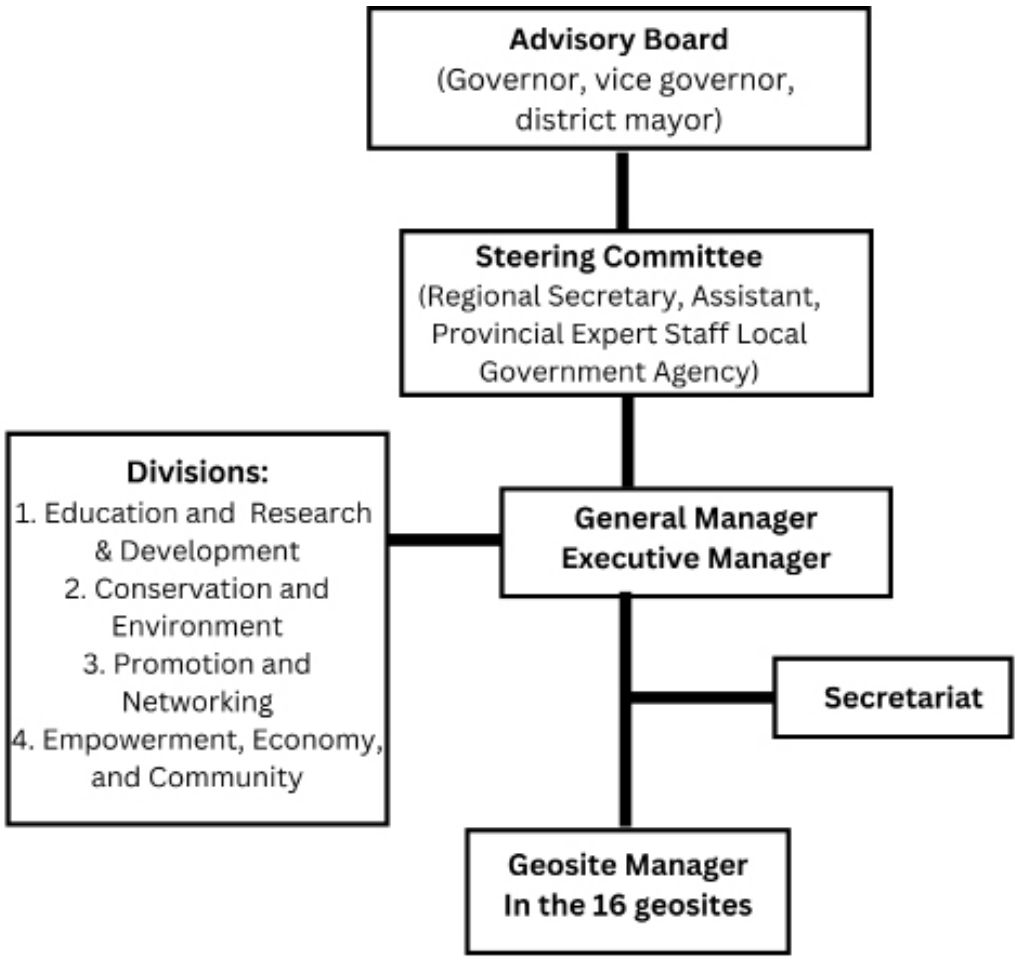

Figure 4. The actual structure of the Management Body of the TCUGGp based on North Sumatra's governor's decree.

nomic benefits was very challenging. Most locals are farmers whose primary focus is earning a living. When approached by the Management Body, their first concern was the economic benefits of participating in geopark activities. The Second Representative argued that not all communities are suitable for a bottom-up initiative due to their economic conditions. Instead, a middle-ground approach combining top-down and bottom-up strategies was suggested. The government or Management Body should initiate activities and once economic benefits become evident the local people would be more likely to join voluntarily (**G** 2021).

Regarding youth participation, the Youth Representative mentioned efforts to involve young people through a free "youth geoparks camp." However, lack of interest was evident among the young population as the registration period had to be extended, and essay requirements had to be lowered to attract people (**H** 2021). Connecting youth across the 16 geosites spread over seven districts around Lake Toba was demanding and strenuous. Many youths move to urban areas for education, from junior and senior high schools to universities. Consequently, these youths live in cities and have limited time to visit their hometowns and participate in geopark activities.

Discussion and Implication for the TCUGGp Management

Based on the findings from previous studies, online news, interviews and observations, and recommendations from the UGGp Council, we categorized the shortcomings in developing, managing, and promoting the TCUGGp in Table 3.

Table 3. Shortcomings in developing, managing, and promoting the TCUGGp.

Human Resources and Capacity	Insufficient human resources Shortcomings in fulfilling the UGG assessor team's requirements Inactive geosites managers Insufficient training and participation of the management and site managers in national and regional activities
Budget and Financial Issues	Limited operational budgets
Community Engagement and Local Participation	Difficulties in convincing local people to participate Low involvement of the local people Low awareness of the benefit of geopark to the general public Low participation of young people
Awareness and Promotion	Low promotion to the general public Low public awareness Insufficient update of the geopark social media and website, Lack of promotion of the geological heritage and interpretation to the public and school students.
Infrastructure and Spatial Challenges	Connecting the extensive spatial spread of the 16 geosites Lack of board direction (signage) to the geosites Lack of visibility of the Geopark panels and boards
Governance, Coordination, and Networking	Lack of commitment and integration among the local governments of the 16 geosites in supporting the management of the Toba Caldera Geopark Weak collaboration with Indonesian geoparks and lack of involvement in regional (APGN) and global (GGN) networks. Bureaucrats dominate the Management Body.

Our findings highlight the limitations of the current Management Body in developing, managing, and promoting the geopark despite their efforts. These challenges have contributed to the warning status issued by the UGGpC. The previous management approach has proven inadequate in addressing the existing issues within and outside the Management Body. Therefore, we propose an alternative management approach, advocating for collaborative governance based on the Pentahelix approach.

The Pentahelix Approach to Managing Challenges in the Caldera Toba UGGp

Effective governance is the backbone of successful geopark management. It enables coordinated action, resource mobilization, stakeholder engagement, and strategic planning (Geopark Management Toolkit 2024)—all essential for meeting UNESCO's criteria. Although UNESCO's recommendations do not explicitly mention governance, this clearly must be considered. The Pentahelix approach fosters collaboration, inclusivity, capacity, and resource sharing, which are crucial for addressing the geopark's challenges. It also can balance power between government and non-government actors in managing the Toba Caldera UGGp. Moreover, it can address the Management Body's challenges in reaching out to the local community, mobilizing active participation, and overcoming limited human and financial resources (Pomeroy 1995; Emerson *et al*. 2012; Nadjib 2016; Lin & Su 2019).

Proposing the Pentahelix approach, we do not aim to change the structure of the organization of TCUGGp's management as we perceive that this is already aligned with UGGp's standards. In fact, the TCUGGp Management Body (Fig. 4) also includes four divisions: Education and Research and Development, Conservation and Environment, Promotion and Networking, Empowerment, Economy, and Community, which is similar to the Pentahelix model. Instead, we emphasize the importance of putting the right people in the right positions, evaluating the appointed personnel, and implementing the policy. Following criticism of the personnel of the TCUGGp, which is dominated by bureaucrats and allegedly influenced by political interest and personnel changes that do not comply with UGGp standards, we recommend the following points to be considered in selecting the personnel for the Management Body:

1. Capacity to be part of the Management Body should be based on knowledge and resources, not just institutional involvement (Emerson *et al*. 2012).

2. The Future Management Body must be inclusive and representative, with all stakeholders committed to collaboration (Nadjib 2016; Keyim 2018; Geopark Management Toolkit 2024). There should be a balance between the bureaucrats and technocrats in the Management Body.

3. The Management Body should share motivation in working together to fulfill the UGGp Council's recommendations (Emerson *et al*. 2012; Geopark Management Toolkit 2024).

The Pentahelix model encompasses five main stakeholders that can influence or are influenced by the management of the Toba Caldera UGGp. Drawing insights from previous studies, online news, and interviews, we identified these stakeholders as Academia, Business, Community, Government, and Media (ABCGM). The following section discusses the rationale behind each stakeholder's involvement and the practical implementation for future actions.

Academia Stakeholders

The National Action Plan for Geoparks in Indonesia, based on Ministerial Decree No.15/2020 (PPN/

BAPPENAS 2020), highlights three main educational goals for Indonesian geoparks, improving research and publication to support geoparks development, enhancing education and information dissemination to raise awareness, and building the capacity of stakeholders in geopark development and management. It underscores the vital role of academia in geopark programs, noting their crucial role in many aspects. Previous studies cited here showed the previous efforts of academia that can be useful for developing, managing, and promoting the TCUGGp. However, more endeavors are needed. In addition, the UGGpC recommendation included the development of a curriculum that related to geopark and disaster mitigation for local schools in the geopark area, highlighting the role of academia in geopark.

The following are the practical implementations for future actions:

1. Education and training programs: collaborating in developing curriculum, training workshops, and professional development (UNESCO Global Geoparks 2019).

2. Internship and mentorship programs: establishing internship programs for students to gain practical experience within the geopark and connecting geosites managers and staff with academic mentors provides guidance, support, and knowledge transfer.

3. Research collaboration: collaborating with higher education institutions (Halibas *et al*.2017) can foster more expansive research collaboration by encouraging academic research projects and engaging the geosites managers in the research projects. In addition, providing scholarships and financial assistance for research projects related to geoparks can also boost researchers' interest.

4. Educational outreach: collaborating with schools and universities to raise awareness of the geopark's significance and inspire community involvement. The Management Body can collaborate with local educational institutions, such as PAUD (local kindergarten), elementary schools, junior high schools, and senior high schools, to promote and raise awareness about geoparks from the bottom to the top level of education.

5. School partnerships: collaborate with local schools to involve students in geopark activities through clubs, field trips, and community service requirements (Henriques *et al*. 2012).

Such collaborations can help achieve the first and second goals of the Geoparks National Action Plan, address the recommendation from the UGGC, and address the challenges in the educational pillar of geoparks (Silva & Sá 2018).

Business Stakeholders

As is apparent from the findings, one of the main reasons for the reluctance of local people to get involved is the lack of economic benefit. Geoparks are expected to stimulate the local economy (Wójtowicz *et al*. 2011; Farsani *et al.* 2012; Lin & Su 2019; Lee & Jayakumar 2021) and contribute to the well-being of the local people. Therefore, collaboration with business-people and local people as active participants in the business is critical.

Practical implementation from the business stakeholder for future collaborations:

1. Resource sharing: provide the geopark with access to technology and tools and encourage volunteer programs. The Management Body can collaborate with the provincial KADIN (Indonesian Chamber of Commerce and Industry) to encourage companies to participate.

2. Financial support and investment: The business sector can also be encouraged to allocate corporate social responsibility (CSR) funds for geopark entrepreneurship programs through corporate sponsorships, donations and grants, microfinance support, sponsoring events, and public-private partnerships. Microfinance support for micro-entrepreneurs in geopark areas can encourage local people to start their businesses. However, starting with capacity building for entrepreneurs is crucial before implementing microfinance support.

3. Inclusive business practices: prioritizing local products and services to support the local economy. The Management Body should strive to widen their networking with local and national entrepreneurs and provide regular workshops to train the local people to find and create economic opportunities related to geoparks in their areas. Besides promoting geo-tourism, various geoparks management initiatives around the world have created crafts, foods, drinks, and activities related to geoparks, such as geo-bakeries, geo-restaurants, geo-crafts, geo-arts, and others (Farsani *et al.* 2012). These represent economic opportunities, named "geo-products" (Rodrigues *et al.* 2021), as promoted by UGG. They should be introduced to and created by the local people to increase their awareness and participation in geopark programs.

Community Stakeholders

Engaging the local people is one of the critical principles of geoparks management. The awareness and affinity of the local people to the environment (Stoffelen *et al.* 2019), in this case, the geopark areas, should be critical factors in planning all geopark programs to ensure that the planning does not contradict the local people's ways, visions, and values of living (Nadjib 2016; Lin & Su 2019). The best way to achieve this is by actively engaging the local people and providing space and opportunity for public discussion. It can be done by involving local people through their various associations and issues of interest.

It is said that the communities in the TCUGGp areas are hesitant to get involved in the activities as they do not see the economic benefit. However, increasing participation can start with raising awareness about the existence of geopark in their area and how it relates to their environment, culture, economy, and daily life. Outreach programs can be started from the grassroots community. The local people in the Caldera Toba UGG areas are known for their abundant associations. One person can be active in several associations based on their backgrounds, such as farmer associations, fishermen associations, clan-based associations, rotating savings and credit associations (*arisan*), religious groups, and other associations.

Although the local people prioritize their livelihoods by spending more time farming or other agricultural activities, they still allocate time to their social life. For example, the various associations hold meetings at least once a month, and the religious groups hold meetings at least once a week outside their Sunday church gathering. There are also gatherings for Elders and the *Posyandu* (a community-based healthcare service in Indonesia, typically focusing on maternal and child health, nutrition, immunization, and family planning) organized by the village office once a month. There are many ways to reach out to the local people. Involving the Village Heads, Village Facilitators (*Pendamping Desa*), and the *Raja Bius* (traditional leaders) of villages around the geosites in the outreach programs should be more helpful and practical.

Raising the local people's awareness about geoparks might spark their interest in being in-

volved. Engaging the local communities can be done in various ways, for example:

1. Knowledge Sharing: locals' history, experiences, and perspectives are known best by the locals. Hence, it is important for the Management Body to consider this when developing informational material. The Management Body can engage the *Raja Bius* (refer to study area section about *the Raja Bius*) and elders to share traditional knowledge and practices related to the geopark's cultural and natural heritage for storytelling development. Elders' suggestions from the locals are important in developing geo-trails by involving them in community mapping projects highlighting lesser-known paths and sites.

2. Cultural and social events: traditional festivals and cultural performances. The annual event of the Lake Toba Festival is the best occasion to incorporate this point. It is suggested that all the people involved in this festival, the organizer and the performers, be briefed about the geopark and then display various information about geopark to the visitors.

3. Community involvement: tour guides, local artisans, transportation services, and environmental monitoring. Preparing and prioritizing the local community to be the tour guide in the geopark area is significant in increasing the interest and participation of the local community.

Government Stakeholders

The TCUGGp's Management Body represents the government as the provincial governor, and the seven-districts mayors of the geopark are included in the organizational structure of the TCUGGp (Figs. 3, 4). However, including the provincial government and district mayors in the organizational structure does not guarantee the success of a management body. Including high-ranking officials without clearly defined roles can lead to inefficiency and lack of accountability. Also, there should be accountability mechanisms such as regular meetings and reporting for transparency and oversight. In addition, empowering professional management by recruiting people with experienced professionals in geopark management, sustainable tourism, environmental conservation, and community development, as well as employing more geology, ecology, cultural heritage, and education experts to lead specific projects.

Moreover, investing in capacity building for the personnel in the Management Body through training programs and knowledge transfer is essential. Further, as the seven districts have equal rights on the TCUGGp, strengthening inter-governmental collaboration and commitment is imperative. Establishing a memorandum of understanding (MoU) between the provincial and district administration is suggested, outlining commitments to the geopark. The commitments should also include the budget allocation for the geopark. One of the main challenges mentioned during the interviews was insufficient and irregular budget. According to North Sumatra's Governor Regulation No. 48/2020 on the 'Management Body of Caldera Toba UNESCO Global Geopark of North Sumatra Province,' the budget for the TCUGGp is allocated from the Central Revenue and Expenditure Budget (APBN), the Provincial Regional Revenue and Expenditure Budget (APBP), the District Regional Revenue and Expenditure Budget (APBD), and other legitimate and non-binding sources of funding under the provisions of applicable laws and regulations. The next step is increasing transparency and accountability through transparent decision-making by making meeting agendas and minutes accessible to the public and public reporting by regularly publishing reports on geopark activities, finances, and progress towards goals. The

last critical step is monitoring and evaluation because, without monitoring and evaluation, it is difficult to know the effectiveness of the programs.

Media stakeholders

Throughout this study, media has played significant roles in spreading news about the Toba Caldera UGGp, whether through mass media or social media. Thus, we advocate that the media act as one of the stakeholders. Research in Indonesia has shown the media's prominent role in promoting various programs across different fields (Awaluddin *et al.* 2016; Sudiana *et al.* 2020; Windiani 2020). Similarly, the media can significantly promote and monitor the Toba Caldera UGGp. Hence, collaboration with the media is critical for promoting geoparks and raising awareness of the significance of protecting geodiversity, biodiversity, and cultural diversity around the geoparks.

By involving these stakeholders and fostering collaboration, the Management Body of the Toba Caldera UGGp can enhance program effectiveness, reverse the warning status, and achieve sustainable development goals through geoparks programs.

Conclusions

As UNESCO global geoparks are promoted to raise awareness and advance behavior and action to protect the unique earth heritage, the fundamentals of the earth heritage will have to be valued. They include geodiversity, biodiversity, and cultural diversity, where proper conservation will reduce geo-hazards in the face of the changing environment and global warming. Geo-hazard-free will be a foundation for better social, economic, and cultural development for the geopark communities and their people. Therefore, the local communities should have been critical stakeholders in geoparks.

The Toba Caldera UNESCO Global Geopark holds immense potential as a site of outstanding geological and cultural significance and a catalyst for regional development and community empowerment. Nevertheless, the Toba Caldera UNESCO Global Geopark (TCUGGp) faces significant challenges across multiple domains, including human resources and capacity, budget and financial issues, community engagement and local participation, awareness and promotion, infrastructure and spatial planning, as well as governance, coordination, and networking. These challenges have hindered Geopark's effective development, management, and promotion, leading to a warning status from the UNESCO Global Geoparks Council (UGGpC). The current management approach has proven insufficient in addressing these multifaceted issues.

To overcome these shortcomings, we propose adopting a collaborative governance model based on the Pentahelix approach, emphasizing the integration and active participation of five key stakeholder groups: Academia, Business, Community, Government, and Media (ABCGM). This model fosters inclusivity, resource sharing, and capacity building, enabling a more dynamic and responsive management structure that addresses Geopark's complex challenges.

By embracing the Pentahelix model, TCUGGp can transform its management approach into more inclusive, adaptive, and effective. This collaborative governance framework addresses the immediate challenges and builds a foundation for sustainable development, aligning with UNESCO's criteria and global best practices. Active participation from all stakeholders ensures that diverse perspectives are considered, resources are optimally utilized, and community needs are met, ultimately enhancing Geopark's resilience and long-term success.

Implementing these recommendations requires commitment, open communication, and coordinated efforts among all stakeholders. The Management Body should prioritize building solid

partnerships, fostering mutual trust, and creating an enabling environment where each stakeholder group can contribute meaningfully. With this implementation and continuous evaluation and adaptation of strategies, the TCUGGp is expected to reverse its warning status and retain its UGGp status while building a better managerial team and sustainable geopark.

Conflict of Interest

The follow-up fieldwork in 2022 and 2023 of this research is funded by Taiwan's National Science and Technology Council (111-2424-H-003-001-DR). The authors do not have any conflict of interest to declare.

Authors' Contribution:

Betty B.S. Naibaho: Conceptualization, Fieldwork and Data collection, Formal analysis, Funding acquisition, Methodology, Visualization, Writing-Original draft preparation, Writing, and editing

Shew-Jiuan Su: Supervision, Conceptualization, Writing – review & editing, Validation.

Availability of data and materials

The data that support the findings of this study are available from the corresponding author, upon reasonable request

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