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Editorial

The General Assembly of the United Nations designated 2022 the International Year of Sustainable Mountain Development to raise awareness of the importance of conserving mountain ecosystems and using them sustainably. In May 2022, the Permanent Mission of the Kyrgyz Republic to the United Nations jointly with the Mountain Partnership Secretariat of the Food and Agriculture Organization of the United Nations (FAO) presented the concept of the *Five Years of Action for the Development of Mountain Regions* to the Permanent Missions of the UN's Member States in New York, which is intended as an action plan for the period 2023–2027 and advocated for the establishment of a broad coalition of governments to better promote the visibility of mountain issues at a High-Level Meeting on Sustainable Mountain Development on the eve of the 77th session of the United Nations General Assembly on 19 September 2022 in New York. Additionally, the UN Deputy Secretary-General Amina Mohammed has urged for greater climate funding and adaptation support for highland communities. The awareness of questions concerning mountainous regions at the General Assembly of the UN is seen as an opportunity to promote action for mountains.

For 15 years, eco.mont has offered its authors a platform to share knowledge and expertise about protected mountain areas globally, in research as well as in management. Within this issue, we have contributions from the Alps, but also from the Ado-Awaye Mountains in Nigeria and the Sino-Vietnamese Limestone area in China.

In the article by Julia Baumgartner, Elisa Kuntner, Johannes Melchert, Jan Misera, Carlotta Schlosser, Christian Schleyer & Nils Unthan on *Biosphere Reserves as drivers of regional governance? Communication challenges within the UN-ESCO Biosphere Reserves Engiadina Val Müstair (Switzerland) and Schwäbische Alb (Germany)*, the authors present the findings of 22 semi-structured interviews with regional stakeholders, including mayors, local politicians, regional government representatives, managers from both BRs, and external experts, all of whom are playing an active role in shaping governance processes in their respective regions. The authors conclude that the BRs can take on the role of mediators of vested interests within regional governance.

In their paper on *Understanding the mountainscape dynamics and its drivers using geospatial technology and indigenous knowledge in the Ado-Awaye Mountains, Nigeria*, Oluwatobi Emmanuel Olaniyi, Paul Okerinu, Oluwaseun Samuel Oduniyi, Dumsile Cynthia Hlengwa & Oluseun Adesola Akinsorotan identify cultural, natural and technological drivers which have contributed to the transformation and fragmentation of this particular mountainscape. Additionally, they provide recommendations to improve the destination's serenity and mitigate the environmental impacts.

Maria Teresa Pellicer-Chenoll, Karolina Taczanowska, Pilar Serra-Añó, José Luis Toca-Herrera & Luis-Millán González analysed German-language tweets published in 2019 and 2020 on national parks (NPs) and associated with the Covid-19 pandemic. They identified a total of 144,126 tweets which focus mainly on scenic values and clearly prefer mountain NPs. The top three NPs named are Bayerischer Wald NP (Germany), Hohe Tauern NP (Austria) and Yosemite NP (USA). According to the data, there is significant potential to improve communications via social media and to encourage the discussion of priority issues within protected areas.

Birdwatching in mountainous protected areas in China has become increasingly popular. Jiaping Xu, Peihao Yan, Zongyue Liu, Huan Qin & Aiwu Jiang therefore conducted a case study in the Nonggang National Nature Reserve on avitourism as an aspect of sustainable mountain development. 197 local households were interviewed. The results showed that avitourism has improved and diversified mountain people's livelihoods, providing employment opportunities and increasing household incomes. Additionally, it has supported biodiversity conservation by raising mountain people's awareness of sustainability and their willingness to conserve biodiversity.

Marta De Biaggi & Theresa Walter introduce readers to the LIFE WolfAlps EU project, which deals with wolf-human coexistence in the Alps. The challenge in the Alps is the acceptance of the natural return of wolves in human-dominated landscapes. The presence of the species requires actions effective at local level to improve the wolf's coexistence with humans on an international scale. The project is therefore disseminating the tools it has developed to support and involve all stakeholders in the analysis, planning and resource allocation that are essential to balance large carnivore conservation with human activities.

In a short report by Alexander Maringer & Markus Blank on *On-site visitor information – a team effort*, the authors report from the Gesäuse NP on how a newly established project team cooperated in developing not only a corporate design but also a standard operating procedure for creating signs, brochures and any other kind of visitor information. Nevertheless, face-to-face communication remains the most powerful tool to engage visitors.

Within the context of the many initiatives that concern sustainable mountain development which are taking place at the level of the United Nations, and also the numerous national and regional conferences in 2022 (AlpineWeek in Brig in Switzerland, EuroMAB, Nationalpark Austria Symposium, as well as the Internationale Mountain Conference in Austria), we hope with this issue that we have contributed to the many topics relevant for mountain communities.

Biosphere Reserves as drivers of regional governance? Communication challenges within the UNESCO Biosphere Reserves Engiadina Val Müstair (Switzerland) and Schwäbische Alb (Germany)

Julia Baumgartner, Elisa Kuntner, Johannes Melchert, Jan Misera, Carlotta Sauerwein-Schlosser, Christian Schleyer & Nils Unthan

All authors contributed equally

Keywords: Biosphere Reserves, communication strategies, communication structures, communication processes, regional governance, regional development, peripheral regions, case studies

Abstract

This article examines the influence of Biosphere Reserves' (BRs) communication strategies on regional governance processes. We conducted semi-structured interviews with regional stakeholders in the UNESCO Biosphere Reserves Engiadina Val Müstair (Switzerland) and Schwäbische Alb (Germany), and evaluated the influence of the BRs' communication strategies on regional communication structures. Our findings show that BRs can take on the role of mediators of vested interests within regional governance. In order to achieve this goal, BR managers would be advised to adopt a comprehensive communication strategy, i. e. comprising the aspects of information, participation, coordination and cooperation. This, however, is directly dependent on the BRs' financial and human resources.

Profile

Protected area

UNESCO Biosphere

Reserves Engiadina Val

Müstair (Switzerland)

and Schwäbische Alb

(Germany)

Introduction

In an increasingly globalized world, new challenges need to be negotiated and discussed at both regional and local levels. Recognizing the necessity of sustainable transformation, Biosphere Reserves (BRs) serve as “*model regions of sustainable development*” (Borsdorf & Jungmeier 2020, p. 3). But how, precisely, are socio-political tensions and conflicts of interest negotiated in these protected areas?

As part of the UNESCO Man and the Biosphere (MAB) programme, BRs strive to create a scientific basis for fostering the relations between people and their environment (MAB 2021). Launched in 1974, the MAB programme has established “*learning spaces for sustainable development*”, and has been reworked, reassessed and realigned at various stages (UNESCO MAB History 2021). In 2016, the Lima Action Plan emphasized the importance of promoting sustainable local development while “*creating added values and benefits*” for people living in BRs (Alfarè et al. 2019, p. 54; UNESCO MAB 2017). By linking national and regional policy-making processes, decision makers were not only to promote deliberative and participatory decision-making, but also to establish new partnerships and networks between public and private actors (UNESCO 2016).

To implement the revised goals of the MAB programme, BR management boards (BRMBs) are legally obliged to engage with new forms of political and social negotiation. The extent to which BRs actually incorporate these required aspects of governance has been the subject of thorough research since the 2010s.

While early analytical frameworks assessed the quality of BR management structures (Schliep & Stoll-Kleemann 2009; Lockwood 2010), they hardly addressed the impact of communication. In the 1990s, related disciplines were already debating the role of communication, and Selle (1997), among others, developed comprehensive approaches to assess communication in planning processes. Based on these theoretical approaches, we apply concepts of communication to the field of BR governance research in order to address the following research questions: To what extent do BR structures contribute to changes in communication between regional actors in sustainable regional development? How do these changes influence regional governance processes?

We conducted 22 semi-structured interviews with regional stakeholders in the UNESCO Biosphere Reserves Engiadina Val Müstair (EVMBR) in eastern Switzerland, and Schwäbische Alb (SABR) in southern Germany, and evaluated BRs' communication strategies and their influence on regional communication structures. While we consider BRs to be important drivers of regional governance, we assume that the effectiveness of governance is often reduced, on an ongoing basis, by unresolved conflicts of interest. Here, BRs may take on the role of mediators of vested interests by applying a comprehensive communication strategy.

Conceptual background

Regional governance describes systems of rules and forms of coordination and communication be-

tween public and private actors at the regional level who are not institutionally linked (Fürst 2004, 2007). In order to be able to pursue sustainable development, BRs depend on well-implemented forms of governance (Graham et al. 2003). BRs contribute to the success of regional development by actively promoting coordinated and rule-governed spatial development to obtain collectively binding decisions (Fürst et al. 2005; Newig 2011; Pütz & Job 2016). Often, governance structures depend on consensus and collaboration of fundamentally different actors who “*work under different incentive systems and, hence, have different logics of action*” (Fürst 2007, p. 17).

The challenges of ensuring collaboration and agreeing compromises in BRs can only be met by systematically involving regional stakeholders in negotiation processes. In the early 2000s, Schliep & Stoll-Kleemann (2009) examined how governance could be implemented effectively in BRs. They emphasized that governance weakness “*can be corrected by enhancing communication among stakeholders, fostering active participation and pushing capacity development*” (Schliep & Stoll-Kleemann 2009, p. 917). Shortly afterwards, a concrete proposal was put forward by Lockwood (2010) to assess the quality and effectiveness of protected area management. While the importance of BRs for sustainable regional development has been investigated with increasing frequency over the last ten years (e.g., Weixlbaumer et al. 2015; van Cuong et al. 2017), research has paid little attention to the issue of communication. Rather, communication is understood only as an accessory of participatory processes and, consequently, is only mentioned as a side note. This has become even more evident since the Lima Action Plan further elaborated on the significance of participatory processes in BRs (UNESCO 2016).

Recognizing the importance of such deliberative and participatory decision-making processes, we understand communication as “*the transmission of meaning from one person to another or to many people, whether verbally or nonverbally*” (Barrett 2014, p. 6). We argue with Selle (1997) that *communication* serves as an umbrella term encompassing multiple aspects (Figure 1).

Applied to planning theory and practice (Selle 1997, 2006), (good) communication and thus a comprehensive communication strategy include the provision of sufficient information and opportunities for participation. Communication in this fuller sense also comprises co-decision-making by third parties, and the coordination of measures and programmes between interdependent actors within one sphere as well as the cooperation of independent actors from different spheres. Thus, regional governance can only successfully contribute to the development of a region when communication-driven as well as communication-enhancing processes are integrated from the start. In mediating between different stakeholder perspectives, BRs must take the following sufficiently into account: raising awareness and sensitization, creating

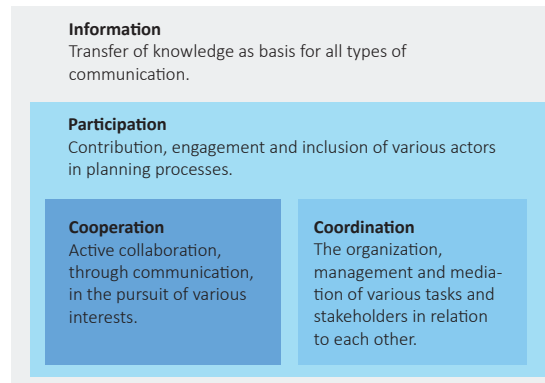


Figure 1 – Comprehensive communication. Source: own design following Selle (1997).

structures that allow for the participation of internal and external stakeholders, bringing different actors together, and coordinating actors in the implementation of their joint projects.

Clearly, simply bringing people together does not guarantee successful communication or compromise. Social learning issues, knowledge, experience, uncertainties, complexities and ambiguities, among other aspects in group-based decision-making, all have to be addressed. Here, legitimacy can only be achieved through the variety and relevance of its participants; only then can a normative transformation, with a shared commitment towards a sustainable change, be achieved (Enayati 2002).

In practice, it is necessary to create a communication environment with formal and informal communication channels that enables all participants to articulate their values and feelings (Enayati 2002; Sellke et al. 2016). Failing to implement such an environment might jeopardize a BR’s sustainable development. In general, designating areas as BRs establishes new institutional structures – understood as formal or informal rules that structure human interactions, both constraining and facilitating them (North 1990) – and long-lasting management structures (Fürst et al. 2005). The institutionalization of sustainable development through BRs, in turn, helps to establish a multi-level system of regulatory structures at different levels (supranational, national, regional, local) as well as top-down and bottom-up processes (vertical coordination) (Pütz & Job 2016). BRs become a key instrument for the mediation of processes without themselves being free of special interests (e.g., promoting sustainable development).

Research locations

Our research locations are two contrasting BRs: the *alpine-rural* EVMBR in eastern Switzerland, and the *peri-urban* SABR in southern Germany. The two BRs are characterized by pronounced *internal* variety in terms of their topography and socio-cultural aspects that have evolved over time. Designated in 2017, the EVMBR covers an area of 44,857 ha and is sparsely

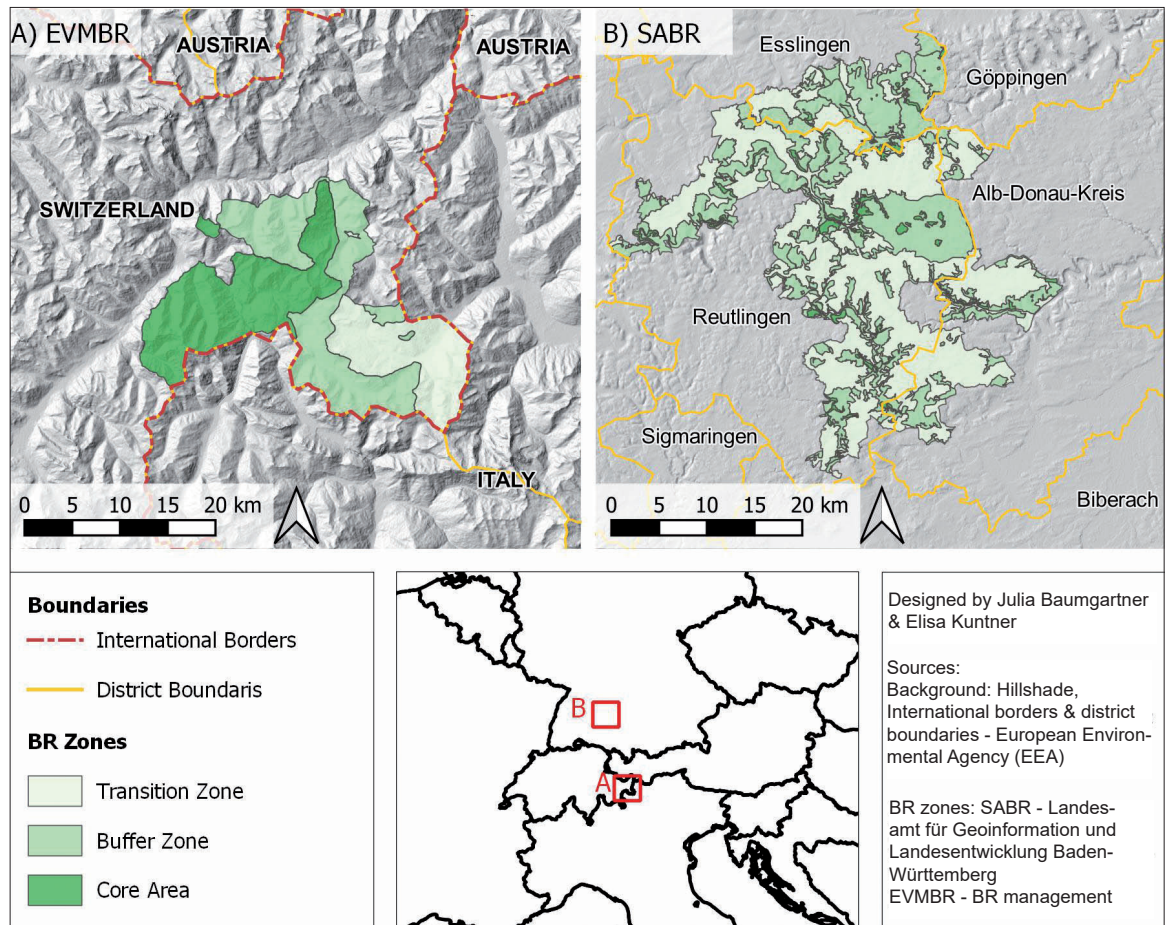


Figure 2 – Overview map of the Biosphere Reserves (BRs) Engiadina Val Müstair (EVMBR, Switzerland) and Schwäbische Alb (SABR, Germany).

populated, with approximately 8,500 inhabitants (von Lindern et al. 2020). It extends over two main valleys (Engiadina Bassa, Val Müstair), which are separated by a high alpine pass (Ofenpass). Due to its peripheral location on the southeastern border of Switzerland and the close proximity of the Val Müstair to the Italian autonomous province of South Tyrol, relations between the valleys were for a long time relatively under-developed. When designating the BR, one major challenge was to combine the existing commitment to nature conservation of the Swiss National Park (established in 1914) with tourism and agricultural land use in the municipalities of the Engiadina Bassa and Val Müstair. Today, the EVMBR is characterized by a complex management structure consisting of three funding partners: the Swiss National Park, and the municipalities of Val Müstair and Scuol (Filli & Abderhalden 2020).

Designated in 2009, the SABR covers 85,268 ha within the districts of Esslingen, Reutlingen and Alb-Donau, and is densely populated, with more than 143,500 inhabitants (von Lindern et al. 2020). The BR is characterized by the lower Albvorland, the Albtrauf ridge, and the higher Albhochland of the Schwäbische Alb mountain range. These topographical particularities have influenced the development of urban,

peri-urban and rural municipalities. The decision to designate this region as a BR was related to the commitment of the surrounding communities and the federal state of Baden-Württemberg to protect the land that became vacant when the military training area Gutsbezirk Münsing was abandoned. Today, the area serves as the core of the protected area. The fragmented overall zoning (Figure 2) is explained by the requirement that each SABR municipality contribute a certain percentage of its area to all three zones.

Methodology

To examine the influence of communication in regional governance processes within the SABR and EVMBR, we conducted 22 semi-structured interviews (eleven in each BR) between January and March 2021 (Figure 3). Due to the COVID-19 pandemic, all interviews were conducted online and recorded digitally; each lasted between 35 and 50 minutes. Following a theory-based sampling process (Glaser & Strauss 1967), we targeted stakeholders playing an active role in shaping governance processes in their respective regions, including mayors, local politicians, regional government representatives, members of both BRMBs, and external experts.

Sampling strategy	Theoretical sampling Mayors, local politicians, external experts, regional government, all representatives and members of both BR managements	A broad range of important stakeholders inside both BRs (e. g. 7 out of 29 mayors contacted decided to participate)	Barriers	Selection bias (interviewees who decided to participate may have a stronger or more positive affiliation with BRs); Institutional diversity of the BR, different political systems at the municipal level between the two countries (Switzerland and Germany)
Data collection	January – March 2021	22 semi-structured interviews in total (11 per research site), ranging from 35 to 50 mins		Travel restrictions due to pandemic: not being able to visit research sites
Data processing	Transcription of all interviews recorded	Qualitative content analysis (Mayring & Fenzl 2014), coding in MAXQDA		Interviews and transcripts: strong regional accents and use of local dialects

Figure 3 – Research Process; BR – Biosphere Reserves. Source: own figure.

While we aimed to interview similar types of stakeholders in both research areas, institutional differences between the BRs and the different political systems in the two countries (Switzerland and Germany), in particular at the municipal level, had to be taken into account during data collection. In the SABR, for example, more interviews with mayors were conducted (seven out of eleven), while in the EVMBR interviews with local political representatives and experts dominated (six out of eleven). To ensure comparability, the same thematic interview categories and similar questions were used; each interview was fully transcribed. Subsequently, the transcripts were subjected to a qualitative content analysis, in the context of the respective area of investigation, and compared to each other.

Although we aimed to capture a broad range of stakeholders, and thus perspectives on communication strategies in BRs, the voluntary character of the interviews may have caused some selection bias, as the stakeholders who chose to participate are likely to have a stronger or more positive relationship with the BR. All stakeholders interviewed were asked about their involvement in, as well as their knowledge of, local stakeholder networks, BR-related changes in regional communication structures, and developments of BR-related bottom-up processes. The collected data were then compared with the findings of the literature review, which had been conducted previously.

Results

Since their designation as protected areas and the associated responsibility to enhance the relationship between people and their local environment, both BRs aimed to establish new communication structures and dialogues between regional stakeholders. Acknowledging the diversity of communication structures and interests at the regional level, we examined the role of BRs as active facilitators of communication networks and platforms, as well as their role as spatial incubators for sustainable inter-municipal cooperation and coordination. In what follows, therefore, we elaborate on

changes of communication processes, and identify the barriers they encounter.

In their role as regional protagonists, BRMBs have created new institutional entities such as steering committees, boards of directors and inter-municipal assemblies, which in turn develop internal organisational and external communication structures. In doing so, they help to consolidate and intensify regular discourses between different administrative districts (SABR) or valleys (EVMBR).

Within the SABR, this becomes particularly evident through regular joint meetings of the BRMB and the steering committee (*Lenkungskreis*). The steering committee has an advisory capacity that supports the development and orientation of the BRMB. Although similar structures, such as a biosphere council (*Biosphärenrat*) and steering boards (*Lenkungsausschüsse*), exist in the EVMBR, their leverage is reduced by the sometimes-problematic intersection of protected areas and municipalities, and their respective areas of responsibility. The complex administrative structure of the EVMBR makes it difficult to evaluate whether a comprehensive communication strategy exists or is being applied. This becomes evident when even stakeholders who are directly involved struggle to distinguish the different responsibilities of each protected area.

In contrast, the management board of the SABR is better equipped in terms of financial and human resources (more than 25 employees), both of which are considerable. Here, the SABR might have benefited from its special funding model. As pointed out by several interviewees, the direct financial involvement of municipalities within the BR has not only led to a greater commitment to developing sustainability-oriented projects but has also increased the financial scope of the BR management and the BR in general.

Yet the development of a new communication strategy does not automatically lead to active stakeholder engagement. This became apparent, for instance, when available funding was not entirely used up by stakeholders for project development.

In both BRs, individual stakeholders exert a great influence on the local population, and ultimately de-

termine whether a particular project enjoys local support or not. In recognizing this dependency, both the SABR and EVMBR try to influence directly those who are known to have some power in fashioning decision-making and communication processes. Having learned from complex negotiation processes in the past, the BRMBs now mediate between different stakeholders, including in informal ways outside official meetings.

In the debates about enlargement that took place in both BRs during our data collection, the direct involvement of influential local stakeholders became particularly evident. With the help of bilateral talks, the EVMBR, for instance, tried to obtain an overview of different interests to minimize potential conflict and fears before communicating the idea of enlargement to the public. For this purpose, the BRMB commissioned a feasibility study with key stakeholders from both the Val Müstair and the valley Engiadina Bassa that evaluated framework conditions, success factors and barriers to collaboration (Regiun Engiadina Bassa / Val Müstair 2019).

By initiating and managing projects, the BRMBs fulfil an important role in alliances and networks. They specifically seek to involve not only regional stakeholders, but also segments of the general population. For instance, the association *Biosphärengebiet Schwäbische Alb e.V.* plays an important role in creating opportunities for participation and their embeddedness in the region. The association is open to all interested parties and consists of a network of municipalities and companies, ecological, societal and economic associations, and private individuals who are involved in the implementation of the BR's objectives.

However, both BRs are confronted by a particular challenge: their participatory formats and discussion panels often involve only a small circle of committed stakeholders who are already actively engaged in many projects and networks. In the SABR, it is evident that the successful implementation of sustainability-oriented projects is related to the long-term commitment and personal conviction of *pioneer* municipalities and their mayors. Municipalities such as Bad Urach, Münsingen and Römerstein, located in the very centre of the SABR, have been involved in the implementation of a model region for sustainable development ever since the proposal in 2005 to establish a protected area around the former military training area. The development of a mutual trust-based relationship between the SABR and those *stakeholders of the first hour* was fostered especially through regular dialogue within and between the committees and working groups. Although smaller municipalities and individual stakeholders also have equal representation in these committees, a distinct contrast appears in the extent to which BR-related issues are addressed on a day-to-day basis. This divergence can be observed in particular in the EVMBR, where limited financial and human resources prevent closer cooperation with new stakeholders.

Within the SABR, however, equal representation of municipalities and individual stakeholders does not guarantee their equal involvement; in the SABR, this inequality is reduced through cross-municipality cooperation and pro-active consulting services of the BRMB. Various small SABR municipalities, such as Neuffen and Beuren, appointed a joint environmental officer to engage more intensively with sustainability discourses and the BR.

In combining our findings regarding changes in regional communication structures, we observed attempts by the EVMBR and SABR to mitigate the influence of spatial barriers. By integrating both centrally and peripherally located municipalities more comprehensively into the further development of their respective regions, these municipalities serve as spatial incubators. Both BRs are shaped by their topographical characteristics, which contribute to the emergence of peripheral and central areas. These characteristics fostered the development of socio-cultural differences over time, and complicated cross-stakeholder and inter-municipal cooperation and collaboration. Identification with long-standing small-scale municipal structures continues to be of importance for local stakeholders. The BRMBs have also been able to strengthen an identification with the natural environment over a larger scale. Our findings suggest that this development has been fostered by a more consistent communication strategy and representation in both areas. As establishing communication strategies is directly dependent on the financial and human resources of the BRMBs, differences in the success of their implementation between the SABR and EVMBR could be observed. Since BRMBs often act as mediators of vested interests, they must be considered important drivers of regional governance. However, the extent to which BRMBs influence the effectiveness of governance is yet to be assessed.

Discussion and conclusion

Reflecting on the role of BRs as establishers of new institutional entities and as facilitators of increased stakeholder involvement while acknowledging their ability to mitigate socio-spatial barriers, we now discuss their agency within regional governance. We build on Selle's (1997) notion that the comprehensive incorporation of communication into planning processes reduces the likelihood of unresolved conflicts of interest. We therefore argue that BRs, as important actors within regional development, should establish and implement sufficiently comprehensive and transparent communication strategies.

This becomes evident when BRs act as mediators of vested interests, following a more holistic approach to sustainable regional development. In practice, they foster bottom-up decision-making processes while committing themselves to the goals of the MAB programme. In enhancing participatory and network

structures, they improve the exchange of information between stakeholders, which significantly increases the acceptance of BRs (von Lindern et al. 2020; Newig et al. 2011).

Given that development projects and planning processes are often threatened with rejection due to seemingly irreconcilable conflicting interests, it is an important task of BRMBs to achieve compromise in the interest of sustainable development. However, their ability to do so very often depends on financial and human resources. Being embedded in superordinate structures, BRs require the ongoing support of traditional political and administrative structures such as municipalities and districts (Pütz & Job 2016; Runst & Stoll-Kleemann 2020).

While we consider BRs as important drivers of regional governance, we argue that the effectiveness of governance is often reduced by unresolved conflicts of interest. Thus, BR managers would benefit from the application of comprehensive communication strategies to strengthen regional governance.

Acknowledging the disparities identified between the EVMBR and SABR, we recognize the importance of a comparison between the effects of communication strategies in further case studies. We believe that extending contemporary frameworks (Schliep & Stoll-Kleemann 2009; Lockwood 2010) for assessing the quality of BR management structures with comprehensive communication strategies could make a significant contribution to the understanding of protected area management, and thus to guidelines for BRMBs.

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Understanding the mountainscape dynamics and its drivers using geospatial technology and indigenous knowledge in the Ado-Awaye Mountains, Nigeria

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Keywords: Ado-Awaye Mountains, transformation, fragmentation, landscape metrics

Abstract

This study quantified the mountainscape transformation and identified its drivers over the last two decades in the Ado-Awaye Mountains, Nigeria, a protected mountain area in Oyo State, managed by the State government in conjunction with communal efforts. This potential mountain tourism destination is home to a suspended lake. A supervised classifier algorithm, a post-classification method, landscape metrics and indigenous knowledge (through interviews and questionnaires) were used to determine the patterns, dynamics, fragmentation and drivers of the mountainscape. The results revealed that the rock outcrop/bare ground/built-up areas and open secondary forests covered the greatest and smallest landmasses of the entire area in the study periods (2000 and 2019), both showing an increase. Mountainscape fragmentation also increased. Three categories of underlying drivers (cultural, natural and technological) contributed to mountainscape transformation and fragmentation in the Ado-Awaye Mountains. Forest restoration programmes and eco-friendly approaches are recommended to improve the destination's serenity and mitigate the environmental impact of the underlying drivers.

Profile

Protected area and
mountain range

Ado-Awaye Mountains

Country

Nigeria

Introduction

Mountains cover 24% of the earth's surface, and 12% of the global population are dependent on their ecosystem services for economic survival and livelihood improvement (Körner & Ohsawa 2005; Schild 2008; García-Llamas et al. 2019). Mountain ecosystems are characterized by topographic variety, climatic variations, diverse vegetation types, unique biodiversity, and ecosystem services (Brooks et al. 2006; Rodríguez-Rodríguez et al. 2011; Payne et al. 2020; Negi et al. 2021; Wang et al. 2022). A mountainscape is a landscape associated with a mountainous region (Körner et al. 2021; Schickhoff 2021). Mountainscapes have the potential to provide many goods and services to those who live in or in close proximity to them (Hamilton 2015; TEEB 2010; Chaudhary et al. 2017). They are important sources of eco-cultural diversity but are highly vulnerable to socio-economic and environmental changes (Balthazar et al. 2015; Zlatanov et al. 2017; García-Llamas et al. 2019). Mountainscapes and their dynamics are of growing interest in landscape ecology and work to ensure proper monitoring, planning and development of mountainous areas (Gunilla et al. 2000; Cushman & McGarigal 2019).

Many drivers (anthropogenic and climatic factors) influence land use and land cover (LULC) dynamics in mountainous regions across the globe (Hailemariam et al. 2016; Pedrono et al. 2016). Traditional agricultural practices along with other unplanned land use, unsustainable tourism, climate change and infrastructure development threaten fragile mountain ecosystems

(Buytaert et al. 2006; EEA 2006; Spehn et al. 2010; Furst et al. 2011; Maxwell et al. 2016; Wu et al. 2017; Qian et al. 2019). The pattern change of these factors affects the ecosystem services provided by the sensitive mountains, resulting in ecological impact and slow ecosystem recovery (Halada 2010; Huber et al. 2013; Pedrono et al. 2016). However, past and present information on mountainscape dynamics and its drivers in the fragile landscape at a local scale is scarce (Poyatos et al. 2003; Reyers et al. 2009), most especially in sub-Saharan African countries such as Nigeria. This dearth of information poses a significant obstacle to the effective management and sustainable development of mountainscapes (Reyers et al. 2009; Balsiger & Debarbieux 2015; Chen et al. 2017).

Mountainscape transformation and fragmentation (MTF) can be understood as the spatial patterns of LULC change in a mountainous area over time (MacDonald et al. 2000; Mottet et al. 2006; Seijmonsbergen et al. 2010; Cabel & Oelofse 2012). Recently, geospatial technology (GT) and indigenous knowledge have been employed to quantify the pattern and drivers of LULC dynamics in particular mountainscapes because of their topographic variations and limited accessibility (Shrestha & Zinck 2001; Alvarez-Martínez et al. 2010). According to Turner et al. (2007), GT has enhanced understanding of the LULC dynamics. Over the years, substantial efforts and breakthroughs have been made to determine LULC using remotely sensed data and other forms of GT (Zhang et al. 2011; Ahmad 2013). The evolution in GT has allowed for LULC change detection on temporal scales (Lu et al. 2004).

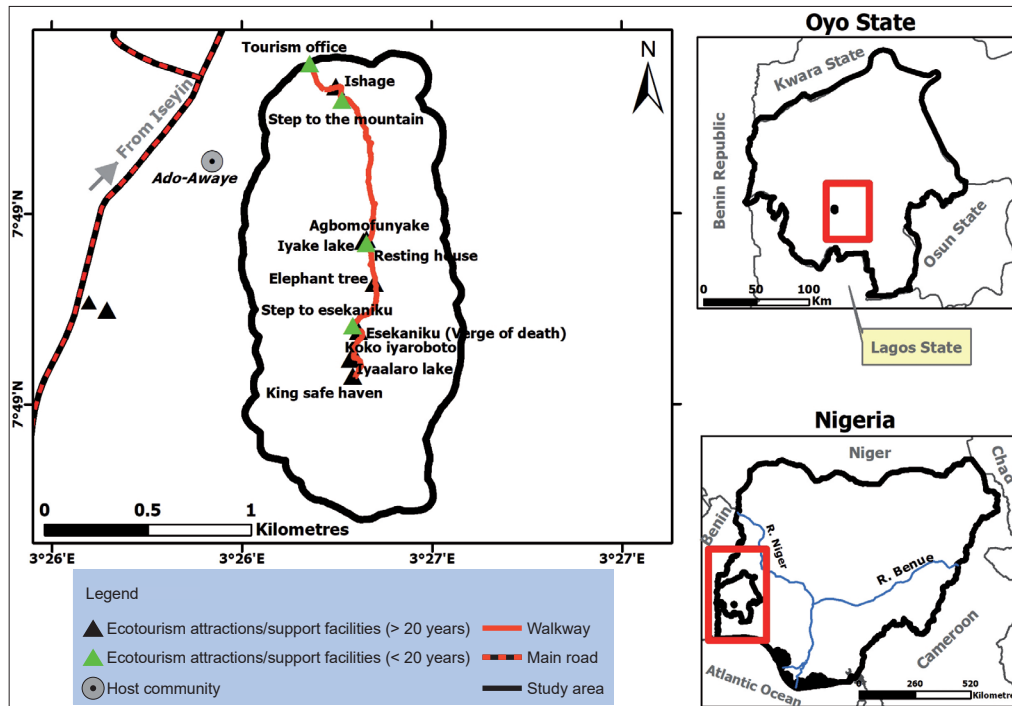


Figure 1 – The Ado-Away Mountains in Oyo State, southwest Nigeria.

Shrestha & Zinck (2001) and Regosa et al. (2015) enhanced the capability of Landsat images through topographic and radiometric corrections for LULC classification in mountainous regions. The image pre-processing reduced the illumination variations and atmospheric effects that limit Landsat images of mountains characterized by heterogeneous and fragmented landscapes (Alvarez-Martínez et al. 2010; Regosa et al. 2015). However, using only LULC analyses to understand the changes in heterogeneous and fragile mountain ecosystems poses limitations (Tovara et al. 2013). Many studies incorporate landscape metric changes with stratified LUCC information to address these limitations in understanding mountainscape dynamics (Kintz et al. 2006; Zomeni et al. 2008; Tovara et al. 2013).

Chaudhary et al. (2017) incorporated indigenous knowledge to determine the factors responsible for mountain landscape change. With an eye to the sustainable planning and effective management of mountain ecosystems, they employed a household survey and LULC analysis to gain indigenous knowledge related to the drivers of change and their implications for mountainscape dynamics. Indigenous knowledge of a mountain community provides cogent information for understanding the complex interactions between humans and mountain ecosystems (Corburn 2003; Pereira et al. 2005). However, Chaudhary et al. (2017) failed to explore the capability of landscape metrics to address the limitations of LULC analyses in understanding mountainscape dynamics.

The present study employed LULC analysis, landscape metrics and indigenous knowledge to determine the patterns and drivers of mountainscape dynamics

in the Ado-Away Mountains, a unique mountainscape in southwest Nigeria. It harbours the only suspended lake in Africa, which is one of only two such lakes in the world. The mountains have intrinsic natural and cultural resources, have potential as a tourism destination, but are also subject to undue anthropogenic pressures (Olaniyi & Bada 2020). As no information existed on the patterns and drivers of the mountainscape in the Ado-Away Mountains, this study determined the mountainscape transformation and its drivers over the last two decades, using a combination of geospatial technology and the indigenous knowledge of the mountain community.

Materials and methods

The study area

The study was carried out in the Ado-Away Mountains in southwest Nigeria (Figure 1), a protected mountain area in Oyo State, managed by the State government (Oyo State Ministry of Information, Culture and Tourism) in conjunction with communal efforts. The area is home to the only suspended lake in Africa, which is also known as Iyake Suspended Lake. Ado-Away town sprawls around the base of the mountain, lies about 20 km west of Iseyin, Iseyin Local Government Area of Oyo State, and falls within the basement complex of southwest Nigeria (Ibrahim 2015). Its location is within latitudes $07^{\circ}048'00''\text{N}$ and $07^{\circ}054'00''\text{N}$ and longitudes $003^{\circ}018'00''\text{E}$ and $003^{\circ}030'00''\text{E}$, with an area of approximately 190.62 hectares (Olaniyi & Bada 2020). There is no major river within the catchment (Ibrahim 2015). The mountains reach 433 m above sea level (Figure 2) and have a

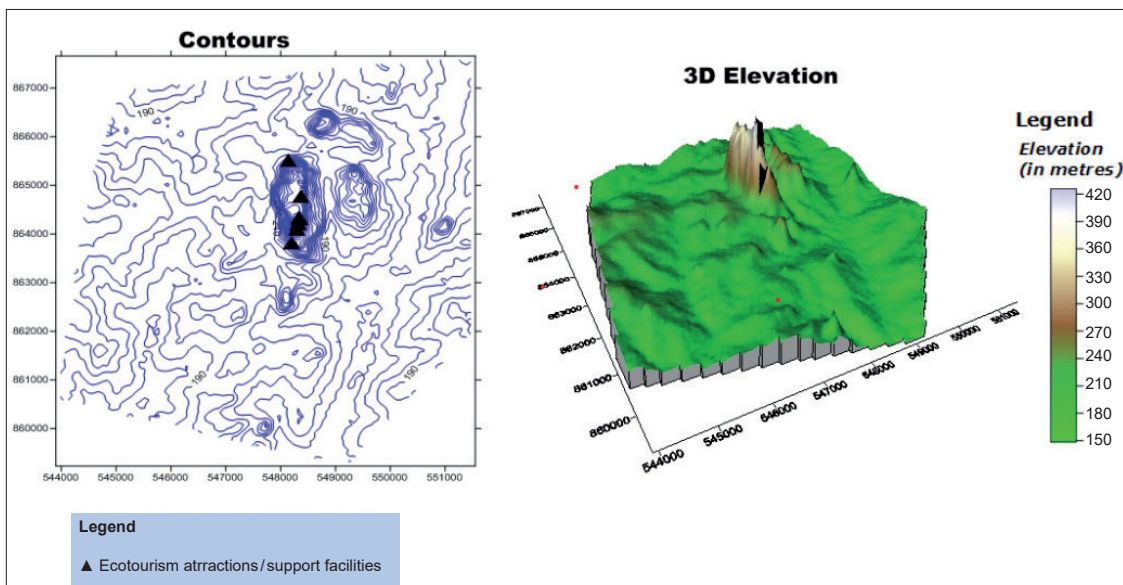


Figure 2 – The topographical characteristics of the Ado-Awaye Mountains.

maximum annual rainfall of 1,790–1,850 mm (Olaniyi & Bada 2020). The vegetation is dominated by savannah with scattered shrubs and open secondary forests (Olaniyi & Bada 2020). It is believed that the Ado-Awaye Mountains harbour a few small- to medium-sized mammals, and some bird species, including the critically endangered Hooded Vulture, *Necrosyrtes monachus*. Yoruba is the predominant indigenous ethnic group in the only local community (Ado-Awaye town).

Data collection and analysis

Acquisition of satellite imagery, ground truthing and image classification

Figure 3 shows the methodological framework of the various techniques used in the study. Spatial data were collected through field observations with the aid of a hand-held Global Positioning System (GPSMap 72s). Landsat 7 ETM+ and Landsat 8 OLI/TIRS images from two time series (2000 and 2019) were also acquired and pre-processed. The pre-processed images were subjected to supervised image classification: three LULC classes were identified using the adjusted United States Geological Survey land cover classification scheme (Anderson et al. 1976) in ArcGIS 10.4 software to derive the LULC types of the Ado-Awaye Mountains. The LULC classes identified include rock outcrop / bare ground / built-up area, open secondary forest, and savannah with scattered shrubs. The field observations were used as training samples for supervised image classification and accuracy assessment of the classified images. Error matrices and kappa statistics were computed using Quantum Geographic Information System software (QGIS version 3.16). The overall accuracy (kappa statistics) for the Ado-Awaye Mountains was 89.00% (0.8537).

Land use/land cover change detection and landscape analyses

Images obtained from the two time series (2000 and 2019) were classified and then compared in order to identify changes in the LULC dynamics; the post-classification method (McGarigal et al. 2002; Lu et al. 2004) was used for this. A transition matrix of the LULC dynamics of the study area was developed using the MOLLUSCE plugins in QGIS 3.16. Field observations and secondary data collection methods were employed to identify the drivers of landscape transformation. Changes in the landscape pattern for the three LULC classes between 2000 and 2019 were detected. These were measured to compute the landscape metrics using the LeCoS plugins in QGIS 3.16. Landscape metrics are indices to quantify the spatial characteristics of landscape pattern, composition and structure, and the dynamics of LULC, at different scales (McGarigal 2013; Wu 2013; Almenar et al. 2019; Hesselbarth et al. 2019). The landscape metrics at the class and landscape levels provide an understanding of the relationship between landscape patterns and processes (Uuemaa et al. 2009). Seven landscape metrics were computed at two metric levels (class and landscape levels).

Four landscape metrics were selected at class level, following McGarigal et al. (2002), namely edge density (ED), number of patches (NP), largest patch index (LPI), and mean patch area (MPA). Three landscape metrics at landscape level were used: the Shannon Diversity Index (SDI), Shannon Richness Index (SRI), and Simpson Evenness Index (SEI) (McGarigal et al. 2002). According to McGarigal & Marks (1995) and Gokyer (2013), ED standardizes the “sum of the length of all patch edges per unit area” (McGarigal & Marks 1995, p. 18; Gokyer 2013, p. 7). NP is a measure of the degree of fragmentation; LPI provides the percentage

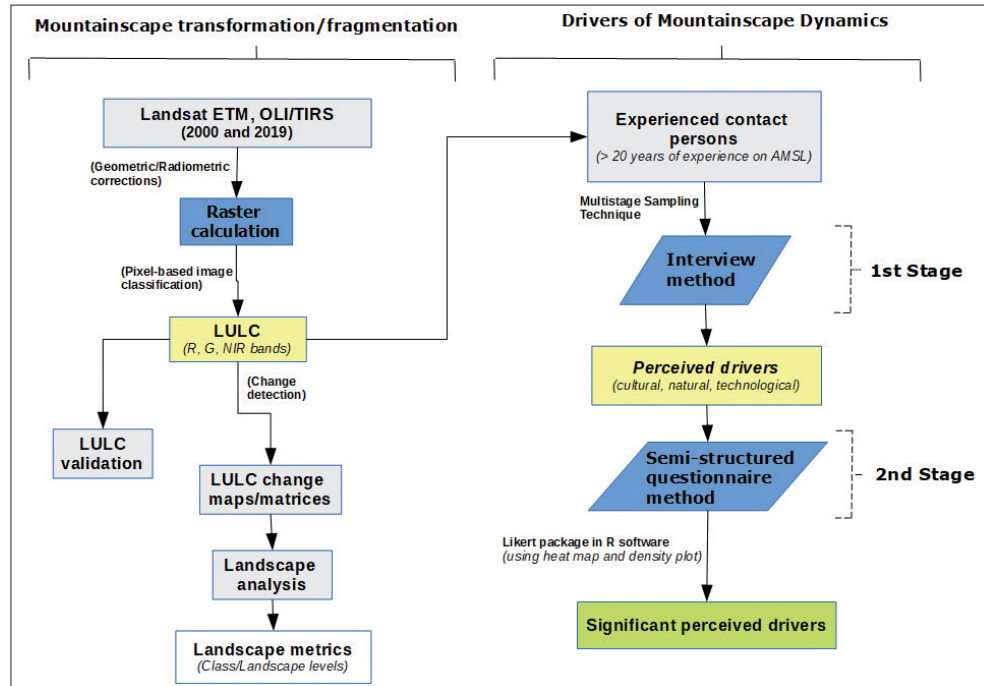


Figure 3 – Methodological framework to determine the pattern, dynamics and drivers of mountainscape transformation and fragmentation in the Ado-Away Mountains.

of the landscape comprised by the largest habitat patch of high connectivity; MPA quantifies “the average patch core area at the class/landscape levels, and provides a good index to landscape suitability for species survival” (McGarigal & Marks 1995, p. 54; Gokyer 2013, p. 12); SDI reflects the variety and abundance of various land cover types within a landscape, using a standardized value ranging from 0 to 1 (Shannon 1948; McGarigal et al. 2012). The value 0 signifies an equal proportion or a high number of LULC classes present, while 1 represents one LULC class that dominates the landscape (Ramezani 2012). SRI measures the number of patch types present in an LULC class within a landscape (McGarigal et al. 2002). SEI measures the distribution of patch types in a landscape (Scherreiks et al. 2022).

Social research setting, participants and survey

A preliminary survey was performed by researchers to familiarize themselves with the setting of the only community (Ado-Away town) close to the suspended lake, and to determine the choice of research sampling technique. The data collection involved a two-stage sampling technique to obtain indigenous knowledge using interviews (first stage) and semi-structured questionnaires (second stage). The perceived drivers of mountainscape transformation were determined using open-ended interview questions (see supplementary file). The Chiefs of the Ado-Away traditional council served as contacts. Five particularly experienced Chiefs were interviewed in order to determine the perceived drivers of mountainscape transformation in the Ado-Away Mountains. The interviews were conducted by the research team leader; the socio-econom-

ic data collected included age, gender, marital status, level of education, religion, occupation, place of birth and monthly income. The Chiefs also participated in choosing locals who had resided in the Ado-Away Mountains for more than 20 years for the second stage (questionnaire).

Because no data on the number of the local community’s residents was available, information was collected from the town’s head and traditional council members. The following information was gathered:

- Average number of households per building = 3
- Approximate number of buildings = 3,300
- Total number of households = 9,900
- Average household size = 6.

$$\text{The total number of inhabitants (s)} = N \times HS \quad (\text{Equation 1})$$

where N = the total number of households, and HS = the average household size; $s = 59,400$ inhabitants. 443 local community inhabitants with over twenty years’ experience in the Ado-Away Mountains were identified by the experienced contacts. The questionnaires were administered randomly to 206 of the 443 inhabitants thus identified (46.50%). The response rate was 100%. The formula by Krejcie and Morgan (1970) was used to compute the sample size:

$$s = \frac{X^2 NP(1-P)}{d^2(n-1) + X^2 P(1-P)} \quad (\text{Equation 2})$$

where s is the required sample size; X^2 is the table value of chi-square for 1 degree of freedom at the desired confidence level (3.841); N is the total number

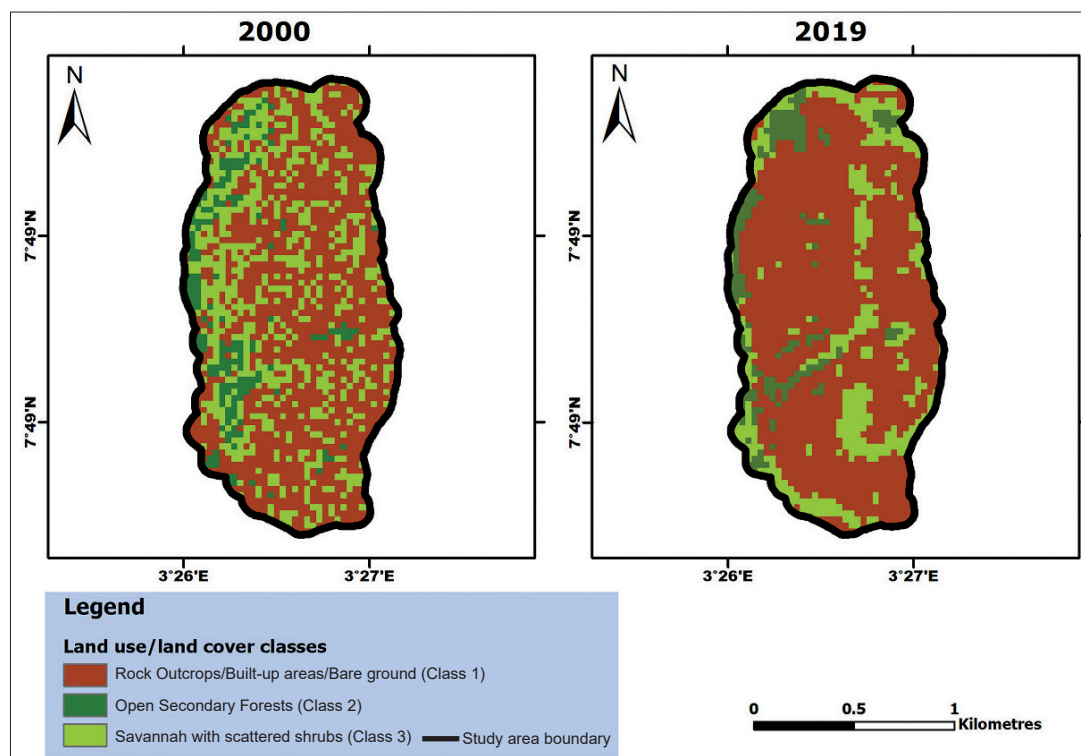


Figure 4 – The land use / Land cover of the Ado-Awaye Mountains, in 2000 and 2019.

of respondents with 20+ years' experience in the Ado-Awaye Mountains (443); P is the population proportion (assumed to be 0.50, since this would provide the maximum sample size); and d is the degree of accuracy expressed as a proportion (.05)

In the first stage, the perceived drivers of mountainscape transformation were identified through the interviews. They were categorized as cultural, natural or technological drivers according to the characterization of Burgi et al. (2004). The cultural drivers included illegal grazing, indiscriminate logging, hunting and bush burning; climate change was identified as a natural driver; the technological drivers included roads, buildings and other infrastructural facilities. The semi-structured questionnaires used in the second stage were designed and subjected to a pre-test (25 respondents) at the Obanla campus of the Federal University of Technology, Akure, Nigeria, to determine the instrument's Cronbach alpha reliability index (79.80).

The questionnaire comprised two sections: Section A, on the degree to which the perceived drivers influence mountainscape transformation (see the supplementary file); Section B, on demographic characteris-

tics. The items in Section A (7 in total) were evaluated using a five-point Likert-type scale (i. e. strongly agree, agree, don't know, disagree and strongly disagree). The demographic characteristics included age, gender, marital status, level of education, religion, occupation, place of birth, ancestral home and monthly income. The local community were then involved in a multi-stage sampling technique. First, the local community was stratified based on the two ethnic sub-groups (Ado and Awaye people), and permanent physical features in the landscape (the Iseyin to Ado-Awaye road) were identified. A direct survey was conducted for primary data collection.

Social research data analysis

The participants' responses were coded and analysed to compute the means and standard errors of the perceived drivers. A heat map and density plot were developed to rank the underlying perceived MTF drivers in the Ado-Awaye Mountains, using the Likert package in R software. Data on the perceived drivers collected from the experienced contacts were converted to binary format (i. e. strongly agree and agree

Table 1 – Attributes of land use/Land cover dynamics for the whole landscape of the Ado-Awaye Mountains, in 2000 and 2019. Total area of the Ado-Awaye Mountains = 190.62 hectares.

Land use/land cover classes	Area in hectares (Proportion in %)		Δ in hectares (%)
	2000	2019	
Rock Outcrops/built-up areas /bare ground (Class 1)	112.14 (58.83)	133.92 (70.25)	21.78 (11.43)
Open secondary forests (Class 2)	16.38 (8.59)	17.01 (8.92)	0.63 (0.33)
Savannah with scattered shrubs (Class 3)	62.10 (32.58)	39.69 (20.82)	-22.41(-11.76)

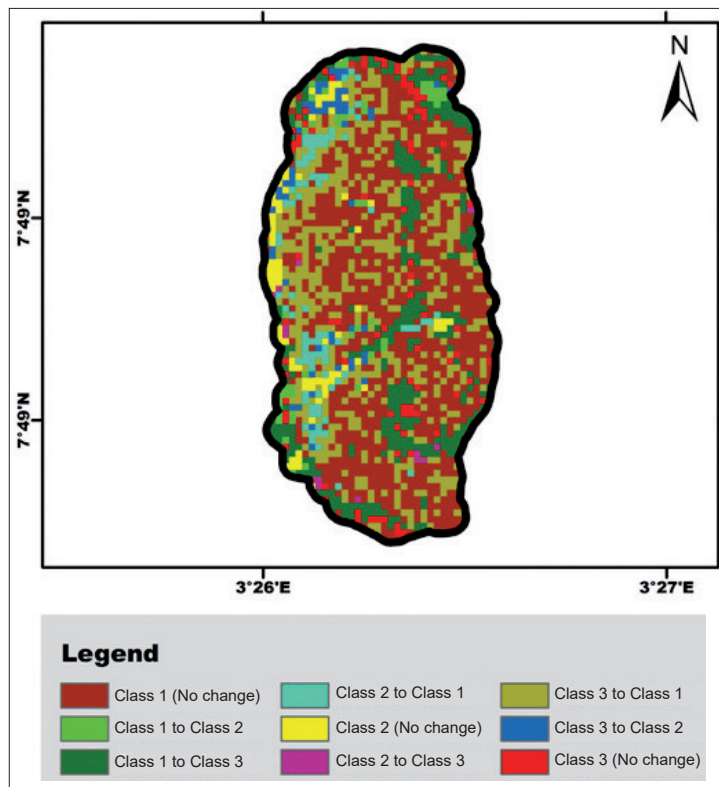


Figure 5 – Transition matrix of the land use/land cover dynamics of the landscape of the Ado-Awaye Mountains. Rock Outcrops/Built-up areas/Bare ground (Class 1); Open Secondary Forests (Class 2); Savannah with scattered shrubs (Class 3); Number of respondents = 206.

as “Yes”; don’t know, disagree and strongly disagree as “No”). These were subjected to inferential statistics using the Statistical Package for Social Sciences (SPSS version 22). The pairwise comparison and significant differences between the perceived drivers of the MTF of the study area were determined using the independent-samples Kruskal-Wallis test.

The sociodemographic factors influencing the community’s perceived MTF drivers locally were determined by analysing the dependent and independent variables, using the binomial logistic regression algorithm. The independent variables were age, gender, marital status, level of education, religion, occupation, place of birth, ancestral home and monthly income. The dependent variables were the perceived drivers, i.e. illegal grazing, indiscriminate logging, hunting, bush burning, climate change, roads, and buildings / other infrastructural facilities.

Results

The results for attributes of the LULC of the Ado-Awaye Mountains in 2000 and 2019 are presented in Figure 4 and Table 1. The total study area is 190.62 hectares. Three LULC classes were identified, namely rock outcrop / built-up / bare-ground, open secondary forest, and savannah with scattered shrubs. The rock outcrop / bare-ground / built-up areas were the most extensive category during the study periods: 112.14 hectares (58.83%) in 2000, and 133.92 hectares (70.25%) in 2019. The savannah with scattered shrubs decreased from 62.10 hectares (32.58%) in 2000 to

39.69 hectares (20.82%) in 2019. The open secondary forests (the lowest % land cover) covered 16.38 hectares (8.59%) in 2000 but increased to 17.01 hectares (8.92%) in 2019.

The results for attributes of the transition matrix of the LULC in the entire landscape of the Ado-Awaye Mountains are shown in Figure 5 and Table 2. Nine transition classes of LULC were observed. Savannah with scattered shrubs underwent the greatest change, with 48.24 hectares (25.30%) becoming rock outcrops / built-up areas / bare ground between 2000 and 2019. From 2000 to 2019, open secondary forests experienced the lowest change in land cover area:

Table 2 – Attributes of the transition matrix of the land use/land cover dynamics of the landscape of the Ado-Awaye Mountains. Total area of the Ado-Awaye Mountains = 190.62 hectares. Rock Outcrops/Built-up areas/Bare ground (Class 1); Open Secondary Forests (Class 2); Savannah with scattered shrubs (Class 3).

Land use /land cover transition classes	Land cover transition	
	Area cover (ha)	Proportion
Class 1 (No change)	78.03	40.93
Class 1 to Class 2	4.68	2.46
Class 1 to Class 3	29.43	15.4
Class 2 to Class 1	7.65	4.01
Class 2 (No change)	7.29	3.82
Class 2 to Class 3	1.44	0.76
Class 3 to Class 1	48.24	25.30
Class 3 to Class 2	5.04	2.64
Class 3 (No change)	8.82	4.63

Table 3 – Landscape metrics of the Ado-Away Mountains, Nigeria, at class and landscape scales, between 2000 and 2019.

Landscape metrics	Rock Outcrops (RO)/Built-up areas (BA)/Bare ground (B)			Open secondary forest (OSF)			Savannah with scattered shrubs (SSS)		
	2000	2019	Δ in RO/BA/B	2000	2019	Δ in OSF	2000	2019	Δ in SSS
Class level									
Edge Density (in metres/m ²)	0.027	0.012	-0.015	0.007	0.006	-0.001	0.027	0.012	-0.015
Number of Patches	18	4	-14	33	24	-9	85	37	-48
Largest Patch Index (%)	57.37	68.84	11.47	1.56	2.22	0.66	11.57	4.15	-7.42
Mean patch area (in m ²)	6,230.00	33,480.00	27,250.00	4,963.64	708.75	-4,254.89	7,395.88	10,727.10	3,331.22
Landscape Level	2000	2019	Δ in Value						
Shannon diversity index	0.87	0.79	-0.08						
Shannon evenness	0.81	0.72	-0.09						
Simpson richness index	0.54	0.46	-0.08						

1.44 hectares (0.76%) became savannah with scattered shrubs.

The landscape metrics of the Ado-Away Mountains for 2000 and 2019 are presented in Table 3. At the class level, the edge density (-0.015 metre / m²) and number of patches (-14) decreased, while largest patch index (11.47) and mean patch area (27,250.00 m²) increased in rock outcrops/built-up areas/bare ground between 2000 and 2019. The edge density (-0.001 metre / m²), number of patches (-9) and mean patch area (-4254.89 m²) decreased, while the largest patch index (0.66) increased in open secondary forest. The edge density, number of patches and largest patch index decreased, while the mean patch area increased in savannah with scattered shrubs. At the landscape level, the Shannon Diversity Index (-0.08), Simpson Evenness Index (-0.09) and Shannon Richness Index (-0.08) decreased.

The underlying perceived MTF drivers for the Ado-Away Mountains are summarized in Figure 6 (roads / footpaths, indiscriminate logging, illegal grazing, hunting, climate change, bush burning, tourism

buildings, and other infrastructures). Most respondents perceived illegal grazing (5.00 \pm 0.00) as contributing significantly to the MTF of the study area; tourism buildings / other infrastructural facilities were perceived as contributing least.

The three categories (cultural, natural, technological) of underlying perceived MTF drivers in the Ado-Away Mountains are presented in Figure 7. Most respondents perceived the cultural drivers, including illegal grazing, indiscriminate logging, and bush burning (4.33 \pm 0.39), as significant contributors. Natural drivers like climate change (3.75 \pm 0.97) were also seen as influencing the MTF. Only a few respondents perceived the technological drivers such as roads / footpaths and tourism buildings / other infrastructural facilities (1.92 \pm 0.20) as contributing to the change and fragmentation. Pairwise comparison of the perceived MTF drivers was carried out using independent samples in a Kruskal-Wallis test (see Figure 8). No significant differences ($P > 0.05$) existed between three pairs of the perceived drivers (i.e. illegal grazing / hunting, indiscriminate logging / roads, and climate change / bush burning).

The sociodemographic factors influencing the local community's perceived drivers are shown in Table 4. The results indicated that the socio-economic determinants of the local communities' perception of roads as a driver of MTF ($P < 0.05$) in the study area were religion ($P = 0.00$), occupation ($P = 0.00$), and monthly income ($P = 0.00$). As regards their perception of indiscriminate logging as a driver, the only socio-economic determinant ($P < 0.05$) was age ($P = 0.01$). No sociodemographic factors influenced the local communities' perception of climate change or bush burning as drivers of changes.

The results of the other three variables (hunting, illegal grazing, building / other infrastructural activities) were not computed because they violated the assumptions of binomial logistic regression (i.e. the dependent variable has less than two non-missing values).

Discussion

This study analysed the LULC pattern and change between 2000 and 2019 in the Ado-Away Mountains,

Table 4 – Sociodemographic factors influencing the local community's perceived drivers of the transformation and fragmentation of the Ado-Away Mountains: binomial logistic regression $n = 206$). * = significant influence ($P < 0.05$); ns = no significant influence ($P > 0.05$)

Variables / Indicators	Significance			
	Roads	Indiscriminate logging	Climate change	Bush burning
Age	0.18ns	0.01*	0.08ns	0.52ns
Gender	0.44ns	0.07ns	0.06ns	0.95ns
Marital status	0.40ns	0.99ns	0.79ns	0.81ns
Level of education	0.07ns	0.88ns	0.33ns	0.91ns
Religion	0.00*	1.00ns	0.51ns	0.17ns
Occupation	0.00*	0.10ns	0.08ns	0.84ns
Place of birth	0.39ns	0.32ns	0.91ns	0.17ns
Family size	0.33ns	0.68ns	0.90ns	0.56ns
Monthly income	0.00*	0.30ns	0.19ns	0.14ns
Constant	0.00*	0.02*	0.00*	0.00*
Overall percentages	83.0%	77.7%	84.0%	85.4%
-2log-likelihood	161.44	198.36	137.78	133.43
Nagelkerke	0.54	0.44	0.34	0.37

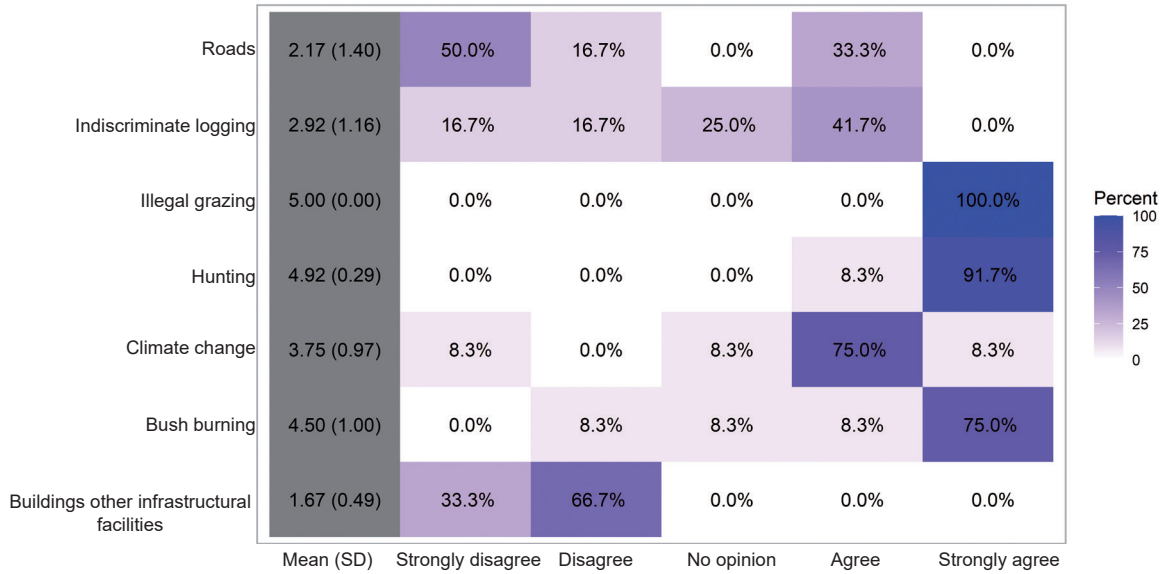


Figure 6 – Heat map showing the underlying perceived drivers of transformation and fragmentation of the Ado-Away Mountains.

using geospatial technology. The findings revealed that the rocky outcrops / built-up areas / bare ground are the most predominant LULC. The dominant vegetation class was savannah with scattered shrubs, throughout the mountainous region but especially on its cliffs and steep sides. This observation supported the findings of Aweto & Adejumbi (1991) and FORMECU (1998) that the area lay within the southern Guinean savannah and was characterized by grasses and scattered shrubs.

A small portion of the study area was covered by open secondary forest. The importance of forests for mental wellbeing is well documented (see e.g. Stigsdotter et al. 2011; FOREST EUROPE 2019). Mountain forests are also important as places for tourism and recreation (Price 2003). The low forest cover of

the Ado-Away Mountains implies absence of shade for recreational purposes and makes it a less than ideal destination for mental wellbeing. Based on the LULC transition matrix, the area covered by savannah with scattered shrubs decreased over the period studied, becoming converted to rocky outcrops / built-up areas / bare ground. This change was attributed to underlying factors, including overgrazing, indiscriminate logging, bush burning, climate change, human trampling, and tourism infrastructural development.

Within the last two decades, three categories of underlying drivers – cultural, natural and technological – have contributed to transforming the Ado-Away Mountains. The mountainscape has changed because of overgrazing by two main actors, the Fulani herdsmen and the inhabitants of Ado-Away.

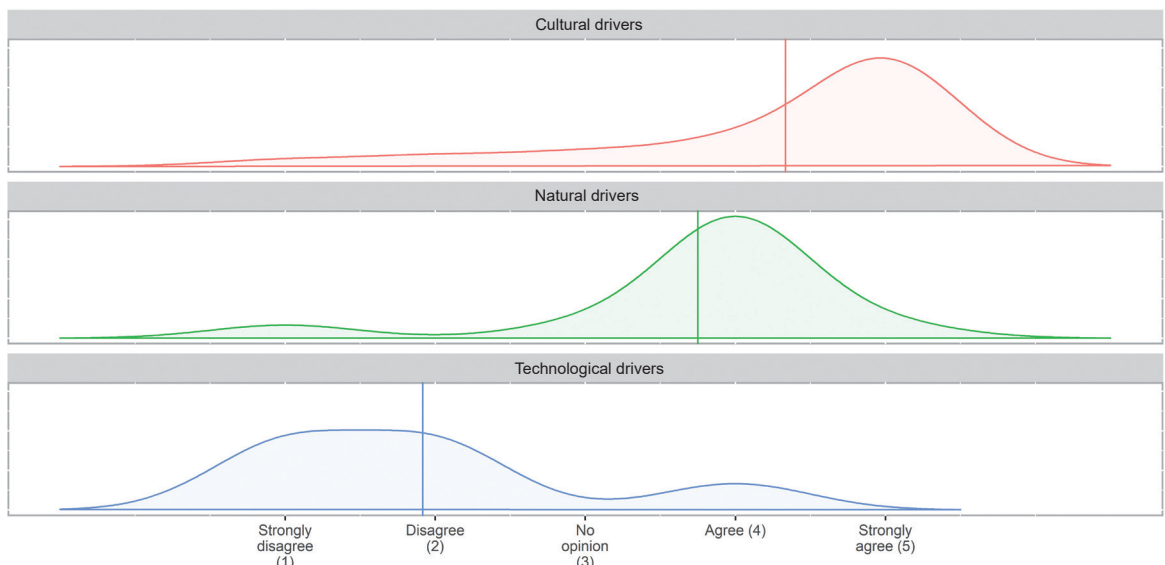


Figure 7 – Density plot showing the three categories of underlying perceived drivers of the transformation and fragmentation of the Ado-Away Mountains.

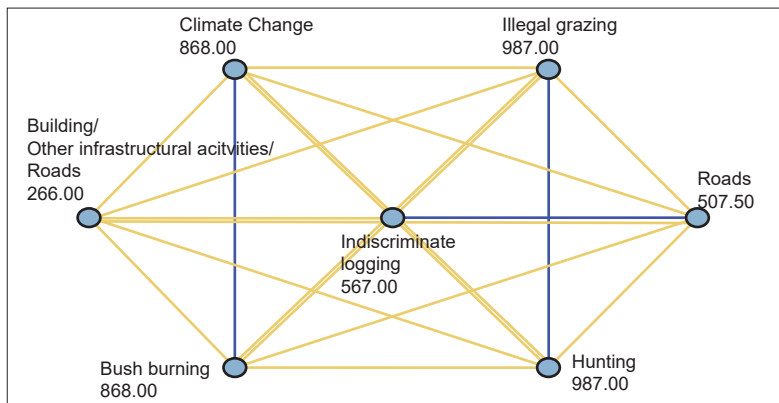


Figure 8 – Pairwise comparison of the perceived drivers of the transformation and fragmentation of the Ado-Away Mountains: Independent-samples Kruskal-Wallis test. Yellow line: significant difference between two perceived drivers ($P < 0.05$); Blue line: no significant difference between two perceived drivers ($P > 0.05$).

The Ado-Away Mountains are dominated by grasses and provide rich forage resources for domesticated animals, but the grazing has contributed to the loss of biodiversity and fragmentation of the mountainscape. This finding is consistent with Akhmadov et al. (2005), who reported that grazing affected biodiversity and resulted in the desertification of Alpine pasture in the Tajik Mountains, Tajikistan. However, this study contradicted Ingty (2021), who found that grazing enhanced biodiversity and species productivity in the Alpine Himalaya in India.

Illegal hunting and indiscriminate bush burning posed threats to the Ado-Away mountainscape. These activities occurred during the dry season, a period with low impedance to mountainscape accessibility. Bush burning, enhanced by climate change, helped hunters to move wild animals to a pre-determined route, making the animals more visible and thus aiding the hunters' indiscriminate activities. Such hunting combined with illegal grazing has led to resource over-exploitation, transformation and fragmentation in the Ado-Away Mountains. Our study agrees with Chettri & Sharma (2016) on the Hindu-Kush in India, and with Marchant et al. (2019) studying mountains in east Africa, that resource over-exploitation by inhabitants because of poverty and other drivers results in biodiversity loss. Olaniyi et al. (2019) linked a high poverty rate to local communities' over-dependence on forest resources through indiscriminate hunting and other anthropogenic activities in Nigeria. This aligned with Ambe et al. (2015) and WWF (2017) who found that bush burning destroyed and fragmented the Montane vegetation of Mount Athos in Greece and the Obanliku Hills /Plateau in Nigeria. It was also consistent with the findings of Brink et al. (2014) and Jung et al. (2016) that anthropogenic pressure influenced the land-use changes in Mount Kilimanjaro, Tanzania and the Taita Hills, Kenya.

Climate change is reported as influencing the dynamics and fragmentation of Montane vegetation in various countries, including Italy, Greece and the USA (Vanneste et al. 2017; Guisan et al. 2019; Weiskopf et al. 2020; Kazakis et al. 2021). There have been a few studies on the impacts of climate change on African

mountains (Nsengiyumva 2019). Climate change has recently been linked to landscape changes of some African mountains, such as Mount Kilimanjaro (Tanzania), the Ethiopian Highlands, and the Atlas Mountain (Maghreb) (Buytaert et al. 2011; Gebrehiwot & van der Veen 2013; Marchane et al. 2017; Siders 2019). In the Ado-Away Mountains, desertification (i.e. the reduction in savannah with scattered shrubs) may be due to increasing atmospheric temperature. An increased rate of desertification has been observed in other parts of Nigeria (Olagunju 2015; Mirzabaev et al. 2019). In mountainous regions, where conditions are particularly harsh, climate change affects vegetation distribution and shifts in biodiversity more than in other ecosystems (Tsering et al. 2010; Vanneste et al. 2017). According to Wang et al. (2016) and Zhu et al. (2017), increases in the extent of rock outcrops imply vegetation degradation and desertification, redistribution of biodiversity, and soil erosion.

In the Ado-Away Mountains, a few infrastructural facilities have been created to enhance cultural and mountain tourism activities. These include a 245-step walkway, a mini relaxation structure and a wooden bridge (Olaniyi & Bada 2020). Excavations during road construction contributed to the reduction of vegetation in the mountains. Based on the Kruskal-Wallis result, the impact of the roads correlated to the indiscriminate logging in the study area. According to Kleinschroth et al. (2019), in the Congo Basin unpaved roads can be linked to increased logging activities in the forests. The perceived driving forces of transformation and fragmentation in the Ado-Away Mountains are consistent with Beniston (2003), who concluded that mountainous landscapes are fragile environments prone to damage when exposed to agricultural activities on marginal soils, deforestation and overgrazing by livestock.

There is a dearth of information on the sociodemographic factors that influenced the local community's perception of drivers of MTF, although it has been established that age and gender shaped local people's perception of ecosystem services in African mountains, such as the Atacora Chain in the Benin Republic (Moutouama et al. 2019). However, our study

has revealed that sociodemographic factors could vary according to the different perceived drivers of MTF. Islam and farming are the dominant religion and occupation in the local community of the study area. Many of the Muslims socialize during their daily prayer sessions and along the routes to their farmlands. This could be responsible for their high perception of roads as a driver of MTF. Age (more than 60) played an important role in local inhabitants' high perception of indiscriminate logging. The degree of indiscriminate logging had decreased over the years thanks to increased awareness by community leaders of its environmental danger.

Conclusion

This study aimed at providing information on the type, pattern and rate of LULC changes, and their perceived drivers, in the Ado-Away Mountains, between 2000 and 2019. The results revealed that the rocky outcrops/built-up areas/bare ground and savannah with scattered shrubs are the predominant LULC and vegetation. Despite the slight increase in open secondary forest over the years, its low coverage detracts from the potential serenity of the mountainous landscape. Changes in the dominant vegetation (savannah with scattered shrubs) were attributed to a few underlying factors, including overgrazing, indiscriminate logging, bush burning, climate change, human trampling, and tourism infrastructural development. The religion, occupation, monthly income and age of the local communities' inhabitants with 20+ years' experience in the Ado-Away Mountains influenced their perception of roads and indiscriminate logging as drivers of transformation and fragmentation in the study area.

Effective management strategies such as forest restoration programmes are recommended for improving the destination's serenity and mitigating the negative impacts of climate change. Overgrazing should be prohibited in order to reduce pressure on the savannah with scattered shrubs. Eco-friendly approaches (e.g. waste management, solar or wind-powered light cable rail system, a smart eco-lodge using solar energy and smart control technologies, green building principles, etc.) should be encouraged to reduce the environmental impact of any tourist infrastructure and activities.

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National Parks in Twitter: A German-speaking perspective

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Abstract

Mining data from social media platforms has become increasingly popular to explore aspects of human behaviour, including attitudes towards the natural environment or visiting protected areas. Most studies and analytical algorithms refer to digital content published in English. However, it is also useful to conduct research in other languages to complement existing international studies. Our main aim was to explore Twitter content on national parks, published between 2006 and July 2021, in German. The study also presents a differentiated analysis for tweets published in 2019 and 2020 on national parks and associated with the Covid-19 pandemic. The tweets came from German-speaking countries, but also other countries worldwide. The most frequently mentioned national parks were located mainly in mountain areas, yet terms, hashtags, emojis and topics directly relating to mountains were rare in comparison to other subjects. Tweets most frequently included words such as forest (*Wald*), holiday (*Urlaub*) and nature (*Natur*); messages related not only to the natural heritage and environmental protection but also to natural disasters. The Covid-19 pandemic and national parks were also a subject of discussion on Twitter, often accompanied by photographs or videos. As 85% of all the tweets studied were never retweeted, 92% never received a reply, and 74% were never assigned *likes*, we conclude that there is potential to improve (social media) communications by users interested in protected areas in mountainous regions.

Introduction

The managers of national parks (NPs) and the scientific community aim to understand the reasons underlying choices of travel destination, patterns of recreational use, human-environment interactions during visits to the NPs, as well as associated pre- and post-travel experiences. The methods traditionally used in recreation research consist of direct and indirect observational studies, on-site and online interviews and mail surveys, visitor tracking by GPS or mobile phone, or the use of administrative data such as tickets sold or entry permits issued (Bielanski et al. 2018; Cessford & Muhar 2003; Hartmann 1988).

In recent years, social networks have gained importance, providing alternative sources of data related to the use of protected areas (Di Minin et al. 2015; Ghermandi & Sinclair 2019; Sloan & Quan-Haase 2017; Teles da Mota & Pickering 2020; Toivonen et al. 2019), and the opportunity to obtain information at a minimal cost in time and resources (Li et al. 2019). Information from social media has been used, for example, to estimate visiting rates, spatial patterns of park use, visitor preferences, feelings and experiences, or to explore cultural ecosystem services (Wilkins et al. 2021).

Social media platforms, including Flickr, Twitter and Instagram, are commonly used as data sources (Tenkanen et al. 2017). Flickr and Instagram content is heavily image-based, while Twitter disseminates short text messages (tweets). Specific tools are required to obtain data published on these platforms (e.g. Application Programming Interfaces: APIs), and to analyse it (e.g. text-mining, computational statistics or machine learning) (Batinca & Treleaven 2015) wikis, re-

ally simple syndication feeds, blogs, newsgroups, chat and news feeds. For completeness, it also includes introductions to social media scraping, storage, data cleaning and sentiment analysis. Although principally a review, the paper also provides a methodology and a critique of social media tools. Analyzing social media, in particular Twitter feeds for sentiment analysis, has become a major research and business activity due to the availability of web-based application programming interfaces (APIs). Such techniques are already used for analysis in the tourism sector (Bucur 2015; Giglio et al. 2020; Kalvet et al. 2020), in NP tourism in particular (Heikinheimo et al. 2018; Mangachena & Pickering 2021; Udyapuram & Gavirneni 2019).

Although social media allow communications in different languages, most research focuses on tweets published in English (Mangachena & Pickering 2021; Pickering & Norman 2020). In addition, much of the progress made on Natural Language Processing focuses on English. However, many tools which include other languages have recently been developed (Litvak & Vanetik 2019; Zierke n.d.).

From our point of view, accepting the axiom that English is the working language of all the citizens of the world is to accept that there is no diversity in the way people express their emotions, desires and concerns in other languages. Indeed, there is a population bias in the analyses conducted in English in non-English speaking countries: because not everybody knows or regularly uses English to communicate, a large part of the population is under-represented in the studies. It is thus useful to carry out research in languages other than English to complement existing international studies related to NPs (Teles da Mota &

Pickering 2021). In this study, we focus on German tweets on NPs, since this language is widely spoken in Europe (Data Europa EU 2012), German-speaking countries are among the leading EU economies (European Commission 2017), and the German-speaking population is among the most active nature-oriented tourists in the world (Starosta et al. 2019).

In this exploratory study of the German-language content on Twitter related to NPs, we address the following research questions (RQ):

RQ1: How many tweets in German are posted about NPs, and what words are used in them?

RQ2: Which are the most frequently mentioned NPs, and how do the users' interests in them vary over time?

RQ3: What emotions or ideas do the users express through emojis, and what people or organizations do they usually mention?

RQ4: What are the main topics of interest of German-speaking users posting tweets about NPs?

Due to the restrictions associated with the Covid pandemic, we also conducted a specific analysis of this topic between 2019 (pre-Covid) and 2020 (during the pandemic). Consequently, our final research question would be the following:

RQ5: How has the Covid-19 pandemic affected tweets about NPs posted in German?

Data and methods

Data retrieval and pre-processing

To build our database, we wrote a Matlab script (the simplest type of program file, which can be used for automating a series of commands) to perform queries through the Twitter search API v.2 (full-archive search).

The search focused on retrieving German-language tweets containing the term *national park* (*Nationalpark* in German) or variations of it (*Nationalparks*, *Nationalparke* and *Nationalparcken*). We also retrieved conversations in which the users expressed their ideas about the original tweet. The search was conducted on 9 July 2021. More than 200,000 original tweets were retrieved. After removing retweets and duplicates, using the unique tweet identifiers, the final corpus comprised 144,126 tweets.

The structure of the tweet along with associated data were stored in json format in order to allow the fields of interest of the study to be extracted. The files contained information on the tweet and its creator. Of more than 150 possible attributes, we used just 11. The standard recommendations used in similar studies (Jianqiang & Xiaolin 2017) were followed in preparing the tweet texts for further analysis. Each tweet was reduced to tokens (tokenization) – i.e. a string of characters representing a unit of text data (also known as a *unigram*) such as a word, number or email address.

The following actions were then performed on the tokens:

1. removing all hyperlinks (*http://url*), hashtags (*#hashtag*), emojis and username links (*@username*) in the tweets. The emojis and hashtags were stored for later analysis;
2. punctuation marks and special characters were removed;
3. all letters were converted to lowercase;
4. words that could add noise to the text and did not add content to the tweets (e.g. the German pronouns *der*, *die* and *das*) were removed using the German stopword list in Matlab's default text analytics toolbox;
5. the words were normalized using the Porter stemmer algorithm (German stemming; see Braschler & Ripplinger 2004) to reduce words (e.g. noun, adjective, verb or adverb) to their root forms.
6. finally, any words of fewer than 2 or more than 50 characters and those occurring only once in the corpus were also deleted.

Three bags of words were formed from the resulting tokens (unigrams: one token; bi-grams: two tokens in succession; tri-grams: three tokens in succession). The original documents (raw data) and associated fields were also stored for further analysis. The remaining fields containing text (e.g. username, user mentions, place...) were not pre-processed in any way.

Although strict duplicates were eliminated, a large number of tweets varied only slightly from others. For this reason, once the documents were cleaned, tweets with minor variations of the original text (e.g. presence or absence of urls) were removed. This identified the original tweets and not the number of tweets sent from one place to another. The IDs of the tweets used in our analysis can be found in Supplementary Material 1. To comply with Twitter's Terms of Service, we are publicly releasing the tweet IDs of the collected tweets only. The data are released for non-commercial research use. Users who wish to reuse our IDs can retrieve the original data using appropriate software (e.g. hydrator).

Descriptive analysis of tweets and national park dynamics over time

Tweet analysis began with a description of the pre-processed tweets and their date of creation. A count identified the number of tweets per day and quantified the tweets with the highest number of retweets, replies and likes over the period selected.

The user location field was used to find the approximate location of the Twitter users. This field is usually composed of the city and the country, separated by a comma (e.g. Hannover, Germany). The tweeter's geolocation was then identified using the nominatim 3.7.2 API, which uses the OpenStreetMap (OSM) dataset. Only when the city and country matched was the result accepted. 1,770 locations were geolocated in this way.

A frequency analysis of the main n-grams was also carried out. An n-gram is a sub-sequence of n ele-

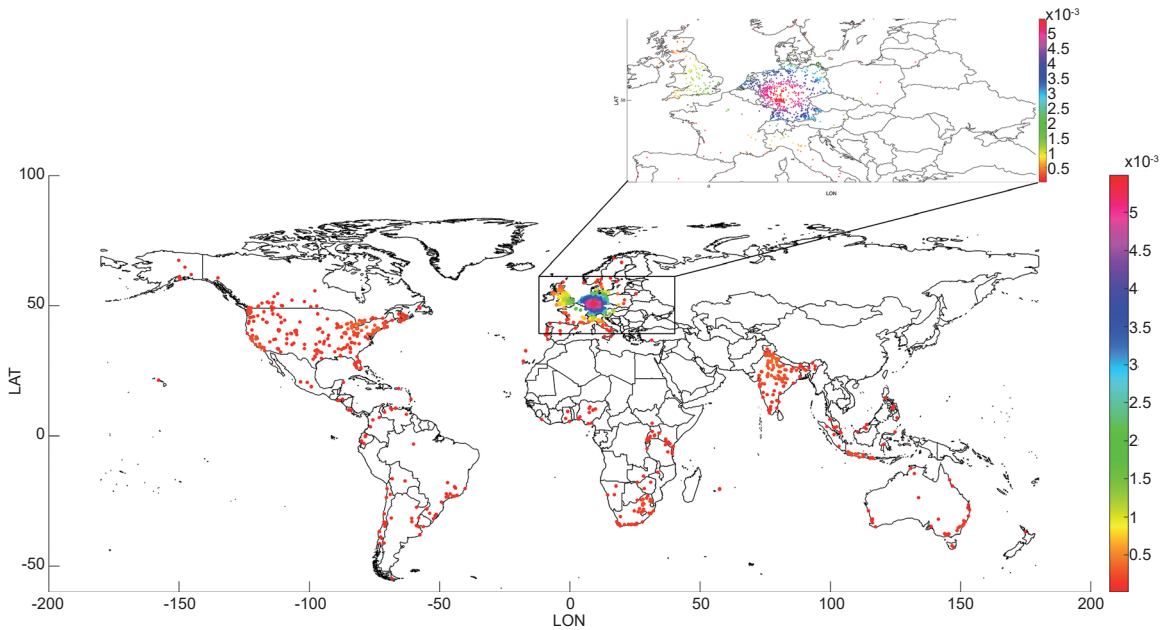


Figure 1 – Location reported by users ($n = 1,770$). The dots represent the geolocations of the Twitter users estimated through the user's location field. The colour bar shows the kernel density of each location.

ments of a given sequence of words. The frequency values of the main uni-grams, bi-grams and tri-grams were represented in word clouds. The bag of bi-grams was used to manually locate those NPs which were mentioned in the tweets a high number of times. To establish the growth and decline of the occurrence of the most-cited NPs throughout the study period, the NPs were represented in a heatmap. All the frequency values were normalized by means of a z-score.

The number of occurrences of words relating directly to Covid-19 that appeared during 2020 was also established.

Emojis

Emojis (images or pictograms that express ideas, emotions or feelings) were extracted from the text of the tweets and stored separately. A count was made of all of them, and those that were repeated most often were represented graphically (using the font Symbola.ttf for unicode symbols). We also looked for the most common meanings given by the users using the Full Emoji List, v13.0, which can be retrieved from the web unicode.org and emojiopedia.org. Emoticons (representations of facial expressions using keyboard characters such as punctuation marks) were not analysed, in order to facilitate text pre-processing (i. e. elimination of punctuation marks and special characters).

Most active users and building networks of user mentions

Certain users presented higher numbers of relevant outputs than others. The top producers were identified using the ID field and the total number of tweets from each of their individual accounts. The profiles of the top 20 producers were analysed.

Tweets often refer to other users or entities by including hyperlinks (e.g. hashtags, urls or usernames) or sources of information. We used the user mentions field to build a directed network in which the nodes were the users and the arcs were the number of times a user mentioned another user. Since most nodes in the network have only a few connections to other nodes, the subnetwork with the largest number of components (i. e. nodes) was represented.

The values of in-degree centrality (i. e. the number of times a node is mentioned by another node) were calculated, (Baek et al. 2022), as was pagerank, which assigns the relevance of a given node within the network, with higher values expressing higher relevance within the network (Borodin et al. 2005).

Topic modelling

To identify the topics that emerged from the corpus, a Latent Dirichlet Allocation (LDA) model was applied (Blei et al. 2003). This discovers underlying topics in a collection of documents and infers the word probabilities in the topics. For a more technical explanation of how the model works, see Büschken & Allenby (2016).

The LDA model fulfils a double function: i) it extracts the main topics that the users find interesting; ii) it serves as a method for selecting the tweets most closely related to certain topics of interest.

To carry out the analysis, the function *filllda.m* implemented in the Matlab text analytics toolbox was used on the pre-processed bag of words (uni-grams). In this case, the words *nationalpark*, *nationalparks*, *nationalparke* and *nationalparken* were removed to avoid distorting the results. Once the bag of words was ready, establishing the number of topics needed was

Table 1 – Retweets, replies and likes.

Total tweets Retweets (count)	66,380
never retweeted (%)	85.38
retweeted > 10 times (%)	0.55
mean retweeted (retweets/tweets)	0.46
Total tweets Replies (count)	18,743
never replied to (%)	92.15
replies > 10 replies (%)	0.07
mean replies (replies/tweets)	0.13
Total tweets Likes (count)	251,933
never liked (%)	73.45
like > 10 likes (%)	2.58
mean (likes/tweets)	1.74

the first step to ensure good cohesion in the resulting topics (González et al. 2021). After fixing the number at 30, a further calculation was used to select the most representative tweets on each topic. The tweets that contained a probability equal to or greater than 0.8 within a topic were selected. A qualitative analysis was carried out with these documents in order to examine them in more depth.

Results

General user data and tweets retrieved

After removing duplicates, a total of 144,126 tweets were retained. On average, the tweets comprised 131 characters. A total of 7,915 tweets included photos ($\approx 5.3\%$) or animated gifs ($>0.2\%$), while most videos were included in mentions of other entities (e.g. YouTube).

The tweets were posted by 64,929 users. Figure 1 shows the user distribution by country in which they reported being on their Twitter account. Most users

were in German-speaking countries, although a considerable number were scattered all over the world.

Statistical data on the number of retweets, replies and likes that the tweets obtained are presented in Table 1.

Hashtags, words and most frequently mentioned national parks in tweets

Figure 2 shows the main hashtags and n-grams posted over the study period. The actual words used as hashtags or uni-grams in the search were removed from the wordclouds to facilitate representation. The most frequent hashtags were #nationalparkservice (2,950), #travel (2,840), #nationalparktour (2,651), #schwarzwald (2,508) and #yosemite (2,505). Although the tweets were written in German, some users used English words in their hashtags, for example #photography (1,878).

In the uni-grams we found that the word *wald* (forest) was associated with the name of a NP (i.e. Bayerischer Wald NP), dominating the other words with a total of 12,938 occurrences. The words *urlaub* (holiday), *natur* (nature) and *neu* (new) also appeared frequently (9,514, 9,368 and 7,185 times respectively). For a detailed analysis, see Supplementary Material 2.

Words related to the environment or nature conservation were particularly important. Here we give those that appeared more than 1,000 times: *naturerb* (natural heritage; 2,392 occurrences); *schutz* (protection; 1,611); *naturschutz* (nature conservation; 1,547); *weltnaturerb* (world natural heritage; 1,144); *waldbrand* (forest fire; 1,431); *umwelt* (environment; 1,002). (Supplementary Material 3 contains several tweet quotations, illustrating the context of the messages).

Table 2 summarizes the frequency of NP names in the tweets. The top three are in Germany (Bayerischer

Table 2 – National parks (NP) that were named by Twitter users more than 1,000 times. US = United States of America

Name	URL	Counts	Country	Mountain area
Bayerischer Wald NP	https://www.nationalpark-bayerischer-wald.bayern.de/	5,860	Germany	yes
Hohe Tauern NP	https://hohetauern.at/de/	4,219	Austria	yes
Yosemite NP	https://www.nps.gov/yose/index.htm	3,968	US	yes
Schwarzwald NP	https://www.nationalpark-schwarzwald.de/de	3,331	Germany	yes
Harz NP	https://www.nationalpark-harz.de/de/startseite/	3,166	Germany	yes
Eifel NP	https://www.nationalpark-eifel.de/de/	3,030	Germany	yes
Krka NP	http://www.np-krka.hr/en/	2,487	Croatia	yes
Kruger NP	https://www.krugerpark.co.za/	1,855	South Africa	yes
Grand Teton NP	https://www.nps.gov/grte/index.htm	1,779	US	yes
Banff NP	https://www.pc.gc.ca/en/pn-np/ab/banff	1,736	Canada	yes
Zion NP	https://www.nps.gov/zion/index.htm	1,670	US	yes
Wattenmeer NP	https://www.nationalpark-wattenmeer.de/	1,602	Germany	no
Berchtesgaden NP	https://www.nationalpark-berchtesgaden.bayern.de/index.htm	1,568	Germany	yes
Sächsische Schweiz NP	https://www.nationalpark-saechsische-schweiz.de/	1,485	Germany	yes
Yellowstone NP	https://www.nps.gov/yell/index.htm	1,484	US	yes
Hainich NP	https://www.nationalpark-hainich.de/	1,387	Germany	yes
Jasmund NP	https://www.nationalpark-jasmund.de/	1,033	Germany	yes
Hunsrück-Hochwald NP	https://www.nationalpark-hunsrueck-hochwald.de/	1,027	Germany	yes
Jim Corbett NP	https://www.corbettnationalpark.in/	1,007	India	yes

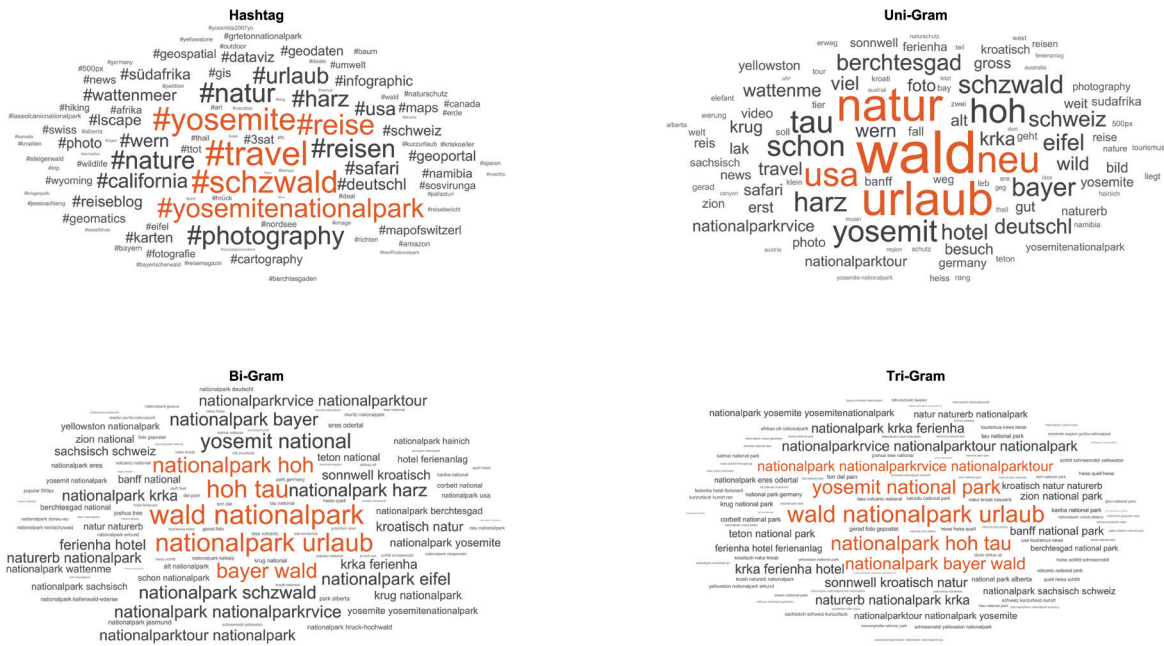


Figure 2 – Word clouds of the most frequent words and hashtags in tweets about national parks.

Wald NP), Austria (Hohe Tauern NP) and the USA (Yosemite NP). The users’ interest in various NPs evolved over the years (Figure 3). Before 2011, Hohe Tauern, Yosemite, Eifel, Wattenmeer, Berchtesgaden and Hunsrück-Hochwald NPs were the most popular. In the last ten years, Bayerischer Wald, Hohe Tauern,

Schwarzwald, Harz and Hunsrück-Hochwald NPs had a larger number of tweets.

Interestingly, the most frequently mentioned NPs (>1,000 tweets) were mostly located in mountain areas (18 out of 19 NPs). Yet, tweet text relating to mountains generally was fairly rare in comparison

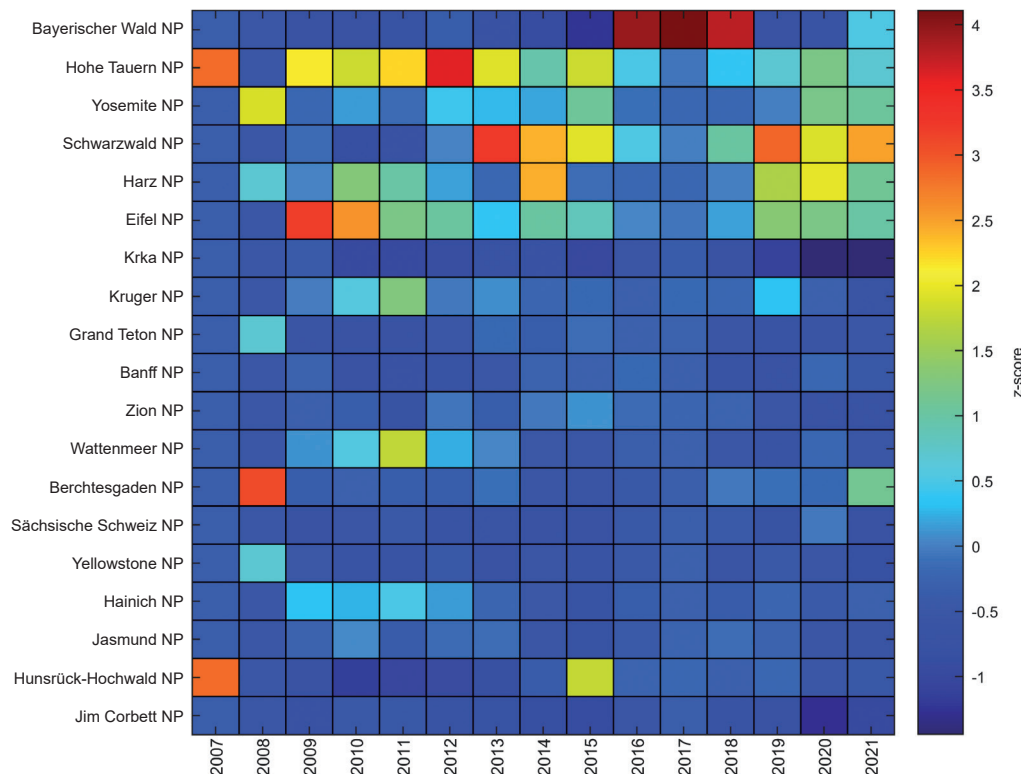


Figure 3 – Occurrence of national park (NP) names in tweets, 2007–2021 (national parks mentioned >1,000 times). The z-score is a measure of how many standard deviations you are away from the mean. 2006 was eliminated from this analysis because very few tweets were posted.

Table 3 – Emojis

Emoji (sentiment score [-1...+1])*	Count	Emoji (sentiment score [-1...+1])	Count
😊 Smiling Face with Heart-Eyes (0.678)	882	🌿 Herb (0.384)	165
📷 Camera (0.430)	803	us Flag: United States (--)	159
🌳 Deciduous Tree (0.486)	506	🍁 Maple Leaf/Flag Canada (--)	152
❤️ Red Heart (0.746)	489	at Flag: Austria (--)	146
🌲 Evergreen Tree (0.385)	480	🏔️ Snow-Capped Mountain (--)	141
😊 Smiling Face with Smiling Eyes (0.644)	404	🌊 Water Wave (0.500)	138
😉 Winking Face (0.463)	358	😊 Beaming Face Smiling Eyes (0.449)	138
📷 Camera with Flash (--)	355	🍂 Fallen Leaf (0.547)	130
👉 Backhand Index Pointing Right (0.390)	341	👌 OK Hand (0.563)	128
👍 Thumbs Up (0.521)	305	😄 Grinning Face (0.568)	125
➡️ Right Arrow (0.147)	282	ca Flag: Canada (--)	123
😂 Face with Tears of Joy (0.221)	278	👣 Footprints (0.344)	121
😎 Smiling Face with Sunglasses (0.491)	268	📌 Round Pushpin (0.111)	118
☀️ Sun (0.465)	258	🍃 Leaf Fluttering in Wind (0.378)	116
de Flag: Germany (--)	254	☀️ Sun with Face (0.558)	114
🐘 Elephant (0.023)	243	🤔 Thinking Face (--)	111
💚 Green Heart (0.656)	209	➡️ Left Arrow (0.467)	105
🏞️ National Park (--)	193	🤗 Hugging Face (--)	105
❄️ Snowflake (0.506)	185	😱 Face Screaming in Fear (0.190)	102
♥️ Heart Suit (0.657)	182	💙 Blue Heart (0.730)	101
⛰️ Mountain (--)	182	😄 Grinning Face with Sweat (0.178)	99

* Sentiment scores are taken from Novak et al. (2015) and range from -1 to 1 , with -1 being the most negative possible sentiment and 1 the most positive. The textual meaning has been extracted from the emojiopedia database. (📷 Emojiopedia – 😊 Home of Emoji Meanings 🌿🍁🍂🌊🏔️👣📌🍃☀️🤔👉👍➡️💚🏞️❄️♥️⛰️ n.d.).

to other subjects. Frequencies of mountain-related hashtags were as follows: #mountain or #mountains: 318; #berge (mountains): 91; #bergtour (mountain tour): 26. Mountain-related uni-grams included *mountain* (1561) and *berg* (994). The full list of n-grams and hashtag frequencies can be found in Supplementary Material 2.

Finally, we describe the impact of the Covid-19 pandemic on the tweets in our corpus, considering the years 2019 (pre-Covid) and 2020 (during the pandemic) only. We found that tweet traffic decreased substantially (-10.6%) in 2020 (10,646 tweets) compared to 2019 (11,916). March 2020 had the fewest tweets in our historical series (507). In all tweets posted in 2020, only 447 (4.2%) contained our search words and also included the words *COVID**, *corona**, *SARS** and *pandemic**. The number of tweets posted each month before the outbreak of the pandemic (2019) and after (in 2020) can be seen in Supplementary Material 4.

Users' opinions changed throughout the pandemic. In February and March 2020, the comments referred mainly to the restrictions imposed on visiting NPs, e.g.:

"The #Tatra National Park will be closed from tomorrow until further notice due to the #Coronavirus..."

Several Twitter users highlighted the positive side of the pandemic for environmental conservation:

"One single, very positive effect I see with Corona, the chronic earth destroyers (tourists) no longer make a permanent pilgrimage across the globe for fun and if we now manage to turn Vienna-Schwechat into a national park, then the crisis really had a purpose!"

However, after the first strict lockdown many tweets contained messages about the large number of visitors to the NPs; other complaints related to overall nature conservation policies.

"#Corona brings #NationalPark #BlackForest visitor records @UmweltBW Franz Untersteller: "The National Park is booming, people enjoy and need recreation in #nature." https://t.co/EE7eKEHyj"

"The Tourist Wave. Leisure in the pandemic attracts masses of Germans to protected areas. Holidaymakers endanger rare animals, rangers are being threatened. Can the national parks counteract a collapse?++"

"Due to the Corona crisis, national parks lack important sources of revenue (visits, tours and school programmes) that are used to fulfil the mandate of #natureconservation, nature and environmental education and #research..."

After the restrictions were partially lifted in the summer months of 2020 and spring 2021, more tweets were posted concerning events and multimedia exhibitions. (Supplementary Material 3 gives a selection in the original language with English translations.)

Emojis

Users sometimes add emojis, emoticons and symbols to highlight their tweets. We found 1,039 different ones. Interestingly, the most-used one was "©" (Copyright) (1,498 times). The fact that it appears so frequently suggests that a large part of the tweet contents (mainly photographs) was copyrighted.

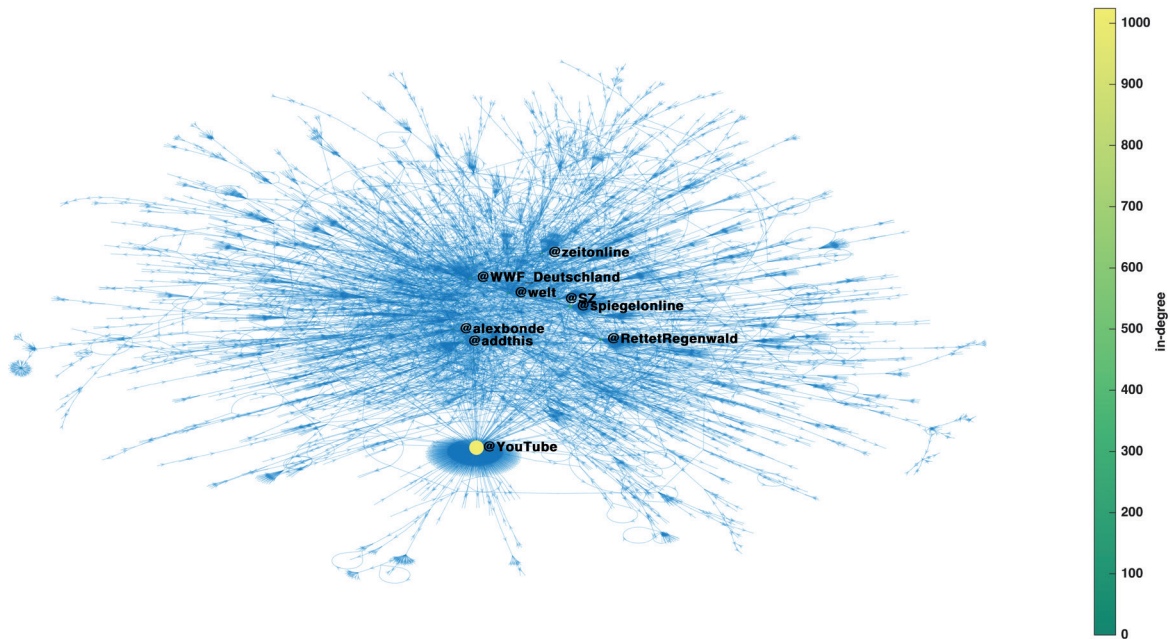


Figure 4 – Largest subnetwork of mentions appearing in tweets (8,519 nodes, 10,245 arcs). Only nodes receiving more than 60 mentions were tagged.

Our analysis focused only on emojis, not on emoticons. Table 3 shows the emojis that appeared in more than 99 tweets. Information on the meaning of each one and standard scores have been added (from Novak et al. 2015). Almost all of them refer to positive feelings. We have to go to the 70th position to find the first emoji with a negative sentiment score, 😏 Pouting Face (-0.173). Emojis related to the mountains were ranked in the middle of the frequency table (*Mountain* ranked 21st and *Snow-Capped Mountain* 26th).

Most active users and network of the most-mentioned user accounts in tweets

There were 90 users who posted more than 100 tweets over the years. The three most active accounts were @nlpschwarzwald (1,602), @NetBird (1,127) and @NpPartner (552). The first is a group of friends of the Schwarzwald NP, and the third is officially associated with a partner of the Bayerischen Wald. The @NetBird tweets were closely related to 3sat, a TV channel belonging to a consortium of German-speaking countries.

Remarkably, the top mentions were YouTube videos (in-degree, 1,772; pagerank, 5.31×10^{-2}), the daily spiegelonline (in-degree, 244; pagerank, 0.81×10^{-2}), and the non-profit association *Rettet den Regenwald e.V.* (in-degree, 197; pagerank, 0.66×10^{-2}). Other online newspapers and some other non-profit organizations appear less frequently. Alexander Bonde, general secretary of the German Federal Environment Foundation (DBU), appears among the most frequently mentioned. Figure 4 illustrates the relationships between Twitter user accounts.

Main tweet topics

Figure 5 shows the 30 largest groups of words that were most likely to appear together within a given topic. From left to right and top to bottom, they are ordered by probability of occurrence in the corpus (i. e. the words of each topic most likely to appear together in the total number of tweets collected). Supplementary Material 5 gives the 10 words associated with each topic and their probability of appearing together.

The first two topics show general words that logically fit in well with tweets on any subject. The rest of the topics relate mainly to the NPs mentioned in Table 2. Some new parks form a separate topic, although they did not appear so frequently – for example, Khao Sok NP in Thailand (topic 5) and Torres del Paine NP in Chile (topic 25). Perhaps most remarkable is the frequent presence of audiovisual content (topics 13, 17, 20, 27 and 29). We see a large number of words relating to photos and images of the parks taken by users, or to television programmes in which the parks were shown, for instance:

“Gesäuse National Park, Styria Austria – Webvideo <http://t.co/Hz3M0bvTVW> #national #park #nature #alps #mountains #styria #austria”

“3sat.de aktuell: 14:05 Under the wings of the eagle - Kalkalpen National Park: After the great wildfire ... <http://t.co/AHiQQCuWjz>”

Aspects of ecology and environmental conservation also appear in some topics. For example, we find demands for greater protection of NPs (topic 10), relating to Virunga NP and NPs in Ecuador, and the desire for a particular natural area to achieve NP status (topic 7).



Figure 5 – Main topics found. From left to right and from top to bottom, the topics most likely to appear in the corpus. The larger the word size, the higher the probability of appearing with the rest of the words in the topic.

“According to a recent #poll, 75 percent of citizens in the #Steigerwald region are in favour of a #national park. Approval is growing particularly strongly in the affected districts. #Forest #Nature #Preservation #Tourism”

There is also a group of tweets which celebrate certain anniversaries (topic 14), e.g.:

“Today, the Grand Canyon National Park turns 100 years old! 🎉😊 What is your favourite place in this beautiful park?”

Finally, some park names are associated commercially with the hospitality industry. These are tweets written as a form of advertising by certain tour operators, e.g.:

“Plitvice Lakes in Croatia: Tips for a holiday at the waterfalls: At the sight of the Plitvice Lakes National Park ...”

Selected tweets (original language + translations) related to the topics referred to above can be found in Supplementary Material 3.

Discussion and conclusions

In our study, we found a relatively small number of tweets about NPs compared to previous studies conducted in Finland (Heikinheimo et al. 2018), Nepal (Bhatt & Pickering 2021) and South Africa (Mangacheva & Pickering 2021). There are two possible explanations for this discrepancy: on the one hand, in earlier research, multilingual searches were used, and consequently the number of tweets was higher; on the other hand, the simplicity of our search strategy allowed us to reduce noise (i.e. unwanted results), but it may also have reduced the total number of relevant tweets.

Although the numbers of retweets and replies do not seem to be high, the number of likes is higher as a percentage. It should be noted that tweets containing images are more likely to be retweeted or to be rewarded with a like (Heikinheimo et al. 2018). There are many photographs, and links to videos were very common in our data.

The main Twitter users were from the former West Germany, in the Rheinland-Pfalz, Hessen and Baden-Württemberg regions. Like Scheffler et al. (2014), we found that Austria was under-represented in the number of tweets collected, despite the fact that one of its NPs was one of the most frequently mentioned in the data analysed. A high number of tweets were geolocated in southern England and northern France. This is understandable, since Great Britain is the non-German speaking country of choice for most Germans ($\approx 142,000$ people) living outside their country (German Federal Statistical Office n.d.). Nevertheless, it should be pointed out that our geolocation system is only an approximation, based on the addresses expressed in natural language by the users. The reader should therefore be cautious in the interpretation of the data, and should read the limitations at the end of this discussion.

The most frequently used uni-grams, bi-grams and tri-grams were words associated with the main NPs. This leads us to think that the contents of the tweets were mainly descriptive. Of the most frequently mentioned NPs, several are in Germany and only one in Austria. Our data agrees with a recent study by Sinclair et al. (2020), in which the most frequently mentioned parks in their study were also the most-visited ones. Factors that make a NP attractive (Puustinen et al.

2009; Siikamäki et al. 2015) were usually closely linked to their forests, scenery, biodiversity and the presence of water bodies. Most of the parks mentioned in our study stand out for their forests and/or their mountainous profile. In fact, the attraction of two of the top three parks (Yosemite NP and Hohe Tauern NP) is clearly based on their mountain scenery. The primeval forest located in a middle-high mountain range protected by the Bayerischer Wald NP is another example of an important nature-based attraction.

The German predilection for mountain parks was a preliminary finding, although it seems logical considering the easy accessibility of mountain protected areas in the main German-speaking countries. Surprisingly, however, terms, hashtags, emojis and topics directly related to mountains in general were comparatively rare in the Twitter content. More studies, using other research designs (e.g. quantitative surveys), would therefore be desirable to investigate actual appreciation of mountain environments and other environmental features. Several parks where water is the main feature (e.g. Wattenmeer NP in Germany, or Krka NP in Croatia) were also mentioned, while only one African park, a park known for its fauna (Kruger NP), appeared among the most frequently mentioned (Kruger et al. 2017).

Although most of the uni-grams referred to the names of NPs, others related to the conservation of ecosystems. It is important to note that German-speaking countries are pioneers in ecological claims and policies (Capra & Spretnak 1984), so this theme appears with some force. Interestingly, most of the tweets containing these words refer to NPs outside Central Europe. It seems that people in German-speaking countries perceive a greater danger to ecosystems when the parks are in countries with less strict regulations (Dahlberg et al. 2010) than those of the EU. However, there was also some criticism of local NPs.

Twitter is a perfect medium to express topics that people are concerned about. The analysis of Twitter users' opinions and moods has become a new decision-making tool for politicians and public assets managers (Segeberg & Bennett 2011). Our data show that organizational accounts have a strong presence on Twitter: three of the most active accounts are institutional. It seems that organizations use Twitter for their official announcements or news. However, they could (or even should) also use it as a discussion forum where they can interact two-directionally with citizens (Feroz Khan et al. 2014).

We also quantified the most-used hashtags, and two of them obtained outstanding results. These were #nationalparkservice and #travel. The first refers to the US federal agency in charge of the management of NPs, national monuments and other protected sites (<https://www.nps.gov/index.htm>). Although the individual NPs usually have their own websites where the characteristics of the park are presented, the cen-

tralized management has been successful in attracting visitors, increasing revenue and improving employee satisfaction (Chung et al. 2010; Jones et al. 2017; Kranich et al. 1999). The second hashtag is a generic and stable one (Feng & Wang 2014) related to tourism (Park et al. 2016), showing the intention of Twitter users to visit parks far from home.

We also monitored the tweets on NPs and Covid-19 posted during 2020. Briefly, there are two large groups of tweets with opposing views. Some users show the positive side of the pandemic – for example, the fact that few people visited NPs during lockdown relieved pressure on the ecosystems. On the other hand, after lockdown was lifted, the higher numbers of visitors to NPs were perceived negatively, due to fear for the conservation of natural habitats.

There is already scientific evidence confirming Twitter users' perceptions of NPs during the pandemic (Bates et al. 2020; Miller-Rushing et al. 2021; Templeton et al. 2021), though in reality these perceptions were neither new nor unique to the pandemic (Gössling 1999; O'Reilly 1986). Although our data do not allow for an in-depth analysis of the consequences of the pandemic, both Twitter users' and experts' opinions indicate that the scenario created by the pandemic may be a good opportunity to rethink access to NPs in such a way as to improve conservation.

Our analysis also looked for the most common emojis that accompanied the main message, and the mentions of other sources of information in the text. Both mentions and emojis relate most frequently to photos and videos. YouTube and the © symbol associated with photos share the limelight. Although Twitter is based on sharing short text messages, users frequently used these texts to introduce audiovisual content. The intention behind a large proportion of the tweets about NPs was thus to show images of the parks; information, experiences and emotions associated with the NPs did not have great weight. Like Heikinheimo et al. (2018), we found that a substantial number of users shared content generated on other platforms, mainly YouTube (Pflugmacher et al. 2020).

Finally, we would like to highlight some important aspects of the topics identified. We used an LDA model to extract the most likely topics in our corpus, which delivered 30 topics. The topics included descriptions of the most important NPs, conservation of the environment, and the importance of the image as a form of expression. However, by grouping the topics together we were able to detect some issues more precisely.

Some users expressed concern about NPs in countries in which they perceived a lack of awareness about environmental conservation (e.g. Ecuador and Virunga NP). However, we also noted words associated with NPs more generally, and that parks often shared the same themes. The interpretation of the topics would go beyond the main objective of this article. Thus future studies should investigate the links between parks

(i.e. their shared topics) by using a more precise search strategy for specific NPs. Practical applications of these analyses range from the conservation and management of NPs to the promotion of tourist destinations attractive to the German-speaking market. Comparison with further languages other than English would also enrich and complement our results.

Our study has certain limitations that readers should bear in mind when interpreting our results. Our search strategy was rather restrictive (i.e. only the word nationalpark and its variations were used). This may have overestimated the relative importance of certain themes that focused on the description of parks. We also focused on the words that were most repeated over time. While this decision helped us to pinpoint the most common topics, it prevented us from identifying aspects that only appeared occasionally and which could be of public interest. Future studies should therefore focus on less frequently used terms to find minority opinions which could nevertheless provide useful knowledge. Of course, the 30 topics we found overlap to some extent, and this should be analysed in future work from a qualitative point of view. Researchers who would like to study our results in greater depth could usefully look for explanations for these associations or overlaps (e.g. topic 23 Berchtesgaden, Yellowstone and Joshua Tree parks), analysing the tweets containing these words to detect possible patterns that explain the coincidences. In addition, we believe that the analysis of just one social network could have limited, or biased, our conclusions. Future work should combine other social media networks that focus more on image-based messages (e.g. Instagram or Flickr) or GNSS/GPS-based Voluntary Geographic Information.

Our research, then, is a first attempt to characterize what Twitter users post in German about NPs. Most phrases found are associated with the names of the parks and with vacations. We found a clear interest in NPs in Central Europe and the United States. We also noticed that a large part of the content had multimedia links (e.g. photographs and videos). From our data, it can be deduced that the tweets seek to express verbally and to show places of special beauty. However, there is also increasing interest in aspects of ecology and environmental conservation. In future, analysis concerning the compatibility of multimedia content with conservation objectives would be desirable.

Several management implications can be derived from our study. The first is that Twitter in German-speaking societies is used by associations and institutions to post information, but there is little interaction between users. As posted information rarely elicits replies from other Twitter users, there is little enrichment of the original content by way of posting new opinions. Discussion of priority issues (e.g. environmental protection) should be encouraged in order to obtain the real opinions of the people who are interested in a given NP. The risks of the uncontrolled promotion

of protected areas and its negative consequences have recently been reported in the literature (Gretzel 2019; Silk et al. 2017), and it is therefore also important to balance promotion in social media and its effects on the physical environment. Digital information should be compatible with nature protection objectives. Finally, the German-speaking public on Twitter clearly prefers mountain NPs. Although this interest could potentially increase discussion related to environmental education, nature protection, geology, ecology, fauna and flora, physical activity, public health and wellbeing and other strategic objectives of the protected areas, curiously, the tweets focus mainly on the parks' scenic values. If the authorities were to repeatedly associate a NP's brand image with concepts that go beyond mass tourism, it might influence positively the ways in which the parks are used and enjoyed.

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Avitourism as an aspect of sustainable mountain development: a case study from Southern China

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Keywords: *birdwatching, avitourism, sustainable development, livelihood improvement, biodiversity conservation, mountainous protected areas*

Abstract

Birdwatching has become increasingly popular over the past two decades. Because of its potential to meet both economic and conservation needs, birdwatching tourism (or avitourism) has been considered a tool for sustainable regional development. To date, very few studies have examined the impacts of avitourism in mountainous protected areas in China. We therefore conducted a case study of the Nonggang avitourism project in Southern China to explore the impacts of the activity on livelihoods and conservation. By investigating 197 local households using a structured questionnaire, we found that avitourism has improved and diversified mountain people's livelihoods, by providing employment opportunities, and increased household incomes. Moreover, it has supported biodiversity conservation by raising mountain people's awareness of sustainability and their willingness to conserve biodiversity. Community participation, government support and collaboration between stakeholders are important for the success of this project. We conclude that, when implemented adequately, avitourism can support sustainable mountain development.

Profile

Protected area

Nonggang National

Nature Reserve

Mountain range

Sino-Vietnamese

Limestone area

Country

China

Introduction

Mountains are both cradles and sanctuaries of the world's biodiversity and home to hundreds of millions of people (FAO 2015). Sustainable mountain development is essential for both biodiversity conservation and human wellbeing (FAO 2011; Payne et al. 2020; Walzer & Plassmann 2021). Defined as “*responsible travel to natural areas that conserves the environment, sustains the well-being of the local people, and involves interpretation and education*” (TIES 2015), ecotourism is one of the most popular sustainable development strategies, because it promises to meet both economic and conservation needs (Kiss 2004; World Tourism Organization 2018).

Avitourism, is the fastest-growing segment of the ecotourism market and has the potential to generate economic benefits and conservation outcomes (Cordell & Herbert 2002; Şekercioğlu 2002). Earlier research predicted that avitourism would generate considerable economic benefits for post-conflict Colombia (Ocampo-Peñuela & Winton 2017). An investigation of the North American market suggests that, for Colombia, avitourism could generate an annual profit of \$9 million and 7,516 new jobs (Maldonado et al. 2018). Moreover, birdwatching is a non-consumptive activity, with low environmental impact (Connell 2009). Birdwatchers are often characterized as male, middle-aged, well-educated, and ecologically aware (Carver 2013), and avitourism is regarded as one of the most sustainable nature-based tourism activities.

Mountain regions with rich biodiversity and endemic bird species have advantages in developing

avitourism (Birinci 2018; Rahbek et al. 2019). Because of the fragility of mountain ecosystems, however, development activities should be monitored carefully for their impacts. As a sustainable development strategy, avitourism has been poorly investigated in mountain regions (Basnet et al. 2021), but because of its growing popularity, its impacts on livelihoods and conservation, particularly in mountain communities, need to be evaluated.

Over the past two decades, birdwatching has spread rapidly in the context of China's booming economy, improved educational level, and people's rising environmental awareness (Lin 2006; Ma et al. 2013). The emergence of birdwatching as a mass-participation leisure activity in China brings opportunities for mountain development, but its impacts also need to be assessed (Walther & White 2018). Therefore, to support avitourism and its development in mountain regions, we conducted a case study in southern China exploring its livelihood and conservation outcomes. Specifically, this study aims to 1) explore the extent of the community's participation, as service-providers, in tourism-related activities; 2) identify the household factors that impact participation in tourism-related activities; 3) examine the livelihood outcomes of avitourism; 4) examine the changes in mountain people's attitude to conservation.

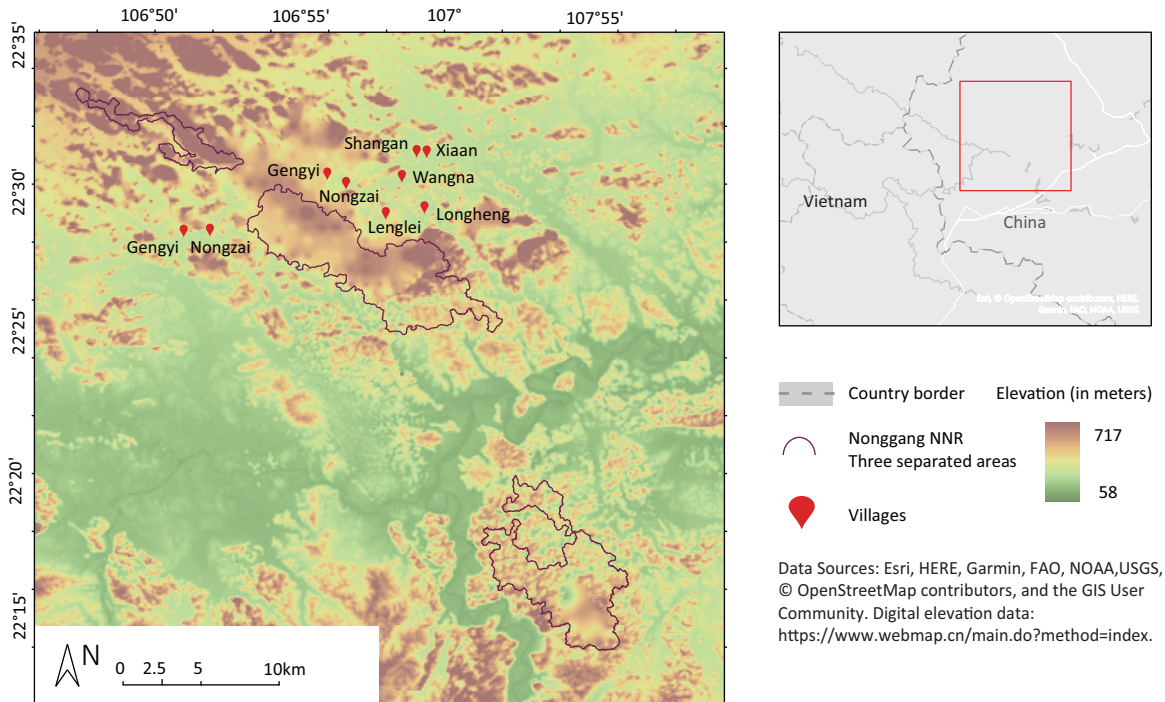


Figure 1 – Location and topography of the Nonggang National Nature Reserve (Nonggang NNR); the nine villages (Longheng, Lenglei, Xiaan, Shangnan, Pucha, Gengyi, Nongzai, Pona, Wangna) that participated in tourism selected for the household survey.

Methodology

Study area

The Nonggang avitourism project, in the area around the Nonggang National Natural Reserve (Nonggang NNR, 弄岗国家级自然保护区, 22.467° N 106.830° E, within an altitude range of 124 to 632 meters) was evaluated to understand the livelihood and conservation impacts of avitourism. The Nonggang NNR was established in 1979 to preserve the rainforest ecosystems and the rich flora and faunal diversity of this limestone region (Guangxi National Nature Reserve 2021) (Figure 1). The Nonggang NNR and its surroundings have been identified as conservation hotspots because they are particularly rich in endemic bird species and medicinal plants (Hu et al. 2017).

We selected the Nonggang avitourism project, in the area around the Nonggang NNR, as a case study for the following reasons. First, the bird resources in this neighbourhood support tourism, but the conservation of these resources also needs residents' support. Second, the Nonggang community is an economically under-developed, traditional agricultural community. Before the advent of avitourism, local people near the reserve relied on agriculture, which provided us with a framework for assessing the livelihood impacts of tourism. Third, the community used to be marginalized from questions of conservation. Policies and laws that take into account only protection but exclude people's needs have caused conflicts near the reserve between the use and the protection of natural resources. Local people used to trap wild

animals, especially birds for sale. This provided us with an opportunity to understand changes in attitude to conservation after the advent of tourism.

Data collection

A questionnaire (in Chinese) was designed to interview 197 selected households (42% of 469 households in the community), including 42 individual *tourism participants* (i.e. people who were involved in providing tourist-related services and activities), and 155 *tourism non-participants*. From April to June 2017, we interviewed every second household along the main roads in 9 villages to understand demographic and household characteristics, people's perceptions of livelihood changes, household incomes, and changes in attitude to conservation. Perceptions of respondents were rated using a five-point Likert scale from 1 (strongly disagree) to 5 (strongly agree).

Data analysis

All analyses were performed in R version 4.0.5, using the *rpart* function of the package *rpart* for classification tree building (Atkinson & Therneau 2022). First, respondents were divided into tourism participant and the non-participant groups. Then, we used descriptive statistics to analyse the respondents' profiles. Second, to understand the effects of demographic and household characteristics on participating in providing services for tourism, we built a classification tree with participation status as the dependent variable. Classification trees can easily handle qualitative predictors without creating dummy variables, thus providing a good explanation of data. Third, to un-

Table 1 – Respondents' demographic and household characteristics (N=197).

Variable	Total N=197	Participant N=42	Non-participant N=155
	%		
Gender			
Male	58.9	66.7	56.8
Female	41.1	33.3	43.2
Age (years old)			
18–27	13.2	16.7	12.2
28–37	17.8	23.8	16.1
38–47	26.4	28.6	25.8
48–57	25.9	11.9	29.7
More than 58	16.8	19	16.1
Household size			
Less than 3	2.5	4.8	1.9
3	8.1	4.8	9
4	28.9	28.6	29
5	29.4	23.8	31
6	19.3	19	19.4
More than 6	11.6	19.1	9.7
Education level			
Uneducated	24.4	19	25.8
Primary school	35	28.6	36.8
Junior high school	34	40.5	32.3
Senior high school/ vocational school	6.6	11.9	5.2
Occupation			
Peasant	84.3	83.3	84.5
Migrant worker	15.7	16.7	15.5
Average household farmland area (in mu*)	16.93	21.82	15.62

*Mu is a Chinese unit of area; 1 mu = 0.0667 ha.

derstand the livelihood impacts, we used descriptive statistics to analyse respondents' perceptions of livelihood changes. We also applied independent-sample *t*-tests to compare the annual household incomes of the two groups. Fourth, to understand the changes in attitudes to conservation, we used descriptive statistics and independent-sample *t*-tests to identify differences between the two groups.

Results

Demographic and household profiles of the respondents

Of 197 respondents, 42 (21.3%) participated in tourism, and the other 155 (78.7%) did not. 58.9% of the respondents were male, and 41.1% were fe-

male. The majority of respondents (69.1%) were over 38 years old. 69.0% had spent either 6 or 9 years in education; 24.4% were uneducated. Respondents were either peasants (84.3%) or migrant workers working in various sectors (15.7%). Over half of the respondents (58.4%) lived in households of 4 or 5 people. The respondents' average household farmland area was 16.93 *mu* (approximately 1.13 hectares) (Table 1).

The classification tree for predicting participation

We split data into a training dataset ($N = 140$) and a test dataset ($N = 57$) to build and test the classification tree. The misclassification error rate was 0.15 for the training dataset and 0.175 for the test dataset, which indicated good reliability of the classification tree.

Which village people lived in was the most important factor determining whether or not they were involved in tourism. The villagers of Lenglei, Longheng and Wangna engaged in tourism more actively. The greater the area of the household's farmland, the more likely the household was to participate in local tourist activities (Figure 2).

Avitourism has made positive livelihood changes

The impacts of tourism on livelihood related to natural resource use, farmland assets, livelihood diversification, employment opportunities and income changes (Table 2). 32% of the respondents perceived the use of natural resources as having been restricted by the development of tourism and biodiversity conservation. 10.6% considered that their available farmland area had been reduced. 38.6% agreed that tourism had diverted villagers from agriculture. 53.8% agreed that tourism had increased employment opportunities, and 24.4% agreed that tourism had improved their income (Figure 3).

Tourism-related activities included acting as a birdwatching guide, and providing accommodation and / or food and transport. Some created small ponds (and hides for rental) to attract birds, generating opportunities for birdwatching and photography. Among 42 tourism participants, 19 (45.2%) engaged in 2 or more of these particular tourism-related activities; most participants (25 individuals, 59.5%) acted as birdwatching guides (Figure 4).

Respondents had four (general) income sources: sugarcane cultivation, tourism-related activities, waged labour (as migrant workers elsewhere), and other. Sugarcane cultivation was the primary source of income

Table 2 – Livelihood changes.

Items	Description
Natural resource use	The development of avitourism and conservation regulations restricted my use of natural resources.
Farmland assets	My available farmland was reduced because of avitourism.
Livelihood diversification	The development of avitourism diverted villagers from agriculture; some who had worked elsewhere as temporary migrant workers returned to start family-owned businesses.
Employment opportunity	As tourism developed, I got more employment opportunities.
Income increment	As tourism developed, my income increased.

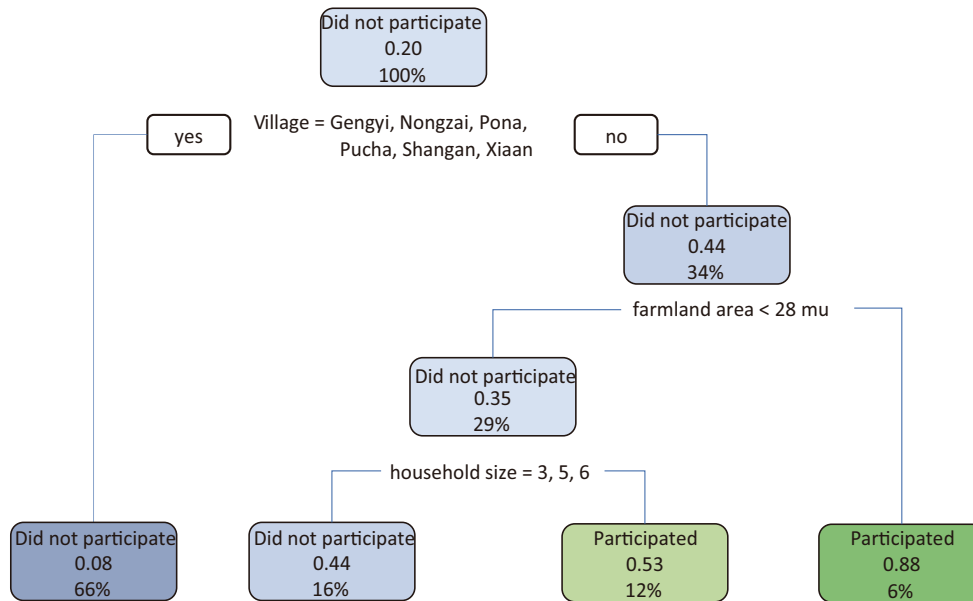


Figure 2 – The classification tree for predicting respondents’ participation status (N = 140). The villages and farmland areas are the most important predictors of respondents’ participation status. Each node (coloured box) shows the predicted class (participated or did not participate); the predicted probability of participation; the percentage of observations in the node.

for tourism participants and non-participants alike. The economic benefits of tourism-related activities were restricted to participants only. The mean annual household incomes were 96,772 and 71,779 RMB for the participating and non-participating groups respectively. Tourism participants had higher incomes from both sugarcane (t -test, $p = 0.005$) and tourism ($p < 0.001$). Tourism-related activities contributed a mean annual income of 12,817 RMB to the participants (Figure 5).

Avitourism has made positive changes in attitudes to conservation

Changes in attitudes to conservation related to knowledge of birds, affinity for birds, willingness to conserve birds, attitudes to wildlife more generally, awareness of conservation issues, and willingness to conserve wildlife (Table 3). Most of the respondents liked birds (90.4%) and were willing to conserve birds (89.4%); for wildlife more generally, most respondents recognized the importance of wildlife (69.5%) and were willing to conserve wildlife (86.8%). These high conservation-attitude scores indicated respondents’ improved conservation attitudes (Figure 6) compared to their former harmful behaviours (41.2% of the respondents admitted having once harmed birds; 30% admitted that they had once harmed wildlife). Although tourism participants tended to score higher for conservation attitudes, the differences between the two groups were non-significant, except that participants had acquired more knowledge of birds (Figure 7).

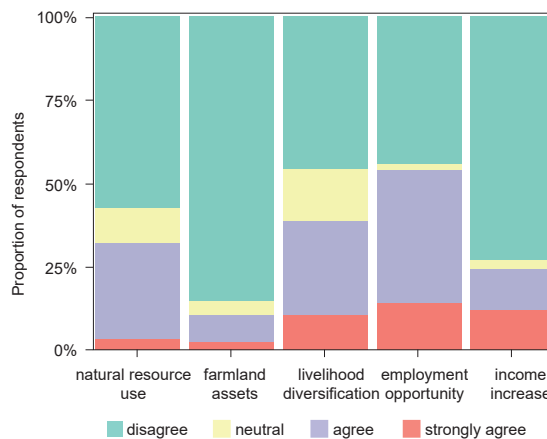


Figure 3 – Respondents’ perception of livelihood changes (N = 197). Positive changes include livelihood diversification, employment opportunity, and increases in income; negative changes include restrictions in the use of natural resources, and reductions in the area of farmland.

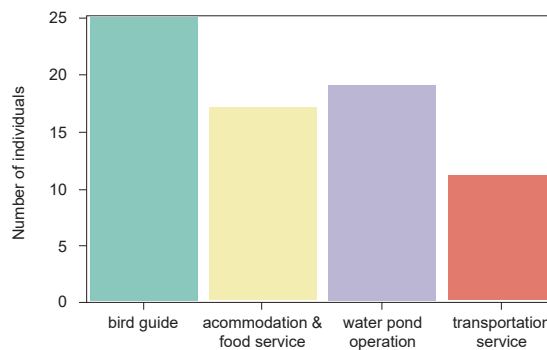


Figure 4 – Respondents’ engagement in tourism-related activities (N = 42).

Table 3 – Changes in attitude to conservation.

Items	Description
Knowledge of birds	As tourism developed, I acquired more knowledge of birds.
Affinity for birds	I like birds.
Willingness to conserve birds	As tourism developed, my view of birds changed and I started to protect birds consciously.
Attitudes to wildlife	Wildlife plays an important role in nature.
Conservation awareness	It is necessary to protect endangered animals.
Willingness to conserve wildlife	As tourism developed, my view of wildlife changed and I started to protect wildlife consciously.
Previous behaviour in relation to birds	I once harmed birds (e.g., stealing eggs, hunting, selling or consuming birds).
Previous behaviour in relation to wildlife	I once harmed other wildlife (e.g., hunting, selling or consuming wild animals).

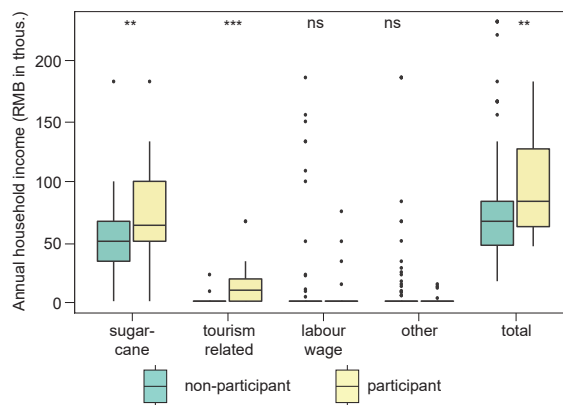


Figure 5 – Respondents' sources of income and annual income. Tourism participants have higher incomes from both sugarcane and tourism activities. RMB is the currency of Mainland China. 6.3 RMB = 1 USD; ***, ** and * denote statistical significance at the 0.001, 0.01, 0.05 levels; ns represents not significant.

Discussion

Avitourism contributes to sustainable mountain development

Avitourism as practised by the Nonggang community can serve as a sustainable mountain development strategy. From a developmental perspective, this form of tourism can improve mountain livelihoods by generating employment opportunities, diversifying local livelihoods, and increasing household income (Qian et al. 2017; Zambrano et al. 2010). This diversification of livelihoods makes mountain communities more adaptive to the fragility of mountain ecosystems and enhances their capacity to cope with environmental and global changes (Loison 2015). Avitourism has generated considerable economic benefits for local people (Lonn et al. 2018; Ma et al. 2019). Investigating the background of local tourism practice reveals that the positive livelihood changes can be attributed to three components. First, the economic benefits of tourism were local ones, affecting local people (Lee & Jan 2019). Second, the local government's support and investment helped build community capacity in tourism operations. Third, the collaboration between the mountain community and the government enhanced mutual understanding (Osman et al. 2018).

From a conservation perspective, avitourism has raised mountain people's awareness of sustainability and improved their willingness to conserve biodiversity (Hunt & Harbor 2019; Masud et al. 2017). Harming wildlife used to be common but has gradually diminished, for three reasons. First, the mountain community and the local government cooperated and established a system for monitoring the mountain ecosystem. Second, the community-based management of an ecological protection zone increased local residents' responsibility and ownership. Third, environmental education enhanced people's awareness of sustainability. Avitourism therefore supported biodiversity conservation both directly and indirectly.

In conclusion, avitourism offers great potential for sustainable mountain development when implemented with community participation, government support and collaboration between stakeholders (Conradin & Wiesmann 2014; Ruoss 2016).

Limitations in local practice and suggestions for improvement

The tourism participation rate was 21.3% of the community. The geographical location of the villages and the smallholding were the most important factors in determining participation (Avila-Foucat & Rodríguez-Robayo 2018). The geographical position of a village determined the chance of tourism participation, while farmland assets decided a household's ability to participate. Because sugarcane was the primary income source for the majority, households with less land have limited financial capital to diversify their livelihoods and might be marginalized in tourism development. Broadening the engagement of mountain people will therefore need more investment in households that enjoy less favourable economic conditions. Expanding tourism-related activities (e.g., providing organic food products, selling souvenirs) will also provide opportunities for local engagement. In addition, avitourism should be introduced to complement existing livelihoods and support traditional farm activities (Tao & Wall 2009).

A few respondents mentioned negative impacts on livelihood, restrictions on the use of natural resources, and reductions in arable farmland. Because mountain communities in China often depend on the land for their livelihoods, mountain people's reliance on land

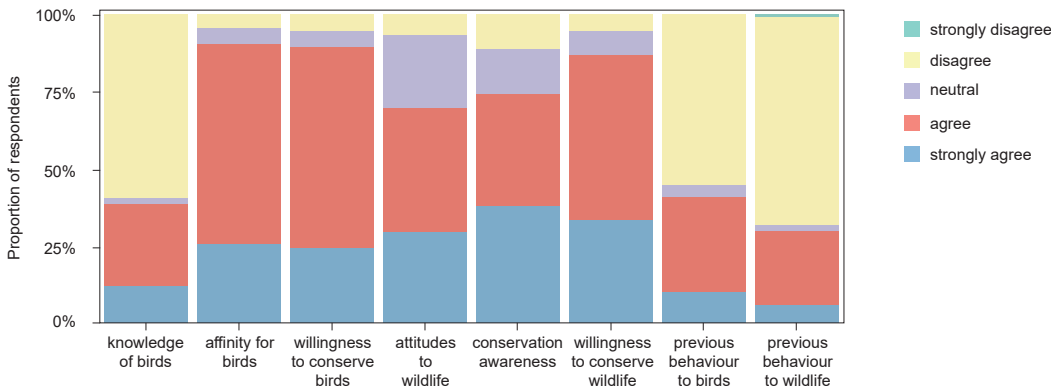


Figure 6 – Respondents’ conservation attitudes changes (N = 197). Most respondents show positive conservation attitudes.

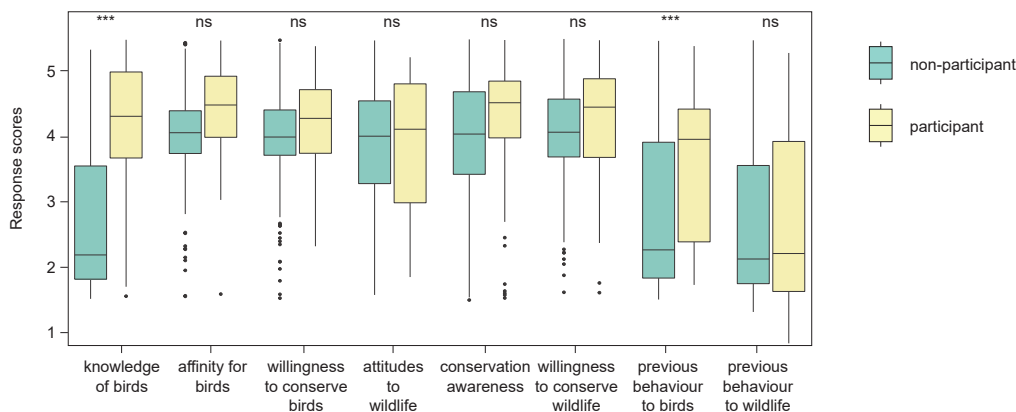


Figure 7 – Differences between participants and non-participants in changes in attitude to conservation. The participants show higher scores in conservation attitudes. The differences between the two groups are not significant, except for participants’ increased knowledge of birds. ***, ** and * denote statistical significance at the 0.001, 0.01, 0.05 levels; ns represents not significant.

and natural resources should be emphasized. In many countries, failure to recognize the community’s rights to land and natural resource use has led to conservation conflicts (De Pourcq et al. 2017; Görmüş 2016). Interventions that mediate conservation conflicts, such as community-based land rights and conservation, should therefore be adopted (He et al. 2020; Inglés-Yuba et al. 2016). Mountain people will have a greater interest in managing local resources sustainably if they have access to, and responsibility for, them.

The economic benefits of tourism privileged the participant group in particular, an inequality of benefit distribution that could widen the wealth gap. Avitourism as a tool for sustainable development requires equality of benefit sharing and empowerment of all local people (Coria & Calfucura 2012). Income derived from tourism should therefore be used to establish public facilities such as schools and clinics for more comprehensive and equitable benefit sharing. Training in skills that increase people’s ability to participate in tourism, the development of opportunities for community participation, and practical co-operation between government and community will support disadvantaged populations in the long term and ultimately help achieve sustainable mountain development.

Conclusion

This study explored the livelihood and conservation outcomes of avitourism in a mountain community. Our results suggested that avitourism, if suitably implemented, can support sustainable mountain development. This form of tourism has improved mountain people’s livelihoods by providing employment opportunities, diversifying livelihoods, and increasing household incomes. It has also supported conservation by raising people’s awareness of sustainability and their willingness to conserve biodiversity. In view of the limitations of current practice, we would make the following recommendations: 1) expanding tourism-related activities and investing in economically disadvantaged households in order to broaden tourism participation and support disadvantaged populations; 2) community-based land rights and conservation should be adopted to support the sustainable use of natural resources; 3) the economic benefits of tourism should be shared with equality.

While we found promising effects of avitourism for mountain development in southern China, similar studies in other regions are required before the results can be generalized to all settings. The effectiveness of avitourism could be improved by studying it in dif-

ferent contexts, such as with and without community participation, and with different benefit-sharing systems. The empirical evaluation of avitourism projects will benefit tourism development more broadly, in theory and practice.

Our conclusions that avitourism has improved mountain people's livelihoods and conservation attitudes are based on respondents' perceptions. However, these effects were only inferred from the literature and from our analysis of the results of the questionnaire; they have not been demonstrated empirically. Thus future work testing causal relationships would help to strengthen the scientific base for the impacts of avitourism, while longitudinal studies comparing the different stages of (avi)tourism (Butler 2006) would help to give a more complete view.

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Wolf–Human coexistence in the Alps: the LIFE WolfAlps EU project

Marta De Biaggi & Theresa Walter

Keywords: wolf, coexistence, alps, livestock farming, damage prevention, anti-poaching, wolf-dog hybridization

Abstract

During the last 30 years, a natural return of wolves has been recorded at local, national and international levels over several mountain ranges in the Alps and, more recently, in both hilly areas and plains in Europe. Accepting the natural return of wolves in human-dominated landscapes is a major challenge, especially in places where memories and experience of coexistence have been lost. After the success of the LIFE WolfAlps project, which ended in May 2018, the European Commission has approved and co-financed LIFE WolfAlps EU (2019–2024), a new project to support wolf–human coexistence at European and pan-Alpine scales. As the expansion of the wolf population knows no administrative boundaries, the presence of the species requires actions effective at local level to improve its coexistence with humans on an international scale. The new, international project works to support local communities in the prevention of wolf attacks, and decision makers in the adoption of the best possible solutions to improve management of wolves, thus improving public acceptance of their expanding distribution and populations, notwithstanding the potential risks. Concrete actions are being implemented to involve all stakeholders interested in and affected by the wolf's presence, in order to make human–wolf coexistence possible across borders, traditions and beliefs.



Figure 1 – Livestock farming in the Alps. © C. Sonvilla_Sonvilla-Graf OG

Introduction – An international approach to a natural transboundary expansion

The wolf population is naturally expanding in the Alps and knows no boundaries: the presence of this large carnivore requires actions coordinated on an international scale and effective at a local level to improve its coexistence with humans and their activities.

After the success of the European LIFE WolfAlps project (2013–2018), which received the Best LIFE Project Award in May 2019, the European Commission approved and financed LWA EU, a new project that, for the first time, works on a European and pan-Alpine scale for the improvement of wolf–human coexistence through a participatory approach, in order

to guarantee the long-term conservation of the transboundary wolf population.

The LIFE WolfAlps EU (2019–2024) project (LWA EU) mobilizes institutions and organizations from Italy, France, Austria and Slovenia which work to mitigate the impact of the wolf on livestock farming, to find a balance between the hunting world and the presence of predators, to fight poaching, to control wolf–dog hybridization, to find and disseminate the best strategies for coexisting with the species in the hilly areas closest to inhabited areas, and to disseminate accurate information to the public based on scientific data.

The presence of the species is still highly controversial as it is associated with a wide range of conflicts with human interests, ranging from depredation on domestic livestock and pets, competition with hunters for game, and the fear of potential attacks on humans. There is a deeply rooted hostility towards the species in human history and culture (Treves & Karanth 2003); rumours, legends and myths have helped to propagate a collective belief in the dangers posed by wolves (Linnell & Alleau 2016). Hunting, trapping, poisoning, issuing edicts of condemnation or placing bounties on the heads of wolves all reflect the hostility that humans have nurtured – and to some extent still nurture – towards the wolf. This also applies to other large predators because of a sense of competition, and feelings of fear and suspicion. In Europe until the end of World War II, when significant amounts of higher-altitude agricultural land (arable land, meadows and pastures) fell into disuse because of the migration of the rural population towards urban regions, the landscape context and agricultural practices were very different (Cimatti et al. 2021; Linnell & Alleau 2016). Intense human pressure on the landscape, and relatively little forest and little wild prey, led to high predation pressure on livestock by carnivores (Linnell & Alleau

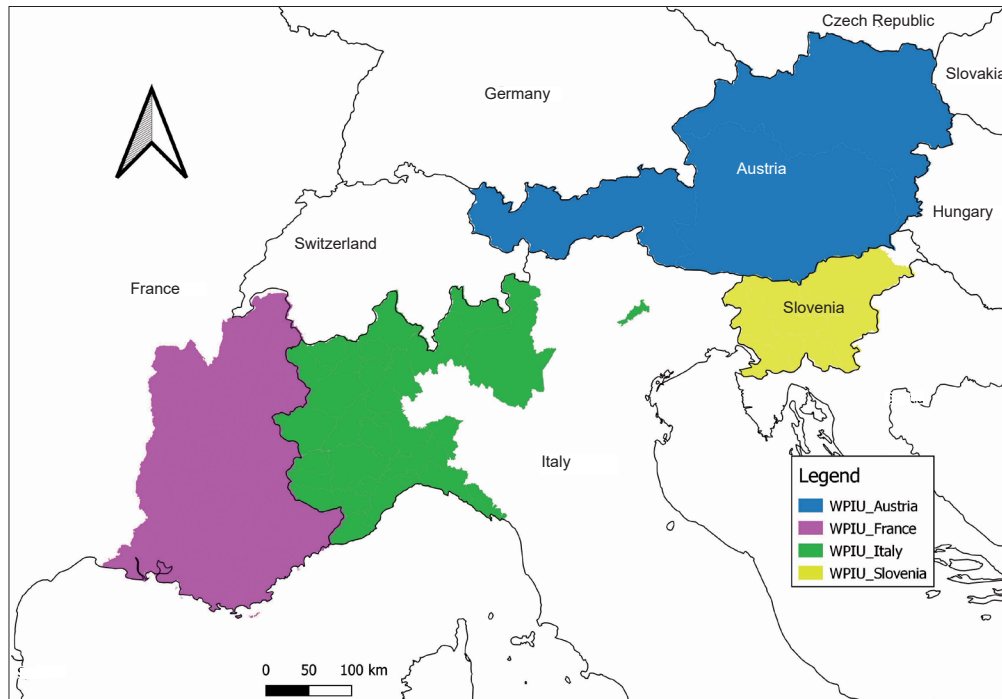


Figure 2 – Distribution of Wolf Prevention Intervention Units (WPIUs) across the Alps in the LWA EU territory. © Modified from Menzano et al. 2020.

2016). After two centuries of active persecution, at the beginning of the 20th century the wolf became extinct throughout central and northern Europe, surviving in Italy, at their historical minimum, with less than 150 individuals in two isolated areas in the Southern Apennines (Boitani 1992). From the mid 1970s onwards, the tables have been turned, and the *evil* wolf has become a *saint* in the minds of most of the general public (Mech 2012). In Europe, human–carnivore relations have been brought into focus (Patterson et al. 2021) by the natural expansion of large carnivore populations (Chapron et al. 2014; Cimatti et al. 2021; Marucco et al. 2022), land abandonment in rural areas (Bürge et al. 2017), the growing rewilding movement (Ceausu et al. 2015), and contextual inclusion of the species under national and international protection lists, such as Appendix II of the CITES Convention on International Trade in Endangered Species of Wild Fauna and Flora in 1977; Appendix II of the Berne Convention on the Conservation of European Wildlife and Natural Habitats in 1979, and Annexes II and IV of the Habitat Directive in 1992. Attitudes are characterized by increased polarization between those laypeople who revere the animal and those who revile it. Indeed, with the recovery of the wolf population, there has been an increase in negative economic impacts and in social conflicts associated with the species (Nie 2003), as it represents “*a change in a system that had taken many, many years to build up*”, John Linnell claims (Nijhuis 2019). Attitudes towards carnivores are not determined merely by any direct costs that ensue, but are the product of a dynamic and complex web of individual, societal and cultural factors (Dickman et al. 2013). Large carnivores

often become symbols of incompatible human–nature worldviews, primarily those of people who uphold traditional rural practices, and those with urban lifestyles (Pooley et al. 2017; Ericsson et al. 2018).

Due to the transboundary character of the wolf population, in the frame of the LIFE WolfAlps EU project a geographically extensive network of partners has been constituted in order to cover the wolf’s Alpid-wide distribution range, and to minimize the high institutional fragmentation that poses a severe threat to the conservation of species such as the wolf that have the potential to expand their territory over considerable distances. Twenty partners and more than 100 supporters are participating in the project, coordinated by the Alpi Marittime Protected Areas Management Body. Of the 20 partners, two are Slovenian, two Austrian, two French and 14 Italian. The partnership is composed of public institutions, mainly natural parks that manage alpine territories and constitute a fundamental connection with local communities, universities, museums, and other regional and national authorities involved in natural resources and land management. With the new LIFE project, a more comprehensive and transnational conservation and management approach has been implemented, although the wolf population is still at very low densities or absent from most of the Eastern Alps. Such a transnational approach leads to periodic confrontation among partners on the diverse conservation issues that may be crucially important in areas of consolidated wolf presence, but less crucial where the wolf has only recently arrived. As an example, illegal poisoning and hybridization with dogs are found to different extents more in Italy, France and

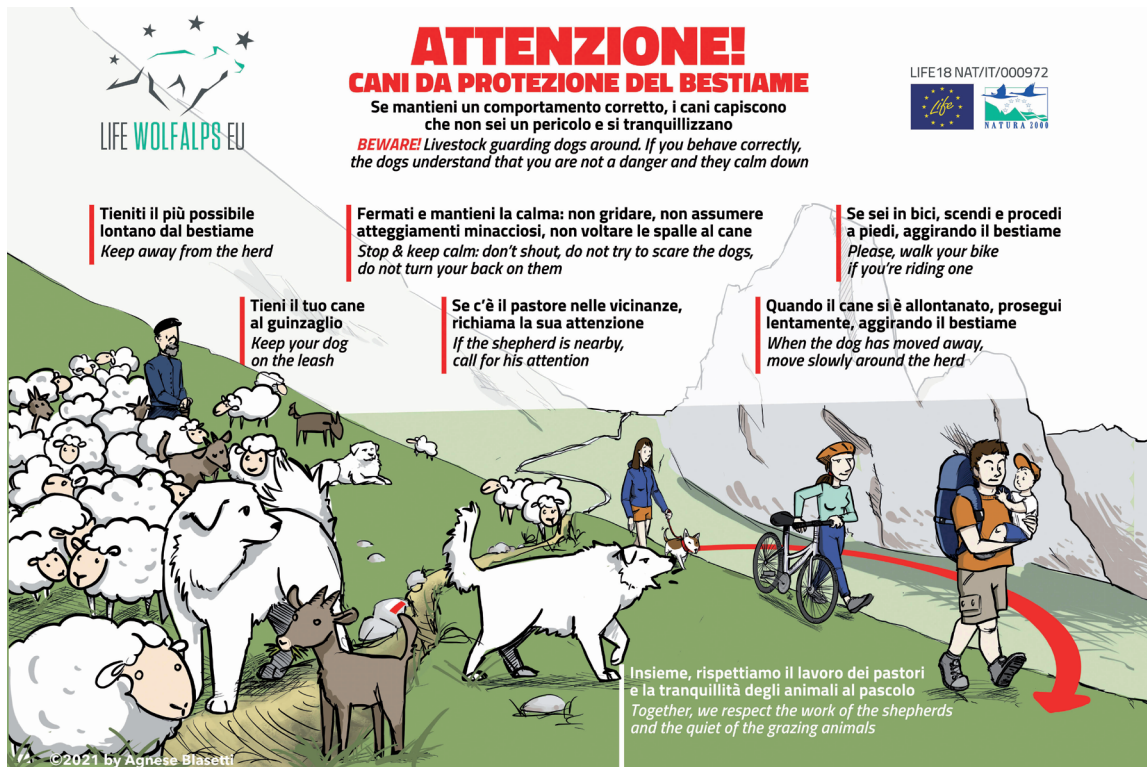


Figure 3 – LIFE WolfAlps EU project: Livestock guarding dog information panel.

Slovenia. Direct fear for personal safety is felt more in these areas than where wolves are less present, for example in Austria.

The nine intervention axes of the LIFE WolfAlps EU project

The LWA EU project presents an integrated trans-boundary approach, designed to overcome the current fragmented practices of wolf management (at both local and national levels) and with the aim of achieving for the first time in Europe overall population-level conservation, management and surveillance. The project is constructed around nine thematic axes (see <https://www.lifewolfalps.eu/en/axes-of-intervention/>):

1. *Damage prevention*: active support to farming activities through the Wolf Prevention Intervention Units (WPIUs), formed to intervene in the field to help livestock breeders prevent wolf attacks, finding individual solutions and implementing prevention systems, supporting breeders to access compensation and prevention measures, as well as in the correct use of livestock guarding dogs.
2. *Wolf population monitoring*: estimates the status of the entire alpine wolf population considered as a biological unit according to the *Guidelines for population level management plans for large carnivores* approved by the European Commission.
3. *Anti-poaching*: fighting illegal killing to ensure the long-term conservation of a viable wolf population in the Alps and to limit the collateral damage caused by the use of poisons for other wild and domestic animals, by establishing dedicated anti-poison canine units and creating shared protocols for intervention.
4. *Hybridization control*: limiting one of the most serious threats to the conservation of the genetic identity of the wolf, i.e. anthropogenic wolf-dog hybridization due to the mating of wolves with free-ranging dogs.
5. *Stakeholder involvement*: implementation of platforms for dialogue and meetings through which the concerns, needs and requests of stakeholders can be addressed in order to activate a virtuous circle in which sharing the responsibility for wolf conservation can generate positive repercussions on all actors involved.
6. *Communication*: disseminate in a clear, objective, transparent way data on the wolf's presence and its impact on domestic animals and wildlife, as well as the results achieved during the project, improving the scientific knowledge available on the wolf and on human-wolf conflicts.
7. *Education*: definition of education programmes dedicated to increasing knowledge of wolves and promoting coexistence. The project will explore the attitudes of critical interest groups and the general public towards wolves. This information will be used in targeted education initiatives to create a lasting base of environmental literacy, stewardship and problem-solving skills for today's young generations.
8. *Ecotourism*: development of responsible and wolf-friendly tourist initiatives to allow visitors and lo-

cal communities to discover in a concrete way what coexistence between large carnivores and breeders means.

9. *Interactions among prey, predators and human activities:* development of a study across the Alps on the dynamics of the prey–predator relationship in the presence of human activities such as hunting, tourism and livestock breeding, in order to make recommendations on how to consider the predation of wolves on wild ungulates in human-dominated landscapes.

Two and a half years after the start, the LWA EU project is now in its full implementation phase; all concrete actions have been initiated. The development and fulfillment of some actions might be extremely challenging in some cases, as they might require the collaboration of institutions or other bodies that are not willing to be involved in the project. In these cases, it is important for the project partners to find a solution. This generally involves the organization of several meetings with all parties to reach an agreement on the topic. The main project lines are reported below.

1. Damage prevention

As a consequence of the increase in population abundance and distribution, concern over the persisting and potential conflict between wolves and livestock breeding is one of the project's main lines of intervention (Figure 2). The WPIUs were established for this reason, and there are now 42 units across the Alps: 28 in Italy, two in France, seven in Slovenia and five in Austria. They are composed of personnel from the Public Veterinary Services, *Carabinieri Forestali* (military unit of the *Carabinieri*), provincial police officers, members of agricultural machinery syndicates and park rangers. Their role is to support professional and amateur breeders before and after wolf attacks (Figure 4). Building a relationship of mutual trust is fundamental for the good development of activities and in order to involve more and more breeders in the application of attack-prevention measures. A lot is being done, and the WPIUs are working constantly to improve their strategies. These strategies include awareness campaigns aimed at tourists, explaining the presence of livestock guarding dogs in pastures during the summer season, and informing tourists on how to behave appropriately (Figure 3).

2. Wolf population monitoring

Wolf population surveillance is ongoing in all the countries involved, and a number of reports have been produced on population abundance and distribution estimates. The complete overview on the wolf population at Alpine and Piedmont-Ligurian Apennine levels will be available by the end of 2022; in the meantime, recent national reports show an increase in abundance and distribution in the Western Italian, French and Dinaric Alps over the last few years, with a



Figure 4 – *Carabinieri Antipoison dog Units*. © CUEA/E. Gallo

clear expansion further into the Central-Eastern Alps, the Austrian Alps and the foothills of Piedmont, and France. In the Italian alpine regions, the most recent estimates of the presence of the wolf, carried out in 2020–2021, documented 124 packs and couples, concentrated mainly in the western range, with mean wolf abundance estimated to be 946 individuals (822–1099; 95% credibility interval) (Marucco et al. 2022). In France, the number of Permanent Presence Areas is increasing throughout the country, with an estimated 145 such areas and 128 packs (summer 2021) (OFB 2022). In Slovenia (2020 / 2021 monitoring season), 12 packs were identified (2 of which are shared with Croatia), and an estimated 120 wolves (106–147; 95% confidence interval) (SFS 2022). To date, wolf monitoring in Austria has mostly been done through reported observations (e.g. camera traps, random encounters) and inspections of livestock that has been killed. However, in the last few years, a reduced form of active monitoring has been applied by the University of Veterinary Medicine, Vienna, in areas where packs have formed. In the monitoring period 2020 / 2021, three packs, all outside the Alpine area, were identified. A total minimum of 50 individuals were found, including wolves from packs, pups and single wolves (Rauer et al. 2022). All the above-mentioned reports are available on the Download section of the LWA EU website (<https://www.lifewolfalps.eu/en/download/>).

3. Anti-poaching

LWA EU continues on the successful path taken by the previous LIFE WolfAlps project, establishing new Antipoison Dog Units (APDUs) that will complement the existing ones, so as to cover the entire Alpine region. The use of poisoned bait is one of the most serious threats to the conservation of the wolf, but it also represents a risk for many other wild species as well as for pets, such as dogs and cats, which can become



Figure 5 – Dog–wolf hybrids in the Piedmont-Ligurian Apennines. © APAP Archives

victims. In Italy there are six new operational LWA EU APDUs, of which two are in Liguria, one in Piedmont, two in Lombardy and one in Veneto. They include members of the *Carabinieri Forestali*, Province Police officers, professional dog trainers, and personnel from parks and regional and provincial public institutions (Figure 4). In Austria, one dog unit is formed by the University of Veterinary Medicine, Vienna, a project partner.

LIFE WolfAlps EU is also supported by five co-financiers which participate in individual actions, using their own resources. A prominent role among the co-founders is played by *Fondazione Capellino*, a non-profit organization (<https://fondazionecapellino.org/en/fondazione-capellino>), which has the preservation of biodiversity as a core objective. Through Almo Nature, the Foundation supplies high-quality pet food for the breeders' livestock guarding dogs, and for the anti-poison dog units engaged in the fight against poaching.

4. Stakeholder involvement

A participatory approach involving and engaging key stakeholders (farmers, hunters and environmentalists) and other groups interested in the presence of the wolf (e.g. hikers, cultural or artisan associations, nature Parks, teachers, nature guides, tour operators, publishers etc.) helps to lower the conflict level. Through thematic platforms, local meetings, involvement in project actions and stewardship initiatives, the project intends to make stakeholders true actors in the process of building wolf–human coexistence in the Alps. Through the Stewardship Programme, the LWA EU project encourages active collaborations with those stakeholders who are willing to interact with the project in terms of ideas, knowledge build-

ing and pilot actions (<https://www.lifewolfalps.eu/en/stakeholders/>).

As stakeholders' perceptions are not formed solely by their interactions with large carnivores, but also by their interactions with other stakeholders (Hovardas 2018), their engagement is being promoted through opportunities for debates, and in particular through project stewards. As an example, several breeders have decided to commit to a stewardship agreement, as they believe that the wolf's presence may represent an opportunity to adjust farming approaches in favour of wildlife and the environment in general. These stewards, involve not only their clients but also other breeders, through personal meetings and collaborations, for example in the use of attack-prevention measures or guard dogs for livestock.

5. Hybridization control

Dog–wolf hybridization is considered a serious threat to wolf conservation by the scientific community. The LWA EU project addresses the loss of genetic identity due to the spread of hybridization, recently documented in the Northern Apennines, the Western Alps and Slovenia, (Figure 5). Dog–wolf hybridization is managed using different approaches across European countries, and also among the LWA EU partners: while Italy has defined a capture-sterilization-release approach for the hybrids, Slovenia has opted for a different solution. In order to prevent the further spread of dog genes into the wolf population, the country's Ministry of Environment and Spatial Planning issues permits, based on phenotypic and genetic evidence, for the culling of nine individuals: one female wolf and eight wolf–dog hybrids (alpha male and seven pups). The permit for



Figure 6 – Event organized for the wider public at MUSE. © MUSE



Figure 7 – Exchange experience with experts on large carnivore topics. © Slovenia Forest Service

the removal from the wild by shooting is valid until the end of 2022. For more information, see <https://www.lifewolfalps.eu/en/category/hybridization-control/>.

6. Communication

Communication plays a fundamental role in the management of a charismatic species such as the wolf. Since the start of the project, the Communication group has worked on creating quality information related to wolves, disseminating project activities, and communicating the correct behaviour to adopt in areas where wolves are present, with particular attention to areas of recent colonization. Communications are targeted, getting in touch and sharing information with stakeholders, local communities, the general public, journalists and influencers, tourism professionals and mountain visitors (Figures 6, 7). The greater visibility of wolves and the rising numbers of direct experiences with the animal due to the species' expansion into new areas, including lowland and fragmented landscapes and ones densely populated by humans, can increase social conflicts and negative attitudes toward wolves because of the fear of aggression. For these reasons, specific protocols and awareness campaigns on wolf ecology and best practices to maintain wolf populations in a favourable state of conservation



Figure 8 – Young Rangers in action. © Archive APAM_I. Borgna

can help further wolf–human coexistence. Specific guidelines on how to deal with bold wolves in particular were produced and discussed in April during the second international thematic conference at the Fortress of Bard, Aosta, Italy (AA. VV. 2022).

Moreover, networking with other LIFE and non-LIFE projects also fosters collaborations, and the exchange of knowledge, pilot experiences, know-how and good practices.

7. Education

Young people are the next generation to be responsible for making decisions on environmental conservation. Various educational activities are being launched by project partners and supporters, addressing different sectors ranging from school children to third-age university students, as well as park and museum visitors. Activities include indoor and outdoor classes, art camps and role-playing. In order to ensure the greatest possible objectivity, experts and representatives from the worlds of breeding, hunting and environmental protection are invited to discuss issues with young people at special conferences in schools. For instance the Young Ranger programme was launched in April 2022 by the 39 members of the parks and museums network with the aim of improving the knowledge and awareness of young tourists, actively engaging them in the protection of biodiversity today and for the future (<https://www.lifewolfalps.eu/en/young-ranger/>). Through the games, insights and beautiful illustrations included in the booklet on the many points of view of those affected by the return of the wolf and the critical issues for the wolf's existence alongside human activities, young people can expand their knowledge and respect of biodiversity. Additional materials, including further insights, were produced by the members of the Young Ranger Network (Figure 8).

8. Interactions among prey, predator and human activities

This action aims to identify the wolf's predation pressure on wild (but also on domestic) animals. It

takes into consideration the ecosystem in which they are integrated, including, therefore, human practices (such as hunting, farming and tourism). The knowledge of interactions between the wolves and their wild and domestic prey is a prerequisite for practical decision-making support tools, for species and land management at ecosystem level. Management approaches at this level are particularly effective if they use a participatory approach. Close collaboration with hunting associations in particular is ongoing in order to conduct monitoring and data analysis.

9. Ecotourism

In order to support and promote responsible tourism activities connected to the wolf's presence, specific guidelines were developed by a comprehensive set of authors from all over Europe. These guidelines address the delicate business of the provision of high quality, educational programmes for tourists which at the same time have as little negative impact as possible on wolves, the surrounding nature and local people. The guidelines are not exhaustive and should be adapted to the local circumstances in each country (Kavčič et al. 2022).

Conclusion – A challenge for wildlife conservation

The LWA EU project has two more years to run and several issues to address, such as the conflict with livestock production and wolf–dog hybridization, as discussed above. However, the most important challenge goes beyond the project and action deadlines: to improve wolf–human coexistence through a participatory approach that brings together all stakeholders for enduring and productive interactions regarding wildlife management based on scientific data. Indeed the problem for human beings with wild species such as the wolf is that its pursuit of survival collides with human pursuits; large, free-roaming predators such as the wolf can require humans to change their habits, their livelihood, and even their place in the food chain (Nijhuis 2019). The LWA EU project will work throughout its duration and beyond for concrete coexistence in a shared landscape, spreading the tools it has developed to support and involve all stakeholders in the analysis, planning and resource allocation that are essential to balance large carnivore conservation with human activities.

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On-site visitor information – a team effort

Alexander Maringer & Markus Blank

Keywords: protected area, national park, Natura 2000, visitor guidance, Austria, heritage interpretation, signs, boards

Abstract

Traditional information signs are not obsolete in the 21st century but can be of value to visitors. We present our collaborative approach to creating interpretation panels. The well-developed workflow helps to design, set up and maintain all formats of on-site visitor information in the Gesäuse National Park.

Profile

Protected area

Gesäuse National

Park, Alps, Austria

Introduction

Today, vast amounts of information are available on the internet. This helps tourists when planning to visit a protected area. Popular websites, mobile apps and augmented reality are used to learn about attractions, accommodation, food and other points of interest. Nevertheless, people still appreciate the possibility of verifying digital information in the field by reading traditional signs. This is especially true when mobile reception is unreliable or absent, and when mobile apps fail to correctly identify geolocations in remote areas.

Therefore, interpretation panels are not obsolete in the 21st century but can be of benefit to visitors when sited appropriately. Following the principles of interpretation, a sign can also stir curiosity and open a visitor's mind. "*The chief aim of interpretation is not instruction, but provocation,*" said Freeman Tilden (Tilden 2008, p. 32).

Designing signs and interpretation panels

Signs can be divided into two categories: information signs and interpretation panels (Gross et al. 2006). Information signs meet visitor's basic needs such as safety and orientation. But interpretation panels, rather, aim to provoke visitors into having their own thoughts, because in Tilden's words (2008, p. 38) "*Through interpretation, understanding; through understanding, appreciation; through appreciation, protection.*"

We strongly believe in the 3-30-3 rule, a very common approach in marketing (Gross et al. 2006): you have just 3 seconds to grab a reader's attention, 30 seconds to engage them, and roughly 3 minutes for them to spend reading the content. So, the title and any pictures have to be catchy and draw the visitor in. But panels must also present the most important information that we really want to communicate to our visitors. Too many words can put visitors off and discourage them from reading. In this case, we would miss the opportunity to communicate our most important information.

Joint team benefits

For many years in the Gesäuse National Park, we have used the concept of *heritage interpretation* (cf. Tilden 2008) as our main approach in environmental education and visitor guidance.

Yet, we have found that each department has its own blindspots when it comes to creating signs. Often, scientists fail to take into account the importance of visitors and the fact that they do not generally share their own specific scientific knowledge. The use of scientific jargon makes it hard for general visitors and non-native speakers to understand text. Another aspect of this is that environmental education loves to present cute, spectacular-looking or so-called *iconic* animals, and hence fails to highlight hidden or less obviously attractive species. Therefore, many old signs created by single departments do not meet the current aims of understanding, appreciation and protection referred to above. Nor do they appeal to our present target groups or fulfil visitors' expectations. In addition, some hot environmental topics in our region, such as bark beetle management, wildlife hunting quotas and the role of rare endemic species within entire ecosystems, are not common knowledge. Occasionally, plants or animals mentioned or presented by way of example have led visitors to false conclusions about their presence, abundance and importance.

We started forming a project team in 2016, involving colleagues with different skills and from different departments, including Environmental Education, Nature Conservation and Research, Public Relations and Maintenance. Workshops followed to bring people together and to generate new ideas (Figure 1). This approach combines multiple points of view from biologists, interpretive rangers, communication experts etc. to great benefit.

First, we found inconsistencies when writing plain text: there was no common, agreed, wording. The problem was exacerbated when translating German into English because of the lack of experienced translators in this field. Today, we have a shared document that includes common phrases in both languages that we frequently use in our work. Knowing about the



Figure 1 – A working session of the project team. © Markus Blank

3-30-3 rule, we reduced the amount of text significantly. Additionally, we tried to simplify our texts to make them easier to read for everyone. Tests like the Flesch-Kincaid readability test or the Flesch Reading Ease score are designed to indicate how difficult a passage is to understand (Gross et al. 2006).

Scientific research found out by eye-tracking that people often read signs and screens in an F or Z pattern (Gross et al. 2006): Z – left to right along the whole line of text; F – reading the first line of the sign, the left-hand side, and a little bit in the middle of the lines. In our design, we try to place the most important information in areas corresponding to the F reading pattern. Additionally, we aim to include appealing drawings of plants and animals to reach the visitor emotionally. By using drawings by the same artist in the same style on most of our information boards, we hope to create a recognition factor. Inspired by the *unigrad* of the US National Park Service (Harpers Ferry Center 2022), we also created a template for all signs and boards, to make it easy for our staff to create signs. All our signage and information panels follow our corporate design (Figure 2).

The position of an interpretation panel is chosen from the visitor's point of view. The locations for practical-information signage are considered thoroughly by the joint team. Locations for both types of signs may change when surrounding habitats change or information becomes outdated. When prerequisites are no longer met (e.g. when forest stands have collapsed and been replaced by young vital trees, and the habitat no longer supports what had been a particularly noteworthy species), the sign must be removed or replaced. Even the best signs cannot reach visitors when conditions result in serious damage to posts or poles. From time to time, we are faced with damage to our infrastructure by wildlife. Even the smallest animals, like ants and beetles, can create huge damage. And unfortunately, vandalism is increasing, even in our remote area. Involving the maintenance crew helps increase the longevity of hardware, simply by



Figure 2 – Information panel at the Tamischbachturm, showing the NP Gesäuse's corporate design. © Markus Blank

choosing the most suitable material, or manufacturing, installation and mounting techniques.

Successful implementation

Team-building and team spirit were boosted during the preparation of our exhibition *Planspitze – mountain of contrasts* (Figures 3a and 3b). To develop the interpretive concept for this exhibition, at least one representative from each department was included in the process. During the planning phase, it was particularly helpful to have inputs from people with different perspectives on the same phenomenon (Brochu 2014; Gross et al. 2002). Additionally, this approach creates a sense of ownership for each participant. As all the park's departments were involved, there was an overarching sense of ownership of the project and a high level of agreement amongst employees about the types of information to be given to the public.

Today, we have an agreed standard operating procedure for creating signs, brochures and any other kind of visitor information. The step-by-step guidelines include whom to involve in which phase of the project. Our products share common visual features, draw on proven educational approaches and latest research findings. The consistent method allows participation at the level of the national park's administration and can include more experts when needed.

Evaluation and revision process

Blindness can occur when a member of staff passes by a sign every day and has long since stopped reading it. In addition, design and text are subject to constant change. Older signs that no longer meet the prevailing taste may not hold visitors' attention. Although the national park does not compete with marketing and product promotion, it does participate in the struggle for attention.

On a regular basis, we review the accuracy of the information presented and ensure that it contains



Figure 3 – Exhibition “Planspitzze – mountain of contrasts”: Interesting facts about rare species in the national park. © Peter Hans Felzmann

nothing false or out-of-date. This review process is supported by the use of sophisticated software, which includes data on the location of a sign or panel, its dimensions and an inventory number, as well as topic and content. So far, we have evaluated several thematic trails (Pichler 2014; Bartosch 2019; Presslauer 2021) in the national park and focused on visitor experiences as a whole. To date, we have not applied any scientific approach to evaluate signs and their various individual components. Nevertheless, we have received sufficient feedback from visitors for the team to adapt and update information. Valuable comments are gathered during visitor tours, from discussions with national park staff in the field, and even from groups of regular visitors. Collecting information as a team in order to update signs across the whole park is also an efficient and sustainable way to necessary innovation.

By 2021, the national park’s administration agreed on 77 strategic goals. Goal number 32 is dedicated solely to signs (both basic signage and information panels), giving this topic great importance. In order not to detract from the *untouched wilderness*, the total number of signs is strictly limited, and only panels that follow our guidelines closely are permitted. Face-to-face communication, however, remains our most powerful tool to engage visitors.

8 easy steps to creating best-practice visitor information

1. Involve relevant people
2. Agree on design guidelines
3. Identify target groups
4. Identify visitor needs
5. Create connections between the visitor and the phenomenon
6. Create text using plain, succinct language; check readability
7. Design hardware to withstand damage, by wildlife and vandalism
8. Define lifecycle of the hardware and its messages

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News from ALPARC CENTR'ALPS – Strengthening cooperation between protected areas in the Alps – new network office in *Immenstadt im Allgäu* (DE), and a workshop

Sabine Weizenegger



The protection and conservation of biodiversity are two of the great challenges of our time, figuring among the responsibilities of protected areas such as national parks, nature reserves or one of the manifold other protection types. Depending on the protected area's country and protection category, there are different requirements and different management approaches. The spectrum of activities ranges from information campaigns to determining and regulating which outdoor pursuits are allowed or not, from environmental education offers to research projects, from species monitoring to visitor guidance measures.

The goals of ALPARC (the network of Alpine protected areas; one of the initiators of this journal) and its new regional platform ALPARC CENTR'ALPS include making the diversity of their roles more visible, and ensuring the transferability of approaches and experiences of individual protected areas to others.

In order to discuss possible areas of future cooperation and the concrete implementation of projects, a workshop took place in Immenstadt (Germany), which was organized by ALPARC CENTR'ALPS together with the Nagelfluhkette Nature Park. Taking part in the workshop were long-standing active ALPARC members from Germany, Austria and Switzerland, as well as representatives of protected areas that had not so far been active in the network. Active participation and cooperation by no means go without saying. An important message from ALPARC's President Peter Oggier, therefore, was: *“All of you are the network, and it is your contributions that make our joint network active and successful,”* as he told participants right at the start of the workshop.

Important future topics for cooperation were identified, including: how best to integrate different stakeholder groups into the work of the protected areas; how digital visitor guidance succeeds, or how the results of management measures can be gauged and presented in an appealing way to potential new partners as well as to the general public. With regards to the important task of species monitoring, it was agreed that existing data should be collated on a supra-regional basis. The participants also agreed that the results of existing projects should be highlighted and disseminated much more widely, and should be made available for use by projects in other protected areas.



A present from Oberösterreichische Kalkalpen National Park for the new contact point in Immenstadt: a 3D relief map showing ecological connectivity in the Alps and within EUSALP's perimeter. Ecological connectivity is an index including indicators like transport infrastructure, population density and protection status. This illustrative tool was much appreciated by the ALPARC CENTR'ALPS team. From left: Volkhard Maier (Director of Oberösterreichische Kalkalpen National Park), Rolf Eberhardt (Nagelfluhkette Nature Park), Peter Oggier (President), Guido Plassmann (Director), Sabine Weizenegger (Network-Coordination).

Background information about ALPARC and ALPARC CENTR'ALPS

ALPARC

ALPARC, the Alpine Network of Protected Areas, was founded in 1995 to support the implementation of the Alpine Convention, in particular the nature protection and landscape conservation Protocol. Since 2013, ALPARC has been a non-profit organization (*association loi de 1901* in French), whose activities cover a large geographical area, from the French to the Slovenian Alps.

The main objective of ALPARC is to promote the exchange of expertise, techniques and methods between the managers of all the major protected areas in the Alps, such as national parks, regional nature parks, nature reserves, biosphere reserves, UNESCO World Heritage sites, geological reserves, and other areas with special

protection status. This exchange enables protected areas to participate in projects that they would not be able to implement on their own at local level. Through international cooperation, ALPARC acts as a mediator between institutions, local actors and Alpine communities in the implementation of the Alpine Convention. The network has three main areas of activity:

- biodiversity and ecological connectivity;
- regional development and quality of life;
- education for sustainable development in the Alps.

ALPARC achieves its goals through:

- organizing thematic events and workshops;
- disseminating information on common issues, including through publications;
- cooperation with other international bodies, organizations and networks;
- developing and coordinating international (in particular European) projects on behalf of, and in conjunction with, alpine protected areas;
- finding partners for projects, providing expertise on various topics, data exchange, map production and linguistic support.

ALPARC CENTR'ALPS – ALPARC's regional platform

ALPARC CENTR'ALPS is a regional platform of ALPARC, to which it is closely linked, and under German law has the status of a non-profit organization (*gemeinnütziger Verein* in German). As part of the international network, ALPARC CENTR'ALPS pursues the same goals and areas of work as ALPARC.

The decentralized structure of the regional platform makes it possible to adapt activities to local needs, guarantee implementation on the ground, promote local initiatives, and enable greater proximity to those responsible for protected areas. The platform offers smaller protected areas the possibility of exchanging information within the ALPARC network via shorter routes and without language barriers, and of implementing joint projects, primarily for the protection of biodiversity.

The ALPARC CENTR'ALPS working area covers the German-speaking central Alpine region, in particular the eastern parts of Switzerland, Liechtenstein, the Bavarian Alpine region, the Austrian provinces of Vorarlberg, Tyrol, Salzburg and Upper Austria, and South Tyrol (Italy).

Further information and ALPARC CENTR'ALPS Team

Further information

ALPARC: <https://www.alparc.org>

ALPARC CENTR'ALPS: <https://www.alparc.org/de/alparc-centr-alps>

Ecological connectivity in the Alps, JECAMI project: <https://www.jecami.eu/>

Projekt Youth at the Top: <https://www.youth-at-the-top.org/de/>

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Peter Oggier, Director Pfyng-Finges Nature Park (CH) and president of ALPARC and ALPARC CENTR'ALPS (FR, DE).

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Adaptation at Altitude – Taking action in the Mountains

Mountains feature some of the clearest indications of climate change: rising temperatures, melting glaciers and changing precipitation patterns are disrupting water flows and affecting ecosystems, creating and worsening natural hazards and threatening livelihoods and communities both within the mountains and downstream. The Altitude Solutions Portal allows to explore tried and tested climate change adaptation solutions for mountain regions, where they have been implemented, and by who.

More information available on: <https://adaptationaltitude.org/solutions-portal>

World Network of Mountain Biosphere Reserves

In December 2021 UNESCO's *Man and the Biosphere Programme* (MAB) has launched the *World Network of Mountain Biosphere Reserves* (WNMBR). The new network, coordinated through the MAB Secretariat in Paris and a joint technical secretariat managed by the Research Centre for Eco-Environmental Sciences of the Chinese Academy of Sciences (China) and the Valles de Omaña y Luna Biosphere Reserve (Spain) aims to provide constant support to Biosphere Reserves through research, strategic partnerships and collaborations as well as North-South and South-South exchanges of experience. This approach will enable the WNMBR to help achieve the Sustainable Development Goals and climatic and biodiversity agreements, without leaving anyone behind.



World Network of Mountain Biosphere Reserves

UNESCO Man and the Biosphere Programme

More information available on: <https://www.mountainbiosphere.org/>

Caucasus Mountain Forum

The third Caucasus Mountain Forum will be held 4–6 July 2023, in Kutaisi, Georgia, with field trips July 7–8 titled *Transdisciplinarity for Sustainable Tourism Development: Role of Caucasus Scientists*. Building on the findings and experiences of the previous two Caucasus Mountain Forums, the third Caucasus Mountain Forum will ensure the sustainability of scientific cooperation and exchange, and will maintain the interface between science and practice through regular dialogue.

More information available on: <https://www.caucasus-mt.net/Caucasus-Mountain-Forum-2023>

Parks discussed in this issue

Abbreviations: NP – National Park; BR – Biosphere Reserve; p. – page

