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Research Paper

A methodological approach for integrating human emotions in protected areas management: Insights from SE Spain

Enrica Garau [a,*], Juan M. Requena-Mullor [a], Cristina Quintas-Soriano [a,b], María D. López-Rodríguez [a], Irene Otamendi-Urroz [a], Mariano Oyarzabal [c], Antonio J. Castro [a]

[a] Andalusian Centre for the Assessment and Monitoring of Global Change (CAESCG), Department of Biology and Geology, University of Almeria, Almería 04120, Spain
[b] Fractal Collective, Madrid, Spain
[c] Ifeva, Facultad de Agronomía, Universidad de Buenos Aires/Conicet, Av. San Martín 4453, CABA C1417DSE, Argentina

HIGHLIGHTS

- We found a research gap on the role of emotions in the management of protected areas.
- We proposed a spatial methodological approach to integrate human emotions in protected areas.
- Emotional relationships between people and protected areas are analysed using an Emotional Nonparametric Relation Index (ENRI)
- We found a strong correlation between the emotional pattern, the level of protection, and the aridity gradient of protected areas.
- Integrating the emotional dimension into protected areas management can inform conservation efforts.

1. Introduction

Protected areas (PAs) are pivotal as conservation strategies for safeguarding global biodiversity (CBD, 1992). In 2021, the global coverage of designated PAs reached 16.64 % of terrestrial and inland water surface and 7.74 % of the marine surface (UNEP-WCMC & IUCN, 2021). The global target is to protect 30 % of the Earth's land and sea by 2030 (UNEP-CBD, 2020). Despite significant global progress in conservation efforts, there is still much work to be done as time is running out, and biodiversity loss continues at an unprecedented rate globally (IPBES, 2019). This scenario has sparked a widespread debate regarding the contribution and effectiveness of PAs for biodiversity conservation. While studies suggest that many PAs effectively contribute to conserving habitats and species (e.g., Feng et al., 2021), some scholars increasingly warn that inappropriate management of certain natural spaces can hinder their ability to benefit and conserve biodiversity (e.g., Hoffmann et al., 2018; Wauchope et al., 2022). Considerable discussion has focused on the factors influencing the effective management of PAs to ensure biodiversity conservation. These factors include the absence of sound policies and legislation, sustained investment and resources, the development of individual and institutional capacities (Borrini-Feyerabend et al., 2013), scientific and technical support (Wauchope et al., 2022), social inclusion of people in PAs management (Raymond et al., 2022), and cooperation between stakeholders across sectors and levels (Brondizio & Le Tourneau, 2016). A growing body of scientific evidence suggests that taking into account the preferences, values, and emotional responses of people living in or visiting PAs is crucial for successful PAs management (Pelegrina-López et al., 2018). However, there is still limited knowledge about the specific role that the emotions people develop in and with nature play in conservation efforts and how they can inform landscape management (Castro et al., 2023). Aiming at incorporating social input into PAs governance, the scientific community has made significant progress in developing various social research methods and participatory approaches over the past decades. These methods aim to gather both individual and collective information from people using quantitative and qualitative techniques (Lynam et al., 2007). Examples of these methods include public participation, geographical information systems, oral histories, and participatory scenario planning (Torralba et al., 2022). Most of these methods are usually applied in different formats (e.g., surveys, interviews, focus groups, and workshops) and combined in various research process steps for different purposes (e.g., analyzing complex social-ecological issues, defining sustainability challenges, and establishing collective solutions). Most research methods applied to integrate social considerations into conservation governance have primarily concentrated on analyzing social perceptions towards PAs to evaluate local support (Bennett et al., 2019), assess

* Corresponding author.
E-mail addresses: egarau@ual.es (E. Garau), juanmir@ual.es (J.M. Requena-Mullor), cristina.quintas@ual.es (C. Quintas-Soriano), mariad.lopezrod@ual.es (M.D. López-Rodríguez), ireneota@ual.es (I. Otamendi-Urroz), oyarzaba@agro.uba.ar (M. Oyarzabal), acastro@ual.es (A.J. Castro).

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conflicts among stakeholders (Ehrhart et al., 2022), and identify values toward nature (Jones et al., 2016). While this diverse array of methods has proven effective in gathering valuable social information for PA management from a cognitive perspective, capturing the emotional bonding of people has yet to be achieved through these methods.

To this end, it is crucial to capture the various forms of connection and disconnection that shape how people relate to nature (Bernaldez et al., 1984; Pramova et al., 2021). This pressing research question is not new. In the eighteenth century, Alexander von Humboldt advocated for the need to experience and understand the management of natural systems through the emotional and affective relationships people develop in and with nature (Abello & Bernaldez, 1986; von Humboldt, 2014). Similarly, at the end of the 20th century, the Spanish biologist Fernando González Bernáldez postulated that part of the origin of our cognitive and emotional processes associated with landscape perception is rooted in the coevolution between people and nature (Bernaldez, 1985; Castro et al., 2023). These ideas are even more relevant today, given the urgent need for new practical tools to help PAs managers design strategies to mitigate biodiversity loss. To move in this direction, it seems fundamental to advance understanding of the factors that shape our emotions and affective experiences in and with the natural world, defining the emotional and affective dimension as the moods, feelings, and emotions that humans can experience in and with nature (Pramova et al., 2021). However, there is still no solid agreement within the scientific community regarding how emotional experiences in and with nature should be assessed and how they can contribute to reconciling conservation issues and informing landscape management (El Ghafraoui, Quinutas-Soriano, Pachecho-Romero, Murillo-López, & Castro, 2023; Pramova et al., 2021; Zylstra et al., 2014).

To the best of our knowledge, although the emotional relationship between landscapes and people has recently been analyzed in the southeast of Spain (Castro et al., 2023; Otamendi-Urroz et al., 2023), no study has yet analyzed the diversity of emotions that PAs generate in people and how this translates in terms of conservation outcomes. Recognizing and addressing this research gap can be used for integrating into PAs management a new piece of information that describes the emotional dimension between people and nature (or PAs). Advancing in this direction can be particularly relevant for PAs located in arid ecosystems in SE Spain, the driest region of all Europe, where PAs deviate from the common imaginary of spaces characterized by green forests and blue rivers, instead being represented by yellow and treeless areas. This aspect may have implications for PAs management, given that people inhabiting dry regions have a poor perception of the value of these ecosystems (Castro et al., 2011; Castro et al., 2018), leading to less social support and influenced conservation policies. According to this hypothesis, the main goal of this study is to present a spatial and explicit approach to unravel and quantify the emotional connection between people and PAs in arid Spain, proposing a quantitative measure, the Emotional Nonparametric Relation Index (ENRI). To accomplish this goal, we selected a range of different PAs located in southeast Spain and established the following specific objectives: (1) to quantify and map the diversity of emotions that people associate with different PAs; (2) to measure the emotional relationship between people and PAs by proposing an Emotional Nonparametric Relation Index (ENRI); and (3) to explore the role of different levels of aridity in the emotional connection between people and PAs. Finally, we will reflect on the potential implications for PAs management.

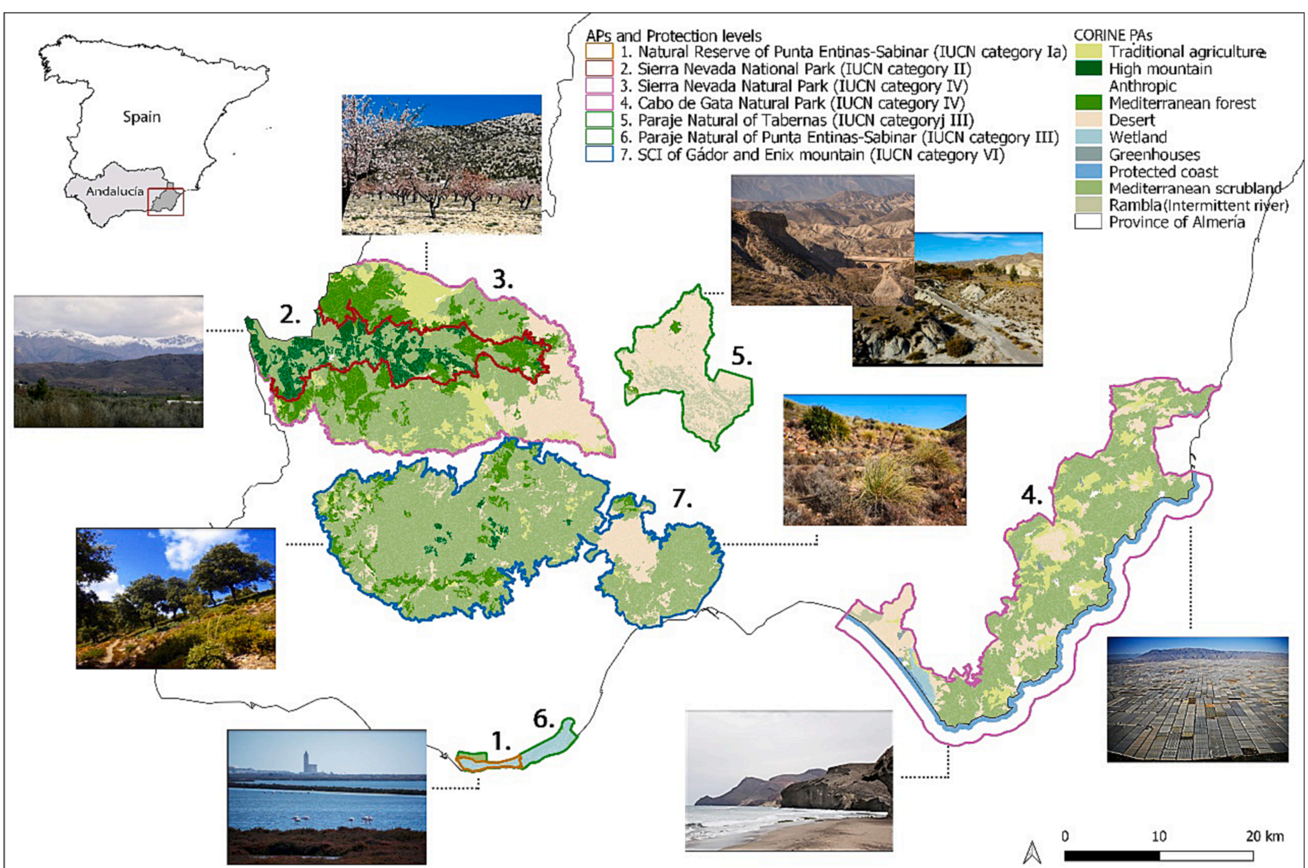

Fig. 1. Study area and selected protected areas (PAs) with associated landscapes. The PAs network is formed by the RENPA network (Spanish acronym for Andalusian Protected Natural Spaces Network - Red de Espacios Naturales Protegidos de Andalucía) and by the Sites of and Sites of Community Importance (SCI) of the European Natura-2000 network. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

2. Methods

2.1. Study region

Our study focuses on a set of PAs situated in the Almeria province in south-eastern Spain (Fig. 1). This region stands as the driest in all of Europe and it is characterized by a Mediterranean climate ranging from semi-arid to arid. The average annual rainfall is 300 mm, with winter temperatures ranging from 12 to 15 °C, while summer temperatures can go up to 40 °C (Armas et al., 2011). Nevertheless, certain areas exhibit a Continental-Mediterranean subclimate with cooler winters (6–12 °C) and mean annual precipitation between 300 and 600 mm, reaching up to 1000 mm and temperatures below zero during winter in high mountains areas (Gómez-Zotano et al. 2015). The region represents one of the most human-modified landscapes in the world, mainly due to intensive greenhouse horticulture and its associated industries, which dominate the economy and have shaped landscapes over the last decades (Quintas-Soriano et al., 2016). In a context where different landscapes reflect contrasting economic and conservation policies (Sánchez-Picón et al., 2011), PAs play an essential role in conserving local habitats, their biodiversity, and the ecosystem services they provide to people (Castro et al., 2015; Quintas-Soriano et al., 2019). This is particularly true in arid and semi-arid regions (henceforth drylands), such as Almeria province, where PAs represent sites of reference where local people look for physical and mental well-being (El Ghafraoui et al., 2003), and ultimately, deeper connection with nature (Castro et al., 2023; Otamendi-Urroz et al., 2023).

We selected a representative set of PAs based on two criteria i) PAs that cover all levels of protection according to the IUCN (Dudley, 2008) and ii) PAs that contain at least two representative landscapes of the study region (Fig. 1 and section 2.2.2 below). Concerning the first criterion, the selected PAs represented five IUCN levels of protection (IUCN, International Union for Conservation of Nature). Specifically, we chose seven PAs types included in the Andalusia Protected Natural Spaces Network (RENPA): the National Park of Sierra Nevada (IUCN category II), the Natural Park of Sierra Nevada (IUCN category IV), the

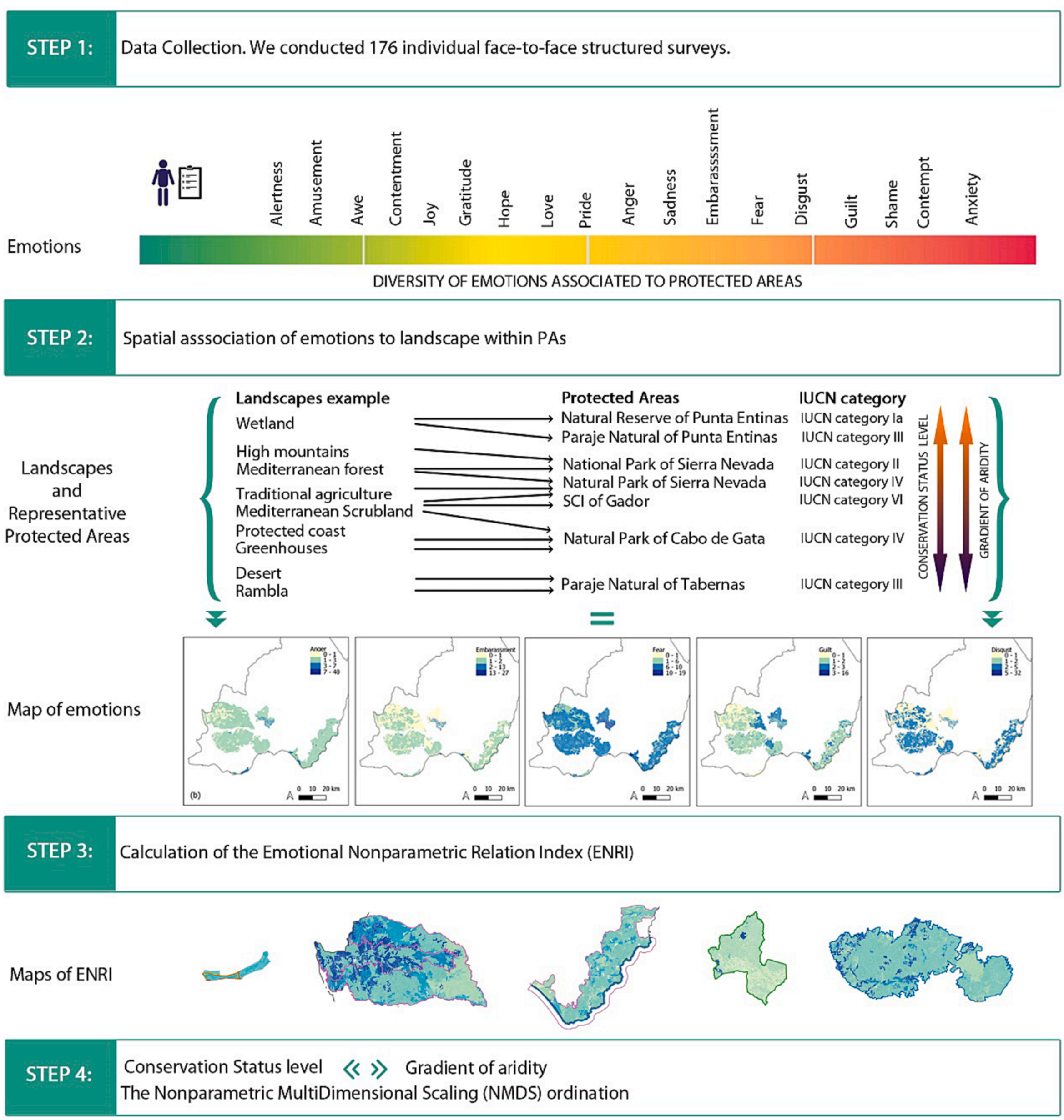

Fig. 2. Methodological steps to assess the diversity of emotions associated with PAs. Each methodological step responds to a specific objective.

Natural Park of Cabo de Gata-Nijar (IUCN category IV), the Natural Reserve of Punta Entinas-Sabinar (IUCN category Ia), the Paraje Natural of Punta Entinas-Sabinar (IUCN category III), the Paraje Natural of Tabernas (IUCN category III); and one site of community importance (SCI) from the Natura-2000 network, the SCI of Gádor and Enix mountain (IUCN category VI) (Fig. 1). Furthermore, to comply with the second criterion, the selected PAs covered a total of nine representative landscapes of the Almeria region, including inner High mountains, Mediterranean forest and Scrublands, Traditional agriculture and Greenhouses, Ramblas (Intermittent rivers) and Desert and Badlands, and Wetlands and Protected coastal landscapes (El Ghafraoui et al., 2003).

2.2. Methodological approach: Assessing human emotions associated with PAs

The methodological approach employed in this study was structured in four main steps: 1) data collection through face-to-face structured surveys; 2) identification of representative landscapes within PAs based on their existing land cover type classification and spatial associations of emotions with the PAs landscapes; 3) assessment of the emotional relationship between people and a selection of PAs through the calculation of the Emotional Nonparametric Relation Index (ENRI); 4) analysis of similarities regarding landscape-linked emotions and the gradient of aridity across all selected PAs through nonparametric multidimensional scaling (NMDS). The specific methodologies utilized in each step are summarised in Fig. 2.

2.2.1. Step 1: Data collection

The data used in this study originated from 176 individual face-to-face structured surveys, during a citizen science community event to record biodiversity. This event took place on the University campus in April 2019 (El Ghafraoui et al., 2003; Otamendi-Urroz et al., 2023). Respondents came from various municipalities of the Almeria province and were randomly selected among the participants of the event. The survey was structured in four sections, but only the third section was used in this research, including (1) human-nature connectedness (HNC) questions, (2) social preferences associated with landscapes, (3) the range of emotions people feel towards landscapes, and (4) socio-demographic characteristics such as age, gender, place of birth/residency, and educational level (Appendix A1). Exclusively, data from the third section of the survey were utilized in this study.

Respondents were invited to choose among 18 emotions classified as positive or negative according to Otamendi-Urroz et al. (2023) and Quoidbach et al. (2014). Positive emotions included alertness, amusement, awe, contentment, joy, gratitude, hope, love, and pride; and negative emotions included anger, sadness, embarrassment, fear, disgust, guilt, shame, contempt, and anxiety. Subsequently, respondents were asked to associate these emotions with nine predefined landscapes proven to be easily recognizable by local people (Castro et al., 2014; Quintas-Soriano et al., 2016). These landscapes included Greenhouses, Traditional agriculture, Desert and Badlands, Ramblas (Intermittent rivers), Mediterranean Forest, Mediterranean Scrubland, High Mountains, Wetlands, and Protected coast areas (Fig. 1). To enhance respondents' understanding of the diversity of landscapes and emotions and make the emotions' section more engaging, a panel displaying images of the nine landscape types was used (Appendix A2). It is essential to note that in this study, the Unprotected coast landscape defined in Otamendi-Urroz et al. (2023) was not considered, as the goal was to focus only on protected areas. To mitigate potential bias associated with respondents linking a landscape to a specific PA, panoramic images with similar lighting and color saturation (García-Llorente et al., 2012) were extracted. Finally, a database was created with the emotion scores associated with each landscape for further analysis.

The sample of respondents included a nearly equal representation of females (52.3 %) and males (47.7 %). The majority of participants were in the age range of 18–30 years (47.7 %), followed by participants aged 31–55 years (34.1 %). Regarding their current place of residence, the majority of respondents lived in large urban centers (77.3 %), followed by urban settlements (11.4 %), while a minority of respondents resided in rural areas (10.2 %). To define large urban centers, urban settlements, and rural areas, we used the classification of the Institute of Statistics and Cartography of Andalusia (2019) (see Otamendi-Urroz et al., 2023).

2.2.2. Step 2: Mapping exercise of emotions in protected areas

In order to construct a map illustrating the emotions associated by respondents with landscapes in the PAs, we first linked each landscape with the land cover type that occurred in a land patch from the CORINE database (EEA, 2018). When the same land cover type occurred in two different landscapes, we matched the CORINE land patch 2018 (EEA, 2018) and the European natural habitat types of community interest map (HCI; Directive 92/43/EEC). For example, grasslands (land cover type) occurred in both Desert and Badlands and High Mountains (landscapes); however, distinct HCIs could be identified in those landscapes (see Appendix A3). In a few cases, the same HCI (e.g., Habitat 6220: Mediterranean xerophytic grasslands of perennial and annual plants) also occurred in different landscapes (e.g., Mediterranean forest and scrublands). In such cases, we used the PA as a distinguishing feature to discriminate between landscapes, as the High Mountains landscape occurs in Sierra Nevada National Park but not in Paraje Natural of Tabernas. Secondly, once the landscape was identified in each CORINE land patch, we assigned to it the emotion scores obtained from the surveys. Finally, we mapped and analyzed the spatial distribution of the diversity of emotions using Qgis v 3.22.11 (QGIS Development Team, 2020).

2.2.3. Step 3: Emotional Nonparametric Relation index (ENRI)

An emotional relationship with a landscape refers to the connection or bond established between an individual and a specific landscape, evoking emotional responses (Otamendi-Urroz et al., 2023). Therefore, we considered a respondent to have an emotional relationship with a landscape if at least one positive or negative emotion was associated with a landscape. The Emotional Nonparametric Relation Index (ENRI) indicates whether a person has a positive (ENRI >0), negative (ENRI <0), or polarized (ENRI $= 0$) emotional relationship with a landscape.

$$ENRI_p = log\left(\frac{\sum_{i=1}^{9} PositiveEmotionscore_i}{\sum_{j=1}^{9} NegativeEmotionscore_j}\right) \quad (1)$$

In Eq. (1), log represents the logarithmic function, Positive Emotion score$_i$ (the same applied for Negative Emotion score$_j$) is the score given by a responder to the ith (jth) positive (negative) emotion linked to the pth landscape. The logarithmic function allows us to detect when positive (negative) emotions were dominant over negative (positive) emotions, thus indicating an unbalance in the scores assigned by the respondents to the landscapes. In cases of balance, i.e., positive and negative emotion scores matched, polarization emerges in relation to the landscape. The ENRI does not does not explicitly assume the underlying functional form of the emotional scores under analysis, making it unrestricted to specific types of data and allowing for broader ways of coding emotion scores. In order to make the ENRI comparable among PAs, the area occupied by each landscape within each PA was considered when computing the index. To do this, we first computed the ENRI for each landscape within the PAs, then, we multiplied the ENRI scores by the percentage of area occupied by the landscapes, and finally, we added the weighted ENRI scores. As a result, we obtained 1) the ENRI scores of the landscapes across PAs, and 2) the area-weighted ENRI score of each PA.

2.2.4. Step 4: Relationship between landscape-linked emotions and aridity across protected areas with different levels of protection

We analyzed similarities in landscape-linked emotions across all selected PAs using nonparametric multidimensional scaling (NMDS). PAs were arranged on a Cartesian axis based on the area-weighted scores of the emotions linked by the respondents to the landscapes. A shorter distance between PAs indicated greater similarity in terms of the associated area-weighted emotions. We used the Mahalanobis distance, as a metric to calculate distances among PAs, considering the potential correlation between emotion scores. We used Kruskal's stress (Kruskal, 1964) to assess the goodness of fit of the NMDS. Kruskal's stress measures the agreement in the rank order of the inter-state distances observed and those predicted from the similarities. Following Clarke's (1993) guidelines for stress values, values lower than 0.3 indicate that the arrangement reached is better than one obtained randomly. Once the ordination was obtained, we fitted the Martonne Aridity Index (Martonne, 1927), calculated by PA (Appendix A7), to the ordination coordinates obtained by PAs and emotions using penalized splines (Oksanen, 2019). All the analysis was carried out using the "vegan" R package (Oksanen, 2019).

2.2.5. Methodological limitations

Our methodological approach presents certain limitations that need to be considered. Firstly, landscape images may encompass a variety of different land-cover types within the same scene. Assigning a single land cover type to such images can oversimplify the complexity of the landscape, leading to inaccurate representations. To avoid potential misinterpretations, we associated multiple land cover types with a single landscape based on expert criteria. Additionally, if the same land cover type is dominant in distinct landscapes, further criteria should be used to assign it the correct landscape. For example, we used the HICs and the location of the PAs in our study region, but other context-dependent criteria can be considered. Secondly, the ENRI is undefined when landscapes do not arise any positive and/or negative emotions. In such cases, the interpretation of ENRI is as follows: if the sum of positive (negative) emotion scores equals zero, then positive (negative) emotions are fully dominant over negative (positive) emotions. When all emotion scores are zero, no emotional relationship arises between landscapes and responders. Limitations regarding data collection and potential biases related to photograph composition, lighting, and color are described in Otamendi-Urroz et al. (2023). For example, the sampling approach used for the face-to-face surveys might not entirely represent the population of Almería province, potentially introducing biases favoring individuals with higher education, younger adults, university students, and those residing in the metropolitan area. Furthermore, the choice of landscape photographs, representing the selected landscapes, may influence the preferences and emotions that participants associate with those landscapes. They may attribute positive or negative emotions to their interpretation of a particular landscape captured in the photograph, considering elements such as the photograph composition, lighting, and color, which may diverge from the broader representation of that specific landscape. Still, our study provides a valuable comprehension of diverse perspectives and emotional connections to different landscapes.

3. Results

3.1. Quantification and mapping of landscape-linked emotions in protected areas

A total of 3,568 emotions scores linked to landscapes (79.5 % positive emotions and 20.5 % negative) were identified by respondents. Our findings revealed diverse spatial patterns in emotion distribution across the PAs (Fig. 3). The number of emotions associated with each landscape ranged from 0 to 439 (Fig. 3). In general, positive emotions were more prevalent than negative emotions, with values ranging between 105 (greenhouses) and 439 (protected coast landscapes). Landscapes such as High mountains (n = 401) and Mediterranean forest (n = 396) accumulated the highest positive emotion scores and were dominant in the national and Natural Parks of Sierra Nevada. The Protected coast (n = 439) and Traditional agriculture (n = 333) landscapes mainly occurred in the Natural Park of Cabo de Gata and Sierra Nevada, while the Mediterranean forest (n = 396) and Mediterranean scrubland (n = 272) landscapes were dominant in certain areas of the SCI of Gador.

In contrast, the respondents identified a lower number of negative emotions (20.5 %) compared to positive emotions, with values ranging from 0 to 105. The Paraje Natural of Tabernas accumulated the highest concentration of negative emotions, mainly associated with the Desert and Badlands (n = 48), and Rambla (Intermittent rivers) (n = 76) landscapes. The Natural Park of Cabo de Gata included the landscape with the highest negative emotion score (n = 249), i.e., Greenhouses, though their occurrence was limited.

When analyzing the emotions score weighted by the percentage of area occupied by each landscape in the PAs, we observed a strong association among positive emotions such as amusement, contentment, and gratitude across all PAs (Fig. 4; heatmap scores in Appendix A5). Similarly, negative emotions like fear, sadness, and anxiety were prevalent in most PAs but exhibited a medium-low level of association. The spatial distribution of emotion scores across the PAs is presented in Appendix A4. Overall, we observed a prevalence of emotions such as

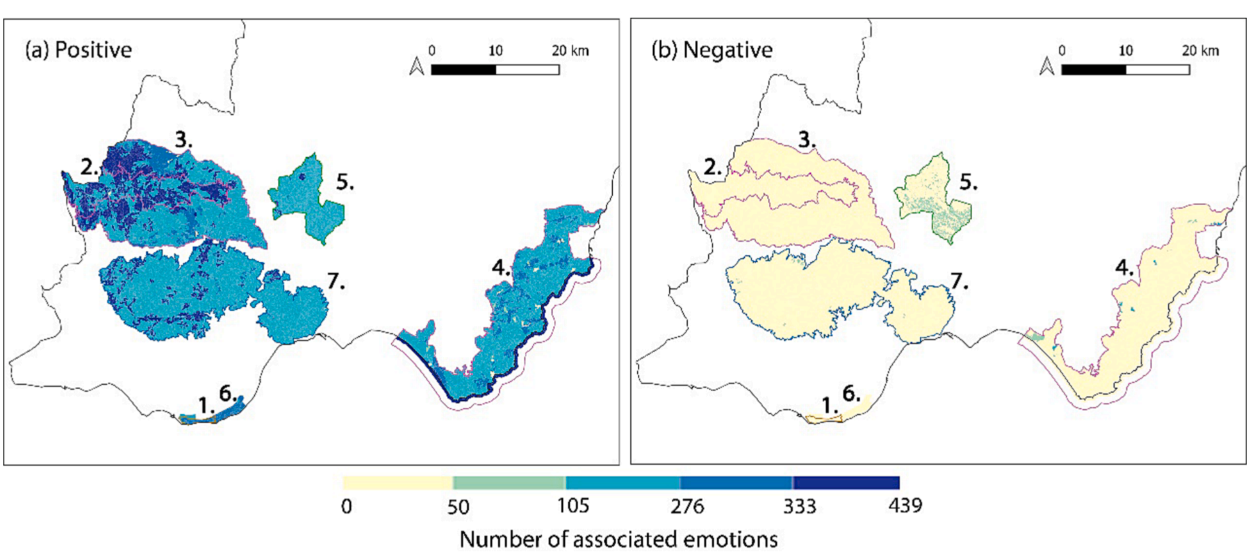

Fig. 3. Mapping of the number of (a) positive and (b) negative emotions in selected PAs.

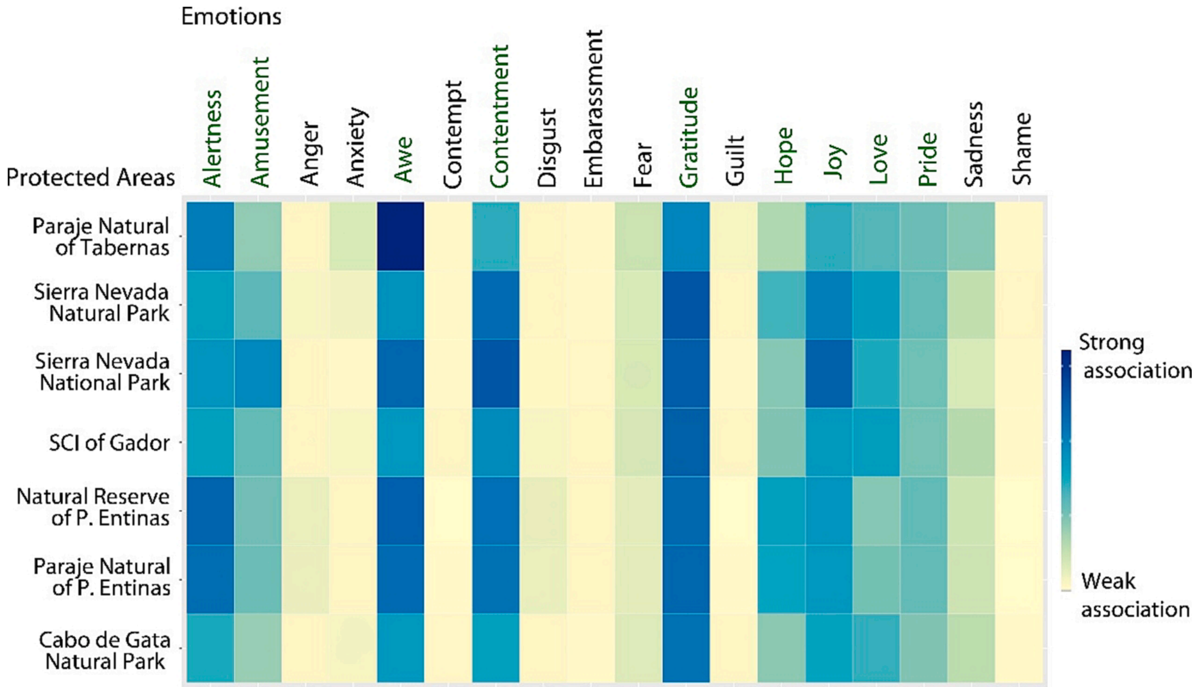

Fig. 4. Heatmap showing the level of association between emotions and PAs. Dark blue indicates a strong association, while yellow indicates a weak association. Emotion scores were weighted by the area occupied by the landscapes in each PA. Positive and negative emotions are colored in green and black, respectively. Heatmap scores can be found in Appendix A5. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

love, attention, joy, and gratitude in both the National and Natural Park of Sierra Nevada. However, negative emotions like guilt, sadness, and anxiety were linked to xeric landscapes (e.g., desert and badlands) located in the southeastern area of the Natural Park of Sierra Nevada. Concerning the desert and badlands landscape, the Paraje Natural of Tabernas contained the largest extension of this type of landscape and exhibited a mixture of both positive and negative emotions distributed across the PAs.

3.2. The emotional Nonparametric Relation index (ENRI)

The ENRI measures the emotional relationship between the respondents and the PAs through different landscape types. All PAs showed a positive relationship, with ENRI values ranging from 0.692 to 1.239 (Table 1). Our findings indicated a positive gradient of emotional relationships across the selected PAs, that is, although the ENRI scores were positive across PAs, the highest scores were observed in both the National and Natural Parks of Sierra Nevada (1.239 and 1.074, respectively), followed by the Natural Reserve of Punta Entinas (1.056). In contrast, the lowest ENRI scores were recorded in the Natural Park of Cabo de Gata (0.946), the SCI of Sierra de Gador (0.941), and the Paraje Natural of Tabernas (0.692).

When considering the contribution of the different landscapes present in each PA to the ENRI, as measured by the area-weighted ENRI score of each landscape in the PAs, we observed a high contribution of wetlands in both the Natural Reserve and Paraje Natural of Punta Entinas (0.836 and 0.975, respectively). This is attributed to the wetlands landscapes achieving high scores of positive emotions and occupying a large area in these two PAs. In contrast, the two landscapes with the highest contribution in the Paraje Natural of Tabernas were deserts

Table 1
Emotional Nonparametric Relation Index (ENRI) across protected areas. The ENRI (right-hand side column in bold) was computed by adding and weighting the emotions scores by the percentage of area occupied by each landscape in the PAs. The gradient of the area-weighted ENRI scores ranges from dark green (high values) to red (negative values).

Protected areas	High mountain	Mediterranean forest	Mediterranean scrubland	Traditional Agriculture	Desert and badlands	Rambla	Wetland	Protected coast	Greenhouses	ENRI
Sierra Nevada National Park	0.622	0.22	0.381	0	0.007	0	0	0	0	**1.239**
Sierra Nevada Natural Park	0	0.349	0.372	0.223	0.128	0	0	0	0	**1.074**
Natural Reserve of Punta Entanes	0	0	0.072	0	0.007	0	0.975	0	0	**1.056**
Paraje Natural of Punta Entines	0	0.015	0.172	0	0	0	0.836	0.014	0	**1.039**
Paraje Natural of Tabernas	0	0.03	0.009	0.012	0.527	0.112	0	0	0	**0.692**
SCI of Sierra de Gador	0	0.151	0.682	0.024	0.082	0	0	0	0	**0.941**
Cabo de Gata Natural Park	0	0	0.518	0.149	0.135	0.004	0.01	0.131	−0.003	**0.946**

and badlands (0.527) and intermittent rivers (i.e., rambla; 0.112), which also accumulated the highest concentration of negative emotions (see section 3.1). Since both landscapes are dominant in this PA, the Paraje Natural of Tabernas achieved the lowest ENRI score. Finally, we observed only one negative area-weighted ENRI score which was associated with greenhouses (-0.003) located in the Natural Park of Cabo de Gata. However, since the Mediterranean scrubland is by far the most abundant landscape, the ENRI score achieved by this PA was 0.946. Appendix A6 shows the spatial pattern of the ENRI score across the selected PAs.

3.3. Association between landscape-linked emotions, level of protection, and aridity across protected areas

The ordination produced by the NMDS resulted in an optimal arrangement of the PAs based on the area-weighted emotions linked to the landscapes (Kruskal's stress 6.7e-05 ⋘≪ 0.3). The spatial configuration of the PAs suggested great similarity between the National and Natural Parks of Sierra Nevada, which were surrounded by positive emotions such as love, joy, amusement, and contentment (Fig. 5). In contrast, the Paraje Natural of Tabernas was arranged away from the rest of PAs, with negative emotions such as sadness or anxiety in its vicinity. The Natural Park of Cabo de Gata and the SCI of Sierra de Gador were the most similar ones, both associated with positive and negative emotions (i.e., fear, sadness, gratitude, or pride). Finally, the protected wetlands of the Natural Reserve and Paraje Natural of Punta Entinas were also isolated from the rest of the PAs and mainly linked to negative emotions (e.g., embarrassment or disgust), because the landscapes associated with negative emotions were dominant in these PAs.

Regarding the level of protection, the ordination analysis revealed a noticeable association between emotions and the levels of protection of PAs. The arrangement of PAs indicated a higher concentration of positive emotions in PAs with higher levels of protection, such as the Natural (IUCN category IV) and National Park of Sierra Nevada (IUCN category II). Conversely, there was a higher concentration of negative emotions in PAs with lower levels of protection, like the Paraje Natural of Tabernas and Punta Entinas (IUCN category III) and the SCI of Gador (IUCN category VI).

Finally, the Martonne aridity index showed an excellent fit to the ordination (adjusted-R^2 = 0.703 and Deviance explained = 95.1 %) (Fig. 5). Overall, PAs with higher aridity (i.e., Martonne index ranging between 0.5 and 1.5), including the Paraje Natural of Tabernas, the Natural Park of Cabo de Gata, and the SCI of Gador, also exhibited an association with negative emotions. In contrast, PAs associated with positive emotions, e.g., the National and Natural Parks of Sierra Nevada, achieved greater index values (i.e., 1.5 – 2.5), and therefore, less aridity conditions. Finally, when jointly considering aridity and level of protection, higher aridity corresponded to a lower level of protection, while a lower aridity gradient corresponded to a higher level of protection.

4. Discussion

4.1. A methodological approach to integrate emotions in protected areas management

Recent research has called out the urgent need for methodological approaches that integrate human needs, preferences, and values as a way to capture the social processes shaping the connectedness between people and nature (Castro et al., 2023; El Ghafraoui et al., 2003). A recent study explored the diversity of emotions associated with landscapes in arid and semiarid Spain and investigated how different emotional states support human well-being (Otamendi-Urroz et al., 2023). However, spatial and quantitative exercises specifically addressing the role of PAs in shaping the emotional connection between

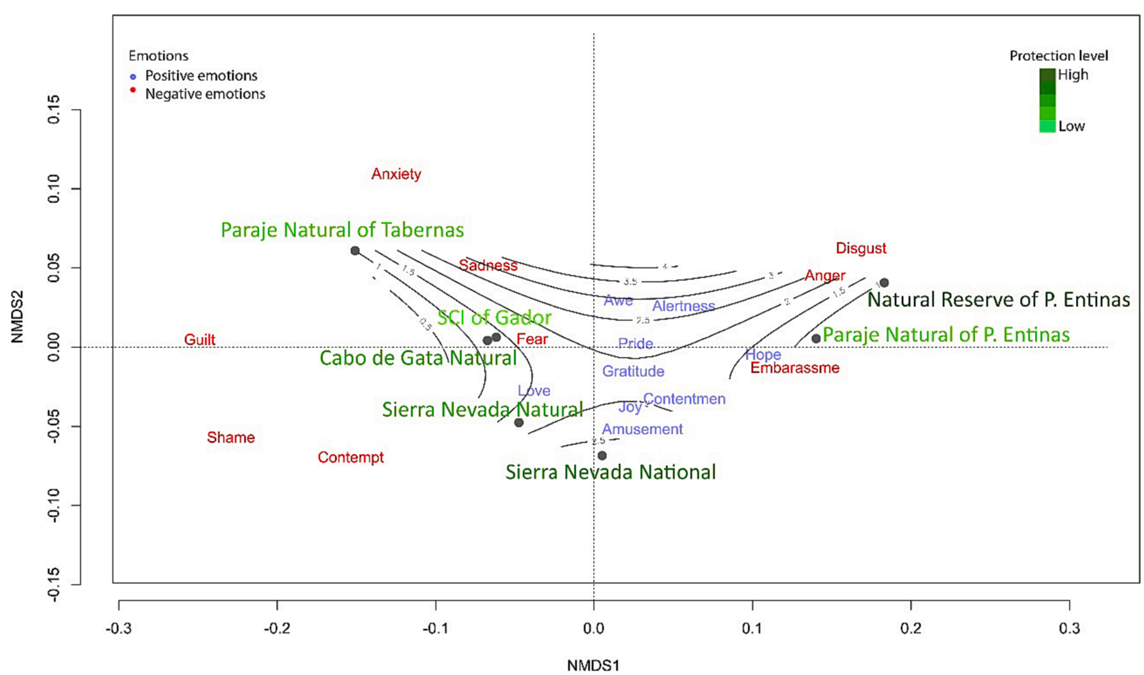

Fig. 5. Nonparametric multidimensional scaling (NMDS). The axes NMDS1 and NMDS2 show the range of distances reached between protected areas. Protected areas were arranged so that the distances between them were as close to the observed differences between the area-weighted emotions linked to the landscapes. A shorter distance between protected areas means greater similarity between them, whereas a longer distance corresponds to greater dissimilarity. Positive emotions are shown in blue, while negative emotions in red. The color of the PAs indicates their level of protection (from clear green, minimum protection, to dark green, maximum protection). For this ordination, the Martonne Aridity Index was fitted as contour lines using penalized splines (Oksanen et al 2019). The aridity index and the NMDS axis 1 and 2 coordinates were used as response variables and predictors, respectively. Each contour line represents a specific aridity value (numbers in black). Protected areas that are close to a contour line have an aridity value similar to that of the contour line. The adjusted-R^2 of the fit was 0.703 and the deviance explained was 95.1%. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

people and nature are currently lacking. Our study fills this gap by proposing an Emotional Nonparametric Relation Index (ENRI) that links human emotions with different landscape configurations (i.e., combinations of land use and cover types), and quantifies, in a spatially explicit manner, landscape-linked human emotions in PAs. Empirical attempts to identify and map the diverse human-nature relations, particularly from the lens of human emotions, remain rare, (Otamendi-Urroz et al., 2023). While we acknowledge potential limitations (discussed in section 2.2.5, see Otamendi-Urroz et al., 2023) inherent in the data collection process, we provide recommendations to address them in future research. It is also worth noting that our method is based on widely field-validated land cover maps commonly used by PAs managers, making the landscape-linked emotions mapping exercise a reliable and practical tool for PAs management. For example, the identification of a negative emotional connection to a specific land use in a particular PA (e.g., negative emotions found in the Paraje Natural of Tabernas and SCI of Sierra de Gador, Table 1) could assist managers in reinforcing conservation strategies by integrating this information into the Resource Zoning Plan (known as the. PORN). Additionally, our methodological approach provides a solid foundation for further research on the human dimension of conservation in PAs (Castro et al., 2023).

Integrating the emotional dimension into PAs management is crucial for understanding the emotional bonds and the roots of the values that people form and develop in and with PAs (Batavia et al., 2021; Manfredo, 2008; Pascual el al. 2023; Petersen et al., 2019). This exercise also provides an opportunity to better understand the factors that hinder or enable human connection or disconnection to and from nature (Castro et al., 2023). Disconnection from nature may diminish our emotional connection with nature and influence our tolerance for environmental degradation, thus reinforcing passivity in action toward the environmental crisis (Soga & Gaston, 2018). Within this context, we believe PA managers can utilize the findings of this research in different ways. On one hand, the ENRI index proposed is a low-data demand index that only requires the collection of social data (e.g., face-to-face surveys) and access to publicly available spatial databases (e.g., land use and cover CORINE database). On the other hand, the spatially explicit outcomes of the ENRI index (i.e., maps of positive and negative emotional connection) offer to PAs managers a practical and useful input for integration into the PAs management (Castro et al., 2015).

4.2. A view of protected areas through the emotion lens

The mapping exercise we conducted revealed significant spatial variation in the positive and negative emotional relations that people attribute to a range of PAs. This is particularly noteworthy given the diversity of landscape configurations of PAs studied in southeast arid Spain. Based on this evidence, we argue that observed emotional relations, whether positive or negative, can be interpreted as expressions of emotional connection towards PAs as a whole. On one hand, results indicated a prevalence of positive emotional relations among PAs characterized by landscape configurations associated with High mountains and Mediterranean forests (e.g., Sierra Nevada National and Natural Park) and those featuring protected coastlines and wetlands (e.g., Cabo de Gata Natural Park or the Natural Reserve of Punta Entinas) (Fig. 3). On the other hand, results also pointed out a dominance of negative emotions (e.g., fear, anxiety, shame, and sadness) linked to dryland landscapes such as deserts and badlands, ramblas (intermittent rivers), Mediterranean scrubland, and greenhouses included in PAs such as Paraje Natural of Tabernas, SCI of Sierra de Gádor and Cabo de Gata Natural Park). These findings may support the Biophilia theory (Wilson, 1984) and other studies demonstrating a general preference for green and blue landscapes (e.g., forests and wetlands) over yellowish and brownish ones (Bidegain et al., 2020; Howley, 2011). This in turn could support the common perception of the former as “beautiful landscapes” (Gobster et al., 2007), while the latter might be seen as sterile and unproductive “landscapes without life” or lacking biodiversity (Castro et al., 2011; Otamendi-Urroz et al., 2023).

Examining the outcomes of the ENRI index at a landscape level, we observed that the values varied depending on specific landscape configurations within a particular PA. The lowest values of the ENRI index were found in the Paraje Natural of Tabernas, characterized by a large expanse of desert and badlands and ramblas (i.e., intermittent rivers) that people associated with both positive and negative emotions. This somehow reflects a highly polarized emotional relationship. This dichotomy arises because some perceive these landscapes as unproductive and lifeless, while others consider them as places where the sense of place and identity is formed. For instance, the Paraje Natural of Tabernas is generally perceived as a unique and captivating place that evokes numerous positive emotions (El Ghafraoui et al., 2003). Cabo de Gata Natural Park showed a medium–low value of the ENRI index, despite a large number of positive emotions being associated with the wetlands and protected coast landscapes. This discrepancy could be explained by the expansion of greenhouses (a negative emotional landscape) within the PA boundaries (García-Llorente et al., 2012).

Our findings emphasize the importance of recognizing that people perceive PAs as complex and diverse landscape configurations. This is the case of the Natural Park of Cabo de Gata, where the ENRI index showed a medium level of emotional polarization. This highlights that even though land use planning in this PA allows and prohibits certain land uses (e.g., greenhouse vs scrubland), people connect and perceive this PA as a unique landscape unit.

This suggests that the spatial landscape configuration in PAs, including factors such as distribution, concentration, and connectivity, can form different trends of emotional relations between people and PAs (Quintas-Soriano et al., 2016; Riechers et al., 2022). We argue that examining the emotional relations associated with landscape configurations in PAs may lead to relevant implications, including the need to raise public awareness about negatively emotional landscapes or the need for new criteria to legally adjust the level of protection.

4.3. Rethinking protected areas as emotional spaces in decision-making

By adding emotional relationships as a new criterion into PA management, we posit that decision-makers could identify landscapes (both inside and outside PAs) that evoke social positive or negative emotional connections and, hence, adapt conservation efforts accordingly (Tapia-Fonllem et al., 2013). Our findings can provide practical guidance to PAs managers in fostering environmental education and raising social engagement with conservation efforts, especially in unique and threatened landscapes such as desert and badlands, clearly linked in our results to negative emotions. Our findings can assist managers in calculating the extension occupied within the PAs by these landscapes, thus facilitating the design of effective environmental education campaigns and other complementary actions to raise public awareness. In this context, we believe this information can be utilized to: i) effectively communicate the importance of preserving dryland landscapes to society; and ii) educate society about the crucial role that PAs play in supporting well-being across drylands of the world.

Here, we argue that conservation policies in PAs often reflect on the emotional responses that people establish in a specific landscape, making emotions or landscape preferences crucial in shaping positive or negative attitudes toward PAs (Batavia et al., 2021; Riechers et al., 2019). On one hand, if positive emotions are associated with a certain landscape, the predisposition to conserve it will be stronger than in landscapes associated with negative emotions. An illustrative example is the conservation of certain animal species, such as the panda, polar bear, or dolphin, commonly linked to positive emotions and charisma, compared to other species like worms, plants, or mushrooms (Martín-López et al., 2007). On the other hand, negative emotions found in specific landscapes may unveil unknown mental rejection (Tapia-Fonllem et al., 2013), ultimately resulting in a lack of desire, willingness, and social support (Soga and Gaston, 2016; Soga and Gaston, 2018). Such emotions may provide important insights into what people value or reject (Quintas-Soriano et al., 2016; Riechers et al., 2020). At the same time, negative emotions observed for arid and semiarid landscapes may reflect the lack of knowledge of the unique biodiversity of this region (El Ghafraoui et al., 2003).

Our findings support this idea and reveal that these emotionally negative landscapes are often located in highly transformed landscapes. On this basis, we argue that decision-makers have the opportunity to design and redirect strategic conservation efforts that capture peoplés emotional connection within PAs (Eigenbrod et al., 2010). Additionally, our results show that PAs with a higher aridity gradient were primarily associated with negative emotions, while those with a lower aridity gradient were linked to positive emotions. This provides clear evidence that dryland landscapes are generally not valued by people, as shown in research conducted on this region (Castro et al., 2011; El Ghafraoui et al., 2003; Rodríguez-Caballero et al., 2018). From a management perspective, we believe that environmental education should play a crucial role in reversing these misperceptions, especially in childhood, fostering curiosity, and strengthening emotional connection to dryland landscapes (Giusti, 2019; van Kerkhoff et al., 2019).

5. Conclusions

This study introduces a novel methodological approach (i.e. the Emotional Nonparametric Relation Index) for quantifying and mapping the diversity of emotional connections that people form in different PAs of SE Spain. Our findings reveal that PAs dominated by mountains and forests are mainly associated with positive emotions, while PAs represented by dryland landscapes (e.g., desert) tend to elicit negative emotional connections. Furthermore, results indicate that PAs with lower levels of protection evoke negative emotions, whereas most restricted PAs are associated with positive emotions. Insights gained from this research provide valuable information to support PAs planning and to foster environmental education and social engagement initiatives in Pas.

CRediT authorship contribution statement

Enrica Garau: Conceptualization, Data curation, Methodology, Writing – original draft, Writing – review & editing. **Juan M. Requena-Mullor:** Conceptualization, Data curation, Methodology, Writing – original draft, Writing – review & editing. **Cristina Quintas-Soriano:** Conceptualization, Data curation, Methodology, Writing – original draft, Writing – review & editing. **María D. López-Rodríguez:** Conceptualization, Data curation, Methodology, Writing – original draft, Writing – review & editing. **Irene Otamendi-Urroz:** Conceptualization, Data curation, Writing – review & editing. **Mariano Oyarzabal:** Conceptualization, Data curation, Writing – review & editing. **Antonio J. Castro:** Conceptualization, Data curation, Methodology, Writing – original draft, Writing – review & editing.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

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Appendix A. Supplementary data

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