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Principles of science communication in UNESCO Global Geoparks: a framework for effective engagement with geoscience

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Abstract

UNESCO Global Geoparks (UGGps) integrate geoconservation with sustainable development, serving as platforms for science communication and public engagement. Despite their societal relevance there remains a lack of structured frameworks to guide effective science communication in these territories. Addressing this gap, the present study proposes an evidence-based framework tailored specifically to the context and challenges of UGGps.

Building on prior research and comparative case studies, the framework is structured around 18 guiding principles, organized into five key dimensions focused on strategic planning, meaningful engagement and continuous improvement. The framework was assessed through alignment with different sets of indicators for science communication and UNESCO guidelines, demonstrating strong alignment and contextual relevance.

By positioning Geoparks as dynamic spaces for public engagement and offering a tailored tool for their unique context, this research contributes to improving environmental awareness, public engagement and policy influence, reinforcing Geoparks' role in advancing the United Nations Sustainable Development Goals.

Although designed for UGGps, the framework is adaptable to other protected areas, UNESCO-designated sites, and wider geoscience communication contexts.

INTRODUCTION

UNESCO Global Geoparks (UGGps) are UNESCO-designated sites that represent innovative territorial strategies, combining the protection of geological heritage with sustainable local development (Eder & Patzak, 2004; UNESCO, 2015). Currently, there are 213 UGGps across 48 countries, fostering science communication and public engagement on issues like energy, resources, clean water, climate change and conservation. Geoparks serve as natural labs, supporting research, contributing to advance science and providing opportunities for non-experts engage with these critical topics. Geoscience communication can be seen as a tool for sustainability, seeking societal engagement with geodiversity and geoconservation (Rodrigues et al., 2023a).

Since its foundation in 2000 and its official recognition as a UNESCO program in 2015, enormous efforts have been made by Geoparks around the world to communicate better, more effectively and reach wider audiences (McKeever & Zouros, 2005) occupying a prominent position not only in geoconservation, but also in environmental education and awareness (Rodrigues et al., *in press*). Geoparks are considered key areas for highlighting

geoscience's contribution to advancing the United Nations Sustainable Development Goals (Capello et al., 2023).

In the context of this work, it may be important to underline the distinct nature and focus of science education and science communication. While both aim to expose citizens to scientific knowledge, science education is mainly concerned with structured learning processes and disciplinary understanding in formal contexts, whereas science communication emphasizes engagement, dialogue, socially-mediated understanding, and participation in informal and public contexts (Kohen et al. 2019; Baram-Tsabari & Osborne, 2015). In this sense, although UGGps operate at the intersection of education and communication, this work focuses on science communication, highlighting how they foster public engagement and societal dialogue on geosciences and sustainability.

Given that both geoscience and geodiversity are deeply tied to place, UGGps provide rich, context-driven experiences that blend scientific, cultural and historical perspectives, fostering personal connections to the environment. In this way, their approach is similar to the principles of place-based education, which emphasizes how meaningful connections to place can foster cognitive, behavioral, and attitudinal outcomes (Semken et al., 2017). By viewing place as a dynamic interaction between people and their surroundings, shaped by time and culture, these spaces deepen understanding, respect for heritage, and encourage sustainable practices (Van Eijck & Roth, 2010). On the other hand, place attachment also boosts community participation by linking psychological, social, and environmental factors, promoting active, sustainable practices that strengthen both stewardship and social cohesion (Manzo & Perkins, 2006), which are also key aspects of territories designated as UGGps.

The relevance and societal role of Geoparks emphasize the need for effective science communication in these contexts, as well as further research in this area. While existing studies often focus on specific strategies, such as the work by DeFelipe et al. (2025) focused on communicating hazards, there is a clear lack of comprehensive frameworks that address the broader and more complex challenges of science communication within Geoparks. Practical resources are also limited, with only a few examples available, for instance those developed within the context of geotourism (*e.g.* Arrage, 2024).

On the other hand, existing frameworks are either too broad in nature conservation (Harwell et al., 2020) or focus on specific dimensions of science communication, as interpretation (Crofts et al., 2020). In fact, the interpretation of natural heritage is one of the few aspects of science communication with key reference works widely applied in contexts with significant geological heritage, such as those developed for United States National Parks by the pioneer Freeman Tilden. Although centered on interpretation and not covering all dimensions of communication dynamics, Tilden's work introduced foundational principles related to audience engagement (Tilden, 1957).

Previous studies have proposed indicators to assess the quality of science communication (Olesk et al., 2021), also applied to the specific contexts of Geoparks (Rodrigues et al., 2025a) and UNESCO provides specific guidelines for meeting Geopark criteria (UNESCO, 2021); yet, none of these offer a structured approach for action.

The common concern in science communication within Geoparks often focuses on creating engaging materials and activities, such as interpretation panels, brochures, trails or virtual tools (e.g., Perotti et al., 2020; Štrba, & Palgutová, 2024). However, science communication and public engagement requires strategic approaches addressing both the multifaceted nature of communication and the broader Geopark concept.

Given this context, the main goal of this paper is to introduce a structured framework as a proposed solution to enhance science communication and public engagement in UGGps. To achieve this, the following objectives are established:

(i) establish key principles for effective science communication in UGGps;

(ii) develop a structured, evidence based framework with guiding principles, adapted to the context of UGGps;

(iii) evaluate the relevance of the framework and alignment with different sets of indicators for science communication in Geoparks and UNESCO's.

This study builds on previous research that identified challenges and opportunities in science communication, focusing on public engagement with geoscience, geodiversity, and geoconservation (Rodrigues et al., 2023a), as well as examining geoscientists as science communication practitioners (Rodrigues et al., 2023b, 2025b). In the context of Geoparks, science communication and public engagement was explored in these territories (Rodrigues et al., *in press*) and a comparative case study was conducted (Rodrigues et al., 2025a), laying the foundation for the present framework.

This study proposes the first tool specifically designed for UGGps addressing their unique challenges and needs. By providing a structured framework, it not only contributes to Geopark management and operations but also offers a model that can be adapted to similar contexts. Improving geoscience communication through this framework can lead to broader societal and environmental impacts, influencing critical areas such as policy development, community engagement, sustainable tourism and environmental conservation.

LITERATURE REVIEW

It is recognized that science communication has become more frequent and professional, as evidenced by the growing number of initiatives, the expansion of research in the field, the development of specialized training programs and professional pathways for science communicators (*e.g.* Trench et al 2014, Gascoigne et al 2020).

However, when it comes to defining and assessing the quality of these efforts, significant challenges remain. Nowadays, science communication cannot focus solely on sharing information by any means; it requires new definitions of quality to address the complexities of contemporary communication, going far beyond mere language simplification processes (Bucchi & Trench, 2014). But, in fact, defining quality is one of the main challenges in science communication (Bucchi, 2013).

As noted by Mannino et al. (2021), academic literature typically links the term to attributes such as accuracy, objectivity, context, style, storytelling and engagement, yet few have

developed comprehensive frameworks. Quality should not aim for uniformity or standardization of practices but instead be related to the nature and culture of the communication contexts (Bucchi, 2014).

Various tools exist to improve science communication, including principles, rules, and practical guides (e.g., Borowiec, 2023; Cooke et al., 2017; National Institute of Health Research, 2017; Robinson et al., 2018; Saunders, 2018), with a specific focus on climate change (Sippel et al., 2022), as well as general principles of geoheritage interpretation and education (Crofts et al., 2020). Additionally, frameworks addressing skills and values have been proposed (Aurbach et al., 2019; Mercer-Mapstone & Kuchel, 2017; Seethaler et al., 2019).

Specific frameworks and toolkits have also been developed for thematic contexts, such as nature conservation (Gunn et al., 2022; Harwell et al., 2020; National Audubon Society, 2011), have also been developed. Furthermore, strategic methodology for fostering science communication at national scales have been outlined (Eesti Teadusagentuur, 2019; Swiss Academies of Arts and Sciences, 2021).

Frameworks in science communication provide consistency by aligning common principles across different efforts, allowing quality to be assessed as multi-dimensional, as in the quality indicators developed by Olesk et al. (2021). Considering that quality is closely linked to effectiveness, these authors proposed Key Performance Indicators (KPIs) structured around three dimensions: trustworthiness and scientific rigor, presentation and style, and connection with society. For example, one KPI related to responsible communication assesses whether communication responsibly addresses complex and controversial topics.

Frameworks can serve as the foundation for a strategic plan by guiding the tactics and methodologies used, ensuring that communication efforts adhere to established quality standards.

Communicating science is more than just 'translation'; it involves not only crafting clear and engaging messages but also fostering dialogue and encouraging active participation, which presents significant challenges. Based on this, the need for strategic communication becomes particularly evident in the context of Geoparks, as will be discussed further. In this context, valuable insights can be gained from works on communication and engagement in parks (Watkins et al., 2018), in ecosystem based management (Long et al., 2015; O'Higgins et al., 2020) and environmental strategic communication (Moscato, 2024).

METHODOLOGY

Based on a structured, interpretive review of literature on science communication and public engagement, 18 principles were identified through analysis of academic research, practitioner frameworks, and institutional documents, including UNESCO guidelines.

A comparative thematic synthesis was applied to systematically extract recurring values, practices, and recommended approaches across diverse contexts. The selection of these principles reflects both theoretical foundations and practical insights, aligning with global standards.

Challenges previously identified in studies conducted within the same research project were also considered (Rodrigues et al., 2025a, in press). These included the lack of a strategic framework, poor contextual coherence, unclear scientific messaging and an overreliance on one-way communication strategies.

Other issues included limited interactivity, underuse of modern technologies, and a shortage of specialized professionals. Best practices were also identified and included, such as ensuring scientific accuracy, engaging diverse audiences, and utilizing effective communication techniques, all of which have been incorporated into the framework.

To ensure the conceptual robustness of each element, relevant theoretical perspectives were examined, offering a deeper understanding of their underlying foundations, as detailed in the following section and Table 1. Given the unique context of Geoparks, particular attention was given to the essential roles of geoconservation, sustainability and community engagement in these territories.

Recurring elements were iteratively grouped based on conceptual affinity, resulting in a coherent set of principles structured into five overarching dimensions. During this process, overlapping ideas were refined and consolidated into broader categories to ensure conceptual clarity and maintain practical relevance.

The sufficiency and distinctiveness of the final framework were validated through subsequent testing of its relevance (as detailed in a dedicated section).

This following section provides a systematic and detailed presentation of each principle, demonstrating how it is designed for the context of Geoparks.

Presentation of the Framework

The proposed framework is structured around five key elements, each addressing different aspects as summarized in Table 1 and further illustrated in Figure 1. All of these elements will be thoroughly discussed and explained in the following section.

The framework begins by laying a solid foundation (I) through strategic planning, evidence-based methods and resource allocation. It then shifts to audience-focused approaches (II), ensuring communication is clear, accessible, culturally relevant, and engaging. Next, it emphasizes innovative communication (III), using storytelling and emotional connections to create impactful experiences. Trust is built through scientific integrity and responsibility (IV), ensuring transparency and credibility. Finally, it stresses continuous evaluation and improvement (V) to ensure long-term effectiveness and consistency.

Table 1 - Summary of the framework: 18 principles and corresponding foundational reference

Principle	*Implementation / In practice*	*Supporting references*
I. Start with a plan - Setting the stage		
1. Purposeful and strategic planning	Define clear objectives for the Geopark's communication strategy, aligned with its mission, ensuring tailored actions for different audiences, including internal publics and stakeholders. Establish measurable short, medium, and long-term goals, along with concrete milestones, to track impact and ensure continuous alignment, effectiveness, and progress in achieving the Geopark's objectives.	Autzen & Weitkamp, 2020; Besley & Dudo, 2022; Cohen et al., 2015; DeFelipe et al., 2024; Groffman et al., 2010; Hallahan et al., 2007; Harwell et al., 2020; Ihlen, 2020; Lang et al., 2018; Moscato, 2024; National Park Service, 2016; Schaaf & Rodrigues, 2016; Zimmerman et al., 2024
2. Evidence-based approach	Consider the 'science of science communication,' using evidence-based methods and drawing insights from research to design communication strategies that bridge the gap between theory and practice.	Cormick, 2019; Groffman et al., 2010; Jamieson et al., 2017; Jensen & Gerber, 2020; Kidd et al., 2019; Liang et al., 2018; Sippel et al., 2022; Zimmerman et al., 2024
3. Resource allocation	Ensure proper resources (funding, time, specialized personnel) are available to communicate effectively, supporting a science communication strategy with professional staff, communication tools, and infrastructure.	Bower, 2018; Watkins et al., 2018
4. Brand building and visibility	Strengthen the Geopark's identity by developing a consistent brand that reflects its unique characteristics, links all its elements, and gives visibility to its narrative.	Raev & Minkman, 2020; Schaaf & Rodrigues, 2016
II. Know your audience - Audience-centered approach		
5. Clear and objective communication	Use simple, clear, and accurate language to minimize cognitive overload and ensure effective communication. Tailor messages to the audience's understanding, using concise content, visual aids, and well-organized information	Harper & Zimmerman, 2009; Kidd et al., 2019; Reedy, 2015
6. Accessible and inclusive communication	Adjust communication to respect cultural differences, values, and needs, ensuring accessibility and inclusivity while being sensitive to specific contexts. This involves using multilingual content, plain language, and inclusive formats to accommodate disabilities, while applying equity-centered frameworks to engage underrepresented groups	Canfield et al., 2020; Dowell, 2014; Heinecke, 2019; Humm & Schrögel, 2020; Polk & Diver, 2020; Schneider & Lewenstein, 2024
7. Interactive engagement	Foster dynamic, two-way communication by actively involving audiences, creating opportunities for dialogue, and promoting participation. This approach encourages deeper engagement through methods like citizen science, interactive activities, and feedback mechanisms, ensuring that strategies align with public needs and empower communities in conservation efforts.	Ahmad, 2015; Bucchi & Trench, 2014, 2021; Gascoigne et al., 2022; Groffman et al., 2010; Nagda et al., 2012; Sippel et al., 2022; Stewart, 2024
III. Make it memorable - Engaging and innovative communication		
8. Emotional connections	Use emotion and enjoyment to create a deeper and lasting impact by engaging audiences through playful elements, storytelling, and emotional connections to the landscape.	Gordon, 2012; Matias et al., 2020; Taddicken & Reif, 2020,
9. Relevance	Show the audience why they should care by linking the content to real-life situations, emphasizing its practical value and relevance for society, making it more meaningful and engaging	Borowiec, 2023; Gordon, 2012; Howell et al. 202; Humm & Schrögel, 2020

10. Interdisciplinary integration	Highlighting the connections between sciences and other fields broadens the appeal and relevance of the Geopark by linking geosciences with biology, ecology, archaeology, history, and anthropology, while also incorporating local knowledge, cultural traditions and daily life.	Gordon et al., 2012; Vitting-Seerup et al., 2024
11. Narrative communication (storytelling)	Use thematic narratives and stories to create a compelling, coherent narrative that links ideas and engages the audience. In Geoparks, these narratives connect the various elements of natural and cultural heritage, enhancing emotional engagement and making the content more relatable and memorable.	Dahlstrom, 2014; Green et al., 2018; Matias et al., 2020; Phillips et al., 2012; Stephens et al., 2010; Thomas & Grigsby, 2023
12. Innovative and creative approaches	Incorporate advanced tools, multimedia content, and immersive technologies to enhance the experiences and engagement of visitors in Geoparks, making complex geological processes more accessible and understandable. Innovations like virtual reality and gamification spark curiosity, foster emotional connections and encourage active participation.	Dowell 2014; Ishii et al., 2019; Jordão et al., 2025; Ruberto et al., 2023; Sayer et al., 2014; Vitting-Seerup et al.; 2024
IV. Build trust - Scientific integrity and responsibility		
13. Science processes framing	Outline scientific processes by emphasizing evidence-based approaches, knowledge construction procedures, and the recognition of diverse perspectives and theories. In Geoparks, framing environmental challenges and research to align with societal concerns, local impacts, and diverse voices fosters transparency, trust, and engagement with the public.	Cyber Valley & BSPEOS, 2023; Chong & Druckman, 2007; Nisbet 2009; Polk & Diver, 2020,
14. Credibility, transparency and trustworthiness	Communicate the science honestly, openly addressing uncertainties, sources, limitations, and potential impacts, while addressing ethical standards. This approach helps strengthen trust in science and policy, with Geoparks fostering credibility through transparency, collaboration with stakeholders, and ensuring inclusive and reliable communication.	Chong & Druckman, 2007; Cologna et al., 2025; Greer, 2025; Ihlen, 2020; Intemann, 2023
15. Community and stakeholder involvement	Foster strong, inclusive relationships with NGOs, businesses, policymakers, and other stakeholders by empowering them through collaborative, participatory approaches. This encourages active involvement in decision-making, integrating local knowledge and cultural values, and building mutual trust and shared responsibility for sustainable development.	Dousin et al., 2024; Long et al. 2015; Moreira et al., 2024; O'Higgins et al., 2020; Orthia et al., 2021, Stewart et al., 2024
16. Addressing controversy (tactful and responsible)	Handle controversial issues with care and responsibility by providing clear, balanced information, different perspectives, encouraging open dialogue, and respecting diverse viewpoints to avoid misunderstandings or conflict. This approach helps build public trust, fosters collaboration and promotes sustainable, contextually appropriate solutions.	Beniermann et al., 2021; Cyber Valley & BSPEOS, 2023; Erviti et al., 2018; Intemann, 2023; Nagda et al. 2012; Nisbet, 2009
V. - Adapt and improve - Evaluation and continuous improvement		
17. Consistent communication	Ensure coherence across all communication efforts, maintaining alignment in message, visuals, and tone to reinforce the Geopark's identity and connection to UNESCO.	
18. Impact evaluation and adaptation	Continuously assess and monitor the effectiveness of communication strategies, adjusting approaches based on audience needs and responses, ensuring alignment with long-term goals. This data-driven process, utilizing tools like surveys and media analysis, informs evidence-based decisions, resource allocation, and ongoing improvements in communication.	Pfleger et al., 2022; Ziegler et al., 2021

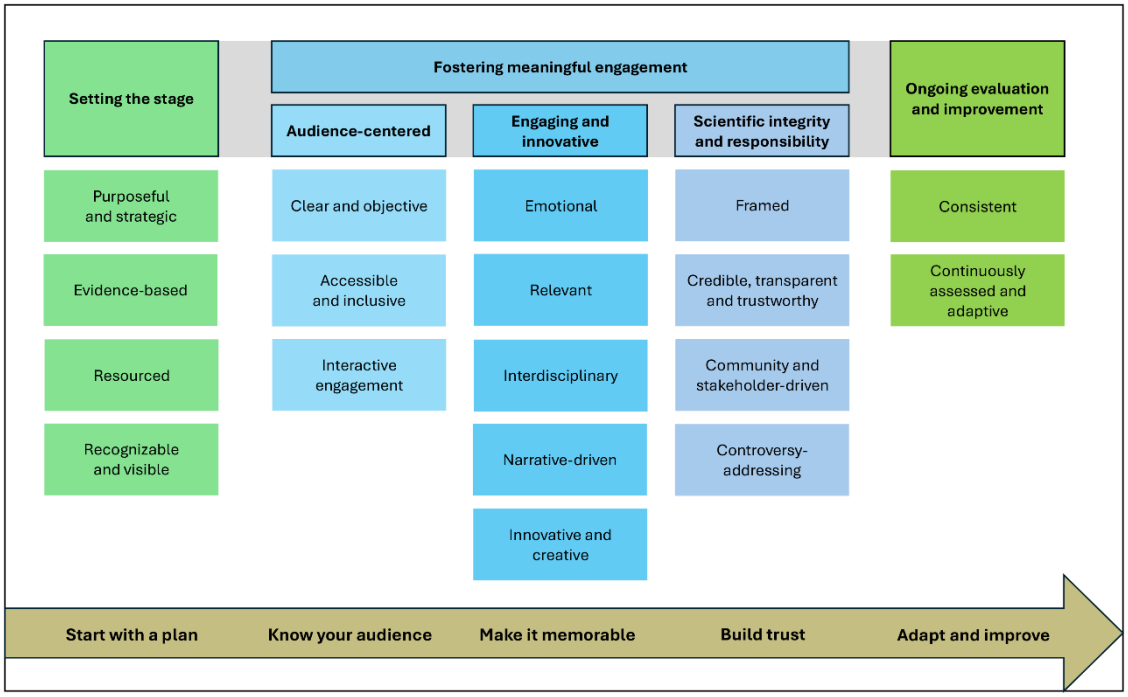

Figure 1 - Diagram illustrating the core components of the Geoparks science communication framework

Purposeful and strategic planning (1)

In Geoparks, strategic communication must align with core missions such as education, geoconservation, community engagement, and sustainable development, integrating marketing, public relations, and media strategies under a unified approach built on credibility and trust, and reflecting Geopark, UNESCO, and UN Sustainable Development Goals (Ihlen, 2020; Autzen & Weitkamp, 2020).

Clear objectives guide actions for diverse audiences, such as visitors, local communities, stakeholders, and internal publics, ensuring alignment across the organization and focusing on measurable short-, medium-, and long-term goals (Groffman et al., 2010; Harwell et al., 2020). Strategic planning emphasizes audience segmentation, tailored channels and tools (publications, exhibitions, workshops, outdoor activities), timing, and a hierarchy of objectives to prioritize critical goals, ensure urgent needs are addressed first, and allocate resources efficiently, while avoiding generic, non-targeted approaches (Besley & Dudo, 2022; Burns et al., 2003; NPS, 2016). Measuring communication effectiveness is essential to assess impact, guide improvements, and ensure the ongoing success of strategic efforts (as discussed later in the impact evaluation section). Examples of strategic approaches include managing wildland fires (NPS, 2016) and addressing risks in UGGps (DeFelipe et al., 2025).

Evidence-based insights from social sciences, strategic science and environmental communication, and media planning guide message design, audience targeting, and vehicle selection to foster dialogue, participation and behavior change (Hallahan et al., 2007; Liang et al., 2018; Moscato, 2024; Cohen et al., 2015; Zimmerman et al., 2024). Strategic partnerships with local communities, authorities, businesses, academic

institutions, and other UNESCO sites enhance relevance, extend impact, and reinforce the Geopark's unique identity and value (Schaaf & Rodrigues, 2016; Besley & Dudo, 2022). Though not academic institutions, Geoparks play a key role in scientific research and public engagement, acting as bridges between scientists and the public and fostering support for sustainable practices and conservation (Autzen & Weitkamp, 2020).

Evidence-based approach (2)

Science communication is a formal transdisciplinary field grounded in evidence and systematic research. It cannot rely solely on intuition, as gaps between theory and practice reduce opportunities for meaningful engagement (Sippel et al., 2022; Zimmerman et al., 2024). Effective communication combines professional experience with empirical research to guide improvements (Cormick, 2019; Groffman et al., 2010; Jamieson et al., 2017; Jensen & Gerber, 2020). In conservation and Geopark contexts, it shapes attitudes and behaviors by drawing on environmental, strategic, and persuasion research, including theories of reactance and planned behavior (Kidd et al., 2019; Liang et al., 2018).

Resource allocation (3)

As with the entire management plan for the Geopark, adequate budgeting is essential for implementing a science communication strategy, covering professional staff, tools, infrastructure, and contracted services (Bower, 2018). Geoparks require diverse professionals, including scientists and communication specialists such as interpreters, educators, and media relation experts (Watkins et al., 2018). Most Geopark teams rely on geoscientists for science communication, whose limited training makes specialized capacity-building essential (Gonzalez-Tejada et al., 2017; Rodrigues et al., 2023b, 2025b). Resources must also support capacity-building, refresher training, exchange opportunities through the UNESCO/GGN network, and communication infrastructure such as signage, exhibitions, interpretation centers, digital media, and publications.

Brand building and visibility (4)

A strong, consistent brand aligns visual elements (logos, signage) and messaging with the Geopark's core mission, reflecting the territory's unique characteristics and fostering a sense of belonging, especially in multi-designated sites (Schaaf & Rodrigues, 2016). Visibility is enhanced through signage, interpretive materials, digital channels, and strategic collaborations with local partners, services, and products, reinforcing recognition of the UGGp area. Integration with the UNESCO label emphasizes international significance, commitment to conservation and sustainability, and highlights scientific, environmental, and cultural values, fostering global visibility, cooperation, and science diplomacy (Raev & Minkman, 2020).

Clear and objective communication (5)

Cognitive load theory highlights that excessive information or poorly designed instructions can overwhelm working memory and disrupt learning (Reedy, 2015). Clear communication goes beyond simplifying concepts, processes, or avoiding jargon. Cognitive overload can be minimized by using concise, well-structured plain language tailored to the audience (Harper & Zimmerman, 2009; Maynard et al., 2024). Messages should be factual, accurate, objective, and logically organized, supported by visual aids, interactive exhibits, and clear signage. Sharp and assertive messaging, emphasizing conservation of geodiversity, biodiversity, and cultural heritage, contributes to shape attitudes and behaviors (Kidd et al., 2019, Maynard et al., 2024), with visible guidelines and codes of conduct reinforcing responsibility. Clarity also requires consistent designation of geosites, boundaries, and territorial value using explicit maps and terminology.

Accessible and inclusive communication (6)

Geoparks must ensure communication is accessible to diverse audiences, including people with disabilities and different cultural backgrounds, using multilingual, plain-language, and inclusive formats, guided by Diversity, Equity, and Inclusion (DEI) frameworks (Polk & Diver, 2020). Engagement should move beyond already-interested visitors reached through interpretation centers or guided walks limits engagement to visitors who are already interested (Humm & Schrögel, 2020) and reach often overlooked marginalized audiences and, applying intercultural approaches and equity-centered practices (Canfield et al., 2020; Dowell, 2014, Lewenstein, 2024). Inclusive communication requires intercultural approaches that consider aspects as language, geography or religion (Schneider & Heinecke, 2019; Lewenstein, 2024). Materials should preserve regional or Indigenous languages and offer diverse formats (e.g., visual aids, tactile experiences) to meet different abilities and learning styles (Falk & Dierking, 2016), while reflecting local cultural diversity and engaging communities to enrich visitor experiences.

Interactive engagement (7)

Science communication research has been showing the benefits of evolving one-way, top-down approaches to participatory models that foster dialogue and collaboration (Bucchi & Trench, 2014, 2021). Engagement evolves from basic “dissemination” and “education” toward more interactive forms such as ““collaboration,” “deliberation,” and “co-creation”, each suited to different goals and contexts, according to the science communication ladder (Gascoigne et al., 2022). Each stage is not inherently more valuable than the others and can be seen as consequential, overlapping modes of intervention tailored to context and goals, with participation as the culmination of dialogue, inspiration, and information (Stewart, 2024).

As in UGGps, communication ranges from "raising awareness of geological significance" to a "bottom-up" or community-led approach to conservation (UNESCO, 2015) these paradigms must be carefully considered.

Active engagement relies on two-way communication, participatory activities, and feedback mechanisms (guided tours, workshops, citizen science, surveys, and public hearings) empowering communities to contribute to research, preservation, and decision-making. Even in traditionally passive settings, interactive approaches (hands-on activities, multimedia, problem-solving, and immersive reconstructions) promote active participation and deeper connection (Ahmad, 2015).

Meaningful engagement turns concern into action, aligning strategies with public needs, fostering shared responsibility, and encouraging community ownership of conservation (Groffman et al., 2010; Sippel et al., 2022; Nagda et al., 2012).

Emotional connections (8)

Emotional appeals and 'edutainment' create lasting experiences that foster engagement and encourage responsible behavior toward nature (Taddicken & Reif, 2020). Playful elements, such as games, mascots, geoproducts, comic videos, and awe-inspiring visuals, so common in Geoparks, capture interest while promoting active participation. Art and the cultural dimension of geodiversity spark curiosity and awe, forming deeper ties to the environment (Matias et al., 2020; Gordon, 2012). Storytelling and interactive experiences, including narratives of local communities, volcanic eruptions, or dinosaurs, further strengthen emotional connections and engagement with natural and cultural heritage (see principles 7 and 11).

Relevance (9)

Effective communication shows the "so what" by linking scientific principles to everyday life, such as geodiversity's role in local agriculture, building materials, hazards or resource management (Borowiec, 2023; Howell et al., 2021). This underscores geology's direct impact on communities and traditions, showing its relevance through geodiversity and ecosystem cultural services and fostering active engagement in preserving natural and cultural heritage (Gordon, 2012). This approach tackle underserved audiences (Humm & Schrögel, 2020), supports transmission of intangible heritage to younger generations, and encourages inclusive communication (principle 6).

Interdisciplinary integration (10)

Interdisciplinary and transdisciplinary integration in Geoparks connects scientific concepts with local knowledge, cultural traditions, and daily life, with the cultural dimension of geodiversity exemplifying this approach (Gordon et al., 2012). By linking geosciences with

biology, ecology, archaeology, history, and anthropology, Geoparks provide a broader understanding of conservation and sustainability.

Sustainability science communication requires new methodologies and collaborations, with transdisciplinary approaches promoting co-creation and strengthening connections (Vitting-Seerup et al., 2024). This approach boosts public awareness of natural, cultural, tangible, and intangible heritage, encouraging active engagement through shared knowledge. The interdisciplinary integration supports a so-called Geopark's 'holistic approach' to protection, education, and sustainable development, in line with UNESCO's vision (UNESCO, 2015).

Narrative communication – storytelling (11)

Storytelling connects audiences with scientific, historical, or personal topics, making complex content, such as geological processes shaping landscapes, the chain of events in volcanic eruptions and their human/economic impacts, or the evolution of an organism in the fossil record more accessible and engaging (Green et al., 2018; Dahlstrom, 2014). In Geoparks, the overarching narrative serves as the umbrella of the site, distinguishing it and guiding branding.

Thematic territorial narratives highlight interconnectedness by linking stories to specific areas, like water, glaciers, or geological history, forming a linked narrative across locations and guiding visitors through trails such as the "Route of the Volcanoes" or "Fossil's Trail." Guided by narrative transportation theory, well-crafted stories immerse audiences, enhancing emotional engagement, memory, and understanding while blending scientific facts with human experiences to bridge knowledge and perception (Stephens et al., 2010; Thomas & Grigsby, 2023; Matias et al., 2020).

Innovative and creative approaches (12)

Creativity in public engagement, through innovative and fun activities, helps reach broader audiences and stimulate meaningful conversations, especially in cultural contexts where science may not be the primary lens through which people engage with knowledge (Dowell, 2014; Sayer et al., 2014). In Geoparks, immersive tools like virtual/augmented reality, interactive apps, gamification, hands-on exhibits, and multimedia displays make complex geological processes tangible and memorable, as supported by the media richness theory (Ishii et al., 2019). Research shows these digital experiences not only spark interest but also increase the desire to explore sites in person, complementing rather than replacing physical visits (Ruberto et al., 2023), especially when enhanced with social interaction that mirrors the emotional intensity of on-site experiences (Jordão et al., 2025). Integrating art and creative approaches further enhances engagement, dialogue, and long-term interest (Matias et al., 2020; Vitting-Seerup et al., 2024).

Science processes framing (13)

Framing scientific processes helps audiences understand how knowledge is generated, distinguishing results, interpretations, opinions, and uncertainties, rather than focusing solely on outcomes (Chong & Druckman, 2007; Cyber Valley & BSPEOS, 2023). Effective framing makes science personally relevant, inclusive, and equitable by incorporating local knowledge and diverse perspectives, thereby enhancing engagement and understanding (Polk & Diver, 2020; Nisbet, 2009). In Geoparks, this approach contextualizes research and conservation in areas like water management, land use, hazards or mineral resources, highlighting societal relevance and local impacts (Mir Pellicer et al., 2024; UNESCO, 2020). By communicating methods, evidence, and evolving theories transparently, Geoparks strengthen trust, promote inclusivity, and support informed decision-making (see principle 14).

Credibility, transparency and trustworthiness (14)

In an era of growing misinformation, conspiracy theories, and declining public engagement with science, Geoparks must prioritize ethical, transparent communication (European Commission, 2025; World Economic Forum, 2025). Building trust requires credibility through reliable sources, transparency about funding, methods, and uncertainties, and trustworthiness in clear, accurate, and accessible messaging (Intemann, 2023; Greer, 2025). Sensitive issues, such as resource use, geohazards, or climate adaptation—demand careful framing to avoid reinforcing false narratives, while training communicators and guides ensures consistent, trustworthy delivery (Chong & Druckman, 2007; Ihlen, 2020). By fostering openness and dialogue with communities and stakeholders, Geoparks strengthen trust in science-based decisions and contribute to more resilient, informed societies (Cologna et al., 2025).

Community and stakeholder involvement (15)

Active participation of communities and stakeholders—such as NGOs, policymakers, educators, businesses, and conservation groups—is essential to the Geopark "bottom-up approach" (UNESCO, 2015). Inclusive, participatory processes foster ownership, resilience, long-term sustainability and socio-economic benefits while respecting cultural diversity (Orthia et al., 2021; Stewart et al., 2024; Moreira et al., 2024; Dousin et al., 2024). Drawing on Ecosystem-Based Management, Geoparks integrate ecological, social, and governance perspectives, promoting shared decision-making and adaptive solutions (Long et al., 2015; O'Higgins et al., 2020). This engagement builds trust, counters misinformation, and strengthens cooperation within the Global Geoparks.

Addressing controversy - tactful and responsible (16)

Geoparks should openly and accurately address sensitive issues—such as resource extraction, land use, or climate adaptation, avoiding distortion or "false balance" (Cyber

Valley & BSPEOS, 2023). Effective communication requires transparency, respect for local practices, and dialogue with diverse stakeholders to reduce polarization and build trust (Nagda et al., 2012; Intemann, 2023). Since controversies are shaped by political, social, and economic factors as well as misinformation (Nisbet, 2009; Erviti et al., 2018; Beniermann et al., 2021), Geoparks must provide evidence-based information and foster participatory platforms (see also principle 7). This approach discourages unsustainable practices and supports culturally sensitive, sustainable solutions

Consistent communication (17)

Geoparks should ensure consistency in communication across all channels to reinforce identity, mission, and values, while maintaining alignment with the UNESCO framework. A unified branding approach, supported by well-trained staff and coherent use of language, visuals, and tone, enhances recognition and prevents confusion (see also principle 4; UNESCO, 2015). This consistency applies to all forms of communication, from tour guiding and signage to digital content and publications (see Table 1).

Impact evaluation and adaptation (18)

Science communication in Geoparks requires ongoing evaluation and adaptation to ensure effectiveness, efficiency and long-term alignment with management objectives (see principle 1). Establishing tailored metrics (NPS, 2016) and applying diverse methods such as visitor surveys, interviews, and analysis of interpretation tools (Štrba & Palgutová, 2024; Wei, 2013) enables data-driven decision making. By embedding evaluation as a continuous learning cycle, Geoparks can refine strategies, allocate resources more effectively, and foster innovation in communication practices (Ziegler et al., 2021; Pfleger et al., 2022).

TESTING THE RELEVANCE OF THE FRAMEWORK

To assess the relevance of the framework within their context, we conducted a comparative analysis of how pre-existing Geopark indicators, especially those focused on science communication, align with the proposed principles. Table 2 presents a side-by-side comparison that systematically matches each indicator to its corresponding principle(s), where applicable.

This approach helps understand the coherence of the framework by checking how well its principles accommodate diverse indicators, its scope by determining whether the framework covers the full range of relevant indicators, and its applicability by assessing how well it interprets real-world practices in Geoparks.

Two sets of indicators were used in this analysis. The first derived from the UNESCO Operational Guidelines for UGGps (UNESCO, 2015) and the official UNESCO Self-Evaluation Form A (UNESCO, 2021). It includes 121 (out of 252) indicators from the seven UGGps official criteria that focus on science communication and public engagement in Geoparks (Rodrigues et al., in press).

Table 2 - Correspondence between the principles of the framework and the indicators (indicator list in supplemental material)

Principle	**Matching Geopark KPIs** (from Rodrigues et al. 2025)	**Matching UNESCO criteria** (from UNESCO, 2021)
1. Purposeful and strategic planning	9.1, 9.2, 9.3, 10(UNESCO, 2021).1	iD.1, iD.2, iD.3, iD.4, iF.3.a, iF.3.h, iF.6.e, iiA.1.c, iiA.1.i, iiA.2.c, iiA.2.d, iiA.2.g, iiA.3.f, iiiB.11.c, iiiB.11.d, iiiB.11.e, iiiB.11.f, iiiB.11.g, ivA.1.f, ivA.1.k, ivA.1.m, ivA.1.o, ivA.2.f, ivA.2.l, ivA.2.n, vA.3, vA.9, vB.5, viiA.5, viiB.1
2. Evidence-based	*(No indicators mapped)*	*(No indicators mapped)*
3. Resource allocation	2.2	iD.5, iD.6, iD.7, iD.8, iF.1.c, iF.1.d, iF.2.a, iF.2.b, iF.2.c, iF.2.d, iF.3.a, iF.3.e, iF.3.g, iF.3.j, iF.3.k, iF.6.c, iF.6.h, iiiA.4.b, iiiA.4.d, iiiA.4.e, iiiB.3, iiiB.4.b, iiiB.4.d, iiiB.4.e, iiiB.11.b, ivA.1.j, ivA.2.j, viA.4
4. Brand building and visibility	1.5, 6.2, 6.4, 6.6, 6.7, 6.8	iB.5, iF.1.a, iF.1.b, iF.1.c, iF.1.d, iF.2.a, iF.2.c, iF.2.d, iF.3.e, iF.5.c, iF.5.d, iF.5.e, iF.5.f, iF.6.b, iF.6.c, ivA.1.l, iiiB.11.g, ivA.1.o, ivA.2.k, ivA.2.n,
5. Clear and objective communication	2.1, 2.3, 5.1, 5.4, 5.5, 5.6, 10.3, 10.4	iC.6, iC.8, iC.9, iC.14, iF.3.b, iF.3.g, iiA.1.k, iiA.1.l, ivA.1.n, ivA.2.m, viiA.6, viiA.7, viiB.1
6. Accessible and inclusive communication	3.3, 5.2, 5.3, 5.6	iF.3.f, iF.3.k, iF.4.a, iF.7.b, iiA.3.h, vA.3, vB.5, vB.14, vB.15, vB.16
7. Interactive engagement	8.1, 8.2, 8.3, 8.4, 8.5, 8.6, 8.7, 8.8, 8.9	iF.3.j, iF.3.k, iiA.1.f, iiA.2.f, iiA.3.d
8. Emotional connections	7.1, 7.2, 7.4, 11.2	iF.6.g
9. Relevance	10.2, 11.1, 11.3	iD.6, iD.8, iD.9, iD.10, iF.5.e, iF.7.a, iiA.1.d, iiA.1.h, iiA.1.k, iiA.1.l, iiA.3.e, iiB.4, iiB.8, iiC.1, iiC.2, iiC.3, iiC.4, vA.14, vB.13, vB.17, viiA.5
10. Interdisciplinary integration	11.1, 11.4	iD.7, iF.3.c, iiA.1.g, iiA.2.h, iiA.3.g
11. Narrative communication	7.3	*(No indicators mapped)*
12. Innovative and creative approaches	7.2, 7.4, 7.5, 7.8, 7.9, 11.2	iF.3.i, iF.6.g
13. Science processes framing	1.1, 1.2, 1.3, 2.3, 6.1	iD.9, iD.10, iiA.1.d, iiA.1.h, iiB.4, iiB.8
14. Credibility, transparency and trustworthiness	1.3, 1.4, 2.1, 2.2, 2.3, 3.1, 3.3, 4.1, 4.2, 4.3, 12.2	iD.9, iD.10, iiB.4, iiB.8, viA.4, viiA.6, viiA.7, viiA.10
15. Community and stakeholder involvement	3.2, 8.9	iD.2, iF.1.b, iF.3.d, iF.5.c, iF.5.d, iF.6.e, iF.6.g, iF.7.b, iF.7.c, iF.7.d, iiA.1.f, iiA.1.j, iiA.2.f, iiA.3.d, iiA.3.e, iiA.3.h, iiC.1, iiC.4, ivA.1.c, ivA.1.k, ivA.1.m, ivA.2.c, ivA.2.l, vA.1, vA.3, vA.9, vA.14, vB.5, vB.13, vB.14, vB.15, vB.16, viA.8, viA.9, viiA.10
16. Addressing controversy	11.3, 12.1, 12.2	viiA.6, viiA.7, viiA.10, viiB.1
17. Consistent communication	6.3, 6.4, 6.5, 6.6, 6.9, 7.6, 7.7, 10.4	iF.1.a, iF.1.b, iF.2.b, iF.2.c, iF.2.d, iF.3.a, iF.3.h, iF.6.b, iF.6.e, iF.6.h, ivA.1.l, ivA.2.k
18. Impact evaluation and adaptation	10.1	iiiB.14, iiiB.16

The second set was adapted from a framework for assessing quality in science communication (Olesk et al., 2021) and includes 60 KPIs for trust, rigor, presentation, style and societal connection, tailored for Geoparks context (Rodrigues et al., 2025a). A detailed list of indicators is provided in the supplemental material.

These two sets are quite different, with the KPIs focusing on communication quality (accurate, accessible, and engaging), while the UNESCO criteria emphasize operational and managerial aspects (such as content, infrastructure, educational programs, geotourism, and community engagement). Despite this, the UNESCO indicators do not provide explicit action-oriented guidance. Their structure also differs: KPIs focus on broader goals, allowing for flexibility in how those goals are achieved and nuanced evaluation, while UNESCO criteria are more prescriptive, focusing on specific actions to ensure correct implementation.

Despite their differences, assessing their alignment with the framework reveals areas where the framework successfully integrates the broader principles of communication with the more specific operational requirements, as detailed in Table 2.

DISCUSSION

In the context of UGGps, science education and science communication are complementary approaches. While education provides structured learning opportunities and disciplinary knowledge, science communication adds value by fostering engagement, dialogue and societal participation, connecting scientific concepts to local heritage, environmental issues, and sustainability for audiences outside formal educational contexts, such as visitors and local stakeholders. Geoparks offer engaging experiences where communication strategies can complement educational programs, enhancing awareness, promoting active involvement and supporting responsible actions in diverse audiences.

The new framework builds on past lessons with a foundation of evidence from previous research and demonstrates flexibility by integrating existing indicators. Rather than reinventing the wheel, the framework evolves existing strategies. The alignment with science communication quality indicators reinforces foundational principles like trust, rigor, presentation, style and societal connection.

The utilization of the two distinct sets of indicators demonstrated the comprehensiveness of the framework, addressing both broader quality principles and specific Geopark's operational requirements. This framework is designed to ensure that each stage of communication, whether strategic, audience-focused, innovative, transparent or adaptive works cohesively to create a comprehensive, impactful and sustainable effort.

Considering the conceptual distinction between science education and science communication, the framework operationalizes this differentiation in practice, focusing on communication strategies, that foster broader publics active engagement. Principles such as emotional engagement (8), relevant (9) narrative (11) or community involvement (15) exemplify this focus, helping create meaningful, contextualized and relevant experiences.

Alignment with indicators

The first conclusion is that most of the principles align well with Geopark KPIs and UNESCO criteria, covering key aspects such as planning (1), stakeholder involvement (15), resources (3), and branding and visibility (4). This shows a complete alignment with the main pillars

for the classification and renewal of the UGGp label: management, bottom-up approach and visibility. The framework's alignment with UNESCO's official guidelines ensures compliance with global standards without proposing any divergences. The framework allows for an alignment of the UNESCO indicators, providing action-oriented guidance.

As expected, except for evidence-based (2), the KPIs align well with the framework, focusing on science communication in Geoparks. This makes the alignment more consistent, with emphasis on credibility (14), engagement (7), clarity (5), and consistency (17) at the top.

Coherence is also supported by the correspondence within major UNESCO guidelines such as management structure (criteria iii) with strategy (1), resourcing (3) and impact evaluation (18); overlap with other internationally designated areas (iv) with strategic (1), branding (4) and stakeholder involvement (15), local and Indigenous communities' participation (v) with inclusivity (5) and community engagement (15), and geoheritage protection (vii) with transparency (14) and responsibility (16).

Evidence-based (2) practices are often seen as a separate standard of scientific quality, not a direct measure of communication effectiveness, but in a framework aimed at non-specialists, like this one, who mainly rely on practical experience, this principle is fundamental.

Addressing gaps from previous research

Previous research identified limitations, including the absence of a strategic approach guiding overall communication efforts, lack of coherence and context, unclear scientific reasoning, overreliance on one-way strategies, lack of interactive approaches, need for a more interactive approach, fostering deeper society engagement, underuse of modern communication technologies, and a shortage of specialized professionals (Rodrigues et al., in press). The framework addresses these by offering a strategic, interactive approach that enhances engagement, addresses scientific integrity, accessibility and responsibility, and the use of modern technologies while emphasizing the need for specialized professionals.

The best practices identified previously, such as strong indicators of scientific accuracy, efforts to engage diverse target audiences, and captivating communication strategies (Rodrigues et al., 2025a), are seamlessly integrated into the framework, which can contribute to improving meaningful engagement. This approach makes Geoparks more relatable and memorable by ensuring that communication is not only clear, but also interactive, culturally relevant, emotionally engaging, and grounded in responsibility.

Correlations between principles

Some KPIs appear under multiple principles, showing that these principles are interconnected. For example, presenting facts truthfully and ensuring conclusions align with evidence connect clear and objective communication (5) with credibility, transparency, and trustworthiness (14). Providing accurate and reliable information builds trust, demonstrating how these principles reinforce each other.

Similarly, identifying scientific sources links framing the scientific process (13) with building trust (14), highlighting the role of transparency and rigor in how science is communicated.

Additionally, a Geopark's active involvement in public engagement regarding controversial issues not only aligns with addressing controversy responsibly (16) but also connects to relating communication to concrete situations (9). Real-life applications and interdisciplinary approaches often require addressing sensitive topics to remain relevant and impactful.

The goal of making an impact in communication appears in both strategic planning (1) and evaluation (18), emphasizing that strong planning and assessment are essential for effective communication. References to Geopark concept and other existing Geoparks reinforce the alignment between Geopark brand identity (4) and consistent messaging (17), demonstrating the importance of a unified and coherent communication strategy.

These overlaps illustrate the complexity of the communication process, where improving one aspect often strengthens others simultaneously.

Areas for development and future improvements

The areas of lower alignment highlight where the framework adds value beyond current standard indicators, namely evidence-based practices (2), responsible communication (6), emotional engagement (8), innovation (12) and adaptive evaluation (18), pointing to principles largely missing from traditional Geopark and UNESCO communication standards that still offer room for development.

The evidence-based (2) principle has no mapped indicators, making it an area for further development to ensure empirical grounding in the framework. Similarly, narratives (11), while not directly mentioned in the Geopark criteria, could be a useful tool for increasing public engagement and could be further explored through new guidelines, toolkits, or training modules.

The framework aims to enhance Geopark communication by going beyond UNESCO guidelines and KPIs. This could position Geoparks not just as places to visit, but as inclusive territories of science, conservation, and local development, aiming to make communication dynamic, engaging, and globally relevant, while ensuring long-term impact both locally and internationally. By reinforcing innovative technologies, local cultural narratives, and emotional connections, it targets broader public.

More specialized teams in science communication and formal training will enhance evidence-based (2) practices and lead to more impactful strategic approaches. Increased feedback and monitoring mechanisms will ensure continuous improvement.

CONCLUSION

Main findings

This study demonstrates the potential of Geoparks as platforms for engaging the public with Earth sciences, integrating science and geoscience communication. The proposed framework provides an overarching strategic approach and aligns with global standards while addressing local needs, emphasizing inclusivity, accessibility, and interactive dialogue ensuring diverse audiences feel heard and connected, fostering active participation.

Incorporating emotional engagement and narrative building into communication efforts further strengthens the public's connection with the subject matter. When geodiversity and geoscience are framed in ways that resonate emotionally and tell compelling stories, they become more accessible and memorable to audiences. Innovation also plays a crucial role in enhancing how science is communicated, offering opportunities to integrate new tools, technologies, and creative approaches that make geosciences more engaging and relevant.

Clear and responsible communication, grounded in transparency and scientific evidence, builds trust and credibility. By framing geoscience and geodiversity in ways that link it to real-world issues and integrating different sciences, history, art, and local traditions, their relevance is enhanced, making them more relatable to diverse audiences. This approach fosters broader public engagement and highlights how scientific knowledge intersects with societal challenges, encouraging shared responsibility and collective action.

By highlighting the environmental and societal relevance of geodiversity and geoscience and promoting engagement, the framework positions Geoparks as key contributors to achieving the Sustainable Development Goals (SDGs), underscoring their role in fostering environmental stewardship, sustainability and social inclusion.

The success of implementing a strategy like the proposed framework is closely linked to the professional capacity of Geopark teams. Investing in capacity building and specific training not only supports the delivery of high-quality communication but also enables the development of more impactful, locally relevant strategies. Embedding continuous feedback and monitoring mechanisms within communication efforts allows for adaptability over time, helping initiatives remain responsive to changing needs and circumstances.

While focused on Geoparks, the framework is adaptable to similar contexts, such as parks and other protected areas or other UNESCO designated sites, such as Biosphere Reserves or World Heritage Sites, specifically under criteria viii (outstanding examples representing key stages of Earth's history). It also has potential for use in other geoscience communication settings, as science centers, museums, geosites, or geotourism attractions.

Limitations and challenges

Although this is not a recipe for how to communicate, nor does it aim for uniformity or standardization, the framework provides tools and principles to enhance science communication in Geoparks and related contexts. By aligning with UNESCO guidelines, the framework is oriented to practical context, though challenges like resistance to change, skepticism, and lack of specialized staff may arise.

Often, quick and simple solutions are sought for simplifying messages and creating engaging content, and this framework may appear complex due to its integrated methodology and paradigm shift. It may also struggle with balancing stakeholder interests and handling controversial issues.

Future research

Further studies should assess the applicability of the framework, such as flexibility across different territories (also beyond Geoparks), practicality for managers and stakeholders, and its effectiveness in improving science and geoscience communication. Additional efforts should focus on creating supporting tools, like training modules or toolkits, to aid implementation and ongoing improvement.

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Supplemental material

Geopark KPIs	*Corresponding principles*																	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
I - Trustworthiness and scientific rigor																		
1. Scientific																		
1.1 Is the presented information scientific?													■					
1.2 Does the Geopark communicate ongoing scientific studies and advances?													■					
1.3 Can the source of scientific information be clearly identified?													■	■				
1.4 Is scientific content reviewed by the scientific coordinator or scientific board?														■				
1.5 Is the Geopark logo visibly displayed on the communication media of the Geopark?				■														
2. Factual																		
2.1 Are facts presented in a truthful and objective manner?					■									■				
2.2 Do the monitors and guides undergo regular and up-to-date scientific refresher training?			■											■				
2.3 Are conclusions and interpretations in line with the evidence?					■								■	■				
3. Balanced																		
3.1 Is an independent opinion from a qualified expert provided?														■				
3.2 Are comments from key stakeholder(s) provided?															■			
3.3 Is diversity appropriately reflected?						■								■				
4. Transparent																		
4.1 Are the method and its limitations clearly described?														■				
4.2 Does communication provide relevant information about the study and its authors?														■				
4.3 Does communication provide relevant information about its own funding and affiliations?														■				
II - Presentation and style																		
Clear																		
5.1 Is the content presented in an accessible and clear language and/or visual means?					■													
5.2 Is the information available in more than one language?						■												
5.3 Does the Geopark employ accessible and inclusive communication strategies?						■												
5.4 Are scientific concepts sufficiently explained?					■													
5.5 Are key messages outlined?					■													
5.6 Are there different levels of information?					■	■												
6. Coherent and contextual																		
6.1 Does communication provide sufficient context to scientific facts, discoveries or claims?													■					
6.2 Is it clear within the territory that we are in a Geopark?				■														
6.3 Is any oral information given about the Geopark, science, and geological heritage?				■													■	
6.4 Are there references or information regarding the Geopark concept and other existing Geoparks?				■													■	
6.5 Is communication coherent in structure and style?				■													■	
6.6 Are there scientific approaches or Geopark content visible in the tourist offer promotion and marketing tools?				■													■	
6.7 Are the geosites signposted?				■													■	
6.8 Are the points of interest clearly marked, and is navigation easy?				■													■	
6.9 Is there consistency in the messages and approaches across different Geopark facilities?				■													■	
7. Spellbinding																		
7.1 Is communication using methods to emotionally engage the audience?								■										
Does the Geopark offer science-related entertainment, such as a mascot, games, toys or themed souvenirs?								■				■						
7.3 Is there any narrative or thematic guideline noticeable during the visit?											■							

Geopark KPIs	*Corresponding principles*																	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
7.4 Are curiosities or popular culture approaches employed?								■				■						
7.5 Is communication making full use of the format's capabilities or is innovative in its use of formats?												■						
7.6 Does the Geopark communicate science on its website?																	■	
7.7 Does the Geopark communicate science on social media?																	■	
7.8 Are there multimedia tools?												■						
7.9 Are there digital visitation and interpretation tools that include scientific information?												■						
8. Interacting with the audience																		
8.1 What role does the audience have in communication?							■											
8.2 What is the main strategic approach in museums, science and interpretation centres?							■											
8.3 What is the strategic approach in guided activities?							■											
8.4 What is the level of public engagement in museums, centres, outdoor guided visits, or other activities?							■											
8.5 Is the audience engaged in a dialogue?							■											
8.6 Does the Geopark actively seek public feedback and contributions?							■											
8.7 Does the Geopark promote public hearings, discussion groups, surveys or questionnaires?							■											
8.8 Does the Geopark promote citizen science?							■											
8.9 Does the Geopark involve local communities in science communication strategies?							■								■			
III - Connection with the society																		
9. Purposeful and targeted																		
9.1 Are the objective and target group of communication evident?	■																	
9.2 Are there tailored activities, with specific objectives, addressing teachers and students, local communities, stakeholders, families, decision-makers, the media, or any other specific audience?	■																	
9.3 Do the selected formats, style and other properties of communication support the objective?	■																	
10. Impactful																		
10.1 Is the aspiration of impact evident in the communication?	■																	■
10.2 Are geoconservation issues communicated?									■									
10.3 Are the public designations of geosites and other geological points of interest adequately clear and explicit?					■													
10.4 Is the term geosite / site of geological interest broadly used in public communication, per its formal definition?					■												■	
11. Relatable																		
11.1 Does communication link between everyday or common phenomena and scientific concepts or results?									■	■								
11.2 Is there any artistic approach to science?								■				■						
11.3 Is the Geopark involved in public engagement about controversial issues, such as disaster risk reduction, exploitation of mineral resources, water resource management, climate change adaptations or land use planning?									■							■		
11.4 Do clear interdisciplinary connections exist, with explicit links between geosciences and cultural traditions, legends, local beliefs, agricultural practices, history, archaeology, or other related fields?										■						■		
12. Responsible																		
12.1 Is communication behaving responsibly by addressing complex and controversial topics?																■		
12.2 Is it evident that communication has considered ethical implications?														■		■		

UNESCO Criteria	*Corresponding principles*																	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Criterion i - Scope and mission																		
iB International value of the geological heritage, geodiversity and singularity																		
iB.5 Do you promote the geodiversity of your (a)UGGp to the public?				■														
iC Geological site conservation																		
iC.6 Do you have an (a)UGGp map indicating the geological sites?					■													
iC.8 Do you inform visitors about the regulations to prevent misuse and damage of individual sites in the (a)UGGp (in situ)?					■													
iC.9 Do you inform visitors about these regulations in your communication material (ex situ)?					■													
iC.14 Do you have a general code of conduct for your (a)UGGp visitors?					■													
iD Education																		
iD.1 Do you have a programme of educational activities specifically on geological heritage?	■																	
iD.2 Do you organize specific training for the teachers at the schools located in your (a)UGGp territory?	■														■			
iD.3 Do you use your (a)UGGp sites for pedagogical / educational school visits?																		
iD.4 Do you organize specific educational programmes for different levels of students?	■																	
iD.5 Have you produced educational tools, activities or programmes explaining your (a)UGGp territory and its characteristics?			■															
iD.6 Have you produced educational tools explaining the geological heritage of your (a)UGGp?			■						■									
iD.7 Have you produced educational tools linking geological heritage to natural, cultural and intangible cultural heritage?			■							■								
iD.8 Have you developed activities or educational tools focused on environmental good practices in the area?			■						■									
iD.9 Do you organize educational programmes on geohazards and disaster risk reduction?									■				■	■				
iD.10 Do you organize educational programmes on climate change?									■				■	■				
iF Sustainable economic development																		
iF.1.a Do visitors to your area easily recognise and understand that they are in an (a)UGGp?				■													■	
iF.1.b Does the population recognise and understand that they live in an (a)UGGp?				■											■		■	
iF.1.c Do you have entrance panels to the territory?			■	■														
iF.1.d Do you have (a)UGGp signage along the roads and/or at important sites?			■	■														
iF.2.a Do you have panels or other systems providing information on the (a)UGGp sites?			■	■														
iF.2.b Do you have public information infrastructure(s) (kiosks, visitor centre, information centre) in your (a)UGGp?			■														■	
iF.2.c Do you have a (a)UGGp museum or an interpretation centre in which you present your (a)UGGp?			■	■													■	
iF.2.d Do you have other exhibition rooms and/or museums or partner museums presenting your (a)UGGp?			■	■													■	
iF.3.a Do you use your website as a regularly updated communication tool for local population and visitors?	■		■														■	
iF.3.b Is there a map on your website presenting the (a)UGGp territory and sites open to the public?					■													
iF.3.c Does your website offer a diversified range of tours?										■								
iF.3.d Does your website promote and explain the different partnerships of your (a)UGGp?															■			
iF.3.e Do you have leaflets, publications, etc., presenting your (a)UGGp?			■	■														
iF.3.f Is there communication material available in other languages?						■												
iF.3.g Have you published a paper tourist map that indicates your sites for visitors?			■															
iF.3.h Do you actively use social media tools dedicated to the (a)UGGp?	■																■	
iF.3.i Have you developed a mobile application dedicated to your (a)UGGp?												■						
iF.3.j Do you have a generic email address with dedicated staff replying daily to visitors' questions?			■				■											
iF.3.k Do you have a public phone number with staff able to reply and answer in multiple languages?			■			■	■											
iF.4.a Are the (a)UGGp sites that you promote to visitors accessible in a safe way?						■												
iF.5.c Have you developed an (a)UGGp branding policy with local products/producers based on clear criteria?				■											■			
iF.5.d Do you have initiatives to showcase and promote the marketing of local products / food?				■											■			
iF.5.e Do you actively promote local sustainable and/or organic food and gastronomy?				■					■									
iF.5.f Do your partners clearly display that they are a Geopark partner (e.g., on their website, inside their premises, etc.)?				■														
iF.6.b Do you provide information regarding your (a)UGGp at the nearest tourist hub?				■													■	
iF.6.c Do you have promotional material available for visitors?			■	■														

UNESCO Criteria	*Corresponding principles*																	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
iF.6.e Does your (a)UGGp provide training for guides or tour operators working with you?	■														■		■	
iF.6.g Do you create or support the marketing of sustainable souvenirs such as casts, replicas and handicrafts that are locally produced?								■				■			■			
iF.6.h Do you have material to enable visitors to self-guide within your (a)UGGp?			■														■	
iF.7.a Do you organise a range of events that help promote and celebrate the natural, cultural and intangible cultural heritage of the (a)UGGp?									■									
iF.7.b Do you encourage and associate with traditional events in your (a)UGGp?						■									■			
iF.7.c Do you organize or support sport events within your (a)UGGp in a sustainable way?															■			
iF.7.d Do you organize and/or support cultural and social events within your (a)UGGp in a sustainable way?															■			
Criterion ii - Interconnection between different heritages																		
iiA.1 Other natural heritage - biotic																		
iiA.1.c Do you communicate and promote your natural heritage?	■																	
iiA.1.d Does your (a)UGGp communicate the protection of the biodiversity?									■				■					
iiA.1.f Does your (a)UGGp develop activities with the communities / NGOs operating in your territory in the field of natural heritage?							■								■			
iiA.1.g Do you have activities (education, tourism, etc.) connecting geological heritage with aspects of the natural heritage?									■	■								
iiA.1.h Does your (a)UGGp identify, protect and communicate about the endangered / endemic species of fauna and flora living in the territory?									■				■					
iiA.1.i Do you actively promote natural protected areas and their heritage in your (a)UGGp?	■																	
iiA.1.j Does your (a)UGGp develop activities with the natural protected areas' management bodies present in your territory?															■			
iiA.1.k Does your (a)UGGp inform local population and visitors about, and carry out activities related to fragile ecosystems ?					■				■									
iiA.1.l Does your (a)UGGp inform local populations and visitors about, and carry out activities related to coastal and marine ecosystems?					■				■									
iiA.2 Tangible cultural heritage																		
iiA.2.c Do you actively promote cultural protected sites and their heritage in your (a)UGGp?	■																	
iiA.2.d Does your (a)UGGp carry out activities with the cultural protected sites present in your territory?	■																	
iiA.2.f Does your (a)UGGp develop activities with the communities / NGOs operating in your territory in the field of cultural heritage?							■								■			
iiA.2.g Do you communicate and promote your cultural heritage?	■																	
iiA.2.h Do you have activities (education, tourism, etc.) connecting geological heritage with aspects of the cultural heritage?										■								
iiA.3 Intangible cultural heritage																		
iiA.3.d Does your (a)UGGp develop activities with the communities / NGOs operating in your territory in the field of intangible cultural heritage?							■								■			
iiA.3.e Is your (a)UGGp involved in the transfer of intangible heritage to the next generations?									■						■			
iiA.3.f Do you communicate and promote your intangible cultural heritage?	■																	
iiA.3.g Do you have activities (education, tourism, etc.) connecting geological heritage with aspects of the intangible heritage?										■								
iiA.3.h If a regional/indigenous language exists in your (a)UGGp, are you involved in its promotion and transmission?						■									■			
iiB Topics related to geoprocesses, climate change, natural hazards and renewable energies																		
iiB.4 Do you help raise awareness of climate change and its potential impacts amongst local populations and visitors?									■				■	■				
iiB.8 Do you help raise awareness of natural hazards, and the associated geo-processes that cause them, amongst locals and visitors?									■				■	■				
iiC Needs for sustainable use																		
iiC.1 If legal mining is carried out in your (a)UGGp, have you developed partnerships to encourage more sustainable extraction and use of natural resources with representatives from the extractive industry (mines and quarries) in your area?									■						■			
iiC.2 Do you promote a greater awareness and understanding of the need for the sustainable use of natural resources in your (a)UGGp?									■									
iiC.3 Do you promote a greater awareness and understanding of your (a)UGGp's water resources and their limitations?									■									
iiC.4 Do you deliver or support initiatives to encourage your partners to use water more sustainably?									■						■			
Criterion iii - Management structure																		
iiiA Management body																		
iiiA.4.b Does the annual budget of the (a)UGGp cover Geopark infrastructure (trails, panels, info-point, museum, etc.)?			■															
iiiA.4.d Does the annual budget of the (a)UGGp cover Education?			■															
iiiA.4.e Does the annual budget of the (a)UGGp cover (a)UGGp promotion and networking activities?			■															
iiiB Appropriate equipment																		
iiiB.3 Does your (a)UGGp directly employ a multidisciplinary team (education, culture, tourism, marketing, etc.)?			■															

UNESCO Criteria	*Corresponding principles*																	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
iiiB.4.b Does your (a)UGGp team include staff dedicated to (a)UGGp infrastructure (trails, panels, info-point, museum, etc.)?			■															
iiiB.4.d Does your (a)UGGp team include staff dedicated to Education?			■															
iiiB.4.e Does your (a)UGGp team include staff dedicated to (a)UGGp promotion and networking activities?			■															
iiiB.11.b Do you have a management plan including: geoconservation strategy including protective and conservation measures and activities?			■															
iiiB.11.c Do you have a management plan including: heritage interpretation infrastructure, tools and publications?	■																	
iiiB.11.d Do you have a management plan including: geoeducation strategy including partners, educational programmes and tools?	■																	
iiiB.11.e Do you have a management plan including: geotourism strategy including services and activities	■																	
iiiB.11.f Do you have a management plan including: sustainable local development, partners and activities?	■																	
iiiB.11.g Do you have a management plan including: (a)UGGp promotional activities and tools?	■			■														
iiiB.14 Do you use questionnaires to assess visitor satisfaction?																		■
iiiB.16 Do you use these data for your (a)UGGp forward planning?																		■
Criterion iv - Overlapping with other international designated areas																		
ivA.1 Overlapping with UNESCO designated sites																		
ivA.1.c Have the other UNESCO designated sites been informed about the aUGGp application?															■			
ivA.1.f Is there a clear justification for how the UGGp status will add value to the territory by being independently branded ?	■																	
ivA.1.j Do you develop common infrastructure to facilitate field activities?			■															
ivA.1.k Do you develop common events (conferences, exhibitions, etc.) with the other UNESCO designated sites?	■														■			
ivA.1.l Have you developed specific tools to provide a clear, visible and independent branding for your (a)UGGp?				■													■	
ivA.1.m Do you develop common activities (education, tourism, sustainable development, etc.)?	■														■			
ivA.1.n Do you mention in your own educational programmes and activities that the territory has other UNESCO designations?					■													
ivA.1.o Have you developed common promotional activities and materials (e.g., press conferences, participation in tourism fairs) in conjunction with other UNESCO designated sites that contain logos of all those represented?	■			■														
ivA.2 Overlapping with other (non UNESCO) international designated areas and/or nominations (RAMSAR, Natura 2000, etc.)																		
ivA.2.c Have other international designated areas and/or international nominations been informed about the aUGGp nomination?															■			
ivA.2.f Is there a clear justification for how the UGGp status will add value to the territory by being independently branded?	■																	
ivA.2.j Do you develop common infrastructure to facilitate field activities?			■															
ivA.2.k Have you developed specific tools to provide a clear, visible and independent branding for your (a)UGGp?				■													■	
ivA.2.l Do you develop common activities with the other international protected areas management?	■														■			
ivA.2.m Do you mention in your own educational programmes and activities that the territory has other international designations?					■													
ivA.2.n Do you develop common promotion and communication activities featuring both logos (press conferences, participation in tourist fairs, etc.) with the other international designated sites?	■			■														
Criterion v - Local and indigenous communities' participation																		
vA Local communities																		
vA.1 Are the local community and local leaders formally and actively involved in your (a)UGGp?															■			
vA.3 Are the local community and local leaders participating in the drafting and implementation of (a)UGGp activities and projects?	■					■									■			
vA.9 Does your (a)UGGp management plan include activities to preserve, study and promote the cultural identity of the local communities?	■														■			
vA.14 Is your (a)UGGp working towards transfering traditional knowledge, practices and management systems to the younger generation?									■						■			
vB Indigenous peoples																		
vB.5 Does the indigenous population participate in the drafting and implementation of (a)UGGp actions and projects?	■					■									■			
vB.13 Is your (a)UGGp actively involved in the teaching and transmission of the indigenous languages?									■						■			
vB.14 Does your (a)UGGp develop activities in indigenous languages?						■									■			
vB.15 If this language is written, does the (a)UGGp systematically ensure production of info material about the Geopark in these languages?						■									■			
vB.16 Can your (a)UGGp rely on temporary or permanent staff able to speak each one of the indigenous languages?						■									■			
vB.17 Do you have information material for visitors that presents the indigenous populations and their culture?									■									
Criterion vi - Networking between UGGps																		
viA.4 Has a member of your (a)UGGp team undertaken an UGGp intensive course or training supported by UNESCO/GGN?			■											■				

UNESCO Criteria	*Corresponding principles*																	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
viA.8 Does your (a)UGGp participate in cooperation and exchange activities with another UGGp (twinning, field visits, etc.)?															■			
viA.9 Does your (a)UGGp encourage and support contact and cooperation with schools of another UGGp (video meetings, visits, etc.)?															■			
Criterion vii - Protection of geological heritage																		
viiA.5 Does your (a)UGGp undertake initiatives to promote the protection of geological heritage locally and nationally?	■																	
viiA.6 Does your (a)UGGp actively discourage the unsustainable collection of geological materials in general?					■									■		■		
viiA.7 Does your (a)UGGp actively discourage unsustainable trade in geological materials in general?					■									■	■	■		
viiA.10 If illegal mines and quarries exist in your (a)UGGp, does the (a)UGGp organize information meetings with the population on the value of geological heritage and local regulation of quarries and mines?														■	■	■		
viiB.1 Do you have active campaigns to discourage the collection and selling of rocks?	■				■											■		