



HAL
open science

Towards coexistence: the implications of a complex and adaptive approach of social-ecological systems for conservation sciences and practices

Elie Pédarros

► To cite this version:

Elie Pédarros. Towards coexistence: the implications of a complex and adaptive approach of social-ecological systems for conservation sciences and practices. Biodiversity and Ecology. Université Claude Bernard - Lyon I, 2023. English. NNT : 2023LYO10065 . tel-04601828

HAL Id: tel-04601828

<https://theses.hal.science/tel-04601828>

Submitted on 5 Jun 2024

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.



**THESE de DOCTORAT DE
L'UNIVERSITE CLAUDE BERNARD LYON 1**

**Ecole Doctorale N° 341
Evolution Ecosystèmes Microbiologie Modélisation**

Discipline : Écologie

Soutenue publiquement le 13 septembre 2023, par :

Élie PÉDARROS

**Towards coexistence: the implications of a complex and
adaptive approach of social-ecological systems for
conservation sciences and practices**

Devant le jury composé de :

Fernandez-Manjarres, Juan	MCF, Université Paris-Saclay (Rapporteur)
Fritz, Hervé,	DR CNRS, UCBL (Directeur de thèse)
Locatelli, Bruno	Chercheur, Université de Montpellier (Rapporteur)
Nel, Jeanne	Chercheuse, Wageningen University (Rapporteuse)
Prévot, Anne-Caroline	DR CNRS, Muséum Nat. D'Hist. Naturelle (Examinatrice)
Say, Ludovic	Professeur, UCBL (Président)
Guerbois, Chloé	Chercheuse, Nelson Mandela University (membre invité, co-encadrante)

RÉSUMÉ

La reconnaissance de l'imbrication des défis sociaux et écologiques a permis de concevoir une analyse du système socio-écologique dont les composantes sociales et écologiques sont interdépendantes et entrelacées. Cette conception socio-écologique redéfinit la place de l'homme dans la « nature » et a des conséquences majeures pour les sciences et les pratiques de conservation. Dans le contexte d'un déclin majeur de la biodiversité, le questionnement à propos des sciences et pratiques de conservation se précise d'autant plus que la question des “manières d'habiter” le monde se fait plus pressante, notamment concernant les relations entre l'homme et la faune sauvage. À partir de l'étude de deux sites contrastés d'Afrique du Sud, l'objectif principal de cette thèse est de questionner et de prendre en compte la redéfinition des fondations ontologiques, épistémologiques et méthodologiques des sciences et pratiques de conservation en adoptant une approche complexe et adaptative des systèmes socio-écologiques.

En étudiant deux sites d'Afrique du Sud, cette thèse est le produit d'une co-élaboration et d'une co-construction de la recherche grâce à la mobilisation d'une diversité de parties prenantes. Le premier chapitre présente en détail le processus de co-élaboration de la recherche notamment par la collaboration des systèmes de connaissances scientifiques et de savoirs locaux “expérientiels”.

Comprendre les dynamiques socio-écologiques au sein de paysages anthropisés nécessite également de repenser les méthodologies permettant d'appréhender ces dynamiques. Dans le deuxième chapitre, je m'attache ainsi à comprendre les implications méthodologiques et statistiques d'une telle entreprise qui fournit un premier élément de réflexion concernant le processus de co-élaboration de la recherche notamment en précisant les particularités des données obtenues lors de méthodes participatives. Le troisième chapitre fournit une application de ces méthodologies dans la compréhension des systèmes socio-écologiques et des dynamiques des relations homme-faune en confrontant ces produits de la modélisation d'utilisation du paysage avec les conceptions de la « nature » des diverses parties prenantes ayant co-réalisé cette recherche. Ces dynamiques socio-écologiques posent néanmoins des questions concernant l'éthique et la prise en compte de la diversité des relations homme-faune dans les sciences de la conservation. Dans le quatrième chapitre, je propose une analyse de l'importance de ces dimensions relationnelles et éthiques dans les sciences de la conservation mais aussi sur

les stratégies appliquées à des systèmes socio-écologiques complexes et adaptatifs. L'approche collaborative dans les sciences de la conservation est considérée comme fondamentale dans la réussite des pratiques de conservation, et le cinquième chapitre a donc pour objet de fournir une réflexion critique sur la conduite pratique de telles approches dans des systèmes, qui dans leur réalité, supposent une complexité (au sens étymologique du terme) de la réalisation du travail scientifique de terrain.

Cette thèse propose donc de repenser les sciences et les pratiques de conservation en tenant compte de la diversité des relations au sein de la communauté élargie du vivant. Adopter une approche relationnelle et complexe est possible en favorisant la transdisciplinarité et en adoptant une position transformative vis-à-vis du changement permettant de tendre vers la résilience du système dont une des composantes essentielles est la coexistence.

ABSTRACT

Recognition of the intertwining of societal and ecological challenges has led to the development of a system analysis in which social and ecological components are interdependent and interwoven. This redefinition of the place of humans in 'nature' has significant implications for conservation science and practice. In the context of a major decline in biodiversity, the questioning is becoming more precise as the issue of "ways of living" becomes more pressing, particularly concerning the relationship between humans and wildlife. The main objective of this thesis is to consider the redefinition of the epistemological, ontological, and methodological foundations of conservation sciences and practices by adopting a complex, adaptive, and transdisciplinary perspective of socio-ecological systems.

By studying two highly contrasting sites in South Africa, this thesis is the product of a co-elaboration and co-construction of research through the mobilisation of a diversity of stakeholders. The first chapter details the research's co-elaboration process, mainly through the collaboration of scientific knowledge systems and local 'experiential' knowledge. Understanding socio-ecological dynamics within anthropised landscapes also requires a rethinking of methodologies used to apprehend these dynamics. In the second chapter, I focus on understanding the methodological and statistical implications of such an undertaking, which provides a first element of reflection concerning the process of co-elaboration, notably by specifying the particularities of the data obtained during participatory methodologies. The third chapter offers a practical application of these methodologies in understanding social-ecological systems and the dynamics of human-wildlife relationships by confronting these products of landscape use modelling with the conceptions of 'nature' of the various stakeholders who co-realised this research. These socio-ecological dynamics nevertheless raise questions about the ethics and consideration of the diversity of human-wildlife relationships in conservation science. In the fourth chapter, I propose an analysis of the importance of these relational and ethical dimensions in conservation science, but also on the strategies applied to complex and adaptive socio-ecological systems. The collaborative approach in conservation science is seen as fundamental to successful conservation practice, and the fifth chapter, therefore, aims to provide a critical reflection on the practical conduct of such approaches in

systems, which in their reality imply complexity (in the etymological sense of the word) in the conduct of scientific fieldwork.

This thesis, therefore, proposes to rethink conservation science and practice in light of the diversity of relationships within the broader community of living things. Adopting a relational and complex approach is possible by promoting transdisciplinarity and adopting a transformative stance towards change to move towards the system's resilience, an essential component of which is coexistence.

ACKNOWLEDGEMENTS

I want to thank the jury for evaluating my work: Juan Fernandez-Manjarres, Bruno Locatelli and Jeanne Nel for their assessment of the manuscript and their valuable suggestions, as well as Anne-Caroline Prévot and Mr Ludovic Say for their role of examiner during the defence. This PhD defence was only possible because of the precious time the jury members have dedicated to this work, and I am very grateful.

I want to thank my supervisor Hervé Fritz for supervising this PhD and Chloé Guerbois

I want to thank the CNRS for making this PhD thesis possible thanks to its 80' prime funding.

Thanks to the structure of the International Research Laboratory, a cooperation between the CNRS, the University of Lyon I and the Nelson Mandela University, for having given me an institutional framework allowing me to carry out this thesis and to create a context favourable to rich exchanges: Pierre-Cyril Renaud, Virginie Rougeron, Franck Prugnotte, many thanks. I would also like to thank Roger Pradel for his friendship during these stays in South Africa. Thanks to all the institutional partners SANParks, Cape Nature, the Touw River Conservancy and the Western Cape Province.

Thanks to Mike Leggatt for your friendship since my arrival in 2018. All these moments, all these discussions have marked my South African experience. Thanks also to all the participants of the workshops and, in a non-exhaustive way, Mona, Quaanitah, Ashleigh, Colin, Miellies, Elise, Koera, Dirk, Luce, Kathrina, Magda, Marly, Francina, Elvis, Patate and of course Elia as well as the Raats, Kruiper and Vaalbooi families.

I want to thank the Laboratoire de Biométrie et de Biologie Évolutive (LBBE) in Lyon and, in particular, Fabrice Vavre, Marie Claude Venner, Stéphane Dray, Samuel Venner, Anne-Béatrice Dufour, Lisa Nicvert, Mary Varoux as well as Nathalie Arbasetti for their warm welcome despite the short time spent there.

Indeed, whether during my master's or the PhD, I spent a large part of my time in the Sustainability Research Unit of Nelson Mandela University. I thank these two institutions for their hospitality. I especially thank Christo Fabricius, Bianca Currie, Dirk Roux, Nelsiwe Mpapane, Fraser Bitu and all the researchers with whom I had the chance to exchange during these five years. A very special thank you to Jan Venter, head of the Wildlife Ecology Lab, with whom I had the opportunity to carry out several field missions,

which were not only very important in broadening my skills but, above all, were the opportunity to share a lot. Thank you Lain Pardo, Elizabeth Kennedy-Overton, Hernu Swanepoel, Amauree Jansen van Vuuren, Ethan Lefleur, Dietre and Rebecca Stols, Jade Harris and Dylan Rice, for your friendship.

I warmly thank the thesis committee, Anne-Caroline Prévot, François Bousquet, Dirk Roux and Isabelle Arpin, for their great benevolence, expertise and their investment in this PhD thesis. I am very grateful to you. Thank you, Dirk, for the warm exchanges and discussions in the research building corridor and for organising the Garden Route Interface Networking meeting, which was a great success.

I especially thank Anne-Caroline Prévot, a member of my PhD committee. Your kindness and welcome within the "Ecological transition and nature experiences" team were essential. Participation in the "TRUC" meetings has enabled me to meet many people and discover increasingly exciting research topics that provide an understanding of the world beyond disciplinary divisions. Thank you for everything. Within this team, I would also like to thank Nelly Parès, whose friendly and wise discussions allowed me to think differently about my subject and significantly contributed to this. Thank you for the re-reading of chapter four! A big non-exhaustive thank you to Mara Sierra-Jiménez, Pauline André-Dominguez, Zénaïde Dervieux and Laura Juillard the TEEN team and CESCO.

I want to thank Priscilla Duboz and Jérémy Allouche for their confidence and support.

A big thank you, Alice Bernard; you have been a great friend during these three years of my PhD thesis. I will remember for a long time all those laughs and in few months it will be your turn ! An equally big thank you to Laura Lacomme, who joined us along the way and shared life at Tamarack's Little House on the Prairie under the care of Charles and Megan Norman. Whether at the Blind Pig or the Beach House, the little world of the Wilderness nightlife has no more secrets for us.

Thanks to my friends from the EBE master Martin Plancke, Shona Nozolino, Laura Kouyoumdjian and Aurélien Oosterlinck and my friends Khalil Sdiri, Clément Touati, Alexis Sanandedji, Andrew Kamagne and Jules Brun.

Raphaëlle, you have an exceptional place in these acknowledgements. You have been by my side since the beginning of this adventure, and your kindness, understanding and support have been crucial to me. I can never thank you enough, and I hope you will

bear with me for a long time. Thank you to your family for their kindness and shared moments.

Finally, an infinite thanks to my family, who have been of unfailing support and have had a determining role in the realisation of this thesis. Thanks to my parents, Isabelle and Jérôme, for their listening and kindness. You have been critical in the completion of this work. You have always supported and advised me in pursuing all my projects. Thank you to my sisters Esther, Dinah (and Mirza) for all these moments, and I wish you the best because you are brilliant and deserve it.

FOREWORD

My thesis consists of five chapters, constituted of three sections. The first four chapters each consist of a section in the form of a scientific paper for publication. I conducted the planning, acquisition, analysis and interpretation of the data for each chapter. However, I use the third person in this thesis to align with formal writing in the first four chapters, the fifth chapter being more reflexive than the others. This thesis was carried out within the International Research Laboratory "Reconciling Ecological and Human Adaptations for a Biosphere-based Sustainability" (REHABS) directed by Hervé Fritz. This research laboratory results from the collaboration between the Centre National de la Recherche Scientifique (CNRS; Scientific Research National Centre), Lyon I Claude Bernard University in France, and Nelson Mandela University in South Africa. This thesis was made possible by CNRS "80|Prime" funding. This work was supervised by Hervé Fritz and co-supervised by Chloé Guerbois.

This thesis aims to interrogate the implications of a complex and adaptive approach to social-ecological systems for conservation sciences and practices by focusing on issues of human-wildlife coexistence. The thesis outline adopted here is understood as a gradation of the reflection on this issue and thus follows the research development process. Although this thesis is rooted in the disciplinary field of ecology and conservation science, adopting a complex social-ecological systems approach requires considering the contingency of the historical and social processes within which our analysis is situated.

Therefore, the **first chapter** examines the possibility of linking the founding principles of landscape ecology with a complex and adaptive approach to social-ecological systems. This articulation between these two schools of ecology, which both include social and ecological dimensions, allows us to introduce the central idea of this thesis, which is reconciliation ecology, which proposes to create, maintain and favour wildlife within anthropised landscapes. This first article section aims to identify the structuring principles of reconciliation ecology to reposition it within the conservation sciences. Through a systematic bibliographical review, we show in particular that reconciliation ecology is a multidimensional process that acknowledges a multiplicity of outputs characterising complex adaptive systems but also that reconciliation ecology can be considered a transformative approach to conservation because it allows to co-create an empowering, equitable, inclusive, and ethical, collaborative environment through the

highlight of "success stories" grounded locally and emerging from both collaborations and citizen initiatives. These results from the scientific mode of knowledge imply that landscape is a concept that goes beyond the geographical area and allows us to move to a conception of landscape based on relationships, a relational landscape. To interject the salient points of the relational landscape research, we conducted preliminary discussions with various stakeholders, which, together with the literature review, identified the research questions and methodologies of this project, which will be further elaborated on and detailed in the following chapters. The spatial dimension of coexistence has been identified as a significant issue, leading to the proposal to mobilise participatory mapping.

The **second chapter** examines the nature of the data generated by participatory mapping and identifies the epistemological challenges of its mobilisation and interpretation. The analysis of the results of multi-species participatory mapping in two contrasting sites in South Africa has highlighted the importance of considering the context of data generation in interpreting wildlife habitat modelling products in anthropised landscapes. Viewing these data emerging from human-wildlife relationships allows us to move from a Cartesian to a relational conception of the landscape.

The **third chapter** involves mobilising these concepts in analysing human-wildlife coexistence mechanisms. After considering the different conceptions of these relationships within conservation sciences, the article section aims to confront the habitat suitability of wildlife species with the different stewardship positions of the stakeholders who participated in the participatory mapping exercise. By modelling the spatial distribution of wildlife species using biotic and abiotic environmental factors, the performance of the modelling is drastically improved. Furthermore, we have shown that the use of the landscape by these species is very divided and concerns land-cover areas with a high intensity of human activities and places where human presence is scarce. It has allowed us to see a particular set of relationships between members of the living world, leading us to discuss an extended living community. The analysis of these social-ecological dynamics and potential conservation strategies about the stewardship positions of stakeholders has allowed us to envisage a divergence in the relationship between humans and wildlife that questions the relevance of conservation schemes applied to all contexts and raises the question of ethics in conservation science and its practices as well as the consideration of relational dimensions in the pursuit of its objectives.

These relational and ethical aspects are explored further in the **fourth chapter**. Based on the work carried out by many researchers on the decompartmentalisation and decolonisation of ecology, we question our ways of inhabiting, in particular by mobilising the dwelling approach, which makes it possible to adopt a specific conception of the relationship. In this last section of the article, we mobilise the collaborative timeline tool that emerged during the preliminary discussions to identify the relational values associated with landscape. The relational value of care features prominently in this timeline and is recognised as fundamental to the emergence of stewardship positions. This paper aims to explore the multiple expressions of care and to understand and highlight the importance of the care dimension for stewardship action. Moreover, we aimed to characterise the importance of Indigenous people's presence in conservation debates for a sustainable coexistence with other living beings in relational landscapes. This section allows us to initiate a broader reflection on the relationship between conservation and care and the integrative capacity of this concept to adopt a transformative posture towards change.

The **fifth chapter** then brings a more reflexive perspective of the work carried out during this thesis, particularly concerning the approach of co-elaboration and co-construction through contact with the different stakeholders, the organisation of the workshops and the position of the researcher in this process which is oscillating.

TABLE OF CONTENTS

GENERAL INTRODUCTION	1
1. Humans and the Earth.....	3
2. From concern for nature to concern for biodiversity and spaces	5
3. Updating the objects of scientific knowledge within conservation sciences.....	8
4. Adopting a transdisciplinary approach to conservation	11
5. Towards coexistence: the implications of a complex and adaptive approach of social-ecological systems for conservation sciences and practices.....	14
SOCIAL-HISTORICAL CONTEXTUALISATION AND STUDY SITES.....	17
I. History of settlement and political construction	19
1. Southern Africa settlement.....	19
2. The South African construction.....	20
3. Categorisation of the Humans	22
II. South African conservation and study sites	25
1. The social-ecological issues of South African conservation	25
2. Garden Route site.....	26
3. Kalahari site.....	27
CHAPTER I – EXTENDING LANDSCAPE ECOLOGY TO RELATIONAL LANDSCAPE RESEARCH	43
I. The entity, the Sum and the whole: introducing complexity in systems study	45
1. Conceiving systems as complex.....	47
2. Complex and adaptive SES	49
II. Landscape strategies and complex social-ecological systems: implications for conservation sciences and practices	55
III. Extension of the concept of relational landscape and establishment of an adapted methodological range.....	77
1. Bridging landscape research to relational thinking.....	78
2. Interweaving scientific and local knowledge.....	78
3. Questions and methodologies as constituent and constitutive parts of this research	82
CHAPTER II - STATISTICAL AND METHODOLOGICAL CONSIDERATIONS IN THE USE OF PARTICIPATORY METHODOLOGIES: THE NEED FOR THE CONTEXTUALISATION OF THE DATA COLLECTED	95
I. Nature of participatory data and ecological interpretations.....	97
1. Participatory data and spatial conservation	97
2. Data reliability and epistemic challenges of participatory practices	99
3. Nature of Participatory data	105
II. Modelling habitat suitability in anthropogenic landscapes: statistical and practical considerations for using participatory mapping to address human-wildlife coexistence in complex social ecosystems	109
III. From a cartesian conception of space to a relational landscape conception.....	135
1. Participatory maps as boundary objects	135

2.	Social-ecological keystone species	136
3.	<i>Landscape values and approaches of spatialised human-wildlife relationships</i>	137
CHAPTER III - NATURE OF HUMAN-WILDLIFE RELATIONSHIPS AND ADEQUACY OF CONSERVATION STRATEGIES.....		141
I.	Coexistence, conflicts and Human-wildlife visions	143
1.	Human-wildlife relationships conceptions in conservation sciences.....	143
2.	From conflict to coexistence: an extension or a reversal of human-wildlife relationships?	144
3.	Dwelling to build coexistence	145
II.	Investigating coexistence in human-dominated landscapes through a social-ecological lens: a co-constructive, participatory and relational approach.....	149
III.	Relevance of conservation strategies in human-dominated landscapes.....	175
1.	Technoscientific conservation	175
2.	The reversal of political-scientific relations in conservation sciences.....	176
CHAPTER IV- RELATIONAL AND ETHICAL DIMENSIONS OF COEXISTENCE AND ASSOCIATED STEWARDSHIP STRATEGIES		179
I.	Decompartamentalising, decolonising and deconstructing conservation.....	179
1.	Colonial conservation.....	181
2.	Decompartamentalising and decolonising conservation.....	185
3.	The inclusion of integrative concepts	187
II.	Adopting a care perspective in multi-stakeholder collaborative research allows an in-depth relational values approach in social-ecological research for stewardship action.....	189
III.	Care and conservation	217
1.	Is conserving caring?.....	217
2.	The care concept in conservation	219
3.	The general and unifying principle of care for social and ecological struggles	223
CHAPTER V - PERSPECTIVES ON SOCIAL-ECOLOGICAL RESEARCH FIELDWORK		225
I.	Complexity of reality, complexity of social-ecological research fieldwork	227
1.	Getting in touch.....	228
2.	Workshop organisation.....	234
3.	The researcher's position	241
II.	General discussion.....	243
1.	A complex and adaptive perspective on social-ecological systems implies recognising the diversity of worldviews and thus reconsidering the ontology of conservation sciences and practices.....	243
2.	The redefinition of the objects of conservation sciences and practices' study questions how we can know the system.	245
3.	Adopting a complex and adaptive approach to social-ecological systems in conservation sciences and practices involves rethinking methodologies and their articulation to consider a broader set of relationships that constitute the system.....	247
REFERENCES.....		250
APPENDIX.....		251

LIST OF FIGURES

Social-historical contextualisation and study sites

Figure 1. South Africa administrative map

Figure 2. Map of the Garden Route site in the George Municipality area

Figure 3. Wilderness, Hoekwil and Kleinkrantz area focus within the Garden Route site

Figure 4. Map of the Kalahari site around the town of Askham and the six farms obtained by the #Khomani San and Mier communities during the 1999 land-claim

Figure 5. Summary of the main events in South Africa between -20 000 years and 1834

Figure 6. Summary of the main events in South Africa between 1838 and the 1999 land claim of #Khomani San and Mier communities

Chapter I - Extending landscape ecology to relational landscape research

Figure 1 PRISMA flowchart describing the included and excluded literature

Figure 2 Studies distribution by the first author and field site countries

Figure 3 Distribution of studies according to their empirical or theoretical focus, whether about their species-focus (A), animal body mass and plants (B) and species taxonomic groups (C)

Figure 4 Landscape strategies trends: number of studies (A) focal scale (B) and reconciliation ecology principles addressed (C)

Figure 5 Scatter diagrams from the MCA of empirical studies: reconciliation ecology principles (A), species' body mass (B), landscape strategy (C) and explicit use of reconciliation ecology (D).

Figure 6 Scatter diagrams from the MCA of theoretical studies: reconciliation ecology principles (A), landscape strategy (B), explicit use of reconciliation ecology (C).

Figure 7. Schematic representation of the importance of scale in determining a landscape strategy.

Figure 8. Illustration of the thesis structure

Figure 9. Presentation of stakeholders' group and participation levels

Figure 10. Graphical representation of the processes identified through thematic coding. Raw coding is represented below and was regrouped by two to identify the methods

Figure 11. Summary of the thesis structure and the related methodologies

Chapter II - Statistical and methodological considerations in the use of participatory methodologies: the need for the contextualisation of the data collected

Figure 1. Methodologies mobilised during the two structuring workshops and participatory practices.

Figure 2. Study sites of the Garden Route (above) and Kalahari (below) with the land cover used for modelling occurrence or habitat suitability and their sub-extents (a) Wilderness (b) Hoekwil (c) Witdraai (d) Askham.

Figure 3. TSS variation for different training data densities using the "all species dataset". ANOVA tests have been performed for the spectrum of density within each modelling technique (p-value >0.05: not display 0.05 < p-value >0.01: *, p-value < 0.01: **).

Figure 4. Comparison of TSS values between sites using the “all species combined dataset” and “caracal dataset”. Student t-tests (p-value >0.05: not displayed; 0.05 < p-value >0.01: *; p-value < 0.01: **), and for each distribution, the CV is shown above.

Figure 5. Comparison of true statistic values (TSS) between species using a calibrated training data density depending on spatial extents, resolutions, and sites. Student t-tests have been performed between species (adjusted p-value >0.05: not displayed; 0.05 < adjusted p-value >0.01: *; adjusted p-value < 0.01: **), and for each distribution, the CV is shown below the ellipse.

Figure 6. Variable importance related to focus species using a calibrated training data density. Student t-tests between species (adjusted p-value >0.05: not displayed; 0.05 < adjusted p-value >0.01: *; adjusted p-value < 0.01: **).

Figure 7. Responses of habitat suitability values for each variable modelled using the Random Forest (RF) modelling technique for Baboon-Garden Route and Jackal-Kalahari. For boxplots of land-cover modalities, pairwise student t-tests were performed. A significant difference between the two modalities is represented by two different letters. The same letter means there is a significant difference between the two modalities.

Chapter III- Nature of human-wildlife relationships and adequacy of conservation strategies

Figure 1. Study sites of the Garden Route (above) and Kalahari (below) with the land cover used for modelling occurrence or habitat suitability

Figure 2 (a) Response curves for the two most critical abiotic variables (Distance to the closest protected area and land use) and (b) variable importance in the Garden Route. Lines between groups in the boxplot express a significant difference (pvalue<0.05).

Figure 3 (a)Response curves for the two more important abiotic variables (Distance to the closest critical biodiversity area and water) and (b) variable importance in the Kalahari

Figure 4. Representation of stewardship types according to environmental discourses dimensions (a) Garden Route (b) Kalahari. Arrows represent a stakeholder's tendency to develop arguments toward another stewardship type.

Chapter IV - Relational and ethical dimensions of coexistence and associated stewardship strategies

Figure 1. Study sites of the Kalahari and the Garden Route

Figure 2. Distribution of the themes of the collaborative timeline post-it notes according to the stakeholder category in the two areas: (a) the Garden Route and (b) the Kalahari

Figure 3. Distribution of the care aspects (relative citation among total care relational value codings) regarding stakeholder groups for the two sites.

Figure 4. Representation of stewardship types according to environmental discourses dimensions formulated by each stakeholder group for the two sites: (a) the Garden Route and (b) the Kalahari. Arrows represent a stakeholder's tendency to develop arguments toward another stewardship type.

LIST OF TABLES AND BOXES

Chapter I - Extending landscape ecology to relational landscape research

Box 1. Reconciliation ecology example of the American crocodiles in Turkey point power plant

Table 1. Articles coding elements

Table 2. Description of the stakeholder's groups

Box. 2. The †Khomani San community film, *The Burn of the Nation*, 2021

Box. 3. The Khoi community theatre, *Awakenings*, 2021

Chapter II - Statistical and methodological considerations in the use of participatory methodologies: the need for the contextualisation of the data collected

Table 1. Research process application of epistemic risks in the use of participatory practices

Table 2. Environmental predictors used for species distribution modelling

Table 3. Summary of participatory mapping data obtained during the two workshops: in the Garden Route, GR (from left to right: Caracal (*Caracal caracal*), Leopard (*Panthera pardus*), Common genet (*Genetta genetta*), Bushpig (*Potamochoerus larvatus*), Vervet monkey (*Chlorocebus pygerythrus*), Chacma Baboon (*Papio ursinus ursinus*), Blue Duiker (*Philantomba monticola*), Bushbuck (*Tragelaphus scriptus*) and Honey Badger (*Mellivora capensis*); in the Kalahari, KH: Caracal (*Caracal caracal*), Leopard (*Panthera pardus*), Common genet (*Genetta genetta*), Eland (*Taurotragus oryx*), Black-backed Jackal (*Lupulella mesomelas*), Gemsbok (*Oryx gazella*), Kudu (*Tragelaphus strepsiceros*) and Honey Badger (*Mellivora capensis*).

Table 4. Data summary for models' calibration at the global extent

Chapter III- Nature of human-wildlife relationships and adequacy of conservation strategies

Table 1. Participants' description for discourse analysis

Table 2. Abiotic variables used for species distribution modelling

Table 3. Observations summary of the participatory mapping process in the Garden Route (GR) and the Kalahari (KH)

Table 4. Modelling performance for species habitat suitability with only abiotic variables in (a) the Garden Route and (b) in the Kalahari

Table 5. Multiple species modelling selection

Chapter IV - Relational and ethical dimensions of coexistence and associated stewardship strategies

Table 1. Participants' description

LIST OF PICTURES

Social-historical contextualisation and study sites

Picture 1. A springbok hip with the representation of antelopes engraved in fire and ochre. Created by Elia Festus

Picture 2. Garden Route (top box) and Kalahari (bottom box) sites

Chapter I - Extending landscape ecology to relational landscape research

Picture 1. Participatory mapping exercise in the Kalahari

Picture 2. Collaborative timeline exercise in the Kalahari (a) and the Garden Route (b)

Chapter V - Perspectives on collaborative research

Picture 1. (A) Informal settlement resident cooking for the soup kitchen; (B) Soup kitchen queue ; (C) Tuber gathering (!goegap for blood pressure issues) ; (D) Discussion around the fire in Miershoorpan ; (E) Coffee in Witdraai

Picture 2. Pictures of the participatory mapping exercises in the Garden Route (A) and the Kalahari (B)

All pictures were taken by myself.

GENERAL INTRODUCTION

“Most writers on emotions and human conduct seem to be treating rather of matters outside nature than of natural phenomena following nature's general laws. They appear to conceive humans to be situated in nature as a kingdom within a kingdom: for they believe that he disturbs rather than follows nature's order, that he has absolute control over his actions, and that he is determined solely by himself.”

Baruch Spinoza, *Ethics Demonstrated in Geometrical order Part III*, 1677; edited by Tradition Classics edition 2013

“Umntu ngumntu ngabantu”

“A person is a person through other persons.”

Xhosa maxim

The concept of humanity defined by relationships with its members and the world around it is neither new nor geographically or culturally situated. Nevertheless, the question of humanity's place in the world is central to the history of ideas. The current challenges of social, ecological and climatic upheavals only update this questioning and lead us to attempt to describe and redefine these relationships. Social anthropology highlighted that collective production relates to how this world is experienced and ordered to make nature a social fact (Charbonnier, 2015). The question of nature as a social construct has been widely debated within philosophy and anthropology to the point of constituting two opposing types of anthropologies: one considering nature as a reality and the other as a social construct (Larrère & Larrère, 1997; p. 103). Descola (2005) has undertaken a significant work of comparative anthropology to establish a typology of these relationships: the “nature” ontologies. He described these ontologies in terms of two dimensions: the consideration of physicality and interiority shared or not with other living beings. It is conducted in a combination of four main ontologies: totemism (shared physicality and interiority), analogism (no shared physicality and interiority), animism (shared interiority but not physicality) and naturalism (shared physicality but not interiority), the dominant ontology of western societies. Naturalism is typical of Western ontologies considering a separation between mind and body, the fundamental separation at the origin of the distinction between cultural and natural (Descola, 2005).

This dichotomous vision of the world based on the separation between the body and the mind is a conception of the world transferred to many other dichotomies, particularly between what is artificial or wild but also between society and science

(Larrère & Larrère, 2018; p. 67). By distinguishing science from society, this conceptual dichotomy has important implications for how we conceive of what is real and what is not (ontology), how we know the world (epistemology) and how we can access the knowledge of the world (methodology) (Preiser et al., 2018). We can see that this conceptual dynamic of nature changes societies' relationship to it and, thus, the way of knowing it.

However, acknowledging the idea of nature as an objective reality without considering other ontologies would promote an ethnocentric vision of the idea of nature (Plumwood, 1998; as cited in Larrère & Larrère, 2018, p. 46).

To understand this idea of nature thought as a social construct, mobilising environmental ethics and the history of the values attributed to this idea is particularly speaking. Intrinsic values are attributed to nature for its own sake, it excludes human considerations in values attributions (Chan et al., 2016). This idea of a nature to protect for its own is the origin of the *wilderness* conception which emerged in the United States and thoroughly analysed by Callicott (1989). Alarcon (2020, p. 46) notes that several environmental philosophers developed this conception of a nature that is not related to human interests and activities promoting the development of a wilderness ethic. This wilderness ethic is fundamental in conservation because it structured the conception of protected areas isolated from human activities. It is still a model and a philosophy in some areas of the world to think about nature and, thus, conservation. Within human-nature relationships, intrinsic values focus on the nature component by giving nature a specific value. The counterpart attributes values to the other component of dualism, humans related to nature: instrumental values. Nature is valued considering what it can provide to humans, and this valuation is particularly visible through the ecosystemic services concept (Chan et al., 2016; Millenium Ecosystem Assessment, 2005).

The current environmental crisis makes difficult to rely only on the traditional idea of a dichotomy between social and natural aspects. It is thus not pertinent to analyse environmental changes using only a strict dualistic approach (Larrère & Larrère, 2018; p. 57). The idea of pristine natural landscapes, which are harvested and exploited for centuries understands nature and artificiality as opposing forces (Larrère & Larrère, 2018; p. 57). It aligns with what Berque (2015; p. 206) describes as a *milieu*: a combination of social, ecological and technical dimensions. Another way of looking at the values of nature, without attributing values to compartments of the system, is to focus on the values attributed to the relationships between these compartments, which allows for

a diversity of values to be considered rather than values centred on the objects of the system (Chan et al., 2016). Furthermore, it involves rethinking how we interact with what we define as "nature".

The question of humans' place on Earth and its relationships was and still is at the heart of the discussions. It is decisive for reflecting on environmental ethics and determining how we act toward nature. Questioning the dualism between nature and culture does not only have theoretical and reflexive implications. It also directs how we conceive the world. It makes it possible to redefine the stakes of scientific research, which is central to this thesis's reflection and realisation. Characterising the diversity of ontologies of relationships with nature also implies looking at the historical dimension of these relations with the Earth.

1. Humans and the Earth

Humans have been transforming the Earth for at least 12,000 years through their activities, modifying the structure and dynamics of the landscape (Ellis et al., 2021). This transformation comes, for instance, from hunting, burning, domestication or agriculture (Ellis et al., 2021). The recent acceleration of biodiversity loss and the threats to the biosphere, in general, have been considered by scientists as a recent phenomenon (Ellis et al., 2021). The ethnocentrism of an objective nature idea (naturalist ontology considered exclusively) has confused the diversity of human activities and populations into a global problem related to human activities in general. The reflection, therefore, focused on humanity as a whole rather than on a differentiated analysis of the different human practices and populations. Indigenous peoples and local communities practising activities that are less harmful to the environment are therefore incorporated into this whole, thus sharing a collective responsibility. Ellis et al. (2021) highlight that it is not the extent of humans' activities that are responsible for this recent decline but the increasing intensity of these activities. Wildlands covered only 27.5% of terrestrial lands in 10,000 BCE, indicating that previous human populations already inhabited 72.5% at the beginning of the current interglacial interval (Ellis et al., 2021), which is at odds with the idea of pristine nature. In the 2000s, the critical transition from lands without human settlements to agricultural and human settlements reached 50%, with less than 20% and 25% of seminatural and natural habitats left, respectively (Ellis et al., 2021). In 2017, 80%

of the terrestrial biosphere was transformed (Ellis et al., 2021). While the responsibility of humans in the decline of biodiversity is firmly established (Jaureguiberry et al., 2022; Moi et al., 2022; Pillay, 2022), the aspects of human causes have to be thoroughly reassessed and needs to focus not only on human presence and the expansion of land-uses but more specifically on the intensification of the latter. This evolution in understanding rapid biosphere changes is essential as it leads to an interest not only in human demography and the extent of the spatial occupation but also in the specific social practices and organisations that are detrimental to the integrity and dynamic of systems. Recognising this co-evolution of the Earth and human societies belies the compartmentalisation of social and natural spheres (Bonneuil & Fressoz, 2016).

Bonneuil and Fressoz (2016) point out that considering the long-term human influence on the Earth (characterising the Anthropocene epoch) allows the idea of nature to enter into human and social issues. Besides environmental ethic arguments, the history of the relationships between humans and ecological processes highlights this need to reconsider the dichotomy between humans and nature. This movement is nurtured by statements from various disciplines and observations. As Bonneuil and Fressoz (2016; p. 51) point out, this overcoming must be considered by thinking together ecology and power relations to understand the formation of environmental inequalities according to « une double relation d'intériorité : [...] Des natures traversées de social [et] Des sociétés traversées de nature » [a double interiority relationship : [...] natures worked by social [and] societies worked by nature]¹. It radically changes the perspective on human-wildlife relationships central to understanding conservation sciences and practices.

The joint dynamics of the Earth and human societies described in particular by the term “Anthropocene” can, however, suggest an essentialisation of the human being without considering the diversity of practices and, therefore, practice intensities of different human groups leading some authors to consider the term more useful as an informal concept (Swindles et al., 2023). This thesis, therefore, focuses on the concrete implications that these human-wildlife relationships have for the global dynamics of the system and how, from a normative perspective, they can foster species diversity and systems complexity.

¹ Free translation from French

2. From concern for nature to concern for biodiversity and spaces

One of the most critical environmental causes is biodiversity loss, leading to the yearly extinction of hundreds of species and populations (Ceballos et al., 2017). For example, in 2015, humans and their livestock represented 96% of the global mammal biomass, whereas wild mammals represented only 4% (Bar-On et al., 2018). The origin of this global decline lies in the intensity of human activities resulting in pollution, climate change, overexploitation of wildlife, landscape changes related to anthropisation and the booming of invasive species due to the globalisation of exchanges (Jaureguiberry et al., 2022). However, the biodiversity crisis is not only the consequence of species extinction as biodiversity integrates communities, populations and gene diversity (Jaureguiberry et al., 2022). Today, population extinctions are more frequent and significant than species extinctions (Jaureguiberry et al., 2022), which means that the wave of extinctions we are experiencing today is significant and does not just concern species extinctions (Ceballos et al., 2017).

While this mass extinction has accelerated in recent decades, conscious conservation efforts have existed for a while (Pascual et al., 2021). Indeed, biodiversity is increasingly threatened despite long-term action by policymakers and conservation organisations (Pascual et al., 2021). We will detail below the evolution of the concern for nature to put current conservation sciences and practices in a historical perspective.

Since the XIXth century, a conscious effort to protect nature has emerged in North America and Europe and developed with the industrial revolution (Larrère & Larrère, 2018; pp. 180-206). During the XIXth century, Henry-David Thoreau described a nature to admire and not to fear (Larrère & Larrère, 1997; p. 186). Starting from this conception of « nature admirable » [*“admirable nature”*]², Larrère and Larrère (1997; p. 184) report that the concern for nature was polarised between two conceptions in the last decades of the XIXth century: partisans of conservation and those of preservation. These two movements are opposed in the values they attribute: instrumental (values given to nature according to the potential provision of resources) or intrinsic (nature for itself). Firstly, Gifford Pinchot advocates the exploitation of forests and the constitution of reserves (Larrère & Larrère, 1997; p. 184). The aim is to conserve to exploit the natural resources

² Free translation from French

better. This vision of conserving nature for instrumental purposes is opposed to the attribution of intrinsic values to nature promoted by John Muir (Larrère & Larrère, 1997; p. 184). Therefore, the preservation movement criticises the conception of nature as a provider and the reinforcement of the compartmentalisation between social and natural spheres. The protection of nature movement was legally justified by the Wilderness Act of 1964 in the United States (Larrère & Larrère, 1997; p. 184). If we consider nature a social construction, it is essential to identify the evolution of these different conceptions of nature. As part of the nature protection movement initiated by John Muir, nature is considered a totality outside humans (Larrère & Larrère, 1997; p. 187). This vision of North American nature is critical in structuring conservation, mainly because this conception has been widely exported worldwide to define conservation schemes. However, Europe is, in fact, subject to particularly intense and prolonged pressure from human activities (Larrère & Larrère, 1997; p. 188). Therefore, the notion of virgin nature is challenging to transpose as such.

In the ecological sense, the landscape is a spatial structure resulting from the interaction between natural processes and human activities (Burel & Baudry, 1999). To think of a landscape is to associate a vision of the world with a physical space (Berque, 2015). However, biodiversity conservation has become an object of scientific research by anchoring itself in a positivist approach to science. Conservation biology has thus developed by studying these conservation issues using an ecological approach based on two assumptions: functionality and normativity (Soulé, 1985; as cited in Larrère & Larrère, 1997, p. 144). The presupposition of functionality, resulting from disciplines belonging to the natural sciences, means that the objects related to this problem are interrelated and underlie a particular organisation (Soulé, 1985). On the other hand, normativity is perhaps the most defining feature of conservation biology because it assumes that diversity and complexity are “good” for the system (Soulé, 1985). Therefore, the discipline tends towards diversity and complexity of the system to ensure its maintenance. This articulation structured the research in conservation biology by introducing biology in conservation sciences. But the difficulty in mitigating the declining global trend in biodiversity is mainly linked to the difficulty of merging and making communicating different conceptions of nature, especially between conservation institutions on the one hand and a diversity of people on the other hand (Pascual et al., 2021). Mace (2014) highlighted that this evolution in framing sciences and practices had

followed the conceptions of Human-Nature relationships: from “*nature for itself*” to “*nature despite people*” and “*nature for people*”. More recently, interdisciplinary research recognised the imbrication of social and ecological systems structured around the concept of a social-ecological system (Mace, 2014).

This paradigm shift follows the critique of the idea of nature made by interdisciplinary research. As Larrère and Larrère (2018; p. 186) demonstrate, « *L'idée d'une wilderness, où l'homme n'est qu'un visiteur temporaire, est la représentation urbaine d'une nature si lointaine qu'on l'imagine inhabitée* » [“the idea of a wild nature, where humans are only visitors, is only an urban representation of a nature so remote that we imagine it inhabited”]³. The concept of nature embedded in the term wilderness reflects a particular representation of nature, it is a construction of nature. They further noted that nature’s sanctuary leads to a double omission: « *celle des hommes qui y vivent, celle de la nature là où les hommes vivent, dans les espaces cultivés et urbanisés* » [“that of the humans who live there and that of nature where humans live in cultivated and urbanised spaces”]⁴. Therefore, nature conservation is approached by two disciplines that are often confused, ecology and conservation sciences, corresponding to different levels of analysis: conservation sciences cannot be reduced to ecology, and ecology cannot be generalised to conservation science.

Larrère and Larrère (2018; pp. 188-206) identified three movements in the construction of the nature protection movement: the first came from the wilderness idea before the industrial revolution, the second stems from the industrial revolution and the third relates to the recent globalisation of exchanges. These shifts in conservation sciences framings highlighted by Mace (2014) are put in historical perspective by Larrère and Larrère (1997), which underline the importance of social-historical dynamics in science framing.

As we reported from the work of Larrère and Larrère (1997), the instrumental value given to nature has been criticised and replaced by giving nature an intrinsic value whose roots have been identified by the authors as related to Kantian anthropocentrism. It can then be renamed a biocentrism (Larrère & Larrère, 2018; p. 191) and this vision first structured conservation policies.

³ Free translation from French

Due to the visibility of human activities and their intensity during the industrial revolution, the division between nature and humans became particularly evident. This division makes it possible to identify the most apparent threats localised geographically: anthropised and natural spaces threatened by the former (Larrère & Larrère, 2018; p. 195). These are no longer only threats linked to practices but also threats in terms of spatial occupation.

Finally, the third set of concerns identified by Larrère and Larrère (2018; p. 201) corresponds to the globalisation of environmental issues. Awareness of the global effects of human activities on biodiversity changes the conception of biodiversity protection. Historically, the repositioning of science and conservation practices shows us the profoundly contingent nature of this enterprise, which is updated in concert with scientific and social evolution. Through its specific research objectives, this thesis tries to integrate this double concealment of nature sanctuarisation: concealment of the humans who live there and that of nature where humans live in cultivated and urbanised spaces, as formulated by Larrère and Larrère (1997). This thesis studies the results of conservation sciences and their practical implications. It calls for the updating of the very objects of scientific knowledge. This correspondence between the values attributed to the idea of nature, the different ontological considerations of this idea, and the practical strategies for protecting nature pleads in favour of the importance of the epistemological objects of conservation sciences and practices.

3. Updating the objects of scientific knowledge within conservation sciences

Conservation sciences and practices are thus strongly driven by the nature of the relationships between humans and nature (Mace, 2014). For some authors, the recent shift in understanding social and ecological systems constitutes a paradigm shift in addressing crucial and urgent social-ecological sustainability (Schoon & Van Der Leeuw, 2015). The interdependency of environmental and societal challenges poses significant problems for stakeholders in apprehending these issues, especially in moving from theory to practice (Preiser et al., 2021a). Scientific research and practices are thus paramount to understand these intertwined social-ecological systems (Folke et al., 2016). The movement towards investigating the intertwined nature of human and natural systems emerged and structured itself with the social-ecological system (SES) concept (Schoon &

Van Der Leeuw, 2015). In the nineties, interdisciplinary research suggested the concept of SES (Schoon & Van Der Leeuw, 2015). The idea considers the compartmentalisation of social and ecological spheres as purely artificial (Folke & Berkes, 1998). SES are, therefore, not the artificial juxtaposition of social and ecological components but are intertwined and depend on multiple relationships between the artificially delineated systems (Biggs et al., 2015; Folke et al., 2010).

To conceptualise the different relationships structuring SES, researchers schematise their understanding of the system with the use of frameworks which allow them to represent elements and relationships of the system (Preiser et al., 2021a). The global understanding of the epistemological approach of the system shapes SES more than specific guidelines allowing it to describe the SES according to Preiser et al. (2021a). Systems are only a tool to represent the world and should be understood as driven by the epistemological background shaping this representation. As a summary of the different SES frameworks, SES is considered a complex adaptive system (CAS) that presents some common characteristics with other frameworks (Biggs et al., 2021). Patterns of relationships at the system level emerge from various interdependent elements, and it is impossible to predict these patterns only from the properties of the system's components (Biggs et al., 2021). These systemic patterns can, in turn, influence the dynamics of the different elements of the system and their ability to interact with other parts (Preiser et al., 2021b). This approach to understanding the system is called “complex” by moving above reductionism and holism. Complex, not in the sense of a particular difficulty to adopt this approach but complex as acknowledging the necessity to consider a diversity of relationships within the system.

According to Preiser et al. (2021b), acknowledging a diversity of relationships between system components at different integration levels implies that these relationships are multidirectional. They generate many feedbacks allowing an important adaptation ability. From this understanding, Preiser et al. (2018) characterise SES as complex (not reducible to the parts nor generalisable to the whole) and adaptive (they can co-evolve and auto-organise in response to perturbations). Preiser et al. (2018) formalised this complex and adaptive perspective of SES by synthesising six general principles to describe these systems. This thesis mobilises this formalisation as a global framework for studying SES.

Adopting a social-ecological approach to conservation suggests that we focus our investigation on the practical ways humans relate to wildlife and, interdependently, the modes of representation of these interactions. Virtuous social-ecological dynamics between humans and wildlife in shared landscapes are characterised by a particular type of resilience, consisting of the avoidance of detrimental consequences of the relationships between actors of the system (between humans and between humans and non-humans): coexistence. From a theoretical perspective, CAS's understanding of SES occurred without profoundly changing practices, acknowledging the difficulty of moving from theory to practice (Preiser et al., 2018). In a more practical understanding of these problematics, the idea of reconciliation ecology, formulated by Rosenzweig (2003a), proposes to enlarge conservation strategies based on empirical evidence promoting both human activities and wildlife persistence. Rosenzweig (2003a) developed this idea based on the linear relationship, classic in biogeography, between species diversity and spaces available for wild species. He proposed a series of examples of coexistence and mutual benefits that emerged empirically (Rosenzweig, 2003a). They are the result of the contingency of multiple principles. Their analysis requires certain interdisciplinarity or even transdisciplinarity. At the largest scale, 1% of biodiversity corresponds to 1% of the suitable area. Creating, maintaining and inventing favourable spaces for wildlife species is thus paramount for thinking conservation away from an artificial dichotomy represented by protected areas schemes (Rosenzweig, 2003b). This need to rethink the conservation approach of SES from local to global has been acknowledged by other recent conservation frameworks such as the UNESCO Man and Biosphere (UNESCO, 2017) or the Shared Earth and Ocean framework (Obura et al., 2021). While nature conservation efforts have focused on areas where human pressure is high, the Shared Earth and Ocean framework focus on the "*middle ground*" when relationship issues cannot be addressed by the dichotomy between humans and nature (Obura et al., 2021). The effort to make the theoretical postulates of the CAS approach of SES operational in practical case studies is gaining increased interest, especially in the case of human-wildlife coexistence, to give adequate responses to the sixth mass extinction.

This thesis further explores the questions posed by conservation sciences and practices about coexistence by adopting a complex and adaptive approach to SES. Finally, this thesis examines the implications of this coupled understanding of social and

ecological systems for conservation science and practice, primarily through the issue of human-wildlife coexistence.

4. Adopting a transdisciplinary approach to conservation

Studying the resilience of social-ecological systems through the approach of a CAS understanding of SES needs to move beyond the disciplinary compartmentalisation of science (Scholz, 2011). Gödel (1931; as cited in Scholz & Steiner, 2015) calls for the unification of different levels of analysis or to frame a meta-level analysis. It has been defined by Piaget (1972; as cited in Scholz & Steiner, 2015) as “*total transdisciplinarity*”. According to Scholz and Steiner’s (2015) definition, transdisciplinarity is a research approach applied to real problems through the inclusion of stakeholders in the research process. While the transdisciplinary approach aims to go beyond disciplinary approaches while being theoretical and practical, how stakeholders are integrated into the process needs further exploration (Tengö et al., 2017).

The division between science and society implies the existence of scientists and non-scientists, of specialisation between those who have the legitimacy to practice science and those who do not. This integration of non-scientists in research projects imply a particular qualification of these scientific activities, citizen science, also known as participatory science. Although the desire for a less compartmentalised science has been asserted in recent decades, non-scientists participation in scientific activity is not a new process (Nègre, 2022, p. 15). Indeed, science became professional only during the XVIIIth century (Nègre, 2022, p. 15). Before that, the scientific research was more a practice than a profession (Nègre, 2022, p. 15). Given that there was no distinction between scientific and non-scientific, it is not easy to qualify science before the XVIIIth century as citizen science, as analysed by Nègre (2022, p. 15). However, non-scientists place in science has varied over the last centuries. The social protests and radical movements that penetrated the scientific community in the 1960s and 1970s are cited by Nègre (2022, p. 17) as one of the origins of citizen science. To illustrate this point, the author notes that in the post-Vietnam War context, many scientists spoke out against what they saw as the excesses of science and technology, including subservience to the military-industrial complex or environmental destruction (Nègre, 2022, p. 17).

According to Nègre (2022, p. 19), the term “citizen science” emerged in the mid-1990s in the United States and the United Kingdom, independently through the work of Bonney (1996) and Irwin (1995). While there is some common ground between the definitions, they differ in the scope they attribute to the concept. On the one hand, according to Nègre (2022, p. 19), Bonney (1996) considers citizen science as an educational and awareness-raising outline, a kind of activity proposed to non-scientists to demystify science. On the other hand, according to Nègre (2022, p. 19), Irwin (1995) sees a performative capacity of this non-scientific practice for the effectiveness of science policy. Irwin's definition is more bottom-up than Bonney's, which remains more vertical in its conception of the relationship between scientists and non-scientists. Thus, science-based public debates must consider the public in terms of data to be obtained and used but also values to consider the epistemological and political dimensions of its participation. Nègre (2022, p. 19) notes that while the visions of Bonney and Irwin are not mutually exclusive, they highlight the extreme versatility of citizen science. The terminology reflects the concept: participation (data collection), engagement (active discussions between parties) and involvement (decision-making role) are three levels of integration of the public in the research process (Nègre, 2022, p. 22). From the separation between participation, commitment and involvement of the people mentioned above, it is possible to identify four main typologies of participatory science that are functions of the decision-making level that the amateur or group of amateurs plays in the conduct of the scientific project (Bonney et al., 2009; as cited in Nègre, 2022, p. 22). Bonney et al. (2009; as cited in Nègre, 2022, p. 23) have defined different types of projects:

Contributory projects are projects with the lowest level of participant involvement. Participants collect data following a more or less defined protocol and transfer the data to scientists for analysis. The process is vertical, and the participant is a data provider. It is the case, for example, of large-scale projects such as those carried out on the Zooniverse platform.

By involving participants in more advanced cognitive tasks that require some training, *collaborative* projects have a higher level of commitment from participants than contributory projects. However, the body of scientists behind the project is still the dominant part of the research.

The shift in the balance between scientists and non-scientists in citizen science occurs in *co-creation* projects. The participants have decision-making power in different

stages of the research process (definition of the problem, method and means). According to Nègre (2022, p. 22), the latter is often at the origin of identifying potential scientific problem and the constitution of an association. A partnership is then formed in which the different actors' roles are defined.

Finally, "*Do it by yourself*" projects are those in which the participants are the most influential (Nègre, 2022, p. 22). Nègre (2022, p. 22) notes that, within these projects, participants claim the freedom to explore science outside of any hierarchical relationship through artistic production, for example, and assume that they do not necessarily follow the norms and standards of academic laboratories.

In the context of broadening the way of doing science and, more specifically, studying adaptive and complex SES, notably according to a transdisciplinary approach, the question of inclusiveness is central. Several authors recognise that in large parts of the Earth, Indigenous peoples and local communities (IPLC) have a paramount role in the resilience of the social-ecological system precisely because of the diversity of practices implemented related to a variety of knowledge systems (Brondizio & Le Tourneau; 2016; as cited in Tengö et al., 2017). The term Indigenous People represents "*people who have a long-term and multigenerational association with a given place*", according to the definition of Wheeler and Root-Bernstein (2020). They are often defined as "*the descendants of people who have been present in a location before colonisation by another ethnic group*" (Wheeler & Root-Bernstein, 2020). Self-identification is paramount to being Indigenous and characterising communities with their worldviews (Hill et al., 2012; as cited in Wheeler & Root-Bernstein, 2020). Following this definition of Indigenous people, Wheeler and Root-Bernstein (2020) define the term "local community" as people who "*currently live in an area and often have a multigenerational association with a given place but are not necessarily defined and do not self-identify as Indigenous*". It describes people living for generations in a place and from immigrant or colon descent. A substantial body of literature calls for better recognition of Indigenous and local knowledge (ILK) for conservation (Mistry & Berardi, 2016; Sterling et al., 2017; as cited in Tengö et al., 2017).

5. Towards coexistence: the implications of a complex and adaptive approach of social-ecological systems for conservation sciences and practices

The recognition of the need for a transdisciplinary approach to conservation, of which inclusiveness is a primary condition, therefore leads to refocusing our attention on the resilience of SES. This focus can be done from the perspective of the relationship between human populations and wildlife. Hence, we will refer to coexistence as a scenario where a shared space between human and wildlife populations promotes a resilient, adaptive and complex social-ecological system.

This thesis aims to deepen the understanding of the adaptive and complex SES dynamics within shared human-dominated landscapes and the theoretical and practical dimensions of coexistence scenarios in the context of conservation sciences and practices.

The primer of this project was methodologically twofold: a literature review of the scientific research on landscape strategies for coexistence and preliminary interviews with local stakeholders (Appendix I). Collaboration between knowledge systems has been considered paramount for conservation (Tengö et al., 2017). The broad delineation of the research themes in the scientific literature allowed us to articulate these insights with the preliminary interview methodology. These semi-structured face-to-face interviews offered the opportunity to engage in a specific relationship with the stakeholders. They allow extending the stakeholder list through a snowballing approach, presenting the broad theme of the research and having insights from the stakeholders. They also collaboratively identify the methodologies that would be efficient in terms of knowledge co-creation and engagement regarding the issues recognised as paramount both for the stakeholders and the research. Regarding the contingency of SES, we will follow the position of Bensa (2006) on the biases of analysis emerging from considering societies as a cultural totality with an irreducible specificity with the idea of actors' positions. Functional or structural order predetermined these positions. Therefore, it will be a question of placing the actors in their historical context, which will allow for a more refined approach to analysing the various positions and the overall understanding of the system. The contextualisation of the study sites will, therefore, not be purely geographical but will be done with particular attention to the history of the settlement of South Africa and the processes of formation of the South African state.

Moreover, it will be a question to address the challenges of interpreting these SES related to the complicated navigation between the categorisation of humans resulting from this historical process and the categories of stakeholders we have defined. This research has been structured by adopting methodologies that meet the criteria of the four participatory science types: contributory, collaboration, co-creation and "Do-it by Yourself". These different approaches to participatory science involve various levels of researcher's involvement in the process.

The first step will be to extend research in landscape ecology, widely used in conservation sciences, to a relational conception of the landscape as a complex and adaptive SES. From this conceptualisation of the relational landscape within conservation sciences, the joint analysis of the scientific literature and preliminary discussions with various stakeholders will enable identifying issues at stake and research questions to formulate collaboratively adapted methodologies. This methodological description must be understood as a methodological emergence that is an integral part of this thesis work. Therefore, the first chapter will describe the co-construction process thoroughly. We will thus detail the methodological issues this thesis underlines and the new research objects it mobilises, modifying the objects of conservation sciences investigation. Adopting a social-spatial approach will allow us to deepen these methodological questions by analysing their statistical implications and the very particular dimension that the data occupies in interpreting the results of their analysis. These methodological meanings will enable a deeper understanding of coexistence mechanisms between human populations and wildlife according to a transdisciplinary approach, i.e., co-constructive, participatory and relational. The insertion of this relational dimension in a CAS approach to SES raises ethical and practical questions whose link with stewardship actions favouring coexistence will deserve to be deepened.

Adopting a social-ecological approach to conservation suggests that we focus our investigation on the practical ways humans relate to wildlife and, interdependently, the modes of representation of these interactions. Virtuous social-ecological dynamics between humans and wildlife in shared landscapes are characterised by a particular type of resilience, consisting of the avoidance of detrimental consequences of the relationships between actors of the system (humans or non-humans): coexistence.

In this thesis, the questions posed by conservation sciences and practices about coexistence are further explored by questioning their ontological, epistemological and

methodological implications. By mobilising a transdisciplinary approach to co-constructing research, the research questions and objectives emerge fully from this project. They are the result of an inductive approach. Therefore, they will not be presented in this introduction, whose aim is to contextualise the realisation of this study and describe the different theoretical frameworks mobilised. Instead, the first chapter will give the research objectives and questions as they emerged from this project.

SOCIAL-HISTORICAL CONTEXTUALISATION AND STUDY SITES

This work requires an interest in the theoretical and practical dimensions of coexistence dynamics within the conservation science framework, especially when approaching transdisciplinary. Before presenting and detailing the different study sites that will allow us to respond to our research questions, it is important to contextualise this work within the broader conservation framework in South Africa, where this research fieldwork was conducted (Figure 1). This contextualisation work has mainly been undertaken and synthesised through Fauvelle's work (2006), notably the sections *“Southern Africa settlement”*, *“The South African construction”*, *“Colour, race and belonging”*, and *“The violence of names”* to give a precise overview of the context in which this work is rooted.

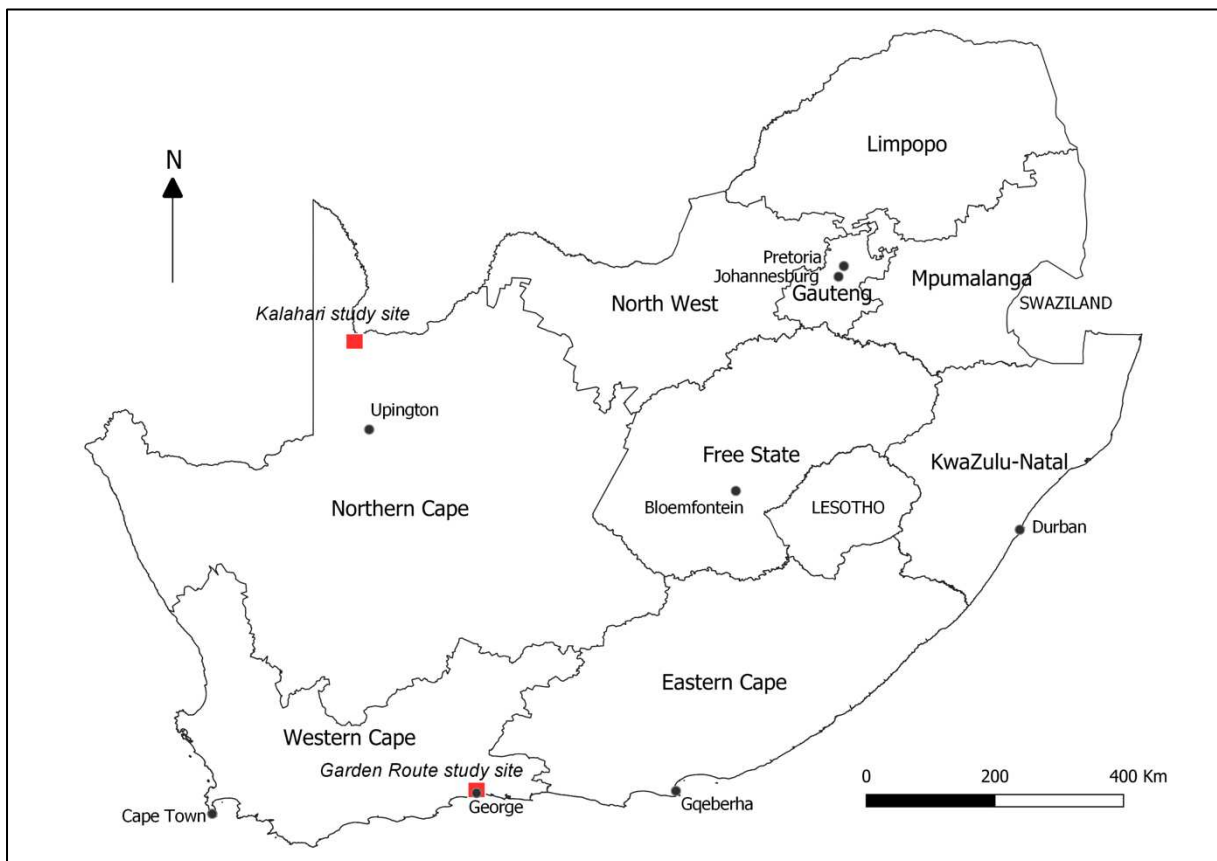
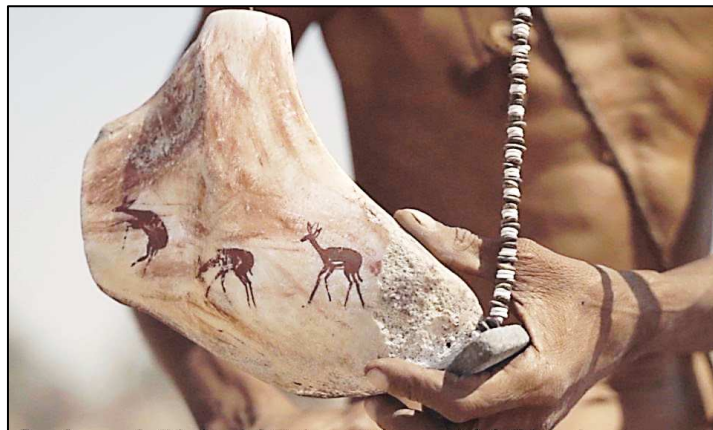


Figure 1. South Africa administrative map

I. History of settlement and political construction

1. Southern African settlement

The history of settlement in Southern Africa is often presented as the concurrent settlement of different populations that later came into conflict for power. This discourse on South African history is still used today in South Africa to highlight a supposed specificity of South Africa about colonisation. However, archaeological evidence, including the discovery of *Australopithecus* skeletons and then representatives of the genus *Homo*, shows that the region has been inhabited for thousands of years (Fauvelle, 2006; p. 117). The archaeological sources also show that these prehistoric populations of the genus *Homo* practised hunting and gathering, which creates a concrete proximity with the Khoisan-speaking people (Fauvelle, 2006; p. 117). This linguistic group comprises Khoi populations, herders-hunter-gatherers (Sadr, 2003) and San populations practising only hunting and gathering. It is striking to compare today's Bushman craftsmanship with the style of rock art widely found in South Africa or even in European caves.



Picture 1. A springbok hip with the representation of antelopes engraved in fire and ochre.
Created by Elia Festus ©Élie Pédarros

These similarities have contributed to the fact that people from the Khoisan language group are considered the Indigenous people of South Africa (Fauvelle, 2006; p. 118). Khoisan people are among the last groups on the planet to practice this mode of subsistence and these groups have been well studied by the anthropologists of the XXth century (Barnard, 1992; Lee & DeVore, 1968; Marshall, 1976 as cited in Fauvelle, 2006; p.

119). These groups were victims of colonisation and apartheid, marginalised, reduced to poverty, rape, murder and contempt (Fauvelle, 2006; p. 130). Today, the San are mainly present in Namibia, Botswana and to a lesser extent in South Africa, representing about 100,000 people (Fauvelle, 2006; p. 119). It is more difficult to establish a precise number of Khoi people because, living in more dense areas close to the coast, they have mixed with other populations to such an extent that it is challenging to identify a formal category, and they do not easily self-identify as such according to some representatives of the community. The establishment of farms by Afrikaans farmers in Khoisan territory, structured as a series of watering holes they regularly visited (Fauvelle, 2006; p. 119), led to them being “employed” on these farms and subject to the farmers' rules, a phenomenon known as *baaskap* (Koot, 2016). However, these Khoisan people should not be seen as living fossils from prehistoric times (Fauvelle, 2006; p. 121). Fauvelle (2006; p. 121) reports that hunter-gatherer societies had begun a process of social complexity in other areas than the Kalahari, where they are today mainly present. Furthermore, it would be omitting the diversity of Khoisan languages, their institutions and modes of representation, and thus deny the history of these peoples (Fauvelle, 2006; p. 150). Khoisan languages were probably spoken throughout southern Africa, given the survival of two possible Khoisan isolates in Tanzania and the existence of clicks in some of Kenya's languages (Fauvelle, 2006; p. 151). These Khoisan languages are now endangered, especially in South Africa, where only a few elders know them. It is essential to note that, as Fauvelle (2006; p. 127) points out, the Khoisan have histories and narratives linked to the various changes that have taken place in their respective geographical environments and in which they have actively participated (Figure 6).

2. The South African construction

The differentiation between the San and Khoi populations within the Khoisan linguistic group has often been attributed to the adoption of herding practices by the Bantu-speaking peoples who settled in southern Africa. But archaeological sources show that these farming practices existed before the arrival of the Bantu-speaking peoples a few centuries later suggesting that the practice of herding by the Khoi appeared spontaneously in southern Africa (Fauvelle, 2006; p. 143). It is an essential point

underlining the dynamics of Khoisan practices often designated passive actors of their history.

With the arrival of the Bantu-speaking peoples, who are exclusively herders, the villages multiplied and confirmed the dominance of herding in this region (Fauvelle, 2006; p. 144). The Khoisan and the Bantu speakers did not remain isolated from each other, as shown by the incorporation of the “clicks” of the Khoisan languages into the Bantu languages, such as IsiXhosa and Zulu, for example.

In the XVth century, the Portuguese and other European nations bypassed Africa to reach their trading posts and colonies in the East Indies stopping sometimes at the Cape of Good Hope without settling (Fauvelle, 2018; p. 104). The Khoisan were not passive towards European incursions into southern Africa, as is often described. As reported by Fauvelle (2006; p. 155), a Portuguese fleet is massacred at the Cape of Good Hope by « *quelques dizaines de villageois khoekhoe poussant devant eux des boeufs dressés au combat, les Portugais ont ordre de ne plus faire halte sur ces côtes. [...] On ne s’y arrête donc guère, rarement volontairement, mais on s’y échoue souvent* » [“a few dozen Khoi pushing before them oxen trained in combat; they are ordered not to stop on these coasts [...] Thus, they hardly stop there, they often run aground”]⁵.

The first European settlement dates from 1652, with the Dutch East India Company (VOC) establishing a trading post at the Cape of Good Hope (Fauvelle, 2006; p. 159). Fauvelle wrote a significant work on the perception of these Khoisan populations on the part of Europeans, which subsequently structured colonial thought in South Africa and the myths relating to the Khoisan people (Fauvelle, 2018). The VOC encouraged the permanent settlement of colons (Figure 6), followed by the arrival of 156 Huguenots who had fled the revocation of the Edict of Nantes in 1685 (Fauvelle, 2006; p. 159). They were welcomed by the United Provinces and offered passage to the colonies (Fauvelle, 2006; p. 159). This community was at the origin of the Afrikaner community (Fauvelle, 2006; p. 160). It is essential to note that Southern African societies did not practice slavery before colonisation: neither the Khoisan nor the Bantu herders practised it; nevertheless, slavery was essential to South African colonial history (Fauvelle, 2006; p. 162). Another critical moment in Southern Africa’s history was the arrival of the United Kingdom in 1795, settled in the Cape colony. The colony, military took, hosted 5000 settlers in 1820

⁵ Free translation from French

(Fauvelle, 2006; p. 165). Fauvelle (2006; p. 169) reports intense tensions between the Afrikaner and British communities, resulting in several republics consecutive to the Great Trek of the 1830s (Fauvelle, 2006; p. 171). Thousands of Afrikaners left the colonies to seek peace outside the borders of the Cape Colony (Fauvelle, 2006; p. 171). This double expansion movement, expressed by Fauvelle (Fauvelle, 2006; p. 154), was characterised by remarkable resistance from the Khoisan and Bantu communities (Xhosa, Zulu, Sotho, etc.) (Fauvelle, 2006). Nevertheless, Fauvelle (2006; p. 172) identifies the creation of these republics as the beginning of the tensions which occurred at the beginning of the XXth century. These republics, less critical than the coasts at first sight, were considered of primary importance with the discovery of diamond and gold at the end of the XIXth century (Fauvelle, 2006; p. 171). In 1910 (Figure 7), Great Britain united the four white political entities (Fauvelle, 2006; p. 171). They combined the different republics into a single dominion: two British colonies (Cape Town and Natal) and two former republics that had lost their independence during the Anglo-Boer War (1899-1902) (Fauvelle, 2006; p. 171). As the new entity had to be named after the white Transvaal Republic, it was renamed the Union of South Africa becoming a republic in 1961 (Republic of South Africa) (Fauvelle, 2006; p. 175). The Republic moved African populations to reserves to separate colonists and African people, initiating the premise of apartheid ideology implementation (Fauvelle, 2006; p. 97). They struggled from these reserves for their rights and acknowledgement as proper South Africans. They gained recognition in the early 1990s after a negotiation resulting from years of resistance both non-violent and armed (Fauvelle, 2006; p. 422).

3. Categorisation of the Humans

Consequently, to the apartheid times in South Africa, it is essential to underline its categorical structure and the racist roots at its origin. Fauvelle (2006; p. 54) highlights that it is often convenient to use categories to describe a population, especially by highlighting the physical differences we perceive. However, Fauvelle (2006; p. 54) insists that this categorisation is external and does not refer to lived identities or origins. This categorisation is mainly based on skin colour and is still commonly used in South Africa nowadays, even in institutional contexts. However, it is deeply rooted in racialist theories from the segregation and apartheid times (Fauvelle, 2006; p. 54).

Skin colour categorisation is essential in South Africa and is still legally and institutionally in force. These categories are crucial for understanding the social-historical context of South Africa and for understanding power issues. Indeed, belonging to a racial category is also a question of social identity (Fauvelle, 2006; p. 55). "Black" is used today to designate South Africans of Bantu-speaking origin. However, in the Cape Colony, the term referred directly to slaves and therefore did not necessarily refer to "black" skin (Fauvelle, 2006; p. 57). Freed slaves were referred to as "free blacks", and the term included all non-whites (Fauvelle, 2006; p. 60). The term "coloured", still used today, refers to non-whites, not Bantu-speaking (Fauvelle, 2006; p. 61). It is a racial category based on the denial of any belonging. In this respect, mixed-race people whose parents are white and black and Khoisan people are considered "coloured". Despite this racist origin of the term, the coloured community is not an artificial group because it has structured itself as a particular group and formed a real identity (Fauvelle, 2006; p. 61).

To gain insight into social relations in South Africa, it is necessary to look at the history of naming different population groups, as they carry a history prevalent in social relations today. According to Fauvelle, the term "Cafir", from the Arabic meaning "infidel" and "miscreant", was used by the Portuguese to refer to African populations throughout the continent and was later replaced by the term "Hottentot" to refer to African people in the Cape and a second step more specifically to the Khoisan (Fauvelle, 2006; p. 67). The Africans adopted this name and superimposed it on the Khoikhoi term (humans among humans) they previously referred to themselves (Fauvelle, 2006; p. 68). This superimposition differentiated between the Cafres and the Hottentots, who were black and lighter-skinned (Fauvelle, 2006; p. 68). As a result, the term Hottentot is now a pejorative in South Africa.

Different words have subsequently been used to refer to these Khoisan communities. The term Bushman, for example, is criticised for its lack of inclusivity (gender and Eurocentric specific) and the term San is preferred institutionally in South Africa (Fauvelle, 2006; p. 69). However, San is also a pejorative term of Khoi-Khoi origin that refers to « *individus perçus comme socialement marginaux ou ontologiquement inférieurs* » ["individuals perceived as socially marginal or ontologically inferior"]⁶ according to Fauvelle (2006; p. 70). Racial categories apply not only to people of African

⁶ Free translation from French

origin but also to European settlers. For example, the Afrikaner term “Boer”, meaning farmer or peasant, was used by the British administration to refer to Afrikaaners and allowed British settlers to distinguish themselves from this white population by seeing themselves as the urban counterpart of colonisation (Fauvelle, 2006; p. 57). However, the Afrikaaners did not use the term themselves until the XVIIIth century, allowing them, as Fauvelle (2006; p. 58) notes, to assert their Indigenous character within the European community and their European character towards other populations.

Therefore, we will refer to both San and Bushmen, Khoi, Khoisan as a whole and White indiscriminately for individuals claiming Afrikaner or British origin, and Bantu for other social groups who speak a language of the Bantu language group. In using these terms, we are fully aware of their historical and social context and use them to refer to social groups that define themselves as such.

II. South African conservation and study sites

1. The social-ecological issues of South African conservation

In the context of the colonial era, particularly in Africa, conservation must be understood in its political and social dimensions. The history of conservation in Africa is deeply linked to European colonisation. While Africa was part of the global wildlife trade, animal populations collapsed due to intensive hunting campaigns by colonists (Blanc, 2020; p. 64). Blanc (2020; p. 64) argues that in response to this dramatic collapse, the British and Germans created reserves in their East African colonies and imposed a substantial apparatus to govern these areas (hunting seasons and permits, prohibition of certain practices). Therefore, the history of conservation in Africa should be placed in the history of colonial hunting practices, which initiated this concern for wildlife considered as resources and allowed this dichotomous vision between humans and nature to be established in African biodiversity conservation policies. According to Blanc (2020; p. 64), the colonists reproduced the European aristocratic model by distinguishing between « le bon « chasseur » du mauvais « braconnier » »["good hunters" [and] "bad poachers"]⁷. Even today, in the Kalahari, San people are legally constrained to hunt wild animals for subsistence. In contrast, at the same time, trophy hunting by wealthy South African or foreigners is a lucrative economy. These hunting reserves also had political and economic purposes (MacKenzie, 1988; as cited in Blanc, 2020; p. 65). They were the primers of protected areas, now considered as a tool for protecting wildlife (Rodary, 2019; p. 11). Therefore, protected areas must be regarded as their social-political emergence and the tangible translation of specific visions of relationships with nature. A protected area is, therefore, never neutral, and this conservation model in Africa, whether successful or not, must be understood as the product of this colonial history.

These game reserves, intended for the tourist industry, were also significant in justifying the conservationist movement and a primary tool in response to specific African independence movements (Rodary, 2019; p. 11). Indeed, often located on the margins of states and at their borders, game reserves that have become national parks make it possible to organise the territory. They are political tools that make it possible to establish

^{7,8} Free translation from French

and legitimise the contours of states and give legitimacy to the power in place (Blanc, 2020). Consequently, conservation and its protected area tool are highly political and should not be considered solely as biodiversity mitigation measures.

In South Africa, Rodary (Rodary, 2019; p. 12) identifies two consequences of this « outil spatio-institutionnel » [*“spatial-institutional tool”*]⁸: spatial segregation between humans and natural areas and a means of controlling population movements. Still in the Kalahari, San people are spatially separated from the “wilderness” area of the Kgalagadi Transfrontier Park and cannot freely access the part of the park they own. Rodary (2019; p. 12) also notes that scientific systems ecology in the 20th century validated this "*spatial-institutional tool*"⁶ of protected areas, notably by highlighting the link between conservation policies and science. Biodiversity issues and the proximity of protected areas must be understood in this context, which shapes the way we conceive and integrate the importance of protected areas into interpretations of socio-ecological processes. However, in the 1970s, this political tool of the natural protected area became part of conservation sciences and practices, mainly linked to the opening of landscape ecology, but also to the recognition of social and ecological dynamics and finally to the globalisation of the problem of biodiversity conservation (Rodary, 2019; p. 13). The South African context for studying human-wildlife relationships within a complex and adaptive social-ecological system is particularly relevant because the issues at stake are salient, and the components of the system are highly identifiable. By contrasting different study sites, the aim is to highlight the mechanisms of coexistence emanating from these sites with an inductive approach. The research was conducted on two contrasting South African sites: the Garden Route and the Kalahari.

2. Garden Route site

In 1772, the Dutch company created a new trading post in George to exploit timber and contributed to the expansion and growth of George. They encountered Khoïkhoï tribes around Hoogekraal, now called Pacaltsdorp, a George neighbourhood. These populations were converted to Christianity (Bell & Bowman, 2002). During the

apartheid, Pacaltsdorp was considered a township for “coloured people”. The Garden Route site (542.96km²), including George municipality (Figure 2), is established from the South to the North between the Indian Ocean and the Outeniqua mountains. The area is renowned for its biodiversity, part of the Greater Cape floristic region, exhibiting high levels of endemic species (Vromans et al., 2010). The Garden Route National Park is fragmented and unfenced, mainly open for access to residents and visitors, with some controlled access areas (Roux et al., 2020). This park is a complex of protected afrotemperate forests, fynbos, lakes, marine ecosystem and mixed with semi-urban, commercial forestry and agricultural landscapes (Figure 5)(Roux et al., 2020). George urban area (193,672 permanent inhabitants, George census, 2011) is a mid-size metropolitan area with significant agricultural development on the west and high-density settlement areas to the south. Within this study site Victoria Bay, Wilderness, Hoekwil and Kleinkrantz (Figure 3) constitute semi-urban essential important tourism destinations, characterised by a mix of coastal and semi-rural lifestyles and increasing development. A hilly landscape depicts Wilderness landscape with residential farm-type settlements on the hilltop and a small city centre on the seaside. Wilderness property owners are primarily of Afrikaner and British descent. Some property owners organised themselves in local conservancies to manage their plots collectively for conservation purposes. Wilderness is nested within the Garden Route National Park with afrotemperate forest and invasive Acacia species that proliferate outside the park boundaries. Productive agricultural landscapes characterise Hoekwil bordered on its southern side by the Garden Route National Park.

This study site is particularly interesting because it is the tangible expression of a social-ecological system representing a mosaic of land uses and a network of an unfenced protected area inhabited by diverse stakeholders, including Indigenous people and local communities. The study of human-wildlife coexistence by adopting a CAS understanding of the social-ecological system is thus particularly pertinent in the Garden Route.

3. Kalahari site

The Kalahari site (542.88 km²) is located around Askham, part of the Dawid Kruiper Municipality, 60 km south of the Kgalagadi Transfrontier Park, which is fenced

off on its South African side (Figure 4). The area is described as a semi-arid savannah, typical of the southern Kalahari landscape, structured by a dunes system (Wasiolka & Blaum, 2011). The area is dominated by large commercial livestock farms, with scattered areas of human settlement structured as a mosaic of formal and informal settlements (Figure 5). Afrikaners people established farms where they made work local hunter-gatherers populations of San people, which belonged to the #Khomani San language group, also known as N|u (Grant & Tomaselli, 2022) and Mier communities. The origin of Mier community comes from the people of Captain Vilander, who escaped the Cape Colony in 1865 (Thondhlana et al., 2011). They settled in the Kalahari in Rietfontein and are predominantly farmers (Thondhlana et al., 2011). In 1931, the Gemsbok Park was created in South Africa, and the government evicted San and Mier's communities living on the park's territory, whereas some stayed there (Sylvain, 2002). From the 1950s, when the remaining small San and Mier groups were classified as "coloureds" during the apartheid, still in use administratively nowadays, they were relocated to remote parts of the Northern Cape (Sylvain, 2002). After additional incentives to limit their rights, particularly concerning hunting and gathering, they were forced to leave the park in the 1970s (Carruthers et al., 2003). After the apartheid, a group of Bushmen led by Dawid Kruiper and his family launched a claim with the Mier community to get property and rights on the plots belonging to the government and Afrikaners farmers. Supported by NGOs and lawyers, the land claim was made within the frame of culture and identity, creating tensions with the other San family of the Vaalbooi (Robins, 2001).

In 1999 the Kgalagadi Transfrontier Park was created on the old South African Gemsbok Park created in 1930. The transfrontier park is co-administrated by the South African National Parks (SANParks) and the Department of Wildlife and National Parks of Botswana. #Khomani San people obtained six farms (34,728 hectares) transferred to the Common Property Association (CPA) management (Bosch & Hirschfeld, 2002). In 2002, they also obtained 57,903 hectares of land in the Kgalagadi Transfrontier Park, the !Ae!Hai Kalahari Heritage Park owned by the #Khomani San and Mier communities (Bosch & Hirschfeld, 2002). Today San people are settled on the Witdraai farm for most of the Kruiper family and relatives, willing to live in a "traditional" way, on the Andriesvale farm for most of the Vaalbooi family and relatives living in a more contemporary form and on Askham town, in a mix of informal and formal settlements. Some business owners from Afrikaners farming families run their businesses in Askham on the other side of the road.

The Kalahari site is particularly interesting for this study as it encompasses specific human-wildlife relationships through the tangible expression of fenced protected areas and free-roaming wildlife. Moreover, social-ecological issues through the strong presence of Indigenous people and local communities highlight the complexity of the system.

The comparison of these two very contrasting sites, both in terms of their social-ecological dynamics and in the conservation strategies implemented or in the diversity of stakeholders, will make it possible to put into perspective the different mechanisms of human-wildlife coexistence based on common research questions and methodologies as well as the specific involvement of Indigenous peoples and local communities among a more extensive set of stakeholders.

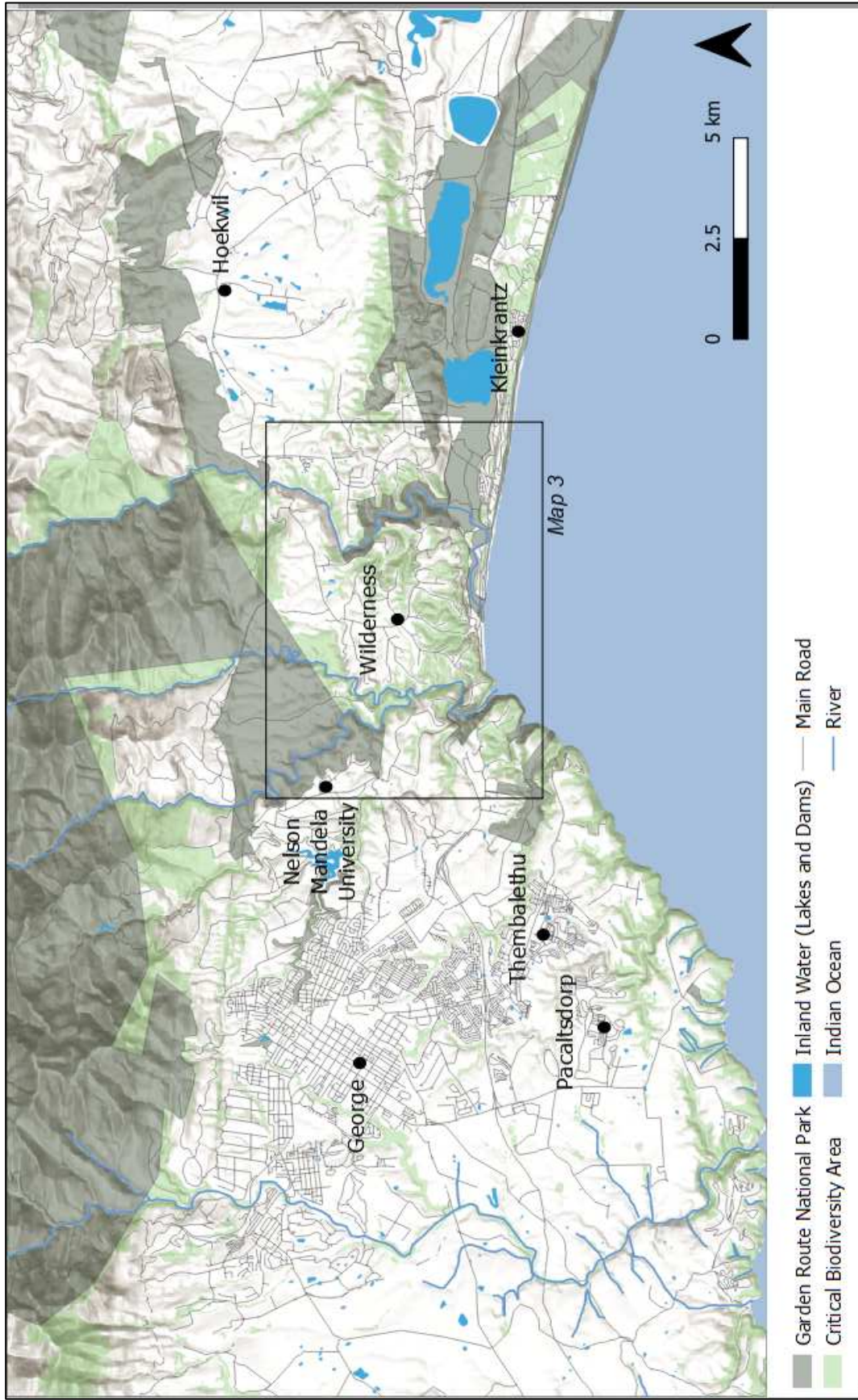


Figure 2. Map of the Garden Route site, in the George Municipality area

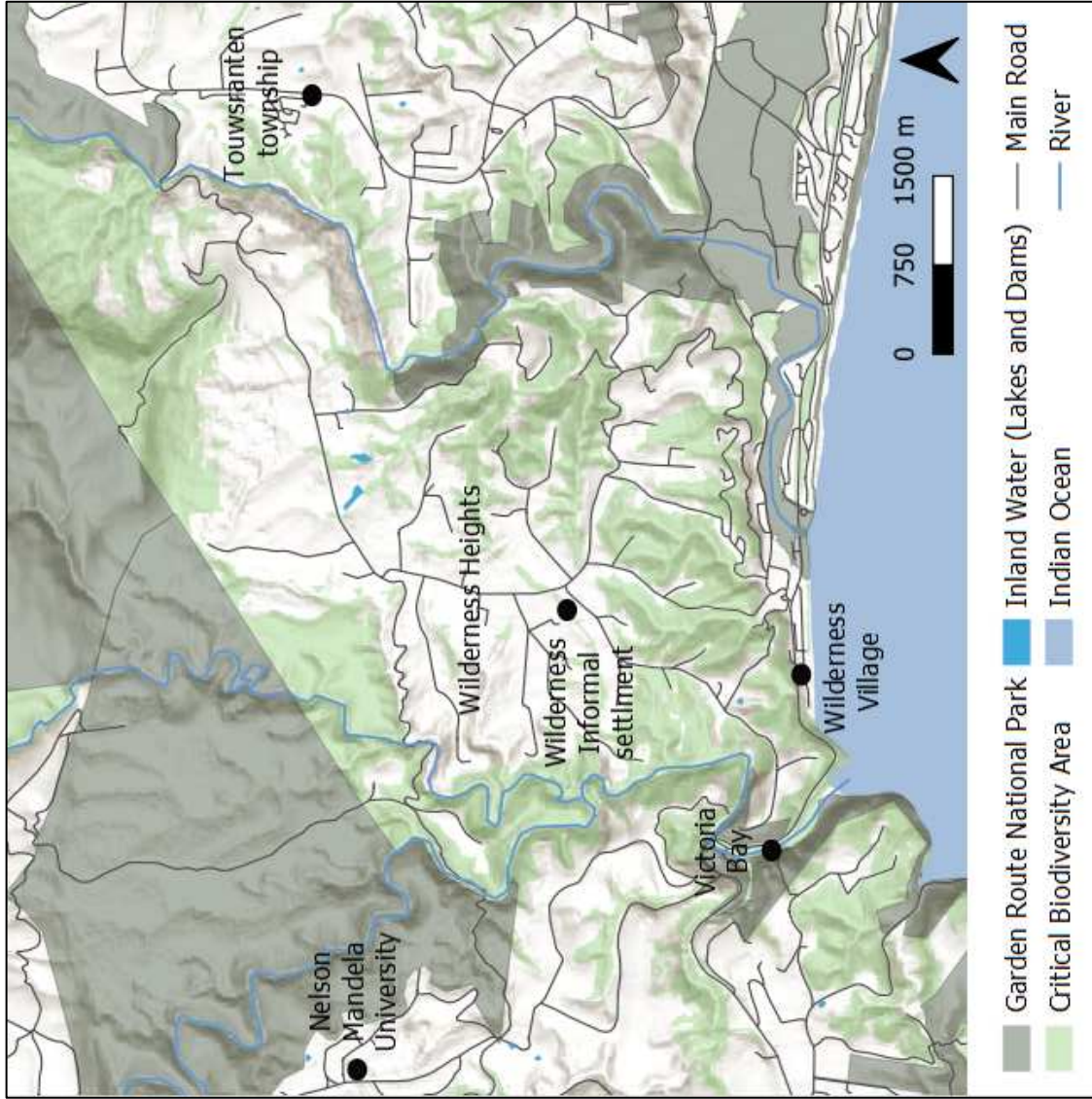


Figure 3. Wilderness, Hoekwil and Kleinkrantz area focus within the Garden Route site

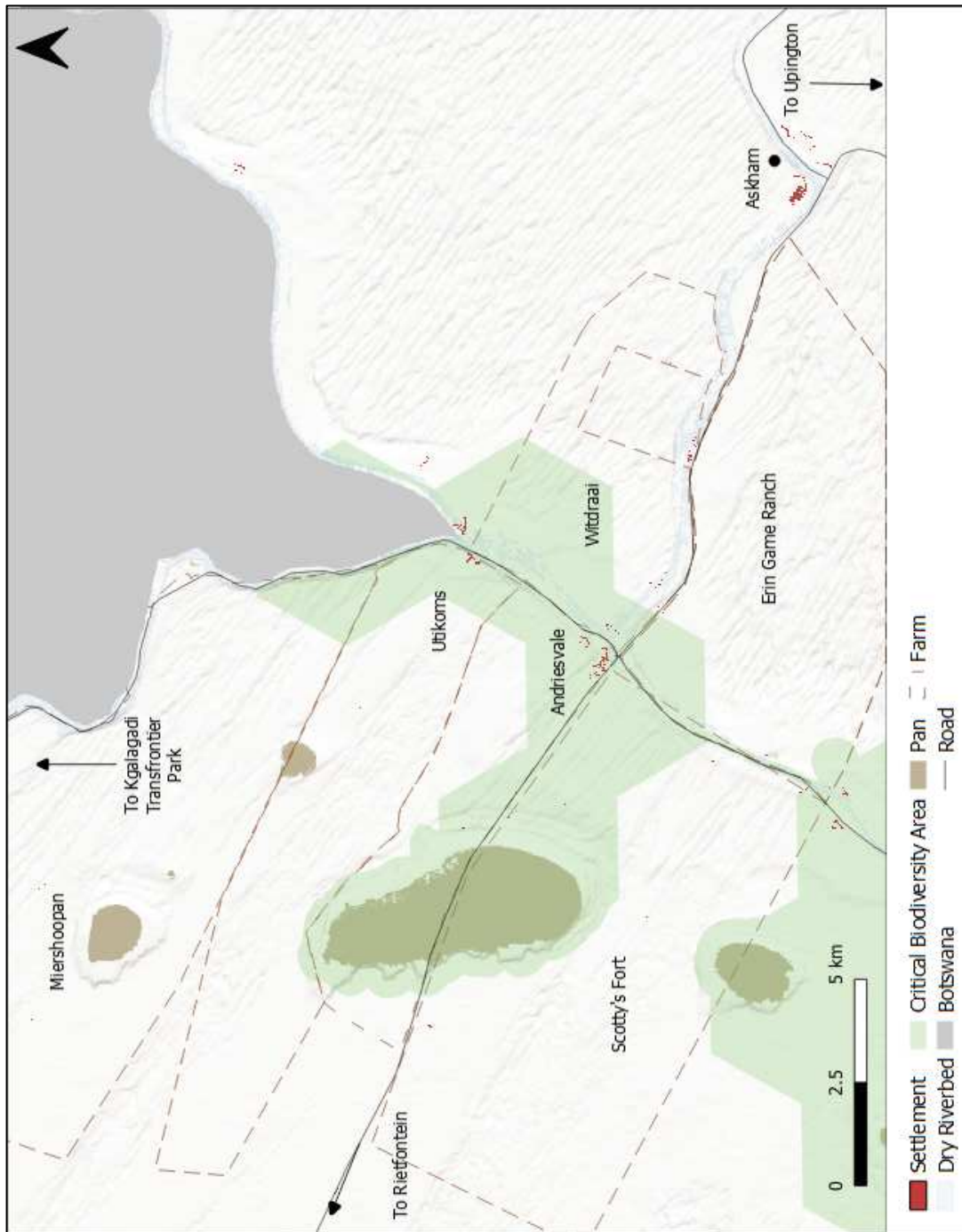


Figure 4. Map of the Kalahari site around the town of Askham and the six farms obtained by the Khomani San and Mier communities during the 1999 land-claim



Picture 2. Garden Route (top box) and Kalahari (bottom box) sites (©Élie Pédarros)

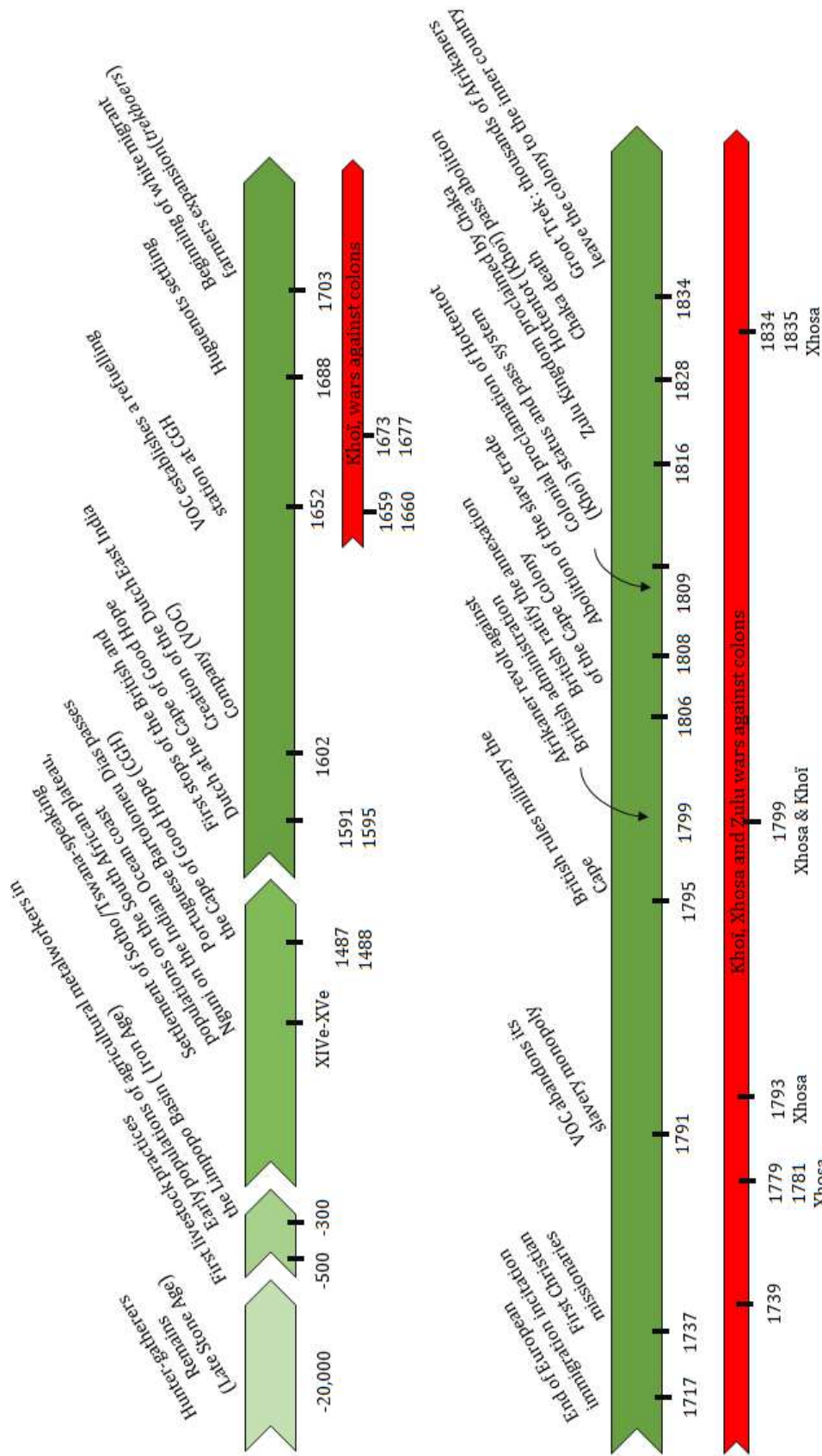


Figure 5. Summary of the main events in South African between -20 000 years and 1834 based on Fauvelle (2006)

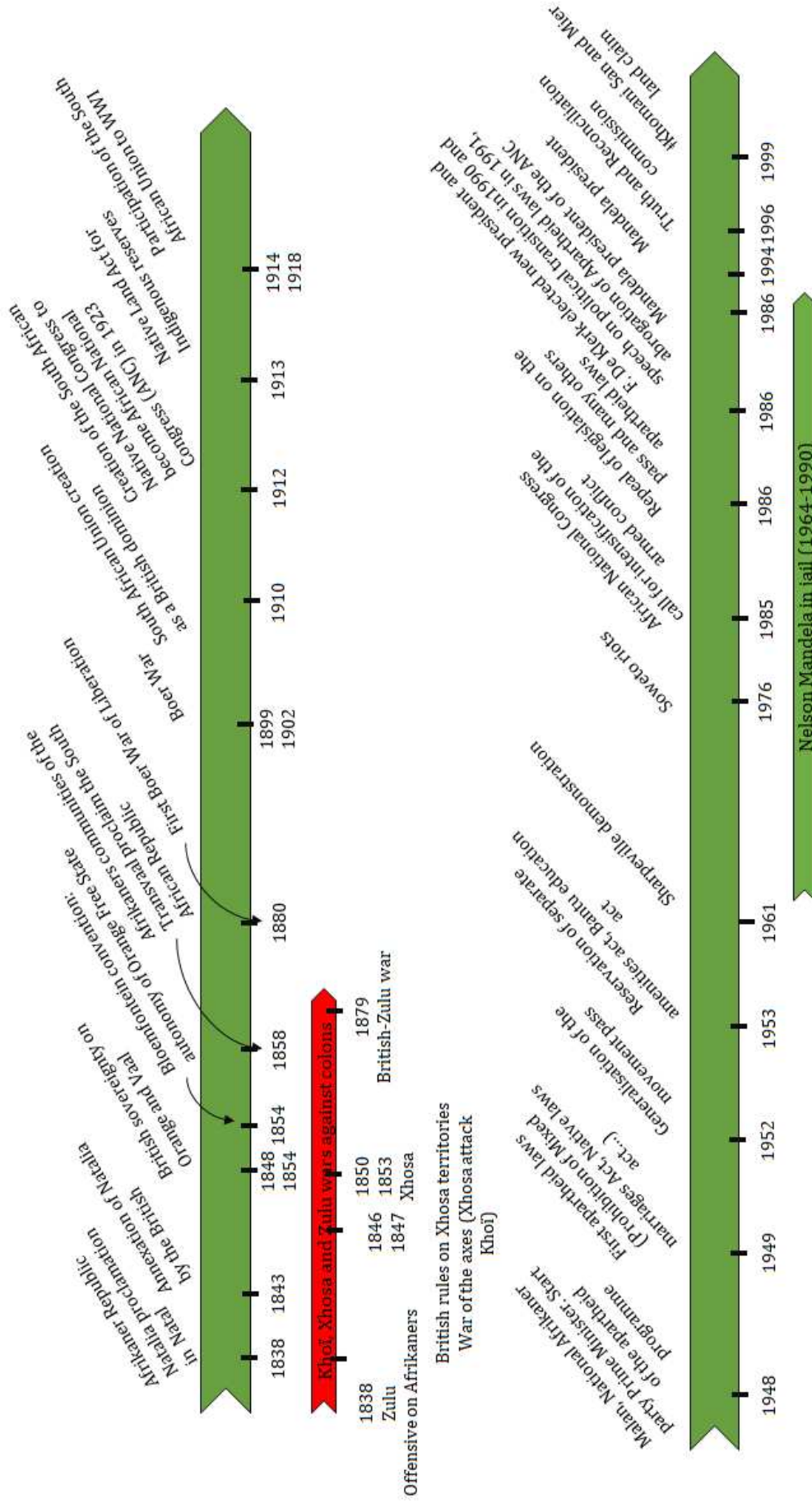


Figure 6. Summary of the main events in South African between 1838 and the 1999 land-claim of Khomani San and Mier communities based on Fauvelle (2006)

CHAPTER I – EXTENDING LANDSCAPE ECOLOGY TO RELATIONAL LANDSCAPE RESEARCH



The old railway line towards the Wilderness
Village, 2022 ©Élie Pédarros

This chapter explores the conceptual implications of a complex and adaptive approach (CAS) to social-ecological systems for conservation sciences and practices. Adopting this approach involves redefining conservation objects (ontology) which affects the manner we access the knowledge of the system (epistemology) and thus requires adapted methodologies. Although landscape ecology is crucial to conservation sciences and practices, especially concerning human-wildlife coexistence, we will compare the characteristics of landscape ecology with the CAS approach. As CAS and landscape ecology approaches have different epistemological basis, we will examine how reconciliation ecology can serve as a bridging concept between the two approaches. Lastly, we will use data from discussions with various stakeholders in two study sites to co-construct the research project and identify its important points. This chapter will serve as the foundation for the following research axes.

I. The entity, the sum and the whole: introducing complexity in systems study

Landscape ecology focuses on places as understood in a larger landscape mosaic: the structure, spatial configuration and context of these places and how they consequently influence ecological processes and change (Wiens, 2009). It shares this focus on areas with conservation sciences (Wiens, 2009). In this section, we will describe the characteristics of landscape ecology through the work of Wiens (2009) to link landscape ecology and the complex and adaptive approach of SES (Preiser et al., 2018). Conservation challenges have often been investigated from a landscape ecology perspective. Wiens (2009) notes that landscape ecology aims to understand landscape patterns and the processes contributing to landscape design to increase biodiversity and human well-being.

One of the main dimensions of landscape ecology is the context of a study site (Wiens, 2009). Landscape ecology aims to understand a study site integrating its surrounding habitat (Wiens, 2009). It is a significant difference underlined by Wiens (2009) with “fortress conservation” schemes that consider protected areas as islands isolated from the external world and related to the island theory in ecology (MacArthur & Wilson, 1985; as cited in Wiens, 2009) and through landscape ecology and acknowledging externalities, conservation sciences and practices focused on the connections between patches of protected areas (Wiens, 2009). Landscape ecology gives essential insights to conservation planners and land managers to achieve their conservation aims by proposing focusing on the protected area and the functional linkages with the surrounding landscape but still adopting a causal relationship between the elements of the system (Wiens, 2009). Explaining and predicting a phenomenon based on the latter's context is the first step towards complexity because it expands the network of relationships under investigation.

Moreover, the externality of threats to biodiversity is also a structuring factor of landscape ecology (Wiens, 2009). This characteristic is shared with complex and adaptive SES, which are radically open and constantly influencing or under the influence of external processes (Preiser et al., 2018). For instance, it can come either from increased predation at the edge of the designated area (Bull et al., 2019; Daly et al., 2018; Iranzo et al., 2018; White et al., 2007) or from the critical intensity of human activities close to protected areas (Geldmann et al., 2019; Jones et al., 2018; Schulze et al., 2018).

Integrating human activities in understanding ecological processes is also a common characteristic of complex and adaptive SES through integrating social components (Wiens, 2009). It proposes to adopt a distinctive look at the effectiveness of conservation sciences mitigation measures, promising to incorporate complexity in conservation sciences. However, although social and ecological spheres are understood as related, they are still conceptualised as entities.

Another significant achievement of landscape ecology has been considering scale's paramount importance (Wiens, 2009). Scale influences ecological patterns and processes and our perception of those patterns and processes (Wiens, 2009). A strategy conducted at one given scale or focusing on a given species may not be extended to another scale or a species responding to the specific ecological process at a different scale (Opdam et al., 2018; Stuber & Gruber, 2020; Tappeiner et al., 2021). The use of the term "perception" by Wiens (2009) is interesting because it includes a subjective character to a discipline which is based on a positivist "scientific" baseline where perception is a bias. Focusing on a specific scale is driven by our perception of ecological dynamics: the notion of scale is contingent on context, and the landscape context thus influences functional scale (Wiens, 2009).

Finally, landscape ecology tends toward sustainability (Wiens, 2009). The discipline is thus driven by a certain ethic acknowledging human activities as paramount in understanding landscape dynamics to formulate adequate measures (Wiens, 2009). However, landscape ecology treats these activities and their outcomes following an intensity gradient, failing to consider a diversity of relationships within the system by adopting a causal and deterministic approach to these phenomena (Wiens, 2009). This is probably the main difference between the scope of landscape ecology and SES's complex and adaptive approach. Indeed, Wiens (2009) argues that this integration of human activity gradients is often compared to biodiversity thresholds, as shown by Arroyo-Rodríguez et al. (2020) and Decaëns et al. (2018). Using these biodiversity or human indicators could depoliticise the understanding of the system by reducing some dimensions to cause-and-effect relationships.

The analysis of the structuring dimensions of landscape ecology highlighted that the issue of bridging landscape research and relational thinking is different from integrating the social components into the study of a landscape. This research field has already proved that acknowledging the social dimension's influence is essential to understanding

landscapes and their dynamics. Thus, the challenge is not to recognise a component's existence or pertinence but to move beyond mechanical approaches to consider the landscape as a complex and adaptative social-ecological system. If, as Larrère and Larrère (1997; p. 203) argue, a landscape is a look that can vary depending on our cultural references, thus, considering conservation at the landscape scale requires adopting a different perspective than causal perspectives. It is especially true in landscapes with overlapping relationships between humans and wildlife.

Conservation strategies are still based on the dichotomic vision of the relationships between humans and nature. Furthermore, landscape strategies have been polarising between land-sparing and land-sharing strategies. Land-sparing aims to set aside areas devoted to conservation and the rest dedicated to human activities (Phalan, 2018). In contrast, land-sharing considers landscape strategies as a mix of conservation areas and human activities also still delineated (Phalan, 2018). Although essential to understand the mechanisms of landscapes, landscape ecology, through its mechanical analysis and interpretation, can fail to resonate with the complexity of SES, understood as the intertwinedness of ecological and social dimensions by considering only a specific set of features. This assumption can be particularly true regarding the diversity of human-wildlife relationships (Hill et al., 2015; Loconto et al., 2020). In the following section, we will clarify the characteristics of a complex approach to social-ecological systems and focus on the “blind spots” of landscape ecology in understanding the global system.

1. Conceiving systems as complex

The notion of complexity stems from the recognition that the traditional approach has difficulty considering a diversity of relationships (Berkes et al., 2003; Burns et al., 2006; Kauffman, 2008). Consequently, understanding the complexity of SES requires understanding their ontological, epistemological and methodological foundations (Preiser et al., 2018).

Reductionism aims to understand an event or object from one level by dissecting it in more detail: events or objects are explained or predicted based on laws or theories from a lower level of integration (Bergandi, 1995). This mechanistic worldview was introduced by Descartes in the 17th century and developed by Newton, who advanced the idea of a “clockwork universe”, reflecting the mechanical approach to understanding phenomena

(Preiser et al., 2018). This mechanical approach incorporates the assumptions of determinism, objectivism, universalism and positivism, typical of an epistemology that reduces problems to lower-level understanding (Preiser et al., 2018). For Fuenmayor (1991), reductionism is rooted in a dualistic perspective of reality, distinguishing between mind and matter as two entities with an infinite gap. To think about the diversity of relations between human populations and the rest of the living world while going above the naturalistic dichotomy implies going beyond reductionism. But this is not an easy task because of the construction of conservation disciplines based on a historically reductionist ecology. Lotka and Volterra, in the 1920s, declared that « l'écologie sera théorique et expérimentale ou ne sera pas » [*ecology will be theoretical and experimental or it will not be*]⁹, leading to an academic current mobilising ecological experiments in the laboratory (Barbault, 1992; as cited in Larrère & Larrère, 1997; p. 133). Reductionism in ecology has been applied in laboratories by reducing "natural" phenomena to restricted relationships under supervised conditions (Larrère & Larrère, 1997; p. 133). *In situ* experimental ecologies thus integrated the first incursions of complexity in conservation.

Another branch of ecology is more related to the relationships structuring the system than the elements themselves. Initiated by Clements in the middle of the 30s, associations between individuals and between species (community ecology) are at the heart of the investigation (Larrère & Larrère, 1997; p. 135). It forms complex entities whose structure depends on the relationships analysed by population ecology but cannot be reduced to it (Larrère & Larrère, 1997; p. 135). It is the first step to moving from reductionism to holism.

Holism is opposed to reductionism because it considers the whole more than the sum of its parts. The South African statesman Smuts (1926) forged the concept. Reductionism and holism represent two different ontologies and epistemologies. However, Edgar Morin (1994; p. 52) considers these two epistemologies perpetuating blind angles in understanding real phenomena. Bergandi (1995) analysed the implications of reductionism and holism in ecology and highlighted that these perspectives share the belief, common to contemporary scientific models, that physicochemical processes underlie psychobiological phenomena. From a holistic view, emergent properties are only partially explicable by the laws that operate at lower levels characterising each level: the

⁹ Free translation from French

sum is superior to the parts. The emergentist holism is systemic (Bergandi, 1995). The debate between reductionism and holism in ecology and biology is critical because it defines how the system will be understood (Odum & Odum, 1959; as cited in Bergandi, 1995) and it reinterprets ecology by making the ecosystem the object of ecology investigation by adopting an assumed holistic perspective. However, according to Bergandi (1995), their conception of retroaction loops conducing to coordination and regulation features as emergent properties is an antagonist to holistic concepts because, ultimately, it is the parts that explain the sum. According to Blandin and Bergandi (1997), the odumian ecosystem is a holistic facade that tends towards a reductionist approach that has become the rule in systems ecology. For them, the fundamental weakness of applying Odum's functionalist conception to the analysis of real situations and dynamics would be the inconsideration that phenomena are contingent and unnecessary. However, this concept of ecosystem is favoured in ecology rather than the approach of contingency and singularity of ecological objects. This concept of the ecosystem in ecology is incapable of integrating humans into its research which is a severe criticism of odumian understanding of ecosystems.

A complex approach tends to go beyond the debate between reductionism and holism (Morin, 1982). Complex thinking intends to go beyond, not by instituting complexity as a simple response to simplification but as a challenge (Morin, 1982). Complexity is what tries to consider what is not viewed by reductionist or holistic approaches, located in the respective blind spots of the two approaches by conceiving the articulation, identity and differences of all these aspects (Morin, 1994).

2. Complex and adaptive SES

From this introduction, aimed at describing the different conceptions of the functioning of systems, we will see in this section the implications of a complex approach to understanding social-ecological systems.

The history of complexity theory and its conceptual roots still need to be clarified: the plurality of understandings of the term “complexity” makes it difficult to define the idea of complexity itself (Chu et al., 2003; as cited in Preiser et al., 2021b). Furthermore, the concept of complexity comes from several disciplines, the synthesis of which has helped to define a comprehensive and collective understanding of complexity theory

(Preiser et al., 2021b). Indeed, complexity thinking in sciences appears under the qualification of "complexity science", "complex adaptive systems", or "complexity" (Preiser et al., 2021b).

Morin (1994) recalls that the semantic origin of complexity comes from the Latin *complexus* meaning "what is woven together". Adopting a complex approach to social-ecological systems does not mean that there is a particular difficulty in mobilising this approach but rather underlines the need to consider a diversity of relationships.

Complexity theory is not a paradigm shift *per se* but a shift in how different disciplines and knowledge systems collaborate to understand a global system (Preiser et al., 2018). The aim of the complex approach of SES is thus not to render invalid past research on the functioning of systems but to bring together these outcomes to understand what needs to be clarified from their perspective. Although there is no global theory of complexity, there are common assumptions that Preiser et al. (2018) summarised to provide the characteristics of complex adaptive systems (CAS). According to Preiser et al. (2018), the interest in looking at the origins of CAS is not only to shape a historical and epistemological perspective of the term but to understand how this approach can be translated into the current understanding of the world. Redefining how we conceive the world (ontology) implies a shift in how we understand the world (epistemology) and how to access the knowledge of the world (methodology).

Preiser et al. (2018) formalised among five other properties that CAS are constituted relationally: their structure and complexity emerge from the relationships between the elements of the system. It means that every element of the system influences others and is itself influenced by others (Preiser et al., 2018). The main interest in studying SES according to a CAS approach is thus relationships rather than the elements system'. This is a break in the classical scientific perception of the relations between world description (epistemology) and reality (ontology) because we shift our attention from elements to relationships and, thus, the way we describe the system. The task of SES is, therefore, to study the trajectory of the system rather than studying the immobile structure of the system (Preiser et al., 2018).

CAS are also adaptive (Preiser et al., 2018). This means that spatial and temporal changes can modify the functions and structure of the SES, with multiple possibilities for reorganisation (Preiser et al., 2018). There is no centralised part of the system where the control capacity is localised; this capacity is everywhere (Preiser et al., 2018).

CAS are, therefore, dynamic (Preiser et al., 2018). Changes are not linear due to *“feedback, contingency, time shifts or multiple time scales that suppress or promote specific internal processes and interactions but also with the environment”* (Preiser et al., 2018). CAS are dynamic precisely because the nature and intensity of relationships are constantly changing. Stability is, therefore, not the norm in CAS, which is a significant difference from the early paradigms of ecology that considered equilibrium and stable states as a value guiding the objectives of conservation sciences (Preiser et al., 2018). It is a radically different approach to studying systems, especially within conservation sciences.

CAS are also completely open (Preiser et al., 2018). The system's activity concerning the environment institutes the system itself (Preiser et al., 2018). The co-constitutive nature of the system and its environment implies no boundaries (Preiser et al., 2018). There are always elements influencing the system or controlled by the system that is external to the artificial limits that one could impose on a set of relationships through its research questions, for example. Thus, the systemic boundaries proposed by Preiser et al. (2018) comprise physical properties, mental constructs and research questions. This system conception shares common characteristics with the *“dwelling”* approach of Ingold (2000), among other approaches to understanding human-wildlife relationships.

Ingold considers that being is always being in an environment, interacting with it (Cooke et al., 2016). Being must always be understood as included in an interactional matrix, not as a solitary vessel navigating the world. Dwelling is then more than occupying a geographical space. It is defined by Cloke and Jones (2016) as *“the rich, intimate ongoing togetherness of beings and things that make up landscapes and places and bind together nature and culture”*. There are interesting characteristics of this concept of dwelling that are related to the complex and adaptative approach of social-ecological systems: more than only aiming at understanding a system, it gives interesting insights concerning humans' conceptions of being with the rest of the living world and questions our relationships with *“nature”*. Cooke et al. (2016) further identify in Ingold's dwelling that it is a continuous interactivity between *“our actions, our knowledge and environmental processes”*. Through this concept of dwelling, the mind, the body and the environment are thus reunited (Cooke et al., 2016).

This dwelling perspective allows us to consider human-wildlife relationships ontologically (West et al., 2018) rather than through a methodological process as for the sense-of-place approach (Masterson et al., 2019; as cited in West et al., 2018) or in a normative sense as for the biocultural approach (Barthel et al., 2013; Sterling et al., 2017 as cited in West et al., 2018). The contingency of the dwelling approach of human-wildlife relationships is also profoundly rooted in CAS. These systems are contingent and depend on the context and are unpredictable. Furthermore, causality, as understood in CAS, is not linear but characterised by complex and dynamic pathways, as highlighted by Preiser et al. (2018), which is in line with this complex and constant interaction between the mind, the body and the environment described by the dwelling (Cooke et al., 2016). Moreover, emergence occurs when entities have properties not reducible to the elements. It means that the sum of the parts' properties does not equal the system's properties (Urry, 2005; as cited in Preiser et al., 2018). Emergent phenomena have an ontological status (Kauffman, 2008; as cited in Preiser et al., 2018) we could ask ourselves to what extent the dwelling is an emergence from the complexity of the social-ecological system. It is imperative to underline the anchoring of CAS in the real world, especially in conservation sciences, with substantial and expected practical implications. However, it also questions the operational inscription of a complex and adaptive conception of SES in conservation research to move from theory to practice. This movement from theory to practice and vice-versa is central to understanding SES and resilience.

The reconciliation ecology idea mobilises landscape ecology assumptions and tempts indirectly to integrate this complex approach by mobilising empirical evidence. This idea emerged at the beginning of the 2000s under the impulse of Rosenzweig (2003b). From landscape ecology considerations, especially the linear relationship between species diversity and surface availability at different scales, the idea is to create, maintain and invent favourable spaces for wildlife species in anthropogenic landscapes. From this assumption, Rosenzweig proposes a series of evidence advocating the possibility of win-win scenarios and their sustainability by concealing biodiversity and human activities. The succession of reconciliation evidence between human activities and biodiversity supports the contingency of human-wildlife relationships and the complexity of the real world. However, this complexity needs to be synthesised theoretically. The link between complexity and landscape ecology is promising for conservation sciences and practices adopting a CAS approach to move from theory to practice. The following section

aims to identify the main characteristics of this link between landscape ecology and relational landscape. We will deepen the ideas of ecological reconciliation, which have particularity compared to other disciplinary frameworks, to provide empirical evidence of these links and thus reveal their practical dimension, which is of particular interest to us in the context of a need for immediate action. In particular, it will be a question of placing the ecology of reconciliation within the conservation sciences and identifying its leading characteristics to think about conservation sciences and practices together.

Box 1. Reconciliation ecology example of the American crocodiles in Turkey point power plant

The United States have a rare and endangered crocodile species: the American crocodile. All of the individuals are living in Florida, where they are very rarely seen. The Turkey Point power plant in the South of Miami has to generate electricity for southern Florida. It consists of two fossil fuel generating units and two that run on nuclear fuel emitting hot water. Turkey Point dug an extensive system of canals to cool off its effluent, and about 64% is open water. The berms support a variety of native and exotic plants, including buttonwood trees, red mangroves and casuarinas. Red mangroves also grow along the edges of the canals themselves. In addition to the variety of plants growing on the berms, a large, healthy population of American crocodiles lives in the cooling canals. This population produces about 10% of all new young American crocodiles in the United States. It is one example highlighting the possibility of coexistence scenarios that benefit humans and wildlife in a human-dominated landscape.

"Win-win ecology, how the earth's species can survive in the midst of human enterprise".

Michael L. Rosenzweig. 2005. Oxford : Oxford University Press.

II. Landscape strategies and complex social-ecological systems: implications for conservation sciences and practices

Élie Pédarros^{*1;2;3}; Hervé Fritz^{1;2}; Chloé Guerbois^{1;2}

¹ REHABS, CNRS - Université Lyon 1 - Nelson Mandela University, International Research Laboratory, George Campus, Madiba Drive, George, South Africa

² Sustainability Research Unit, Nelson Mandela University, George Campus, Madiba Drive, George, South Africa

³ Laboratoire de Biométrie et Biologie Evolutive, CNRS UMR 5558; Université Claude Bernard Lyon 1; Villeurbanne Cedex, France

Article info

Abstract

Reconciliation ecology
Coexistence
Land sharing
Land sparing
Conservation

Reflection on how human activities should spatially integrate the needs of other species has been dominated by the debate on "land-sharing" versus "land-sparing" based on the discontinuity between humans and nature, characterising naturalism. The idea of "reconciliation ecology" aims to go beyond this dichotomy by rethinking "anthropogenic habitats so that their use is compatible with a broad array of other species". We systematically reviewed the literature focusing on the land-sharing/land-sparing debate and coexistence and analysed the constructs of these framings based on the principles of reconciliation ecology. Our analysis suggests that reconciliation examples consider processes with multiple dimensions. Empirical studies consider reconciliation ecology a toolbox more than a conceptual framework. Therefore, practical implementation may not be a significant challenge. Still, its use as a concept with practical applications will require explicit references to guiding principles and social-ecological indicators to consider the complexity of SES better.

1. INTRODUCTION

Conservation sciences have undergone major evolutions in their framing, purpose and relation to scientific disciplines since the discipline's emergence at the end of the 20th century (Adams et al., 2004). Conservation sciences are mission-driven disciplines subject to paradigm shifts and fashion where adaptability is paramount (Redford et al., 2013). Over the past 50 years, the conceptual evolutions of conservation sciences paradigms are associated with changes in framing human-nature relationships from "nature for itself" to "nature despite people", "nature for people", and finally, "people and nature" (Mace, 2014). Space has been a persistent issue in conservation, as illustrated today by the debates around the shared Earth framework versus the 30x30 Conservation

Initiative (Obura et al., 2021). Acknowledging the intertwinedness of social and ecological components characterising social-ecological systems (SES) calls for integrating complexity in our understanding of systems when addressing spatial conservation aspects and considering different worldviews to formulate adequate conservation strategies (Preiser et al., 2018).

The reflection on how human activities can spatially cater for the needs of other species has been dominated by the "land-sharing" versus "land-sparing" debate (Fischer et al., 2014). In a land-sparing strategy (LSP), a fraction of the land is dedicated to conservation, while the other fraction is dedicated to human settlements and production systems. These landscapes have discrete primary objectives: food production or biodiversity conservation (Balmford et al., 2019), with the intensification of agricultural land use allowing conservation elsewhere (Green et al., 2005; as cited in Balmford et al., 2019). The land-sharing strategy (LSH) advocates less retention of natural habitats and extensively farmed semi-natural habitats to maintain biodiversity throughout anthropogenic landscapes (Green et al., 2005). Another strategy is proposed by reconciliation ecology, which emerged in the early 2000s, aiming to find pathways for biodiversity and human activities to coexist (Rosenzweig, 2003a, 2003b). The difference between reconciliation ecology and LSH lies in how the dichotomy between nature and society is understood. Indeed, reconciliation ecology has no preconceived notion of the "naturalness" of space as long as it benefits biodiversity. The reduction in surface favourable to wild species is linearly correlated with decreased species diversity at every scale (Rosenzweig, 2003a). This argument would support an increased protected area coverage on our planet, as was planned in the Aichi Biodiversity Target 11 and persists in the 30x30 Conservation Initiative. However, Rosenzweig's idea of reconciliation ecology proposes to rethink "*anthropogenic habitats so that their use is compatible with a broad array of other species*" (Rosenzweig, 2003b). It would supply a natural extension of protected areas which remain cornerstones in biodiversity conservation. Other trends in conservation sciences advocate the importance of this objective, for example, in SES research with the concept of complex adaptive systems (Preiser et al., 2018) or the Shared Earth approach (Obura et al., 2021). The latter proposes to focus conservation on shared spaces and equity from the local to the global scale (Obura et al., 2021).

However, LSP and LSH, through their acknowledgement of two distinct compartments (humans and wildlife), are based on a particular way of considering

human-wildlife interactions, namely *naturalism* (Descola, 2005), describing worldviews typical of the Western mindset. Debates between LSP and LSH advocates also concern how biodiversity should be quantified and at which scale (Fischer et al., 2014). Moreover, these conceptions, mainly when applied in conservation practices, conduct an understanding of the interactions between the two components, which has been studied explicitly from a conflict perspective between humans and wildlife within the same geographical entities (Baynham-Herd et al., 2018; Dickman, 2008; Peterson et al., 2010; Simioni et al., 2016). However, most of the labelled "human-wildlife conflicts" could be qualified as "human-human conflicts" regarding how wildlife should be managed (Frank, 2016; Madden & McQuinn, 2014; Peterson et al., 2010). Some authors recommended replacing the term "conflict" with "coexistence" to integrate better the social dimension of the problem (Madden, 2004a, 2004b; Peterson et al., 2010).

We define coexistence as an inter-species dynamic favouring the social-ecological system's resilience in favour of the diversity of its different components. Coexistence implies a continuity between humans and other living beings as it considers the multiple relationships between the elements of the SES. This continuity requires deep investigation, especially concerning spatial planning. Conversely, reconciliation ecology has the specificity to supply evidence-based examples of virtuous coexistence processes beyond the dichotomy between humans and wildlife. It would allow us to extend the diversity of worldviews for conservation sciences and practices and possibly overcome the debate between LSP and LSH. Moreover, it could overcome the epistemological difficulties of moving from theory to practice, local to global, and vice-versa which requires embracing the plurality of values, the complexity and unpredictability of SES, the multiplicity of stakeholders, the potential impacts of global changes, and linking conservation to transformative adaptation (Colloff et al., 2017).

This review attempts to fulfil two primary objectives: firstly, to place landscape strategies (LSP, LSH, reconciliation ecology) within conservation sciences and, secondly, to assess to what extent reconciliation ecology principles are present in other landscape strategies, namely LSP and LSH. It is, therefore, questioning the place of reconciliation ecology at two levels: conservation sciences and practices. To meet these objectives, we used the principles of reconciliation ecology described by Rosenzweig (2003a) as a reference to systematically review the scientific literature contributing to landscape strategies favouring biodiversity (Fischer et al., 2014).

2. METHODS

2.1. Framing reconciliation ecology and its principles

We first reviewed Rosenzweig's book "*Win-win Ecology: How the Earth's species can survive in the midst of Human enterprise*" (2003b), formalising reconciliation ecology to identify reconciliation ecology principles. These principles are used as categorisation criteria for the reviewed publications (Table 1). The principles include i) a spatial approach; ii) a focus on ecological communities; iii) consideration of local community empowerment; iv) a focus on participatory approaches; (v) the adoption of a historical perspective, and (vi) a prospective approach to evaluate the potential outcomes of conservation measures; (vii) the influence of psychological aspects in conservation processes and (viii) the focal scale of the study which influences the definition of the problem and scale perception at stake.

2.2. Review process

The systematic literature review analysed how reconciliation principles are reflected in studies addressing human-wildlife coexistence strategies. To perform this review, we followed the guidelines of Pullin and Stewart (2006). We included the articles resulting from the following query: "Reconciliation ecology" OR (Sharing AND Sparing AND Land) OR (Co*exist AND Biodiversity AND Conservation). The terms conflict and coexistence are not antagonists but only translate a specific and circumscribed state of mind in dealing with the same issues relative to human-wildlife spatial relationships (Baker & Harris, 2007; Bhatia et al., 2020; Frank, 2016; Madden, 2004b; Sidhu et al., 2017; Sinu & Nagarajan, 2015). It, therefore, seemed more relevant within the reconciliation ecology framework to deal with the subject from the point of view of coexistence. We combined article requests from Web of Science, Isidore and Google Scholar databases. The final number of studies reviewed in detail was refined based on a two-step process (Dressler et al., 2016; Hevia et al., 2017; Lozano et al., 2019; Nieto-Romero et al., 2014) : (1) title and abstract and (2) full content of the article. It allowed a selection of 357 articles for the bibliographic analysis (Figure 1).

We then used additional categorisation criteria to refine the analysis (Table 2),

aiming at explicitly exploring other covariates of the expression of the landscape strategy. Foremost, we designated studies as theoretical (presenting a reflection without practical experimentation) and empirical (review based on data collection).

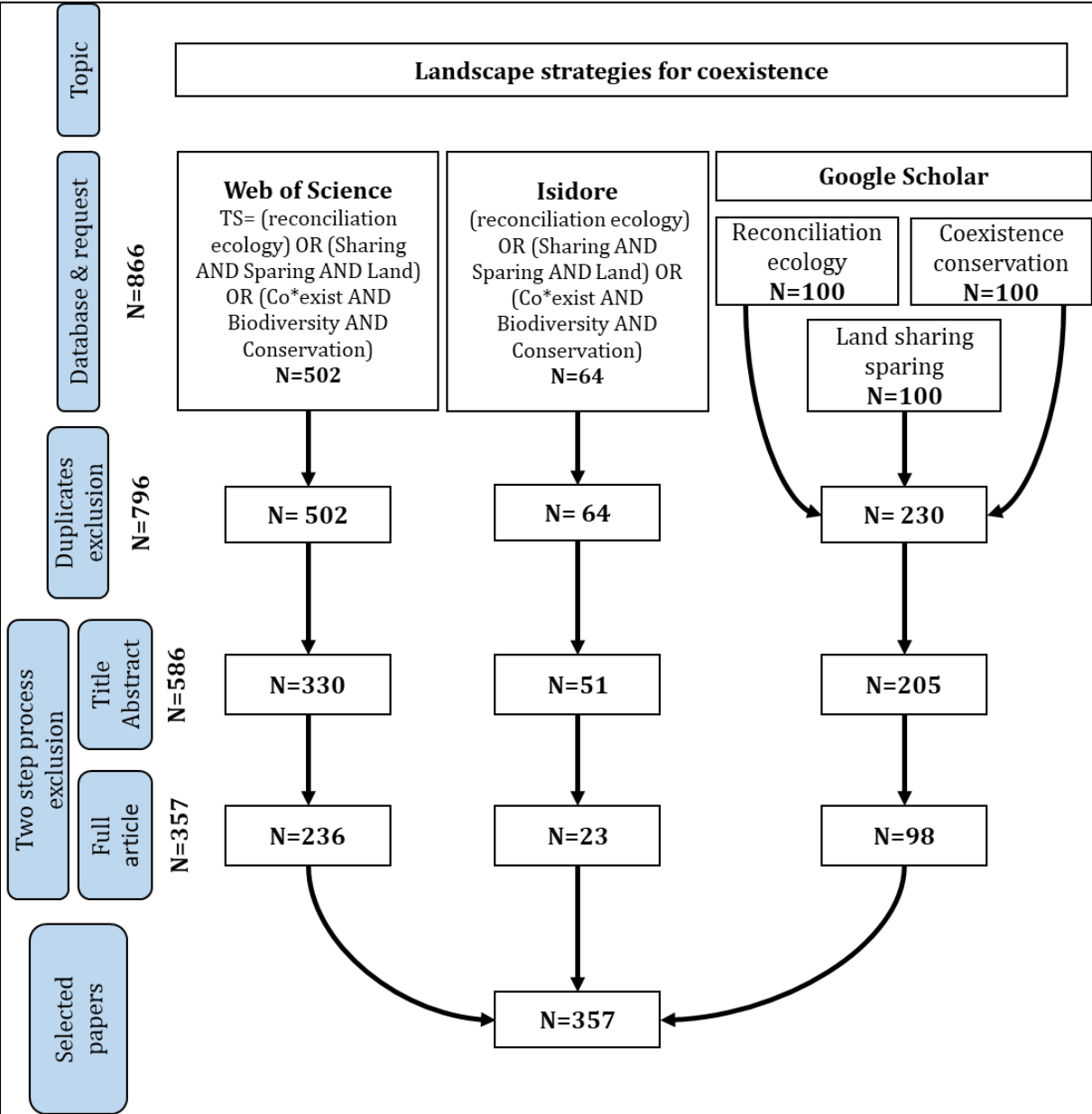


Figure 1. PRISMA flowchart describing the included and excluded literature

Table 1. Articles coding elements

Identified Reconciliation ecology principles		
Principles	Decision elements	Terms
Spatial	Are there any spatial-related elements concerning concepts, experimental design and interpretation?	Logical (Yes/No)
Ecological community	Is the study focusing on ecological communities or a specific species?	Logical (Yes/No)
Community empowerment	Is there any reference to community empowerment in this study?	Logical (Yes/No)
Participatory science	Are citizens involved in the research process?	Logical (Yes/No)
Historical approach	Is the system considered historically influenced, a product of the contingency?	Logical (Yes/No)
Prospective approach	Is the study proposing a hypothetical scenario of system evolution?	Logical (Yes/No)
Psychological	Does the study account for any psychological disposition in formulating landscape strategy?	Logical (Yes/No)
Focal scale	The spatial scale in the study	Local Landscape Cross
Additional variables for analysis		
First author country	Academic country of the first author	
Study site	Country where investigations take place and from which data are collected	
Experimental model	Targeted species	
Species Taxonomic group	Studied species in broad taxonomic group	Figure 4
Species body size	Body size category	Small ($x < 1$ kg) Medium ($1 \text{ kg} < x < 30$ kg) Large ($x > 30$ kg)
Strategy	What is the author's suggestion for the land partition?	Land-sparing (LSP) Land-sharing (LSH) Beyond LSP/LSH
Empirical	Is the study an empirical study? As opposed to theoretical	Yes/No
Reconciliation ecology	Is reconciliation ecology explicitly used or referred to?	Yes/No

We performed descriptive bibliometric statistical and multivariate analyses with R (version 3.6.2). Data is a set of individuals (articles) described by qualitative variables. In addition, we performed Multiple Correspondence Analyses (MCA) using the ade4 package (Dray & Dufour, 2007). MCA were conducted in empirical (Figure 5) and theoretical studies (Figure 6). We drew confidence ellipses representing 95% confidence based on the underlying distribution. If we were to add individuals to the analysis, the mean would still fall within the confidence ellipse. If we add individuals to the study, the mean would still be included in the confidence ellipse, unlike the interpretations from a confidence interval representing a finite set.

3. RESULTS

The analyses are structured in two interdependent parts (descriptive and multivariate analysis) that allow us to answer our two objectives concomitantly: on the one hand, to place landscape strategies (LSP, LSH, reconciliation ecology) within conservation sciences and, on the other hand, to evaluate to what extent the principles of reconciliation ecology are present in the different landscape strategies, i.e. LSP and LSH.

3.1. Landscape strategies within conservation sciences

The concern of academics is geographically heterogeneous, with most of the research conducted by countries of the “North” (USA, UK, France, Australia and Germany) and Brazil in the tropics. Research sites are located worldwide except in the Middle East and Northern Africa. However, most empirical studies occurred in countries where the first author is institutionally established (Fig 2).

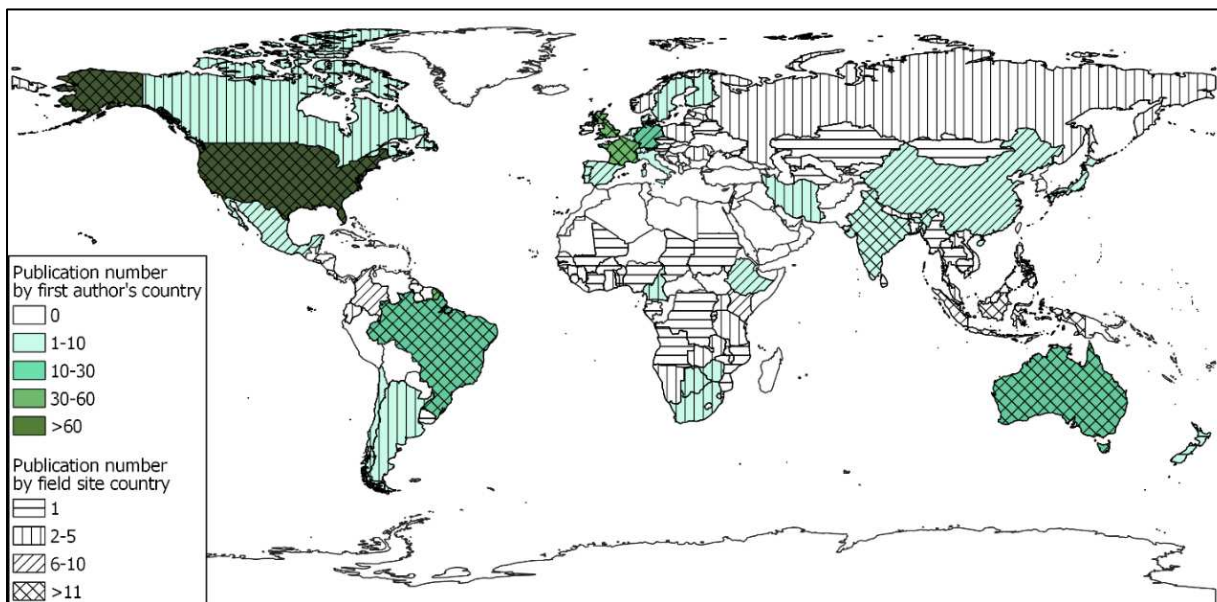


Figure 2. Studies distribution by the first author and field site countries

Reconciliation ecology emerged as a research field in the mid-nineties, and the number of publications steadily increased. However, the interest in the reconciliation ecology only started growing in the 2005's. We quantified 136 publications citing reconciliation ecology in 2019 (Fig 4A). The increase in the number of publications related to LSP and LSH is more significant than those related to publications using reconciliation

ecology explicitly (Fig 4A). This result is in line with the conclusion of other articles that the debate on landscape strategies has been dominated by the opposition between LSP and LSH, i.e. according to a compartmentalised conception of the system. The comparative approach to systems in conservation science, which we will call discontinuous, is therefore predominant compared to relational approaches to components, which we will call continuous, within which the ecology of reconciliation is embedded.

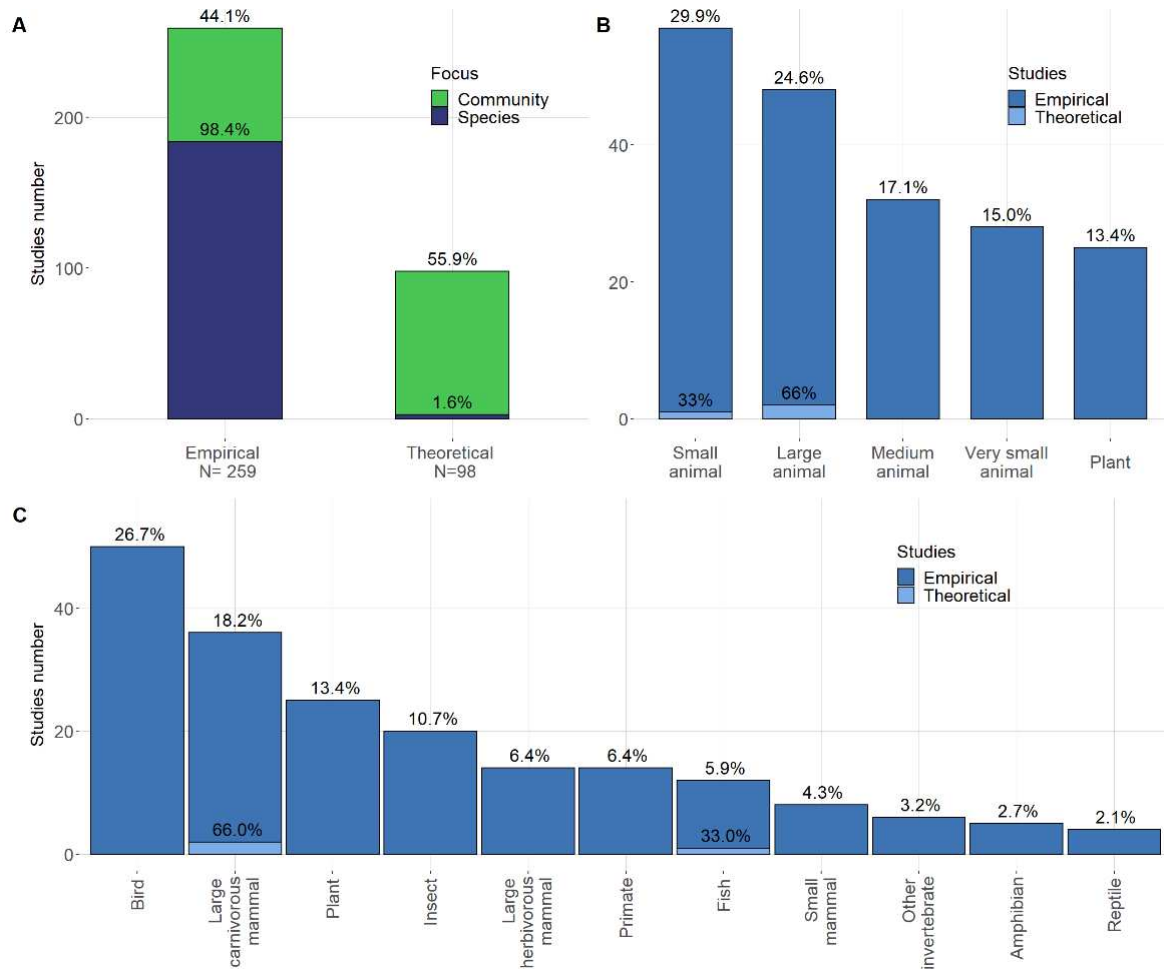


Figure 3. Distribution of studies according to their empirical or theoretical focus, whether about their species-focus (A), animal body mass and plants (B) and species taxonomic groups (C)

Among the 357 papers, 72.5% were empirical studies. Furthermore, 71.0% of empirical studies were species-specific against 3.1% for theoretical studies. Eventually, there are significant differences in the focus of empirical and theoretical research, resulting in various strategies proposed in the species studied and scales adopted. Nevertheless, the predominance of empirical studies focusing on a single species to

identify general system-wide strategies corroborates this compartmentalised system approach in conservation sciences.

We found that the LSH strategy was supported in 36.9% of the studies, while 11.7% supported an LSP strategy. However, most studies (51.4%) proposed moving beyond the debate between LSP and LSH. This indicates that despite the predominance of the discussion between LSP and LSH, these strategies are unsatisfactory for most studies. Furthermore, it illustrates the nature of the link between conservation sciences and its practices and the difficulty of proposing relevant landscape strategies.

Research focusing on species or species groups mainly targeted birds and carnivorous mammals, both small ($0.1 \text{ kg} < x < 1\text{kg}$) and very large animals ($x > 60\text{kg}$) (Figure 3B and 3C). This species bias in the attention paid to specific categories of organisms in conservation science corroborates what has already been highlighted in the literature.

Before 2013, authors mostly adopted cross-scale approaches to tackle the issue of land strategies. In contrast, afterwards, authors adopted approaches at the landscape scale, with the proportion of local scale studies remaining lower (Fig 4B). The emergence of a landscape rather than a local approach after 2013 illustrates the growing consideration of the context of a given spatial unit and, therefore, a more complex approach to understanding the processes linked to the relevance of conservation strategies.

The paramount importance of the spatial approach puts spatial ecology at the centre of these questions. Thus, the other principles, whether psychological, temporal (historical and prospective), participatory sciences and community empowerment, can be considered as reflecting approaches belonging to disciplines other than landscape ecology. Thus, their low involvement in the studies selected for this bibliographic review indicates a disciplinary specialisation in treating these questions (Fig 4C). Reconciliation ecology is an underrepresented idea in conservation sciences, although its principles are present in many studies. Reconciliation ecology principles are not referred to equally in the literature, and most reconciliation ecology studies used spatial ecology with a focus on ecological communities. Therefore, ecological reconciliation principles are independent in their use within conservation science.

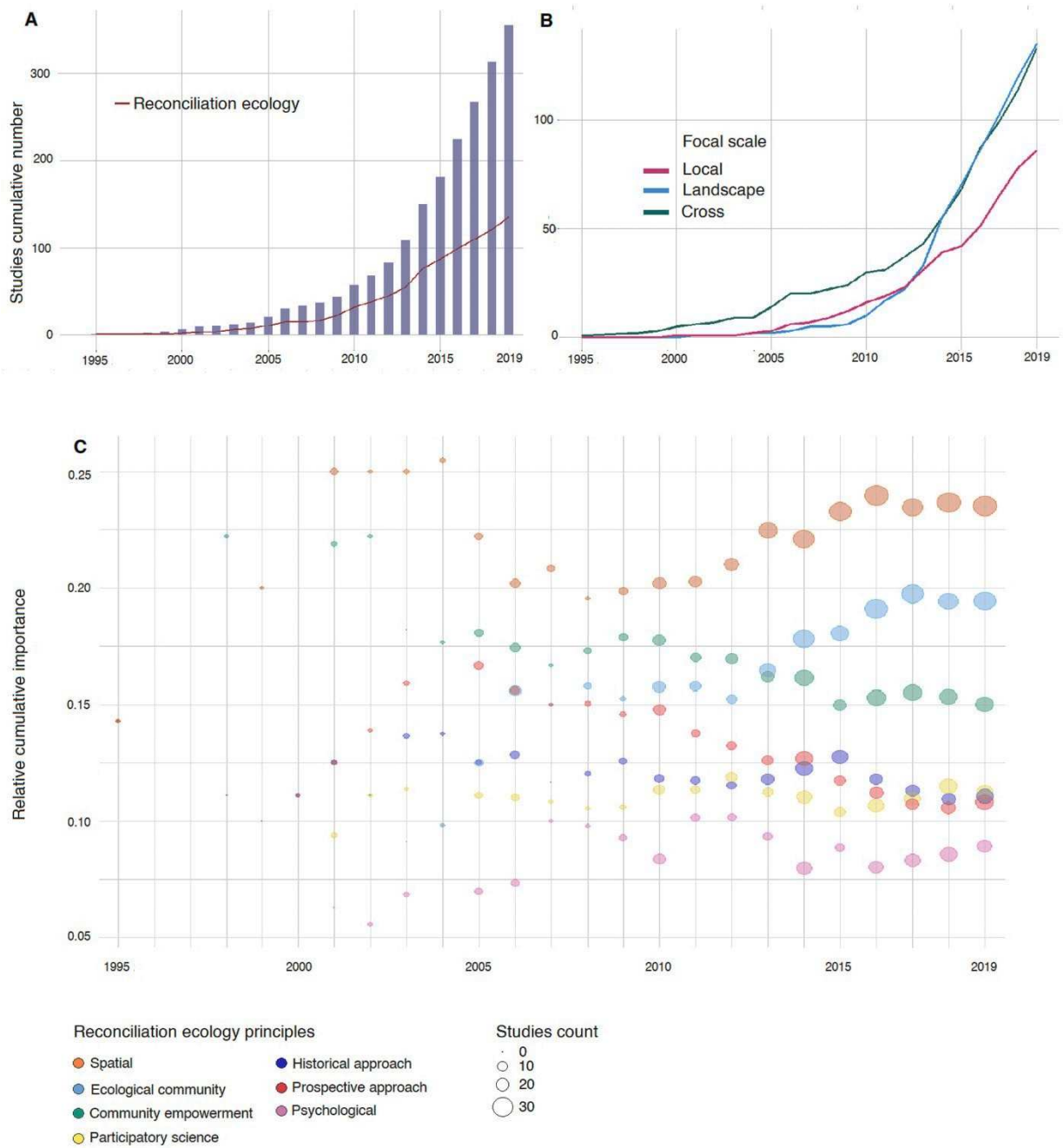


Figure 4. Landscape strategies trends: number of studies (A) focal scale (B) and reconciliation ecology principles addressed (C)

3.2. Reconciliation ecology principles and landscape strategies

We distinguished between empirical and theoretical studies in the analyses to account for conservation sciences approaches about their application in practice. We used the first two principal axes of the multivariate analysis to display the results, as they explained 47.2% of the variance for empirical studies and 44.0% for theoretical studies. The first axis reflects the use of reconciliation ecology principles, opposing “Yes” to “No” about the fundamental principles of reconciliation ecology. The second axis mostly discriminates the focal scale at which the study is conducted, opposing “Local” to the two other modalities. This underlines the importance of the scale considered and the use of the different principles of reconciliation ecology in formulating specific landscape strategies. The grouping of multi-scale and landscape scales approaches in opposition to the local scale supports our results from the descriptive analysis of the increasing interest in considering multiple processes in understanding the system.

Empirical studies (Figure 5) proposing a LSP strategy differ from those advocating other strategies. They mobilise fewer reconciliation ecology principles and are more related to spatial ecology than LSH strategies. They suggest going beyond the LSP/LSH dichotomy (LSP/LSH) that mobilises more diverse reconciliation ecology principles. In addition, independent of the proposed strategies, empirical studies are more prone to adopting landscape and multi-scale approaches than local ones. Finally, empirical studies advocating reconciliation ecology explicitly are not identifiable from those not referring to it. Reconciliation ecology principles are used without referring to reconciliation ecology explicitly, emphasising the challenge of moving from theory to practice and questioning the ability of reconciliation ecology to perform this shift. The analysis allows the identification of the studied species based on their body size according to the scale at which the study is conducted and to what extent reconciliation ecology principles are mobilised. These studies highlight three body-size groups: large, medium and small animals. Studies on small animals mobilise few reconciliation ecology principles, and authors mainly proposed LSP strategies. Studies focusing on medium animals tend to mobilise more reconciliation ecology principles at the local scale and offer either LSH or LSP/LSH strategies. Finally, studies focusing on large animals tend to rally reconciliation ecology principles at cross-scales, and authors propose either LSH or LSP/LSH strategies. Despite the relative absence of explicit reference to reconciliation

ecology as a discriminant factor, we can observe that studies focusing on large and medium animals are more likely to use the idea of reconciliation ecology than studies focusing on small animals.

Due to few theoretical studies formulating LSP strategies, we exclude these studies from the analysis. Theoretical studies (Figure 6) proposing a LSH strategy differ from those advocating LSP/LSH strategies. They are mobilising more reconciliation ecology principles than studies suggesting LSP/LSH strategies. However, LSH studies are more prone to adopt landscape-scale approaches than LSP/LSH advocating cross-scale approaches. Theoretical studies backing reconciliation ecology explicitly are identifiable from those not referring to it. Although trivial, this result indicates the validity of identifying the principles of reconciliation ecology since these studies fully mobilise them.

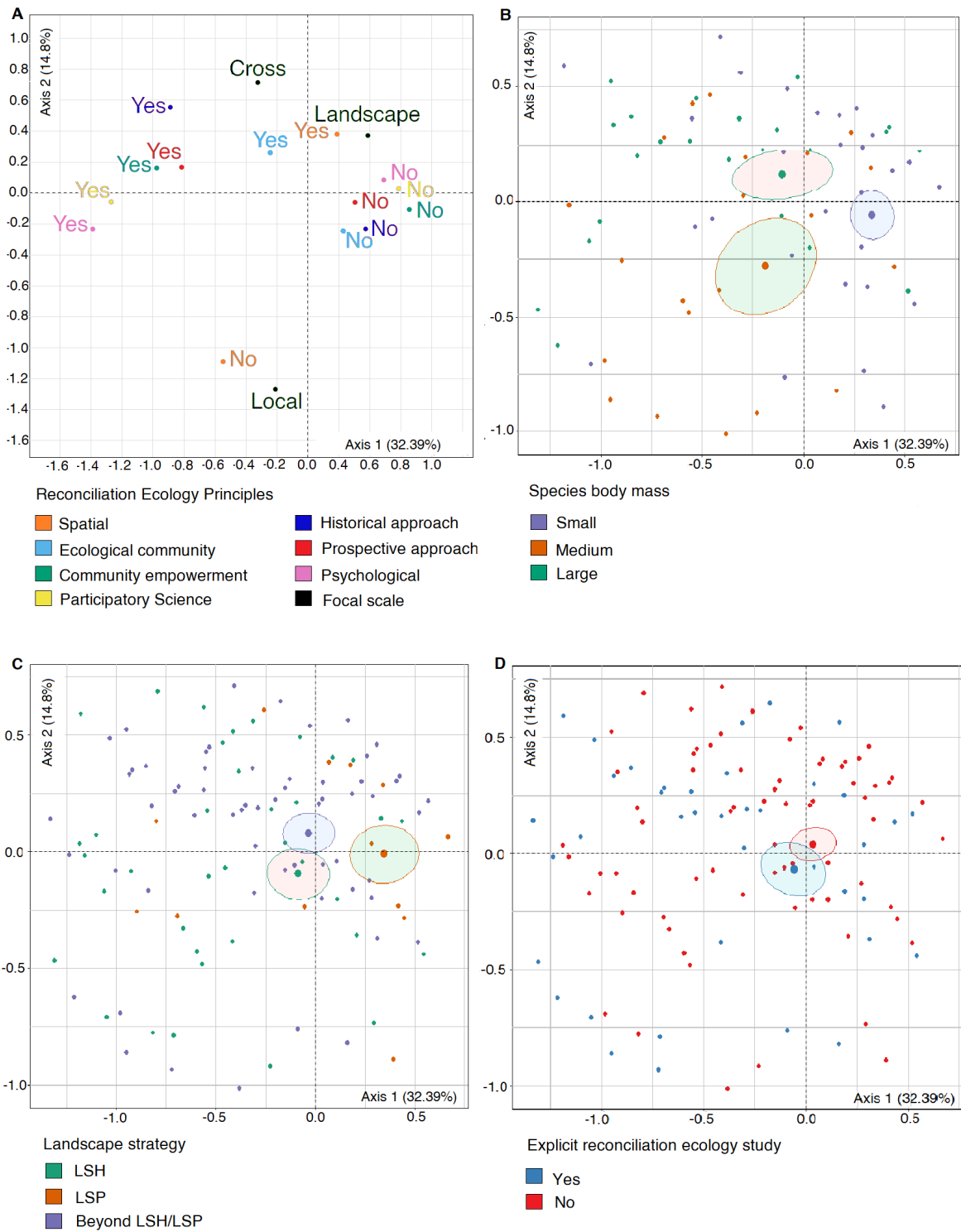


Figure 5. Scatter diagrams from the MCA of empirical studies: reconciliation ecology principles (A), species' body mass (B), landscape strategy (C) and explicit use of reconciliation ecology (D).

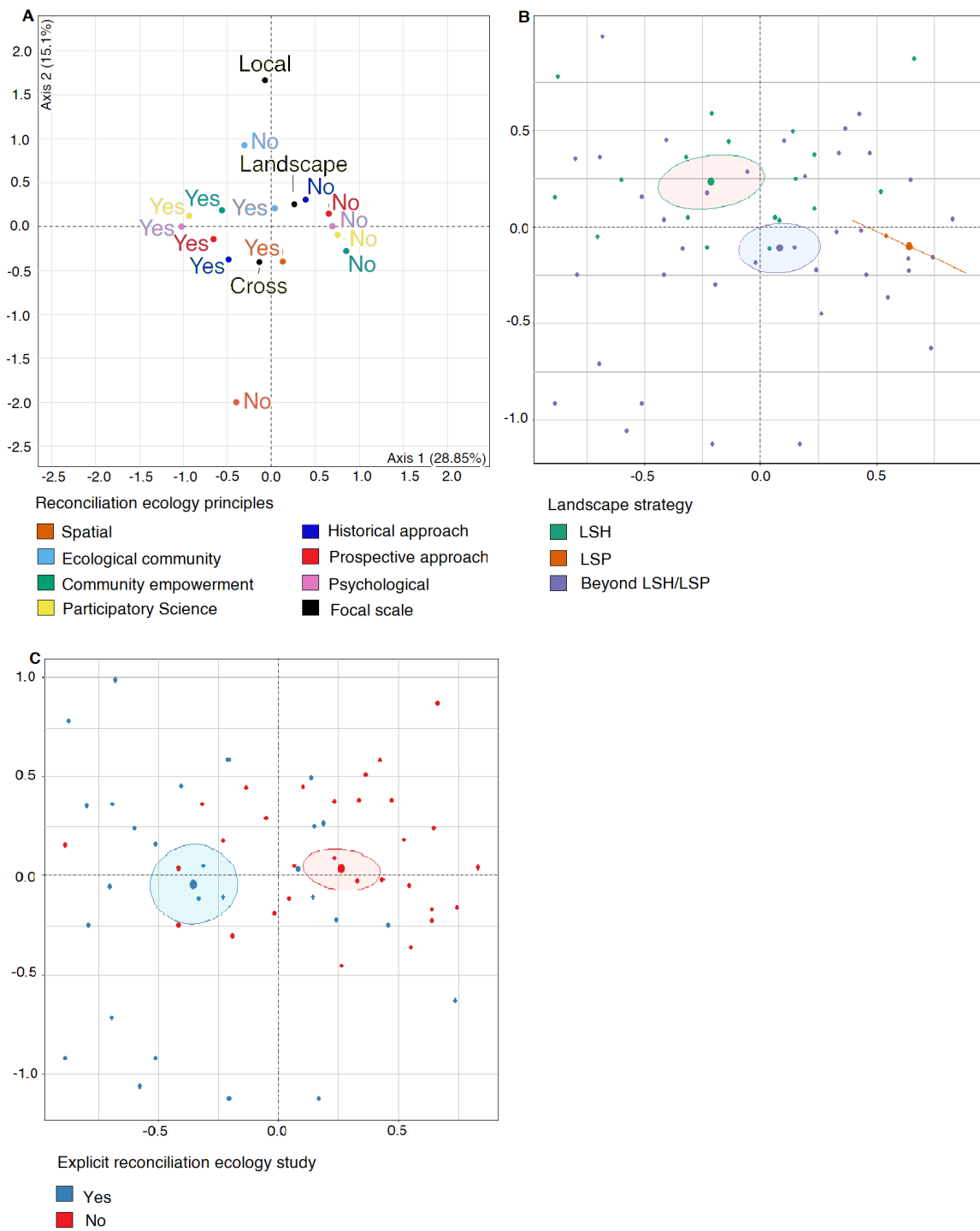


Figure 6. Scatter diagrams from the MCA of theoretical studies: reconciliation ecology principles (A), landscape strategy (B), explicit use of reconciliation ecology (C).

4. DISCUSSION

4.1. Landscape strategies and conservation sciences

In our effort to link landscape strategies and conservation sciences research, we have highlighted the importance of the link between conservation sciences and practice. Indeed, conceiving the system, whether by compartmentalising its elements or considering them as interconnected as a social-ecological system, determines the type of strategy proposed. For example, the geographical bias in the study of landscape strategies is characterised by the predominance of studies led by the North and carried out both in the North and the South. However, suppose that sciences, particularly conservation, are the product of historical, cultural and social processes. In that case, we can assume that the failure to consider a diversity of worldviews leads to the formulation of homogenous strategies that can fail to resonate with specific contexts and thus just and desirable futures (Chan et al., 2016).

The predominance of the debate between LSP and LSH can be explained by the mobilisation of homogeneous worldviews reflecting a particular conception of the system typical of the naturalist dichotomy. Furthermore, the LSP/LSH debate was built around the biodiversity and agricultural production trade-off. It is, therefore, a classic economic relationship since it concerns the efficient allocation of a scarce resource, land, between two compartments (Fischer et al., 2014). The conceptual separation between nature and culture has led to not conceiving the surrounding environment as a genuinely social issue other than as a source of resources to appropriate, value and allocate (Descola, 2005). This allocation between components conceived as natural or non-natural (related to human activities) is a practical emanation of this naturalistic relational ontology. It is evident in the framework of the LSP strategy. However, LSH strategies also retain this dichotomy, even if the notion of sharing may suggest a break with the conception of sparing. Far from being a break, they can be considered an inversion of the LSP strategy while keeping this compartmentalised conception of the components of the system. The use of scale to analyse these strategies is particularly telling since a land-sparing strategy at a regional scale can be seen as a land-sharing strategy. Conversely, a land-sharing strategy at a landscape scale can be seen as LSP at a local scale (Figure 7).

Finally, the limited number of studies considering the multidimensionality of landscape issues could limit the implementation of reconciliation ecology. This debate is, therefore, an imperfect reduction of the more global question addressed by reconciliation ecology: how to protect biodiversity without setting aside humans and their activities? The predominance of empirical rather than theoretical studies and the fact that the proposed strategies tend to go beyond the dichotomous approach between LSP and LSH indicates that the problem lies not in the design of landscape strategies but in the underlying concepts. In other words, our results suggest that the theoretical part of the treatment of the problem, notably by rethinking the system design, is crucial to formulate landscape strategies relevant to conservation.

The decreasing trend of publications in the reconciliation ecology field compared to the overall research about land strategies highlights its limited uptake compared to SES sciences since its formulation by Rosenzweig (2003a). The use of reconciliation principles across the literature highlighted their division between two disciplinary approaches: “classic ecological” and social-ecological. This division may reflect the historical trend in conservation relative to the conceptual shifts of the relationships between humans and wildlife and, by extension, to human-nature relationships. Reconciliation ecology aims to go beyond the disciplinary approaches characterising naturalistic ontology. Reconciliation examples (Rosenzweig, 2003a) are multidimensional processes that acknowledge a multiplicity of outputs describing complex adaptive systems (Berkes, 2004). This difficulty of reconciling multiple disciplines with the different theoretical basis, traditions and practices could be overcome by promoting transdisciplinarity through participatory methodologies. Moreover, our analysis revealed that reconciliation ecology principles are also rooted in studies which do not claim the concept. This disjoint presence of principles in the literature reflects the potential for reconciliation ecology to be a cohesive and structural framework for conservation sciences and that its principles are mobilisable independently. Our review suggests that the main challenge of reconciliation ecology lies in the theoretical structuring of the principles it implements through its empirical evidence, which could be translated from local evidence to global principles.

Besides the conception of a compartmentalised system, species and scale focus tends to influence the formulation of landscape strategies. Especially in empirical studies, the complexity of reality can contribute to the substantial use of other principles depending

on the context of the study site and the issues at stake. The solid spatial dimension of reconciliation ecology also contributes to mobilising principles common to spatial ecology. This reveals the cohesive character of reconciliation ecology within different conceptions within the conservation sciences, allowing, in particular, to empirically enrich the theoretical concept of social-ecological systems.

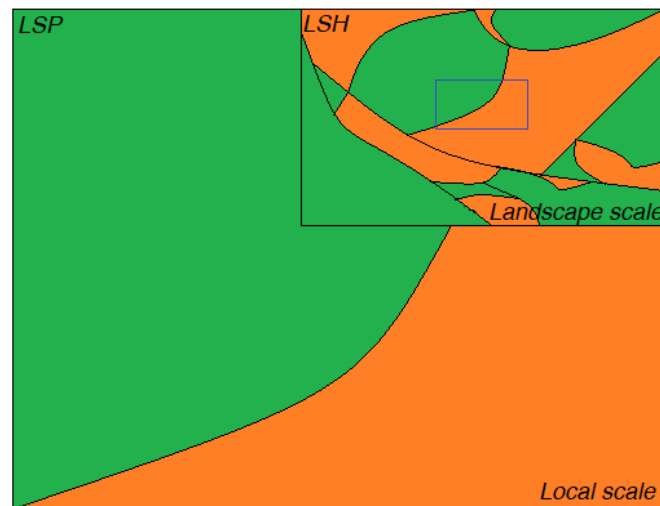


Figure 7. Schematic representation of the importance of scale in determining a landscape strategy.

4.2. Landscape strategies and reconciliation ecology principles

According to Rosenzweig, reconciliation ecology is often concerned with the “*reinvention*” of an ecosystem, but it can also go beyond and focus on a particular species (Rosenzweig, 2003a). This review confirmed this assumption as its principles are present and associated in many articles, with about half of the studies focusing on ecological communities globally. However, a solid taxonomic bias exists on mammals, birds and plants as studied species (Burton et al., 2015; Troudet et al., 2017). This bias highlights the importance of our experience (direct or symbolic) with wildlife in representing our surrounding environment. Focusing on charismatic species or systems could function as surrogates by being either flagship species or ecosystems umbrella. However, the choice of surrogate species has tended to be ad-hoc (Andelman & Fagan, 2000), and conservation priorities sensitive to the selection of the surrogate (Lentini & Wintle, 2015). Large mammals can occur in anthropogenic landscapes because of territories larger than designated protected areas (Crespin & García-Villalta, 2014; Crooks et al., 2011;

Johansson et al., 2016; Kansky et al., 2016). This mismatch between actual territories and designed protected areas emphasises the need to rethink landscape strategies for their survival and viability (Fritz, 2005). Some smaller species are more sensitive to human disturbance, and protecting areas from human development is paramount (Bretagnolle et al., 2018; Edwards et al., 2015). According to our results, the joint conservation of large animals (problematic species concerning human interests; Kansky & Knight, 2014) and small animals (less problematic but sensitive to human disturbance) could be considered challenging for the advent of cohesive reconciliation ecology. Besides demonstrating a discontinuous design of the system elements described previously with interpretations resulting from the study of an aspect of a component which would apply to all the others, this also underlines the hierarchical character of the interest of conservation sciences.

In the case of large carnivores, many studies highlight that implementing one of the traditional strategies (LSP or LSH) is unsuitable for these species. Protected areas are often too small to host multiple individuals due to their extensive habitat range (Athreya et al., 2013; Woodroffe & Ginsberg, 1998). Free-roaming large carnivores in a model of LSH are not acceptable for many human populations (Lozano et al., 2019). It underlines the weaknesses of the reduction of spatial conservation strategies in the LSP/LSH debate.

Furthermore, surrogate species can fail to adequately consider local communities' perceptions (Bowen-Jones & Entwistle, 2002). However, it can be an effective means of conserving biodiversity at regional and local scales (Caro et al., 2004; McGowan et al., 2020; Williams et al., 2000), and some authors discussed the concept of cultural keystone species (Clark et al., 2021; Platten & Henfrey, 2009). The term social-ecological keystone has also been employed as a metaphor for understanding a social-ecological system's structure, function, and resilience (Winter et al., 2018).

However, this difficulty formulating landscape strategies could express a mismatch between study scales. This mismatch is more promising than limiting because it allows reconciliation ecology to merge different streams of scale-specific social-ecological studies. It is made possible by the mutual recognition of the necessity to extend the understanding of the elements and relationships of the system. Moreover, at first sight, some studies not relevant to reconciliation ecology can be considered as addressing a particular issue at a specific scale within reconciliation ecology. However, their recommendations are limited to their particular system's relationships which cannot be generalised to reconciliation ecology. We highlighted the influence of the study's spatial

scale in the proposed resulting conservation strategy. However, the link between spatial scales and strategies is inconsistent. The statistical association between spatial scales and strategies in our analyses suggests that encompassing the diversity of strategies implies crossing spatial scales in conservation sciences. It is consistent with other studies highlighting the importance of multi-scale-disciplinary approaches to unravel endogenous processes shaping human-wildlife coexistence (Guerbois et al., 2012). These results align with reconciliation ecology, which advocates the importance of considering different scales to implement its idea of “*inventing, establishing and maintaining new habitats to conserve species diversity where people live, work or play*” (Rosenzweig, 2003a). Thus, the spatial approach is paramount for reconciliation ecology, especially regarding scale effects. The passage from multi-scale approaches to landscape approaches after 2013 should, therefore, not be seen as abandoning multi-scale processes but rather as refocusing research in favour of policies that recognise a specific diversity and complexity of landscape processes in line with landscape ecology (Wiens, 2009).

Nevertheless, other reconciliation ecology principles are also deeply rooted in SES research through their implicit use in empirical evidence that reconciliation provides. Promoting the research co-design through the collaboration of knowledge systems between researchers and local communities could sustainably benefit biodiversity conservation within the landscape by addressing more dimensions of the issue (Tengö et al., 2017). According to Couvet and Ducarme (2014), controlling human activities implies a question of equity. These issues raise questions concerning how research is conducted and, thus, epistemic issues concerning the relationships between science and society. Reconciliation ecology offers an opportunity to co-create an empowering, equitable, inclusive, and ethical collaborative environment (Kia-Keating & Juang, 2022) by highlighting “success stories” grounded locally and emerging from collaborations and citizen initiatives. These locally-grounded responses to promote favourable spaces for wildlife in anthropogenic landscapes are also considered in reconciliation ecology as a contingent and empirical process that links its historical approach to principles from historical ecology (Balée, 2006). It recognises the path dependency of human relations with wildlife. The empiric character of reconciliation ecology naturally integrates into more prospective approaches to evaluate conservation measures' potential outcomes and replace conservation actions in a social-ecological trajectory (Rega et al., 2019). Psycho-environmental aspects have been highlighted as paramount to implementing

reconciliation ecology practically because of its underlying objective to redefine the relationships between humans and wildlife within shared landscapes. As illustrated by (Rosenzweig, 2003b), reconciliation ecology is a change of mindset implying new rules, values and knowledge. Understanding the psychological determinants of action is paramount for the reception and the success of conservation (Raymond et al., 2013) and the perceived effects of the latter, which is needed for the practical implementation of reconciliation ecology (Subiza-Pérez et al., 2020). These reconciliation ecology principles, emerging from local and empirical evidence, can thus be applied to effect this change toward transformative conservation.

4.3. Through its complex approach to social-ecological systems, reconciliation ecology advocates the importance of redefining human-wildlife relationships

We highlighted that the debate between LSP and LSH is constructed according to a compartmentalised understanding of the system, which can be reduced to a trade-off between allocating natural and non-natural functions to a space. Therefore, the LSP/LSH is an imperfect reduction of the more global questioning addressed by reconciliation ecology on protecting biodiversity without setting aside humans and their activities. Therefore, one of the main questions is what differentiates the ecology of reconciliation from these strategies. If it does not fit into this dichotomy, it differs in how the system is understood. Our results show the difference between the latter and the LSH strategy.

Reconciliation ecology requires a redefinition of the relationships between humans and wildlife. Several authors suggest other ways to go beyond this dualism and to reconsider our relationships with other living beings (Berque, 2015; Descola, 2005; Godelier, 1984; Latour, 2004). The ontological relationships, which can be classified into four types: naturalism, analogism, animism and totemism (Descola, 2005), allow us to understand better the anthropological foundations of the diversity of relationships between humanity and its environment. The conceptual separation between nature and culture (dualistic) has led to not conceiving the surrounding environment as a genuinely social issue other than a source of resources to appropriate, value and allocate (Descola, 2005), which characterises the LSP/LSH debate. The concept of “nature” is essential in its descriptive use of the systems but problematic when its use is normative for conservation (Larrère & Larrère, 2018) because precisely this is not a norm, and the concept of nature

exists only in circumscribed societies (Descola, 2005). It highlights convergent points with the idea of reconciliation ecology as stated by the ecologist Rosenzweig (Rosenzweig, 2003a), especially concerning the notion of “natural” and “artificial” character of reconciliation ecology setups with no *a priori* regarding this distinction as soon as it benefits biodiversity. By mobilising many principles traditionally belonging to different disciplines, reconciliatory ecology proposes another relationship with "nature" that moves away from the naturalist dichotomous vision while identifying their needs. Thus, moving away from a dichotomous concept of nature, in particular by convening participatory processes, taking into historical account processes and human needs and how these are perceived, would make it possible to update our modes of relationship with nature and, therefore, wildlife. Using these principles in empirical research would thus allow for the enrichment of interpretations and, therefore, landscape strategies beyond the LSP/LSH debate.

The emergence of research on relational values (Chan et al., 2018) in sustainability sciences makes it possible to conceive of a collaboration between the physical thought of the relations between humans and nature and relational thinking, a collaboration bearing, particularly on the concept of the landscape (Stenseke, 2018). Reconciliation ecology tools can concretise this link between relational values and landscape research, thus integrating the plurality of relationships. This emphasis on relational landscapes (Stenseke, 2018) anchors reconciliation ecology in SES research both in its practices, through the tools it allows to mobilise, and in the practical formalisation of the ideas and concepts proposed by the relational landscapes research agenda. From the double challenge of integrating local, global and theoretical-practical processes, reconciliation ecology could supply a pathway for SES research to overcome the gap between theoretical and practical aspects in providing empirical evidence of human-wildlife coexistence principles. Furthermore, by practically addressing coexistence issues in shared landscapes and illustrated by empirical evidence, reconciliation ecology enriches the more theoretical positions of social-ecological research and other frameworks, such as shared earth and sea, by linking to the structuring principles we analysed in this study.

III. Extension of the concept of relational landscape and establishment of an adapted methodological range

The analysis of the reconciliation ecology idea shows that, although the principles of landscape ecology are essential for understanding landscape functioning, there is a need to go beyond purely landscape considerations in conservation sciences by advocating the CAS perspective of SES to conceive the interweaving of social and ecological aspects of the system. Complexity emerged in reconciliation ecology from the real world and is presented as raw materials that are difficult to translate to theory and precise conservation strategies. Thus, it is challenging to identify practical measures to define favourable spaces for wildlife species in anthropogenic landscapes. More than integrating humans as a component of a more comprehensive system, we highlighted that relations between the components of the system at different scales are shaping CAS. The meaningfulness of these relationships between humans and wildlife depends on the values humans assign to their relationships towards nature and specific places (Pascual et al., 2017). The landscape strategies described in the literature review differ not in their practical characteristics of landscape organisation but in conceiving the compartmentalisation of social and ecological components. The theoretical foundation on which landscape strategies are based is thus crucial in their practical implementation, bringing us back to the tension between theory and practice highlighted in the literature (Preiser et al., 2018). It is then a question of overcoming this tension between theory and practice by questioning this specific dichotomous vision of the system to ensure that it is based on elements that allow for the integration of a diversity of values and modes of relationship that practically anchor it in the network of interactions that structure the system.

Therefore, the first conceptual step is to extend the notion of physical landscape to relational landscape in socio-ecological studies. It implies collaboration and interoperability of knowledge modes that must be specified. This collaboration of knowledge systems in this research is thus ensured between the literature review, scientific knowledge mode, preliminary discussions with stakeholders, and local knowledge. This collaboration allows for the co-construction and co-elaboration of this doctoral project. It will detail the salient aspects and outcomes regarding objectives and research questions emerging from this collaboration.

1. Bridging landscape research to relational thinking

Relational values have been recently introduced into sustainability sciences and, according to Stenseke (2018), imply closer connections to other social sciences. Relational values focus on *“the objects of cultural identity, social and moral responsibility towards nature and social cohesion”* (Pascual et al., 2017). Relational values imply a shift in the valuation of nature and question by the way the idea of nature as an ontological entity. They deal explicitly with human relations to the *“material dimension of our environment”* represented by physical objects and processes (Chan et al., 2016). It is important to note that relational values have an object and are not metaphysical concepts.

Bridging landscape research and relational thinking (Stenseke, 2018), extending the notion of “geographic landscape” to the idea of the relational landscape by introducing relational values would be promising to address the diversity of looks that constitute the landscape but also address the complexity and adaptability of the SES while taking advantage on landscape ecology advances. For instance, concern for nature, care, connectedness, and individual or cultural identity are relational values. However, few studies empirically investigated relational values in conservation (e.g. Chapman et al., 2019; Foggin et al., 2021; Skubel et al., 2019). Furthermore, studies lack mobilising diverse stakeholders (De Vos et al., 2018). Moving from a Cartesian consideration of landscape to that of a relational landscape is not just an effect of semantic style. Indeed, it allows us to adopt diverse landscape views, fundamental in SES thinking, and to explicitly consider the interrelations between biophysical elements, humans and non-humans. Adopting a relational landscape research approach means considering the diversity of the looks at the landscapes and thus adapting the required methodologies. Public participation in research and decision-making is often justified through social justice; therefore, including a diversity of stakeholders means the acceptance of heterogeneity as a social justice tool (Jones, 2011; as cited in Setten & Brown, 2013).

2. Interweaving scientific and local knowledge

Including a diversity of individuals and groups together implies necessarily power relationships. As advocated by Mathevet et al. (2018b), participatory methodologies always suggest power relationships and to balance this, participatory

processes should be transparent and radically open to potential participants (Colding et al., 2006; as cited in Mathevet et al., 2018a). It is also true for the person who adopts the posture of some form of scientific authority, the researcher, and the participants. Moreover, Indigenous people and local communities have complementary insights to exchange with scientific knowledge and the translation of information from one knowledge mode to another (here, from the scientific to the local knowledge system and vice versa) faces multiple challenges (Tengö et al., 2017). However, this dialogue between knowledge modes needs to be detailed thoroughly, and that is what Tengö et al. (2017) realised and that we will use as a guideline when collaborating with different knowledge systems in this thesis. Tengö et al. (2017) note that Indigenous and local knowledge systems radically differ from the scientific knowledge system carried out by Western societies because it is embedded in other worldviews (Johnson et al., 2015; as cited in Tengö et al., 2017).

Consequently, the authors highlight the need to create environments conducive to collaboration and learning between the various stakeholders to build bridges between knowledge systems. The authors identify this need as “*actors, institutions and processes*” (Tengö et al., 2017). Tengö et al. (2017) define knowledge systems based on the insights of Van Kerkhoff and Szlezák (2016) as “*networks of actors connected by formal and informal social relationships that dynamically combine doing, learning, and knowing*”. Additionally to this definition, it is essential to note that there is no value judgement between different knowledge systems; they are all produced in a context of power relations leading to representation issues (Cash et al., 2003; Hill et al., 2012; as cited in Tengö et al., 2017).

However, Tengö et al. (2017) argue that the emergence of new knowledge from knowledge systems collaboration can have benefits and disadvantages for participants needing in-depth investigation to avoid potential harm as much as possible, as highlighted by Whyte et al. (2015). Tengö et al. (2017) proposed five tasks to engage this process: mobilise, translate, negotiate, synthesise and apply, which we will report below based on Tengö et al. (2017).

According to Tengö et al. (2017), *mobilising* means developing tools that allow the production of knowledge about experience and knowledge without restricting this emergence with specific rules relative to particular knowledge, such as the scientific one (Fazey et al., 2013; Raymond et al., 2010; as cited in Tengö et al., 2017).

It is also essential that this knowledge is approved and legitimised by the participants. (Danielsen et al., 2014; as cited in Tengö et al., 2017). As highlighted in their work, it includes a strong collaboration between knowledge systems to mobilise different knowledge systems and imply a strong partnership between the researcher and the participants. Tengö et al. (2017) further note that knowledge brokerage is paramount and are innovative methods that should be tested and experimented with to ensure that knowledge mobilising is effective (Fazey et al., 2013; Rathwell et al., 2015; Wyborn et al., 2021 as cited in Tengö et al., 2017). In this thesis, methodologies have been identified and discussed through preliminary discussions to emanate from this dialogue (Appendix I).

Another essential task presented by Tengö et al. (2017) for knowledge systems collaboration is *negotiation* which is the collaboration between different knowledge systems while respecting the system's specificities (Cash et al., 2003; Clark et al., 2016; as cited in Tengö et al., 2017). They highlight that promoting discussions between stakeholders is crucial for the research outcomes to anchor the project in a long-term association beyond the project itself. Negotiating acknowledges the different power relationships between stakeholders on the one hand and with the researcher on the other hand and creates a place where trust, listening, and expression ability are central. This task has been undertaken through preliminary discussions and focus-group discussions.

Moreover, the ability to *synthesise* knowledge is crucial. Synthesising knowledge contributes to lay common ground for a particular issue by involving a systemic understanding of the problem to identify the characteristics that would make sense to the whole community of stakeholders (Armitage et al., 2011; as cited in Tengö et al., 2014). "*Co-produced synthesis*" can promote the identification of new research questions and create a real team of participants, catalysing trust (Tengö et al., 2014). This task has been undertaken through focus-group discussions and validating the methodologies' outputs.

Apply task describes the common knowledge that will allow to move from theory to practice through decision-making and feedback between knowledge systems (Tengö et al., 2017). Tengö et al. (2017) note that these applications must be meaningful for all participant groups and can take different forms (Raymond et al., 2010; Robinson & Wallington, 2012) considered at different scales (Barber et al., 2013). For three reasons, this may be the more challenging aspect of engaging with Indigenous people and local community stakeholders. The first reason is the ability of the research, given the institutional rules and funding availability, to ensure the project's continuity and give a

long-term warranty to the stakeholders, which can be an external factor to consider when engaging in this approach. Secondly, it questions the role of the researcher within conservation processes and its legitimacy to impulse changes which would be (even collaboratively) driven by its a priori ideas through the inclusion of stakeholders, conduction of processes or facilitation. Finally, this task is crucial for this project and research because it could annihilate the subsequent projects and drive away these populations from science and research. Therefore, clarity and transparency about the possible outcomes and probable difficulties should be discussed with all the participants to ensure that there would be no false expectations. This task has been undertaken through preliminary discussions and the workshop structure of the research.

Finally, *translating* aims to make the group-specific knowledge understandable for all the participants (Tengö et al., 2017). It is possible by the multiplicity of exchanges during the participatory process to clarify some points or to highlight concrete examples to get the essence of the idea (Tengö et al., 2017). Boundary objects can also ensure this translation task (Tengö et al., 2017).

Therefore, as noted by Tengö et al. (2017), when engaging with different participants, the representation of a group by a few individuals is always an issue (Beck et al., 2014; Hill et al., 2015 as cited in Tengö et al., 2017). For example, in our study sites of the Garden Route and the Kalahari, representatives of each group presented themselves as such. Still, their legitimacy to represent the group is challenging to assess. Moreover, this issue points to the researcher's role in the process and their legitimacy to decide who deserves to be representative. It is a complicated task because it could bias the process in favour of individuals' interests if not correctly assessed. Tengö et al. (2017) underline that knowledge alone is not enough to move from theory to practice, and it must be linked to agency to foster transformative action (Folke & Berkes, 1998). It relates to the theoretical emergence of the action of stewardship resulting from the interdependence of knowledge, agency and care (West et al., 2018). It is imperative to consider the social and historical contexts of knowledge production, especially when collaborating with Indigenous people and local communities that were and still are prone to marginalisation and intimidation towards institutions (scientific or not) (Tengö et al., 2017).

According to Tengö et al. (2017), following Agrawal (2002), Indigenous and local knowledge is carried out and constituted by their representatives through formal and

informal institutions. Indigenous methodologies are undertaken following their worldviews, defined as a shared way of understanding the world (Dryzek, 2013) as reported through the examples cited in Tengö et al. (2017) of Kealiikanakaoleohaililani and Giardina (2015) or Smith (1999). There is, therefore, a significant challenge in formulating methodologies to account for this diversity of experience because knowledge sharing and learning can consolidate and revive Indigenous institutions (Tengö et al., 2017). This is the primary assumption of this thesis.

3. Questions and methodologies as constituent and constitutive parts of this research

The literature review on landscape strategies, coexistence and reconciliation ecology allowed us to frame the research questions about coexistence broadly and to assess state of the art in studies about human-wildlife coexistence. Spatial coexistence appears paramount for conservation, and landscape ecology insights are essential. However, the literature review suggested that these spatial patterns are the tangible manifestation of coexistence. In that case, the latter is presupposed by other dimensions that must be integrated into the analysis. To incorporate these elements into the study of the SES for human-wildlife coexistence, the project has been framed by mobilising the five tasks to enable the bridging of knowledge systems proposed by Tengö et al. (2017). This collaboration between several knowledge systems is multi-stakeholder: it involves transfers between individuals and stakeholder groups and the scientific system with this Indigenous and local knowledge.

The research is structured in two main phases: a preliminary phase and a data collection and reflection phase (Figure 8). The objectives of the preliminary stage were (1) to engage with different stakeholders, to present the overarching project and build trust through face-to-face interviews, (2) to adopt a bottom-up approach in the design of the research both concerning research questions and methodologies and (3) understanding the issues at stake locally and contextualising the social-ecological system. This project has been granted ethical clearance from Nelson Mandela University (H20-SCI-SRU-003). A purposive stratified sampling has been adopted among four categories: governance, conservation organisations, and local and Indigenous communities. Stakeholders groups represented by individuals or institutions were defined *a priori* and were extended through the snowballing approach. The inclusion of stakeholder

categories was pursued until a stakeholder group was obtained whose level of expertise was common to both sites (Figure 9). Participants were selected according to their interests and potential influence on conservation strategies. The Garden Route involved fourteen participants, and twelve for the Kalahari site participated in the preliminary interviews.

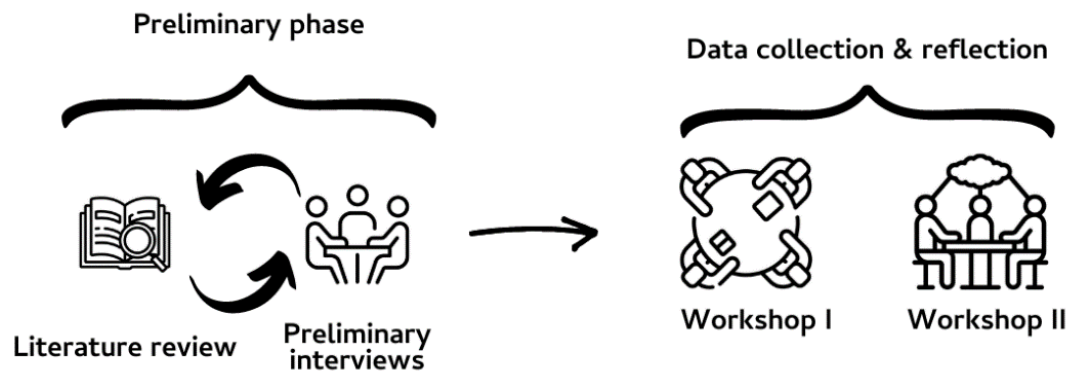


Figure 8. Illustration of the thesis structure

The preliminary interviews were analysed thematically to identify processes at stake locally. We conducted the first round of raw coding and then classified themes to identify the different processes.

The environmental issues identified as crucial in the Garden Route were primarily related to human presence and activities, including landscape fragmentation and the increasing presence of humans in all habitat types. To a lesser extent, fire and resource exploitation were identified as potential threats. As the theme of the study focused on mammals, the recurrence of invasive plants in the discussions shows a significant concern on this subject. Regarding problematic species, baboon, bushbuck and bushpig were regularly mentioned. The state of their population does not worry the participants, but their presence creates many problems of coexistence. The responses envisaged are diverse in the means implemented depending on the species considered. Baboons crystallise the tensions: from the lethal solution to the use of means promoting coexistence, they polarise positions. Damages caused are multiple and affect all categories of inhabitants, regardless of their activity. Leopard and caracal, although rarely seen, are also regularly mentioned. They do not pose any particular coexistence issue in Wilderness. Nor does it pose a security problem, as no attacks have been reported. As farms in the study area are mainly fields and pastures, caracals only pose some particular problems apart from predation on domestic cats. The scale of nuisance is therefore

restricted to the household. There is a solid attachment to the area among the participants and a strong emotional dimension, positive or negative, towards other living beings. Given human pressures, sharing the territory is an ideal but challenging strategy. Several participants widely discussed the aspect of the way of life associated with the place.

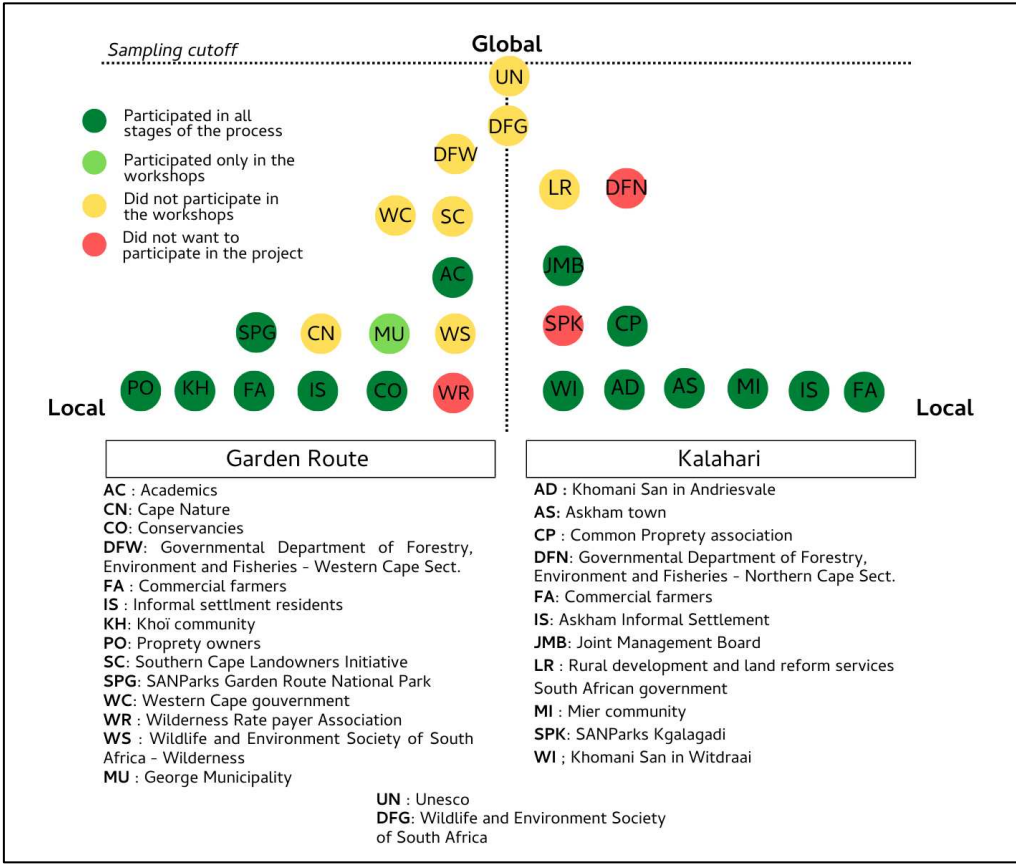


Figure 9. Presentation of stakeholders' group and participation levels in the two sites

Table 2. Description of the stakeholder groups and their participation

Site	Stakeholder group	Participation (Prel. Int/W1/W2)	Description
Garden Route	Academics	✓✓✓	Students and researchers affiliated with Nelson Mandela University
	Cape Nature	✓∅∅	Cape Nature is the chief custodian of the Western Cape's natural environment and is governed by the Western Cape Nature Conservation Board. It is a government entity responsible for managing and maintaining nature reserve complexes
	Commercial farmers	✓✓∅	Owners of commercial farms (dairy, fruits trees, corn)
	Conservancies	✓✓✓	Association of property owners leading citizen-based conservation actions in their residency area
	DEFF	✓∅∅	Department of Environment, Forestry and Fisheries - Western Cape section
	Municipality	∅∅✓	Representants of George municipality
	Informal settlement residents	✓✓✓	Wilderness informal settlement residents
	Khoi community	✓✓✓	Khoi community of the Korana tribal house (members from Pacaltsdorp, Kleinkrantz and Blanco)
	Property owners	✓✓✓	Property owners of Wilderness
	SANParks	✓✓✓	South African National Parks - Garden Route National Park
	SCLI	✓∅∅	Southern Cape Landowners Initiative
	WESSA	✓∅∅	Wildlife and Environment Society of South Africa - Wilderness
Western Cape Government	✓∅∅	Western Cape Province Dept Environmental Affairs & Development Planning	
Kalahari	Witdraai †Khomani San	✓✓✓	†Khomani San community inhabiting Witdraai farm area. Most of the Dawid Kruijer family lives there and aims to keep a traditional lifestyle
	Andriesvale †Khomani San	✓✓✓	†Khomani San community inhabiting Andriesvale farm area
	Askham †Khomani San	✓✓✓	†Khomani San community inhabiting the Askham area characterised by a mosaic of formal and informal settlements
	Askham town	✓✓✓	Residents of Askham town in formal settlements and living from commercial activities
	Common Property Association	✓✓✓	†Khomani San assembly responsible for organising and making decisions about living on the land obtained in the 1999 land-claim
	Rural development	✓∅∅	Rural development and land reform services mobilised to accompany the process of land-claim
	Commercial farmers	✓✓∅	Commercial farming owners (livestock)
	Mier community	✓✓✓	Mier community members living around Rietfontein and which was part of the land-claim process
Global	Joint Management Board	✓✓✓	The Joint Management Board of the Kgalagadi Transfrontier Park area returned to the Mier and San (†Khomani San, Mier, SANParks)
	UNESCO	✓∅∅	South African National Commission for UNESCO
	DEFF	✓∅∅	Department of Environment, Forestry and Fisheries

The recent immigration of people from Johannesburg and Cape Town with an anxiety-provoking view of the outside world leads, according to the participants, to a translation of values not adapted to this place. It was mentioned by commercial farmers, informal settlement residents, and the Khoï community. It is reflected on the ground in construction fences and gates that reinforce the isolation of private property and prevent wildlife's free movement within the landscape. The Khoï community is in the process of structuring itself with several upcoming meetings aimed at self-determination. The Khoï claimed to have been victims of colonisation and undermined. They expressed their willingness to perform a theatre play to all the participants to highlight their political struggle and the embeddedness of ecological dynamics. In the Kalahari, participants were concerned about climate change and erosion of the landscape but did not mention any human-wildlife coexistence issues. Jackal, Caracal and Honey Badgers are a potential threat to poultry, but the phenomenon is not considered an issue. Eland has been evocated as scarce and is the emblem of the community. The primary concern was the #Khomani San culture's persistence and role in the current system. The access to the Kgalagadi Transfrontier Park, from which they theoretically own a part, is linked to this problem through the ability to collect tubers and other vegetal products for medicine and the hunting ability to transfer this knowledge to younger generations. The role of researchers has also been widely evocated through the expression of their disappointment toward those who engaged with the community and left the area, letting the community live in harsh conditions. Another critical point was the ability of some community members to return to living in the park, which led to various discussions about human-wildlife relationships and community heterogeneity in terms of the ability to live there. The schema of Figure 9 represents the processes highlighted during these preliminary interviews and was quite similar between the two sites. The preliminary interviews provided an opportunity to discuss methodologies to implement in the research process. Research questions were formulated based on these ideas and proposals, and the literature review and associated methods were adopted.

The processes of landscape structure, coexistence, monitoring, knowledge transfer, belonging of individuals in the SES and direct drivers identified through preliminary interviews and the literature review were addressed by understanding the social-ecological requirements of wildlife species in human-dominated landscapes according to a relational landscape perspective applied to species distribution modelling.

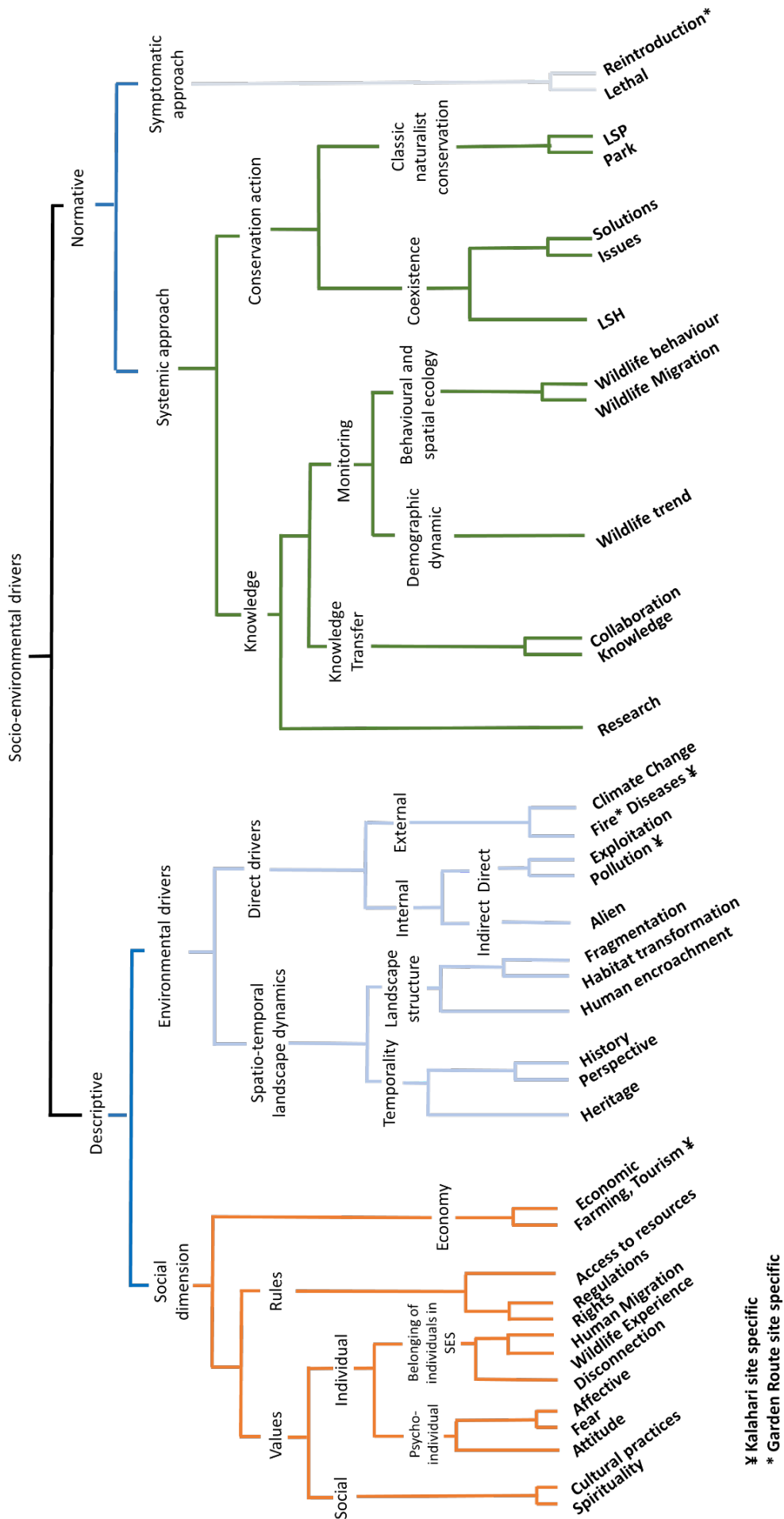
Moreover, it questions the importance of co-construction and co-design for understanding social-ecological dynamics and coexistence. A participatory mapping methodology has been developed to achieve the objectives related to the research questions. However, the mobilisation itself of the participatory mapping methodology needs to be investigated. Indeed, the integration of contextualised data generation into the interpretation is paramount. It is then a question of identifying and evaluating the parameters resulting from integrating the data production context into statistical modelling to demonstrate the relevance of these approaches to model wildlife distribution in anthropogenic landscapes. Participatory mapping is a methodology allowing to map values (Brown & Kyttä, 2018). Brown and Kyttä (2018) show that participatory mapping allows diverse individuals and institutions to produce maps to guide spatial planning (Corbett, 2009; as cited in Brown & Kyttä, 2018). Participatory mapping exercises followed the guidelines we developed during the master's degree (Pédarros et al., 2020) and were conducted during the first workshops in the two sites.

The processes of values, rules, direct drivers, temporality, belonging of individuals in the SES, psycho-individual dimensions, knowledge transfer and coexistence identified through preliminary interviews together with the literature review were addressed by exploring the multiple expressions of temporalised relationships within the landscape and especially care to understand and highlight the importance of the care dimension for stewardship action. Moreover, this aims to characterise the extent of Indigenous people's presence in conservation debates for coexistence with other living beings in relational landscapes. A collaborative timeline methodology has been developed (Table 2) to achieve the objectives related to the research questions. We thought about research questions and methods interdependently. It was also needed to confront the relational landscapes values and stewardship action, i.e. wise use of natural resources, with the collaborative timeline exercises during the first workshop.

The processes of knowledge transfer and research conduction identified through preliminary interviews and the literature review were addressed by assessing the efficiency of co-learning methodologies. Questionnaires were given to the participants before and after the first workshop. However, it could have been more successful as participants were tired of writing the questionnaire while others struggled to write.

During the preliminary interviews, the †Khomani San community expressed the willingness to document their way of life and to communicate their struggles by realising

a film (Box 2). In parallel, the Khoï community desired to perform a theatre show during the first workshop for the same reasons (Box 3). We provided logistical support for realising the movie and the theatre show. By giving carte blanche to the Indigenous communities, the aim was to enforce the trust relationship to provide a distinct voice to this multi-stakeholder process in which power relations were evident. This methodology supported the whole project. The film and the theatre transcript are accessible in Appendix II.



‡ Kalahari site specific
 * Garden Route site specific

Figure 10. Graphical representation of the processes identified through thematic coding. Raw coding are represented below and were regrouped by two to identify the processes.

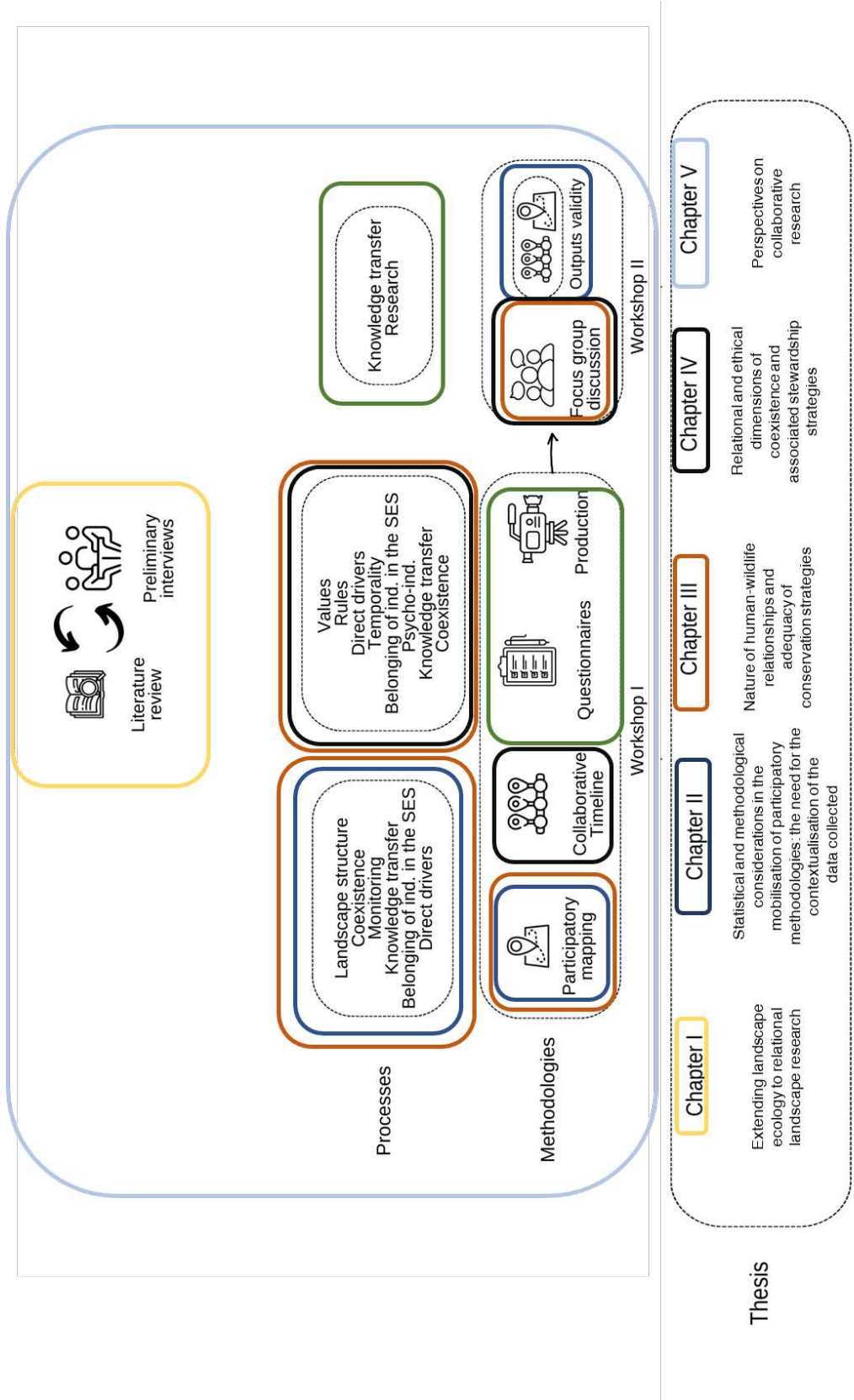


Figure 11. Summary of the thesis structure and the related methodologies



Picture 1. Participatory mapping exercise in the Kalahari (©Élie Pédarros)



Picture 2. Collaborative timeline exercise in the Kalahari (a) and the Garden Route (b)
©Élie Pédarros

Box. 2. The ꞤKhomani San community film, *The Burn of the Nation*, 2021



The film was realised in October 2021. The film has been granted ethical clearance from Nelson Mandela University (H20-SCI-SRU-003), the Working Group Of Indigenous Minorities In Southern Africa (WIMSA) and the Common Property Association. The film was realised according to the participants and presented during the second workshop for final approval from a larger community audience.

The film is watchable here: https://youtu.be/8sf_peH8Fkk

Box. 3. The Khoi community theatre, *Awakenings*, 2021



©Élie Pédarros

The theatre show was realised in October 2021. The show has been granted ethical clearance from Nelson Mandela University (H20-SCI-SRU-003). The Khoi community in Pacaltsdorp entirely conducted the script and rehearsals, and the show was performed at the end of the first workshop to all the different stakeholders' groups (Appendix II).

CHAPTER II - STATISTICAL AND METHODOLOGICAL CONSIDERATIONS IN THE USE OF PARTICIPATORY METHODOLOGIES: THE NEED FOR THE CONTEXTUALISATION OF THE DATA COLLECTED



Witdraai farm settlement, 2021 ©Élie Pédarros

In this chapter we will address the epistemological and methodological dimensions of the use of participatory data in the scientific knowledge system. More precisely, we will investigate the use of data from participatory mapping used to model favourable habitats for wildlife in human-dominated landscapes. We will first discuss the epistemological challenges of using participatory data to explore, secondly, the practical and statistical implications of using this data to model wildlife persistence in our two study sites. Finally, we will examine participatory mapping as a boundary object and its potential to broaden the diversity of relationships studied within the social-ecological system.

I. Nature of participatory data and ecological interpretations

This chapter will focus on the nature of the data obtained through participatory mapping. In the first section of this chapter, we will detail the use of data obtained by spatial ecology protocols. In the second section, we will evaluate the methodological and statistical aspects of its production and analysis within a participatory mapping methodology. Finally, in the last section, we will define the characteristics that justify its contribution to the CAS approach to SES and evaluate how it will enable an ontological, epistemological and methodological re-evaluation of conservation sciences and practices.

1. Participatory data and spatial conservation

Conservation biology increased the understanding of the responses of biological systems to different external perturbations by acknowledging the need to enlarge the relationships with other disciplines, particularly with human sciences (Bennett et al., 2017). However, integrating social and natural science epistemologies, perspectives, and methodologies in conservation efforts remains challenging to understand the systems' complexity (Swanson & Ardoin, 2021). Those challenges hinder the mobilisation of social science to improve conservation sciences and practices (Bennett et al., 2017). To bring landscape research and relational thinking together through a relational landscape approach (Stenseke, 2018), it is essential to explore participatory methodologies in current conservation to weave together different knowledge systems (Tengö et al., 2017). Policymakers have mainly used the principles of biogeography to understand human-wildlife coexistence in anthropogenic landscapes to investigate the biodiversity dynamics (Devictor et al., 2010). Because this chapter involves the collaboration between biogeography and participatory sciences, we will detail the relationships between the discipline and the methodology through the work of Devictor et al. (2010).

"Amateurs and field naturalists" were the first to gather biogeographical information on species diversity, abundance, and distribution (Devictor et al., 2010). Despite this shared history between biogeography and participatory methodologies, these data were not always consistently recorded or fully utilised. For biogeographical purposes, participatory methods can be mobilised through two approaches that

researchers must consider as a trade-off (Devictor et al., 2010). First, we can focus on monitoring biodiversity on specific plots or, largely, in many plots for a given sampling effort. The first approach provides valuable information concerning a specific site at a particular time (Devictor et al., 2010). In contrast, the second approach extrapolates local results to a broader scale and from a long-term perspective (Devictor et al., 2010).

In this thesis, the second approach is privileged, but if participatory mapping workshops were replicated regularly, the overall approach would tend towards the first approach. The main advantage of citizen science is the large size of the datasets obtained compared to the time allocated to more technoscientific monitoring methodologies, as advocated by Greenwood (2007; as cited in Devictor et al., 2010). It has been recognised that these methodologies ensure robust statistical power (Devictor et al., 2010). Participatory methodologies involving citizen scientists and specialists often produce similar results, highlighting their efficacy (Newman et al., 2003; Schmeller et al., 2009; as cited in Devictor et al., 2010). The comparison of habitat suitability modelling based on participatory mapping data with *post-hoc* validation (ground-truthing) allowed us to recognise the robustness of the methodology in the case of baboon distribution in the Garden Route (Pédarros et al., 2020). The assumption on the non-scientific gathering of participatory data is thus not demonstrated but lies in the cultural division between science and society, promoting specialisation and legitimacy.

Moreover, the relevance of a large-scale investigation is not related to the studied scale or amount of data because these datasets can still be biased (Devictor et al., 2010). Species counts depend on the ability of the observer to detect a given individual, which introduces the complexity of dealing with true and false presences (Devictor et al., 2010). In the case of participatory mapping, modelling often only uses presence-only data as it is conceptually more difficult to rely on true absence reports from participants. However, as Devictor et al. (2010) note, an essential standardisation can maintain detectability bias constant over time and thus provide valuable interpretations. In the case of participatory mapping exercises, posterior standardisation can balance the detectability bias, enhancing the statistical power of analyses, especially by giving basic guidelines to the participants.

Many processes and technics exist for extracting useful information from citizen science datasets, as reviewed by Stern and Humphries (2022). Moreover, because statistical power depends on the number of information gathered and individuals

participating in the process, participatory methodologies can quickly go beyond this limitation (Schmeller et al., 2009). Above the relevance to deriving interesting biodiversity indicators, Stern and Humphries (2022) emphasise that “*citizen science projects have contributed to the study of many specific targets, such as the mechanisms of driving species responses to land-use changes, species-specific traits affected mainly by global warming, changes in phenology but also habitat suitability and protected area efficiency*”. There is a wide range of applications and research questions to address when mobilising participatory methodologies for biogeographical purposes.

Devictor et al. (2010) show that besides these “data” advantages, participatory methodologies for biogeography and conservation are often based on how biodiversity is experienced by people, which integrates the relational thinking in landscape research, as promoted by Stenseke (2018). They highlight that these programs are particularly relevant to monitor “ordinary species” and “familiar species”, which refer to the nature directly around us (Devictor et al., 2010). By focusing on more common species, participatory methodologies for biogeographical purposes can counter the dualism between humans and nature within the scientific knowledge system and avoid the related conception of a distant nature advocated by the wilderness idea (Larrère, 2012). In the case of the Garden Route and the Kalahari, the species mentioned by the participants during the preliminary discussion were the most common and familiar species not under specific protected status. However, because they are common where people live and work, these species are at the centre of the issues of human-wildlife coexistence.

2. Data reliability and epistemic challenges of participatory practices

As Brown (2017) notes, spatial aspects of relational dimensions are often addressed through participatory mapping. However, this mapping of intangible elements can be challenging to assess. The criteria of objectivity is a central question in the epistemology of participatory sciences (Bedessem & Ruphy, 2020), which implies a distinction between “*validity-as-accuracy and validity-as-credibility*” (Brown, 2017). For instance, Brown (2017) pointed out that a weak mapping effort in participatory mapping can limit the collection of relevant data if participants are not invested and motivated in the research process or, on the contrary, seek to match the expectations of the researcher (Kaminska et al., 2010; Krosnick, 1991 as cited in Brown, 2017). In contrast, the author emphasises that participants with more interest and engagement in the process will

allocate more time to the exercise, providing better quality. In our case of participatory mapping focusing on species occurrence during workshops, assessing mapping effort is trivial because the workshop planning imposes the realisation of the exercise in due time. Participatory mapping attributes can thus be differentiated based on the cognitive challenge and complexity of the spatial features to be mapped.

The potential for bias from sampling design results, according to Brown (2017), comes from two conditions: the biased representation of interests or disinterests for specific land uses and a “spatial discounting” linked to the sampling and the frequentation heterogeneity of the study area. Moreover, even when the panel of participants appears to represent the population, the non-response bias can bias the interpretations of the data obtained a posteriori (Brown, 2017). Therefore, the interpretations from the exercise should be contextualised by its realisation conditions. The “recruitment” of participants in the process can have important implications for the representativity of the outcomes (Tengö et al., 2017). Nevertheless, previous participatory mapping research has established that random sampling does not produce an improved representative sample of participants despite the constant bias toward “*older, more formally educated male participants with higher incomes*” (Brown, 2012). Brown (2017) highlights that the ideological bias linked to participation in a participatory process is more important than the bias related to socio-demographic representativeness. The potential biases in using participatory mapping methodologies are thus not particularly important at the knowledge transfer stage through the implementation of scientific knowledge systems but in the conditions of data collection. The participant is thus part of the validity process rather than a simple data contributor. Broad recruitment efforts, including household sampling, not just volunteers who could have an out-of-frame interest in the project, to achieve good geographical representation and study area coverage is essential for remote areas with low representative participants such as the Kalahari site (Brown et al., 2018). The preliminary discussions fulfilled this necessity. Another limitation is that spatial surveys rely on participant memory recall for the number of observations and locations, resulting in the potential temporal and spatial inaccuracy of wildlife sightings. This time effect has been described as “the forgetting curve” (Averell & Heathcote, 2011). The “forgetting curve” is a non-linear function in which people remember recent events more than older ones. We thus limited the observations to the past three years in our participatory mapping methodology.

Besides the issues related to the exercise design and conduction, involving non-professionals in science involves epistemological challenges. Based on the typology of participatory practices, Bedessem and Ruphy (2020) described the different aspects of scientific objectivity based on an "*epistemic risk account of the notion*" (Biddle, 2016; Koskinen, 2020; as cited in Bedessem & Ruphy, 2020). The typology of participatory practices distinguishing contributory, collaborative and co-create categories proposed by Bonney et al. (2009) is pertinent to reflect different degrees of public engagement in participatory methodologies mobilised in this thesis. We noted that data and participants are challenging objects in conducting participatory practices and their interpretation. As a trade-off, this typology also suggests various degrees of academic researchers' implications in the research process. The researcher should provide an objectification of the process and its interpretations to assure reliability and reproducibility (Bedessem & Ruphy, 2020). Objectivity has been recognised as a complex epistemological concept historically situated (Daston & Galison, 2007; as cited in Bedessem & Ruphy, 2020). According to Koskinen (2020), Bedessem and Ruphy (2020) use the term "*usable objectivity*" to describe the aspects of objectivity that can be used to evaluate research processes and that we will employ to assess the reliability of our interpretations.

Moreover, participants can be involved in different steps of the research process depending on their involvement; this concept of "usable objectivity" allows one to assess these dimensions (Bedessem & Ruphy, 2020). Following this, objectivity can be targeted by avoiding an epistemic risk, which is "*an error that arises anywhere during knowledge practices*", as defined by Biddle and Kukla (2017) and reported by Bedessem and Ruphy (2020). A given epistemic risk corresponds to a part of objectivity, and avoiding this type of epistemic risk promotes objectivity (Bedessem & Ruphy, 2020).

The first domain emphasised by Bedessem and Ruphy (2020) concerns the "*reliability and epistemic quality of the experimental and cognitive techniques and processes*" deployed that authors call "Baconian objectivity". It depends on the reliability of the protocols (Bedessem & Ruphy, 2020). Epistemic risks and benefits of participation are, in this case, related to the realisation of the methodology (Bedessem & Ruphy, 2020). If we take participatory mapping as an example, this kind of epistemic risk would appear if participants are unfamiliar with using maps and cannot correctly situate themselves (Bedessem & Ruphy, 2020).

Trust is then paramount to ensure a good communication process between the scientist and the participants but not only. Bedessem and Ruphy (2020) highlighted that the main challenge is educational: scientists mobilising these participatory methodologies should be taught to communicate with non-professionals (Bedessem & Ruphy, 2020). However, the authors note that avoiding an epidemic risk is more an advantage in the research process than a constraint because it is in the participants' interest to tend towards objectivity if they want their practical problems to be considered.

Beyond Baconian objectivity, Bedessem and Ruphy (2020) emphasise that epistemic risks related to impartiality are related to conflicts of interest and research misconduct. It can also be related to problems of heterogeneous expertise in the specific case of co-created science leading to erroneous interpretations (Bedessem & Ruphy, 2020). In the context of Indigenous people and local communities in conservation, promoting these stakeholder categories may appear as the "objectivity of impartiality" in conservation decision processes (Bedessem & Ruphy, 2020). In addition to the previously mentioned risks, co-created science is subject to epistemic risks related to scientific expertise (Bedessem & Ruphy, 2020). This epistemic risk has social and political consequences (Bedessem & Ruphy, 2020). Various ideas may appear in public debates with a party concerned, stemming from political will to favour one contradictory group rather than another (Bedessem & Ruphy, 2020). It was the case with our emphasis on Khoisan communities, especially in the Garden Route with the Khoï theatre forum.

As highlighted by Bedessem and Ruphy (2020), since interactive objectivity requires the mobilisation of transparent processes and communication between participants and researchers, epistemic risks in such objectivity can also be linked to issues of "*shared standards and culture.*" It connects with the five tasks identified by Tengö et al. (2017) for the collaboration of knowledge systems. To explore this epistemic risk, Bedessem and Ruphy (2020) consider the notion of "*transformative criticism*" expressed by Longino (1990), which defines the way knowledge is transformed during the participatory process. This "*transformative criticism*" can contribute to increasing the heterogeneity of perspectives and, thus, the efficiency of the participatory process (Bedessem & Ruphy, 2020).

In the conduction of the research presented in this thesis, four approaches of participatory practices have been envisaged: contributory, collaborative, co-created and

do-it-by-yourself (Figure 1). Based on this typology, the research process tends to be objective by avoiding the epistemic risks highlighted by Bedessem and Ruphy (2020).

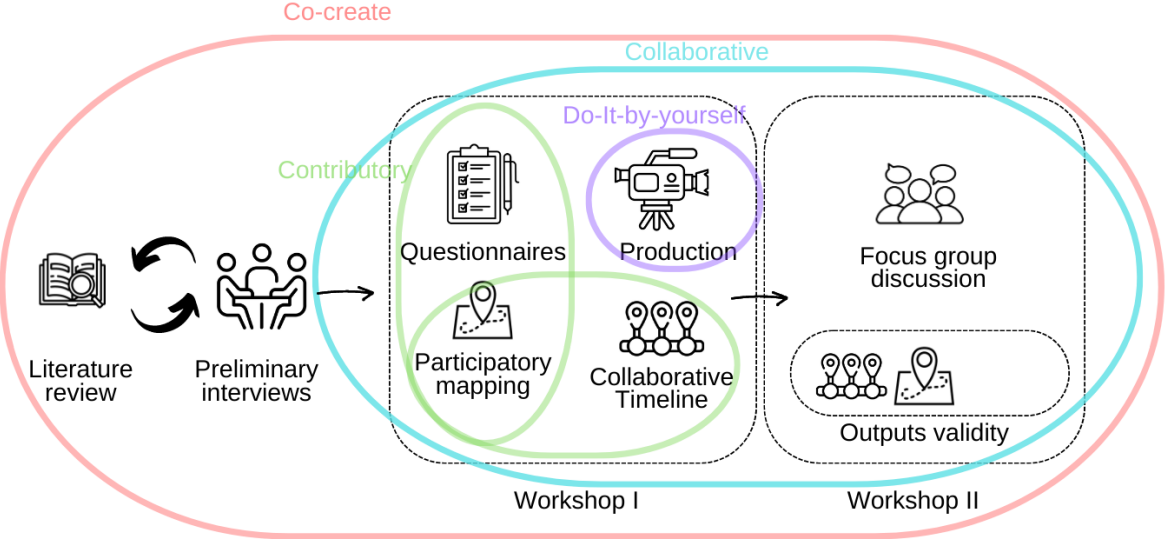


Figure 1. Methodologies mobilised during the two structuring workshops and participatory practices.

Table 1. Research process application of epistemic risks (Bedessem & Ruphy, 2020) in the mobilisation of participatory practices

Objectivity domain	Participatory typology	Benefits	Issue	Methodologies	Response to issues
Baconian (reliability of the experimental or cognitive techniques used)	Contributory	More data	Data collection protocols' reliability	Mapping	Knowledgeable participants mobilised, detectability considered (sampling, visibility, accessibility) and replicated protocol
				Timeline	Four main categories framing the methodology
				Questionnaire	Structured questionnaire
	Collaborative	Contribution of lay expertise	Issues of reliability of inquiry and protocols	Outputs validity	Validation and discussion of data collection outputs
				Focus group discussion	Conservation and coexistence issues discussions in plenary assemblies
Impartiality (no distortion by explicit non-cognitive interests)	Contributory	Better control of conflicts of interests	Issues of scientific integrity	Mapping	Focus on multiple species (problematic or not) in a familiar area to every participant
				Timeline	Impartiality as objectivity
				Questionnaire	Cancelled due to the non-representativity of nonliterate individuals
	Collaborative			Outputs validity	Nominal group technic to allow individual, intra and inter groups opinion
				Focus group discussion	
	Co-created	-	Unbalanced production of scientific expertise, fragmentation of the research agenda	Preliminary discussions	Outputs of the preliminary discussion supported by a literature review of scientific literature
Interactive (the transparent process of critical discussions between epistemic agents is assured)	Contributory	Interactive learning processes between participants	-	Mapping	Workshop process maximising interactions
				Timeline	
				Questionnaire	Cancelled
	Collaborative	Increased efficiency of transformative criticism processes	Asymmetry in responses to mutual criticism, lack of shared practices, norms and trust	Outputs validity	Initiative-taking facilitation to promote diversity of expression
Co-created	Focus group discussion				

3. Nature of Participatory data

The data resulting from participatory practices and emerging from the collaboration of different actors are promising for conservation sciences because they are the emergence of complex mechanisms. However, these data are subject to strong constraints in their validity, mobilisation and generation, as highlighted by the epistemological analysis and their interpretability.

Stern and Humphries (2022) realised a comprehensive literature review about the complementarity of experiential wildlife knowledge (i.e. knowledge obtained through participants' interactions with wildlife) and other kinds of wildlife data. The authors emphasise that the primary difficulty lies in understanding the collaboration problems between these different knowledge systems (Stern & Humphries, 2022).

The review realised by Stern and Humphries (2022) identifies four parameters to consider in mobilising experiential knowledge for species distribution modelling: elicitation methods, statistical methods, potential bias considerations and evaluation methods.

According to the review conducted by Stern and Humphries (2022), the most common knowledge elicitation methods are interviews and questionnaires and, to a lesser extent, participatory mapping, workshops and collecting pre-existing data. Thus, more perspective is needed on the collective elicitation of experiential wildlife knowledge when using participatory methodologies. Potential epistemic risks have been considered in constructing and conducting participatory mapping workshops. The main question emerging from the collaboration of knowledge systems for spatial ecology is to know if the data obtained are analysable and interpretable in the same way as data from more standardised protocols.

The literature on this subject shows that an effort to collaborate on different knowledge systems and methods has been undertaken (Stern & Humphries, 2022). The most frequent combination highlighted by the literature review of Stern and Humphries (2022) is habitat models produced by regression and statistical methods using knowledge from point observations. Still emerging from this review, habitat models are prevalent, focusing on habitat modelling. Species distribution models and habitat models share similar statistical methods and knowledge forms. However, species distribution models

frequently use additional methods such as Maximum Entropy (MaxEnt) or Random Forest (RF) (Stern & Humphries, 2022).

Finally, according to the literature review conducted by Stern and Humphries (2022), articles describing methods used to consider potential bias in local knowledge methodologies apply these methods during participants' selection or knowledge elicitation stage. The author's review has identified methods for reducing bias, which primarily involve selecting reliable participants, targeting specific skill sets such as key stakeholders, or deliberately selecting participants who did not observe the species. We considered spatial filtering and a three-year timeframe in the participatory mapping exercises we conducted. Moreover, Stern and Humphries (2022) note that modelling methods of bias correction include using mixed-model, weighting responses, participants as a random effect, defining reliability scores, incorporating road distance, visibility and sampling effort as a covariate to account for accessibility bias (Pédarros et al., 2020; Skroblin et al., 2021; as cited in Stern & Humphries, 2022), or standardising observations (Service et al., 2014; as cited in Stern & Humphries, 2022). We considered detectability as the product of visibility (road accessibility and landscape visibility) and participant sampling (Pédarros et al., 2020).

According to the review of Stern and Humphries (2022), authors generally assess modelling consistency with independent data (Stern & Humphries, 2022) and studies that have compared local wildlife knowledge with studies mobilising conventional scientific methodologies (e.g. camera traps, radio collars) have heterogeneous conclusions regarding the concordance of the two approaches (Brook & McLachlan, 2009; Clevenger et al., 2002; Pédarros et al., 2020; Tendeng et al., 2017; as cited in Stern & Humphries). Some additional research has revealed that there are few similarities between experiential wildlife knowledge and models that rely on independent data (Kowalchuk & Kuhn, 2012; as cited in Stern & Humphries, 2022), which nuance the analysis of Devictor et al. (2010).

Integrating the possible data collection biases into statistical modelling has been widely covered in the literature. The aim is to format this data to meet the criteria of Baconian objectivity. Although it is possible to approach a valid habitat model of the absolute species distribution in a given area using participatory mapping data, this does not inform us about the nature of this observational data from participatory mapping. These observations are, in fact, the expression of more or less direct interactions between

the observer and the animal and reflect a specific relational landscape which is of great importance in the study of the coexistence mechanisms within social-ecological systems considered complex and adaptive. Furthermore, it could consider the context of data generation that a statistical approach would tend to negate. It is, therefore, necessary to analyse more precisely the methodological and statistical aspects that will make it possible to account for this interactional landscape by mobilising landscape research parameters (observation density, scale effect, heterogeneity of the landscape or the focal-species effects) on the interpretability of participatory mapping data collection in a relational landscape. Therefore, the objective of the following section is to consider the context of the participatory mapping data in the interpretation of habitat suitability modelling. It is imperative to reconsider human-wildlife relationships methodologically and to align them with their epistemological and ontological considerations. This will be further explored in the following section by analysing the results of participatory mapping conducted in the two study sites.

II. Modelling habitat suitability in anthropogenic landscapes: statistical and practical considerations for using participatory mapping to address wildlife persistence in complex social-ecological systems.

Élie Pédarros*^{1;2;3}; Hervé Fritz^{1;2}; Chloé Guerbois^{1;2}

¹ REHABS, CNRS - Université Lyon 1 - Nelson Mandela University, International Research Laboratory, George Campus, Madiba Drive, George, South Africa

² Sustainability Research Unit, Nelson Mandela University, George Campus, Madiba Drive, George, South Africa

³ Laboratoire de Biométrie et Biologie Évolutive, CNRS UMR 5558 ; Université Claude Bernard Lyon 1; Villeurbanne Cedex, France

Article info

Abstract

SDM
Participatory mapping
Data context
Landscape features
Social-ecological system

Understanding patterns of species spatial distribution is fundamental to conservation science. In recent decades, recognising the intertwined nature of social and ecological subsystems within social-ecological systems has been accompanied by developing participatory data collection methodologies at the landscape scale, such as participatory mapping. However, these methodologies require statistical and broader epistemological considerations to understand the results and provide a relevant analysis. This study was conducted in two highly contested conservation sites in South Africa. We analysed the results of modelling data from participatory mapping exercises, considering the context of acquisition and landscape of the data. By analysing the influence of observation density, landscape heterogeneity and traits of mapped species, our study proposes concrete recommendations for modelling the spatial distribution of species using participatory methodologies. We emphasise the importance of balancing the amount of data obtained with the heterogeneity of the landscape, which can significantly influence the modelling output and its interpretation. Furthermore, the ecology of focus species, whether common or cryptic, has a significant influence on the statistical performance of the model and, therefore, on the interpretations that can be made. We thus advocate, in this collaborative effort of combining knowledge systems, the context of data acquisition taken into account in the modelling, in addition to more classical techniques of addressing bias.

1. INTRODUCTION

Humans and wildlife co-adapt and interact to live in shared landscapes when the institutional framework provides the social-ecological conditions allowing it (Carter and Linnell, 2016; as cited in König et al., 2020). This definition corresponds to the transformation of conservation sciences and practices in addressing complex social-

ecological systems (SES) to face the current decline of biodiversity (König et al., 2020). Humans-wildlife interactions shape human cultures, animal communities, and species evolution, and these interactions are increasing due to climate change, species recovery and reintroductions (Pooley et al., 2021), colonisation, appropriation and human intensification of use in lands inhabited and used by prior societies (Ellis et al., 2021). It is thus urgent to facilitate coexistence with wildlife in shared multi-use landscapes (König et al., 2021; Rosenzweig, 2003a). However, ontological, epistemological, methodological, and practical challenges constrain understanding human-wildlife coexistence (Pooley et al., 2021). The main objective is to adopt a dynamic approach to human-wildlife interactions, moving beyond "*datafication*" to address interaction concerns and contextualised analysis (Devictor & Bensaude-Vincent, 2016). Mobilising experiential wildlife knowledge held by local people can improve understanding of the social-ecological system (Stern & Humphries, 2022). It has the advantage of building credibility, salience and legitimacy, which is essential for translating knowledge into action (Cash et al., 2003). While biodiversity monitoring is crucial for understanding species' habitat requirements (Pocock et al., 2018), participatory mapping methodologies could be a bright boundary object for collaborating different knowledge systems, views and rules (Colloff et al., 2017). They would bridge the artificial divide between local and scientific knowledge (Agrawal, 1995). As most of the studies using participatory mapping for species distribution modelling consider the methodology mainly as a data provider aligned with classical methodologies such as GPS collaring or camera traps with an effort to control for context and detectability (Stern & Humphries, 2022), we believe that the nature of experienced-based data needs to be fully acknowledged in the analysis by considering its originality and complexity.

The assumption is that relational dimensions within the SES determine the occurrence data obtained by participatory mapping. We then hypothesise that mobilising experiential wildlife knowledge for species distribution modelling in anthropogenic landscapes gives insightful perspectives for human-wildlife coexistence if the complexity of the data obtained is recognised in the interpretation of model outputs. Furthermore, it implies investigating how statistical analysis leading to model outputs is conducted to make the most of this information and to identify the constraints relative to the practical implementation of participatory mapping workshops for meaningful interpretation.

This study analysed the results of participatory mapping workshops for mammal distribution modelling in two contested South African conservation sites: the Garden Route and the Kalahari. Our objectives were (i) to integrate the context of data production into the interpretation of participatory mapping models, (ii) to identify and evaluate the parameters resulting from this integration of the data production context into statistical modelling (relative density of observation, scale and extent of studied area, species traits and habitat heterogeneity) and (iii) demonstrate the relevance of these approaches to model the distribution of large mammals in anthropogenic landscapes and address issues of human-wildlife coexistence in a complex manner.

2. METHODS

2.1. Site description

The study area of George municipality (542.96 km²) (Figure 2) is established between the Indian Ocean and the Outeniqua mountains in the Garden Route. The area is distinguished by its mountains, valleys, and coastal plains (Baard & Kraaij, 2014). Average annual rainfall is between 800 and 1100mm, with temperatures ranging between 18 and 25 °C (Baard & Kraaij, 2014). The area is well-known for its high level of endemism (Baard & Kraaij, 2014). However, due to the booming forestry sector in the '70s, the Indigenous vegetation is at risk with the increasing presence of invasive exotic species, mainly represented by *Pinus* and *Acacia* species (Baard & Kraaij, 2014). The Garden Route National Park (1210 km²) provides a unique example of a social-ecological conservation approach (Palomo et al., 2014), characterised by a network of protected areas connected by multiple corridors in a mosaic of land uses. The area is home of baboon (*Papio ursinus ursinus*), vervet monkey (*Chlorocebus pygerythrus*), predators such as honey badger (*Mellivora capensis*), common genet (*Genetta genetta*), leopard (*Panthera pardus*) and caracal (*Caracal caracal*), antelope species such as bushbuck (*Tragelaphus scriptus*) and blue duiker (*Philantomba monticola*) but also bushpig (*Potamochoerus larvatus*). George urban area (193;672 permanent inhabitants, George census, 2011) is a medium-sized metropolitan area with significant agricultural development on the west and high-density settlement areas to the south. Victoria Bay, Wilderness, Hoekwil and Kleinkrantz constitute semi-urban areas and essential tourism destinations, characterised by a mix of

coastal and semi-rural lifestyles and increasing development (Guerbois et al., 2019). The sub-extent of Wilderness, 20.99 km², our first fine-scale focus area, is characterised by a hilly landscape with residential farm-type settlements on the hilltop and a small city centre on the seaside (Figure 2a). The sub-extent of Hoekwil, 32.13 km², our second fine-scale focus area, is characterised by productive agricultural landscapes bordered on their southern side by the Garden Route National Park (Figure 2b).

The Kalahari study site is in the arid savannas and dunes systems landscape of the southern Kalahari around Askham in the Dawid Kruiper municipality (Northern Cape, 542.88 km²). The area belongs to the †Khomani San community, which claimed and obtained six farms and a part of the Kgalagadi Transfrontier Park in 1999. Human density is very low and concentrated in small settlements (mixed formal and informal) on old farms like Andriesvale or Witdraai (Figure 2c), constituting our first fine-scale focus area (24.40 km²). Askham is the main residential area with a petrol station and a grocery shop and is our second fine-scale focus area (23.65 km², Figure 2d). The population is composed mainly of San people, Afrikaans speakers, and named the †Khomani San Community. With an average rainfall of 150 to 300 mm per year, the southern part of the Kalahari is the driest part of the desert (Kepe et al., 2005). Temperatures are seasonally contrasted: hot during summer (min: 20.4±1.2°C, max 38.1±1.8°C) and cold during winter (min: 0.6±0.8; max: 23.8±1.4)(Noakes & McKechnie, 2020). The economic activity is dominated by extensive grazing of small ruminants (sheep, *Ovis aries* and goat, *Capra hircus*) and cattle (*Bos taurus*)(Wasiolka & Blaum, 2011). The Kgalagadi Transfrontier Park is home to the typical Kalahari mammals, including rodents, small and large carnivores and large herbivores. The park is fenced on the South-African side; thus, very few large predators roam freely outside the park. Small carnivores such as cats (caracal, *Caracal caracal*; African wild cat, *Felis lybica*), foxes (cape fox, *Vulpes chama*; bat-eared fox, *Otocyon megalotis*) or mongooses (yellow mongoose, *Cynictis penicillata*; common slender mongoose, *Herpestes sanguineus*) but also large herbivores such as Kudu (*Tragelaphus strepsiceros*), Gemsbok (*Oryx gazella*) and Elands (*Taurotragus oryx*) are present outside the park. There are few movements of animals in and out of the park.

Given the contrast between these two sites in landscape structure and social-ecological dynamics, comparing the Garden Route and Kalahari sites will identify specific and typical characteristics of each site. Further, if commonalities appear in the data-

generating process, it will provide a basis for particular and generic recommendations for using participatory mapping to model species distribution.

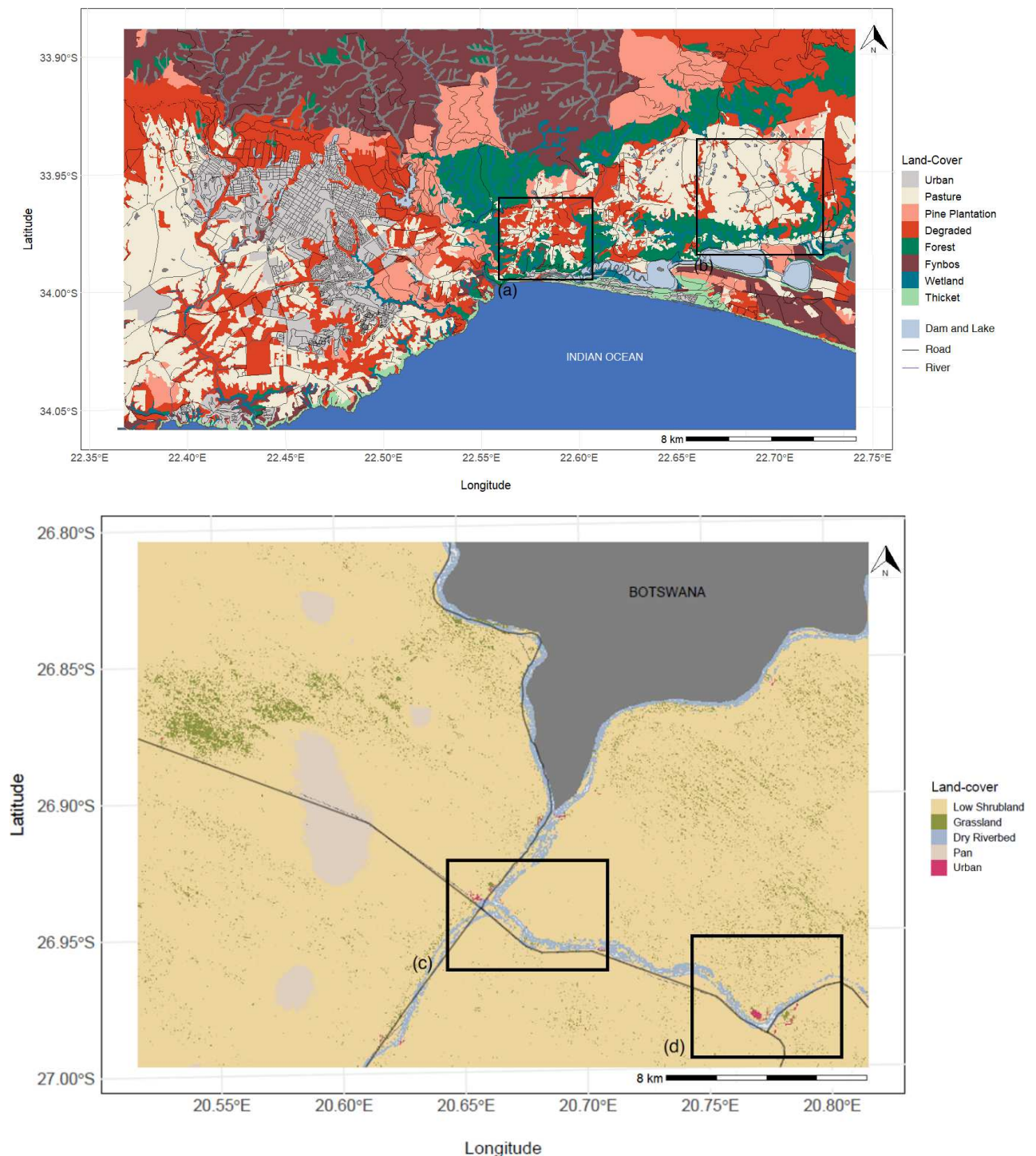


Figure 2. Study sites of the Garden Route (above) and Kalahari (below) with the land cover used for modelling occurrence or habitat suitability and their sub-extents (a) Wilderness (b) Witdraai.

2.2. Participants selection and data collection

This study is part of a collaborative research project which received ethical clearance from Nelson Mandela University (H20-SCI-SRU-003). Following a stratified purposeful sampling, we engaged with key stakeholders among four categories: governance, conservation organisations, residents, and Indigenous communities. The stratified sampling was adopted to target persons or groups of people knowledgeable about the area and interested in wildlife. We conducted preliminary discussions to frame the study and select mentioned species for modelling. The workshops gathered fifty participants for the Garden Route site (GR) and thirty-one for the Kalahari site (KH).

We adopted a participatory mapping methodology to collect and share participants' sightings in the area. It allows knowledge co-production to enhance knowledge systems collaboration. We organised one data-collection participatory mapping workshop at each site. For each site, we defined the global extent of the study area, with observations mapped at the resolution of a 300x300 m grid, which proved adequate in a previous study (Pédarros et al., 2020). For each site, we selected two sub-sites with reduced spatial extents and chose to map observations at two resolutions: 300x300 m and 100x100 m grids. We chose these resolutions to filter observations to avoid spatial auto-correlation spatially (Fourcade et al., 2014; Kramer-Schadt et al., 2016). The global extent base maps were A0 prints from aerial imageries of the study area (1/45000), while sub-sites base maps were A1 prints from aerial images (1/7500).

Aerial photos were provided by SANParks GIS services, where main roads, rivers and inland water were displayed to ease location by participants. A printed georeferenced grid (300x300 or 100x100) was placed underneath the map to collect the informant's data, and both the map and grid were clipped on solid support (Pédarros et al., 2020). We organised groups with diverse stakeholder categories to maximise cross-interactions between participants. Each informant first informed the sites visited at least twice a week (households, work, regular leisure activities using a flat pin) to define the area of intensive observation sampling and then locate their sightings over the past three years using round pins. A specific pin colour identified each species, and boards with species names (scientific name, English, Afrikaans, Xhosa), pictures and pin colour were displayed to ease the process. During workshops, several maps were proposed on separate tables to speed up the mapping process, and the complete protocol was replicated on each map.

Each group spent 20 minutes around each map. All information from the pins was reported on the grid underneath using colour pens and signs. Data was captured from these datasheets onto georeferenced cell matrices. We performed GIS analysis using Quantum GIS 3 (QGIS 3.10.0) and R studio (R 4.2.0) software.

2.3. Species Distribution Modelling

2.3.1. Datasets and environmental predictors

To assess the effects of the density of observations and habitat heterogeneity, we combined species-specific datasets into an "all-species combined dataset" to increase the size of the analysed dataset to allow comparisons between sites and remove the specific effect to obtain a "wildlife occurrence probability". Indeed, training and testing data are randomly drawn regardless of the corresponding species. To further assess the potential effect of habitat heterogeneity at the species level, we focused on the GR and KH caracal datasets, as the species was sighted at both sites at each scale. We also see this species-centred approach as a test of the "all-species combined dataset" approach, in case the latter would function as a homogenisation factor of the modelling technique and precluded assessing the effect of habitat heterogeneity in predicting species distribution. We also performed models for baboons in the Garden Route and jackals in the Kalahari, offering larger datasets and allowing an in-depth practical perspective on species distribution modelling.

An in-depth literature survey selected a set of independent predictors (Table 1). We controlled for correlation between predictors to decrease the collinearity in models (Barbet-Massin & Jetz, 2014). We removed the distance to the protected area for the Kalahari site because it was correlated to the distance to the closest critical biodiversity area for Extent B ($r > 70$) but kept the distance to the closest freshwater body and land-cover at Extent B-300m, although correlated to allow comparison (Appendix III). We used the datum WGS84 calibrated on the 23° East meridian as a spatial reference system (Appendix IV).

2.3.2. Detectability correction

As described in the literature, we considered species detectability as a function of different factors integrating the diversity of potential biases associated with citizen data (Pédarros et al., 2020; Skroblin et al., 2021; Stern & Humphries, 2022). Therefore, for a given pixel unit, detectability was defined as:

$$D_i = S_i \times V_i \times R_i$$

i : pixel unit. $D(i)$: detectability within pixel i . $S(i)$: spatial sampling intensity for pixel i . $V(i)$: visibility within pixel i . $R(i)$: proximity of pixel i to the closest main road.

Table 2. Environmental predictors used for species distribution modelling

Variable		Description	Reference	Layer	Site
Land cover (Categorical)	Urban Pasture Plantation Degraded Forest Fynbos Wetland Thicket	Urban area Rural residential area and commercial agriculture Plantation areas Degraded areas mainly dominated by invasive species Afrotropical forest Fynbos Hygrophilous vegetation Dune and coastal vegetation	Vlok et al. (2008) Vromans et al. (2010)	Urban Farm Plantation Degraded Forest Fynbos/grassland Drain Thicket/marine	GR
	Fire (Categorical)	Burnt vs Unburnt	Cape Nature, 2022	All fires	GR
Landscape metrics (Quantitative)	Protected area	Distance to the closest Protected area (m)	SANBI (2002) & Cape Nature (2017)	Protected Area	KH, GR
	Critical Biodiversity Area	Distance to the closest CBA (m)	Northern Cape Dep. of Env. and Nature Cons. (2016) & Cape Nature (2017)	Critical Biodiversity Area	KH, GR
	Water	Distance to the closest freshwater body area (m)	SANLC (2020) & Ahrend (2018)	River, Inland water, Dry Riverbeds	KH, GR
	Slope	Average slope for each pixel (°)	Danielsen and Gesch, 2011	Relief contours 10m	GR

We created a distance matrix for tarred roads to define the likely bias associated with higher traffic and relative accessibility (R_i). A target (c. one meter high) was randomly placed for each habitat's visibility. The distance at which the target disappeared from the observer was measured 20 times for each habitat (Valeix et al., 2011). The relative visibility for each habitat (V_i) is given by the average visibility distance of the open environment as the reference for the highest visibility. We considered the mean interdunes distance as the maximum visibility for the low shrubland cover in the Kalahari, dominated by high sandy dunes. Each matrix bias follows a standardised normal distribution rescaled between 1 and 20 (Elith et al., 2010). We considered the product of these standardised bias correctors as a proxy of species detectability within the landscape (Appendix V).

2.3.3. Species distribution modelling

To select the best modelling techniques (Elith et al., 2006), we performed species distribution modelling using the BIOMOD 2.0 multimodal platform (Thuiller et al., 2009). BIOMOD allows us to compare the most frequently used techniques in species distribution modelling (Barbet-Massin et al., 2012; Harmange et al., 2019; Monnet et al., 2015). We retained from the selection analysis the following models: Generalised Linear Modelling (GLM), Generalised Boosting Regression Model (GBM), Random Forest (RF) and MaxEnt because they show high True Skill Statistic ($TSS = \text{Sensitivity} + \text{Specificity} - 1$; i.e. true positive + Specificity, i.e. true negative - 1; Allouche et al., 2006) and high sensitivity. As we only have presence data, we created pseudo-absences datasets with equal presences and pseudo-absences as recommended in the literature (Barbet-Massin et al., 2012). For each modelling, we ran 40 pseudo-absences datasets (Barbet-Massin et al., 2012) and replicated them three times (Thuiller et al., 2009). For each species dataset, we obtained a combination of 480 models. BIOMOD randomly subset the dataset in a training dataset, used to build the model, and in a testing dataset, used to evaluate the model according to a data split coefficient. The recommended data split coefficient is 70%, meaning that 70% of the total dataset is used as training data and the remaining 30% as testing data (Thuiller et al., 2009). We used this split coefficient to harmonise the density of occurrences in the training dataset between sites, species, and extents/resolution combinations for each modelling session. This allowed us to test the effect of observation density on the ability to model species

distribution. When the modelling failed three times in a row for species with insufficient observations, we slightly increased the split (by 1% at a time) to increase the training dataset without significantly changing the density of the training dataset at the study site scale. We considered TSS as the models' metric evaluation.

2.3.4. Heterogeneity

To compare GR and KH habitat heterogeneity, we used Renyi's index. Renyi's generalised entropy (Rényi, 1970) is a method to generalise entropy measurement in one formula by changing only one parameter, α . When α equals zero, all the spectral values contribute to the index. When equal to 1; it corresponds to Shannon's index, and when equal to 2; it corresponds to the collision entropy, also named Renyi's entropy, where the weight of the most prominent spectral values is higher with minor differences among the attained heterogeneity maps (Ricotta et al., 2003; Rocchini et al., 2021). We computed the heterogeneity of the respective global extents using the land-cover layer (300m resolution) for the two sites with the R package rasterdiv (Rocchini et al., 2021) with $\alpha = 2$ and a moving window of nine pixels (side of the square moving window for index computation) (Appendix VI).

3. RESULTS

3.1. Participatory mapping data collection

For the GR global extent (extent A - GR), 314 sightings were recorded (Table 3), representing an average of 6.32 sightings per informant (0.58 sighting/km²) against 83 in KH (extent A - KH), representing 2.59 sightings per informant (0.15 sighting/km²). Concerning the sub-sites, in GR, the more informed site was Wilderness (extent B - GR), with 220 sightings representing 4.36 sightings per informant (10.39 sighting/km²) and the Witdraai area for the KH (extent B - KH) with 55 sightings representing 1.72 sightings per informant (2.20 sightings/km²). Conversely, the Hoekwil area (GR) was only informed by 29 sightings (0.58 sightings/informant; 0.90 sightings/km²), and Askham (KH) was only informed by 11 sightings (0.34 sightings/informant; 0.47 sightings/km²). Therefore, given the low amount of data for the last two sub-sites, Hoekwil (GR) and Askham (KH), we decided not to include them in the analyses. The datasets were calibrated to obtain the

same observation density in each site to compare outputs between sites using the data split coefficient (Table 4).

Table 3. Summary of participatory mapping in the Garden Route, GR (from left to right: Caracal (*Caracal caracal*), Leopard (*Panthera pardus*), Common genet (*Genetta genetta*), Bushpig (*Potamochoerus larvatus*), Vervet monkey (*Chlorocebus pygerythrus*), Chacma Baboon (*Papio ursinus ursinus*), Blue Duiker (*Philantomba monticola*), Bushbuck (*Tragelaphus scriptus*) and Honey Badger (*Mellivora capensis*); in the Kalahari, KH: Caracal (*Caracal caracal*), Leopard (*Panthera pardus*), Common genet (*Genetta genetta*), Eland (*Taurotragus oryx*), Black-backed Jackal (*Lupulella mesomelas*), Gemsbok (*Oryx gazella*), Kudu (*Tragelaphus strepsiceros*) and Honey Badger (*Mellivora capensis*). Silhouette images coming from ©Phylopic


















GR										Total
Extent A – 300m	43	4	10	38	65	69	5	63	17	314
Extent B – 100m (Wilderness)	17	7	12	22	40	46	7	58	11	220
Hoekwil	4	0	0	6	5	5	0	7	2	29
Total	64	11	22	66	110	120	12	128	30	563
KH									Total	
Extent A – 300m	13	0	7	7	12	17	15	12	83	
Extent B – 100m (Witdrai)	9	0	10	6	8	6	6	10	55	
Askham	3	0	2	2	2	0	0	2	11	
Total	25	0	19	15	22	23	21	24	149	

Table 4. Data summary for models' calibration at the global extent

Site	N	N Calibrated Training	N Calibrated Testing	Calibrated Density for a 70% split	Training Density	Split (%)
GR	314	220	94	0.580	0.410	70
		110	204	0.287	0.203	34
		55	259	0.144	0.101	17
		28	286	0.074	0.052	9
KH	83	58	25	0.153	0.110	70
		29	54	0.076	0.055	35
		15	68	0.037	0.027	18
		7	76	0.018	0.013	8

3.2. Density and landscape heterogeneity effects

We logically hypothesised that higher observation densities give a better model performance. The density of points used for training the models affected the model performances, translating into significant differences in TSS values (Figure 3). The respective extents A-300m in GR and KH show that the higher the density of data used to train the model, the higher the TSS. It is observable within and between sites with higher TSS values for GR, which had more observations and used more data to train the model than KH (Table 3). Considering TSS as a reference, Random Forest (RF) is the most reliable modelling technique for the two sites. GBM is, on the other hand, very sensitive to data density and failed for lower densities in KH. The coefficient of variation (CV) is a relative measurement of the dispersion around the mean. It allows us to compare the level of variation between different models with different means. In the case of modelling techniques with many models run, we expect the best models to have a lower coefficient of variation because of the convergence in the modelling outputs. In GR and KH, the CV decreases with the density of points. In terms of data density needed to perform these modelling techniques, the elbow of the CV curve is around 0.1 observations per km² for GR and 0.03 observations per km² for KH. Above this density of points, the CV has less variability and thus suggests a more reliable prediction of species distribution. KH remained with a higher CV after the elbow, a likely consequence of the lower density of observations compared with GR. This also translates into lower TSS overall for the KH models.

We also hypothesised that homogenous landscapes offer better modelling outputs than heterogeneous landscapes, as predicting distribution may require fewer observations. The measurement of Renyi's index for the two sites shows that GR has a mean index value higher than KH, indicating a higher land-cover heterogeneity for GR than KH. This differential heterogeneity between GR and KH is also visible in the distribution of Renyi's indexes, with an overall higher number of pixels unit counted for specific index values for KH. We evaluated the effects of heterogeneity (Figure 4) by comparing GR and KH (Extents A). We realised the analysis for caracal because utilising a diversity of species could lead to a homogenisation of the observations across the landscape and bias the interpretation (0.017 obs/km²). The GBM modelling technic failed because of its small size. There was a significant difference in the TSS values between GR

and KH regardless of the modelling technic. KH has significantly higher TSS values than GR.

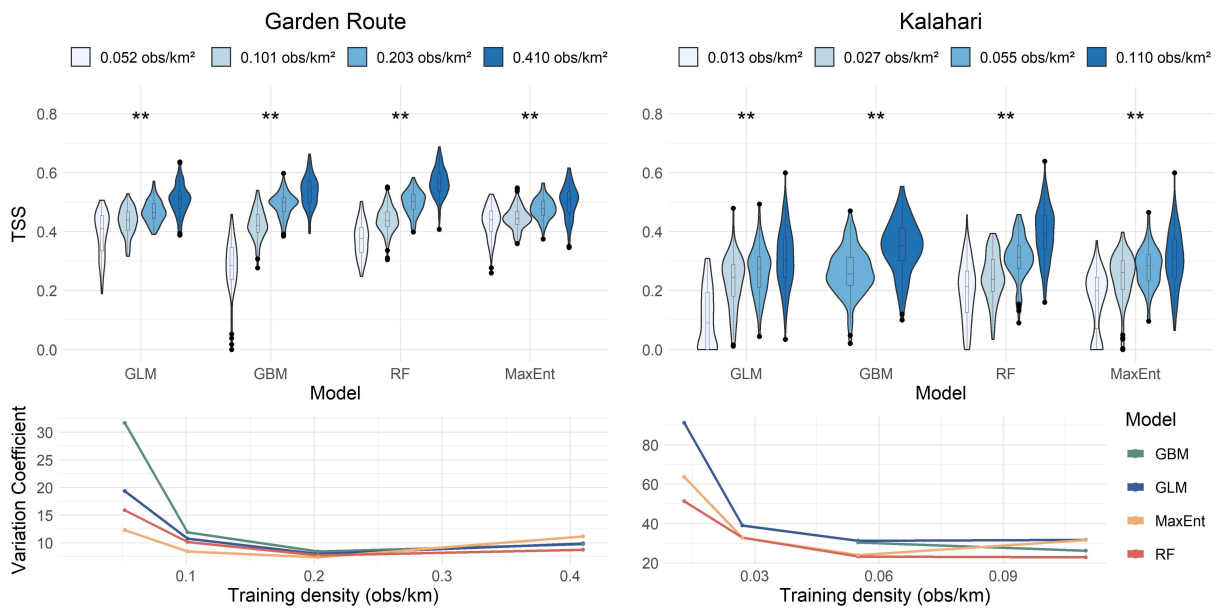


Figure 3. TSS variation for different training data densities using the “all species dataset”. ANOVA tests have been performed for the spectrum of density within each modelling technique (p-value >0.05: not display 0.05 < p-value >0.01: *; p-value < 0.01: **).

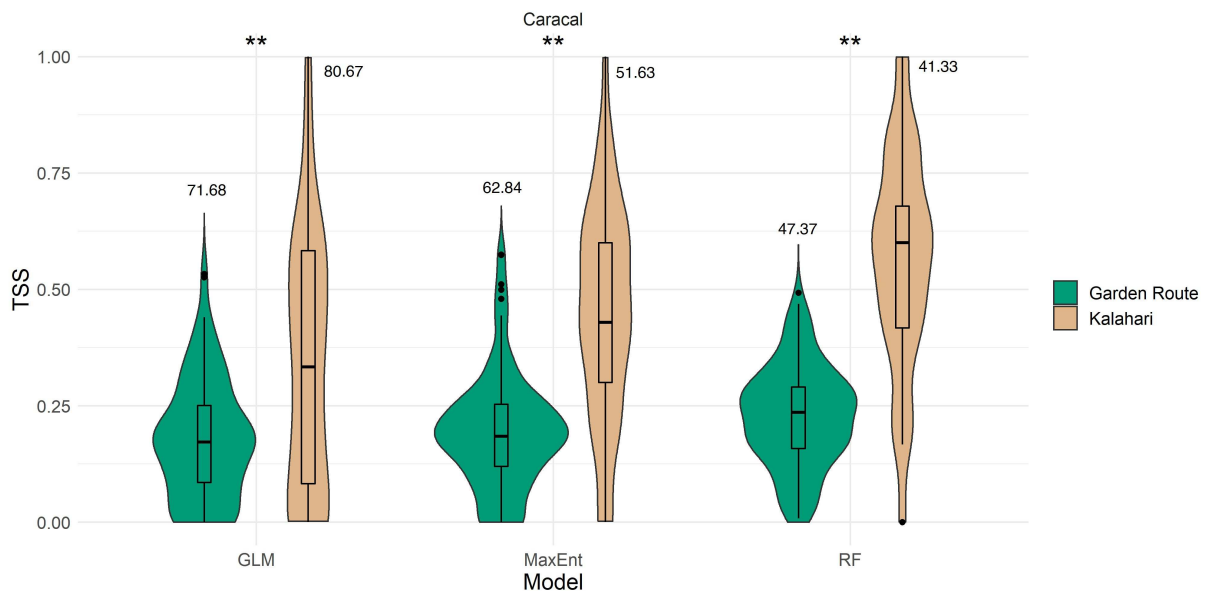


Figure 4. Comparison of TSS values of the caracal dataset modelling between GR and KH. Student t-tests (p-value >0.05: not displayed; 0.05 < p-value >0.01: *; p-value < 0.01: **), and for each distribution, the CV is shown above.

Ultimately, our results showed that landscape heterogeneity affects modelling processes leading to lower performance of models compared to more homogenous landscapes for a given density of observations. This link between data density and landscape homogeneity can be a parameter to consider countering one or another effect by its antagonist.

3.3. Spatial extent, resolution and species traits effect

This section investigated the scale effect (spatial extent and resolution) on modelling outcomes. Because the map provided to participants may constrain the mapping process, we hypothesised that the chosen scale strongly influences the possible interpretation of modelling outcomes and the species' particular ecology.

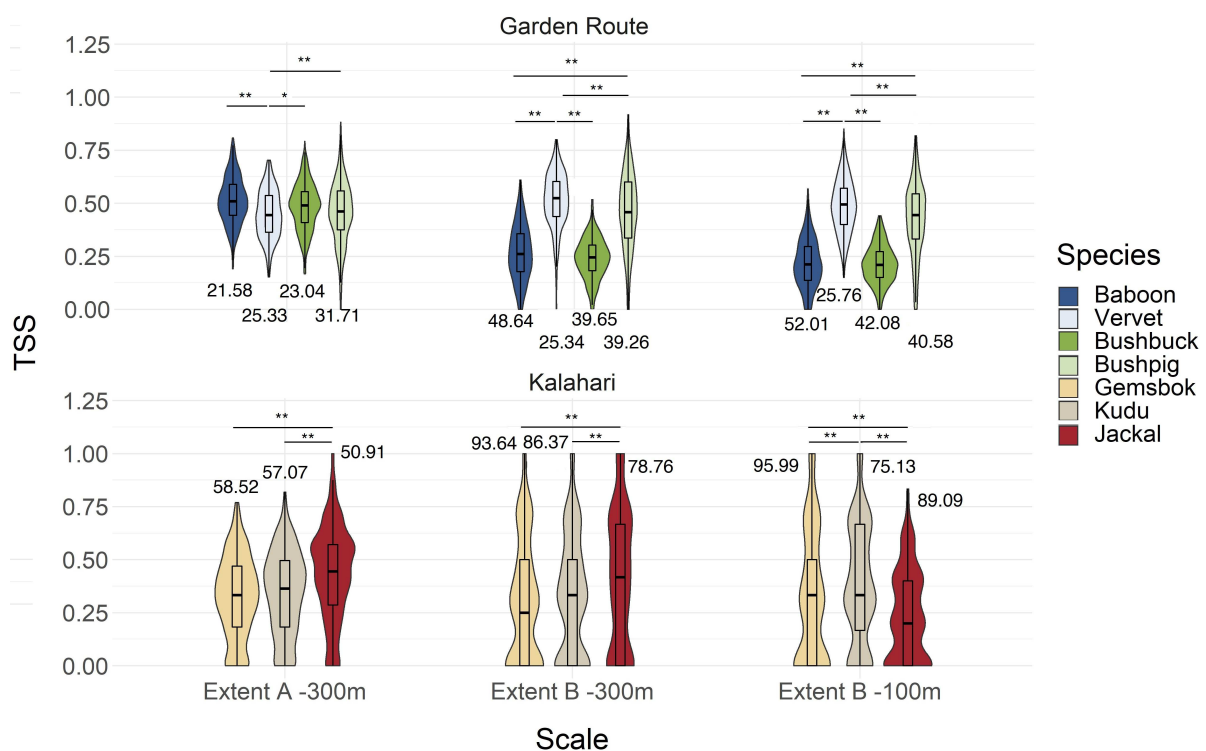


Figure 5. Comparison of true statistic values (TSS) between species using a calibrated training data density (Extent A-300m GR: 0.050 obs/km², KH: 0.015 obs/km²; Extent B GR: 0.71 obs/km², KH: 0.250 obs/km²) depending on spatial extents, resolutions, and sites. Student t-tests have been performed between species (adjusted p-value >0.05: not displayed; 0.05 < adjusted p-value >0.01: *, adjusted p-value < 0.01: **), and for each distribution, the CV is shown below the ellipse.

For GR, the extent of the area chosen for modelling (Extent A 300m vs Extent B 300 m) has more effect on TSS than the resolution (Extent B 300 vs Extent B 100 m). The same species-TSS patterns between the 300m and 100m resolution (Figure 5) indicate that the resolution has a negligible impact on model performance. Moreover, TSS differences between species are the same. Concerning the CV analysis, CV has a similar order of magnitude for GR regardless of spatial extents and resolutions, which is not the case for KH, with a higher CV for lower resolutions and extents. When looking at the modelling performance at the species level, we observed different responses regarding the spatial scale chosen. Baboon and bushbuck modelling processes decrease at smaller extents, whereas vervet and bushpig show increasing performance at smaller extents. They consider the spatial resolution, baboon, vervet and bushbuck modelling performance decrease, whereas the bushpig seems equal. Ultimately, studied species are likely to influence the modelling performance of the model, and the outcome may vary depending on the spatial scale and especially at the largest extent of the study area.

3.4. Participatory mapping practical contextualisation to investigate human-wildlife coexistence

Once the model's performance has been assessed, one other possible source of variation, depending on the extent and resolution of the study, is the contribution of candidate variables to the spatial distribution model. Two levels of investigation need to be carried out: (1) the intra-specific level to see how species-specific models may be influenced; (2) the inter-specific level, comparing whether the relative importance for candidate variables changes differently between species. The latter point may be related to the interplay between species ecology and spatial representation of candidate explanatory variables. Within species, the pattern clearly shows that variable relative contribution may change (e.g., CBA for jackal or Land-use for baboon, Figure 6). Because responses were different for each species for any given candidate variables, the interspecific comparison of the relative effect of the variables on species is also modified by both extent and resolution, though mostly affected by change spatial extent. In the GR, baboon and bushbuck species have significantly different relative importance for all the five variables evaluated (The fire variable is not included because it is restrained to the

extent A 300m). Still, this difference was reduced by a lower extent and smaller resolution for distance to CBA, whereas it was the reverse for slope.

When looking at the difference between species and the relative importance of variables according to spatial extents and resolution in GR (Figure 6; Table 4), we observe that differences between species depend mainly on the spatial extent chosen and, to a lesser extent, on the spatial resolution.

Conversely, baboon and vervet differ for all variables except Distance Protected. Baboon and bushpig variables' importance is different for the variable Distance Protected when changing the spatial resolution and for Slope when changing the spatial extent, which is also the case for this variable when looking at the differences between Vervet and Bushpig. The resolution influences the Distance CBA importance between vervet and bushbuck significantly. For jackal, in KH, the spatial extent has an essential effect on Distance to CBA variable importance, whereas there is negligible effect for kudu and gemsbok for this variable. (Figure 6; Table 4). The relative impact of Distance to CBA for these species is significant at the most considerable extent and resolution. Distance to Water variable is more critical for jackals to a small extent, whereas the spatial scale has a negligible effect on kudu and gemsbok. When changing spatial resolution, the land-cover variable varies for kudu but does not affect other species.

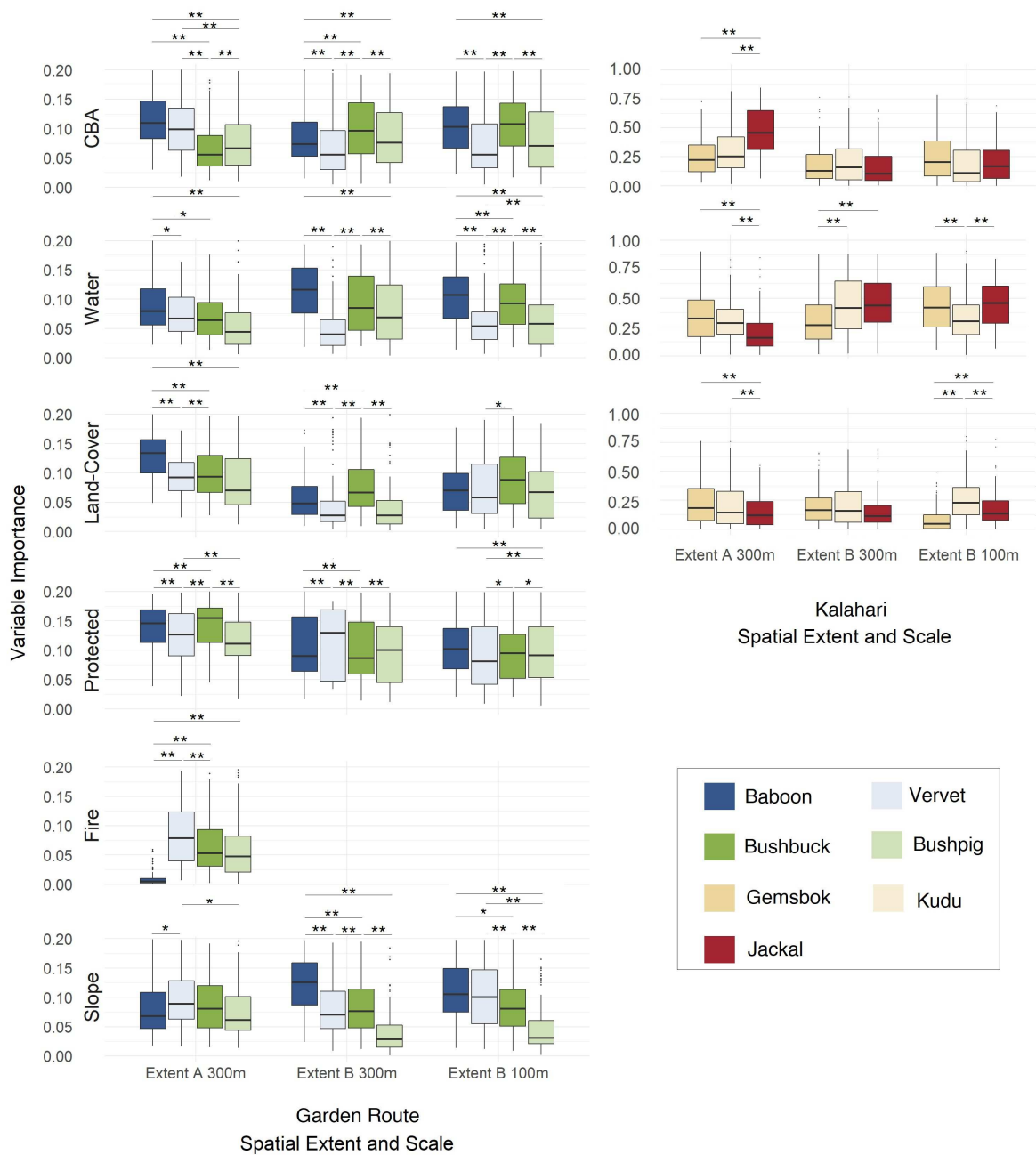


Figure 6. Variable importance related to focus species using a calibrated training data density. Student t-tests between species (adjusted p-value >0.05 : not displayed; $0.05 < \text{adjusted p-value} < 0.01$: *; adjusted p-value < 0.01 : **).

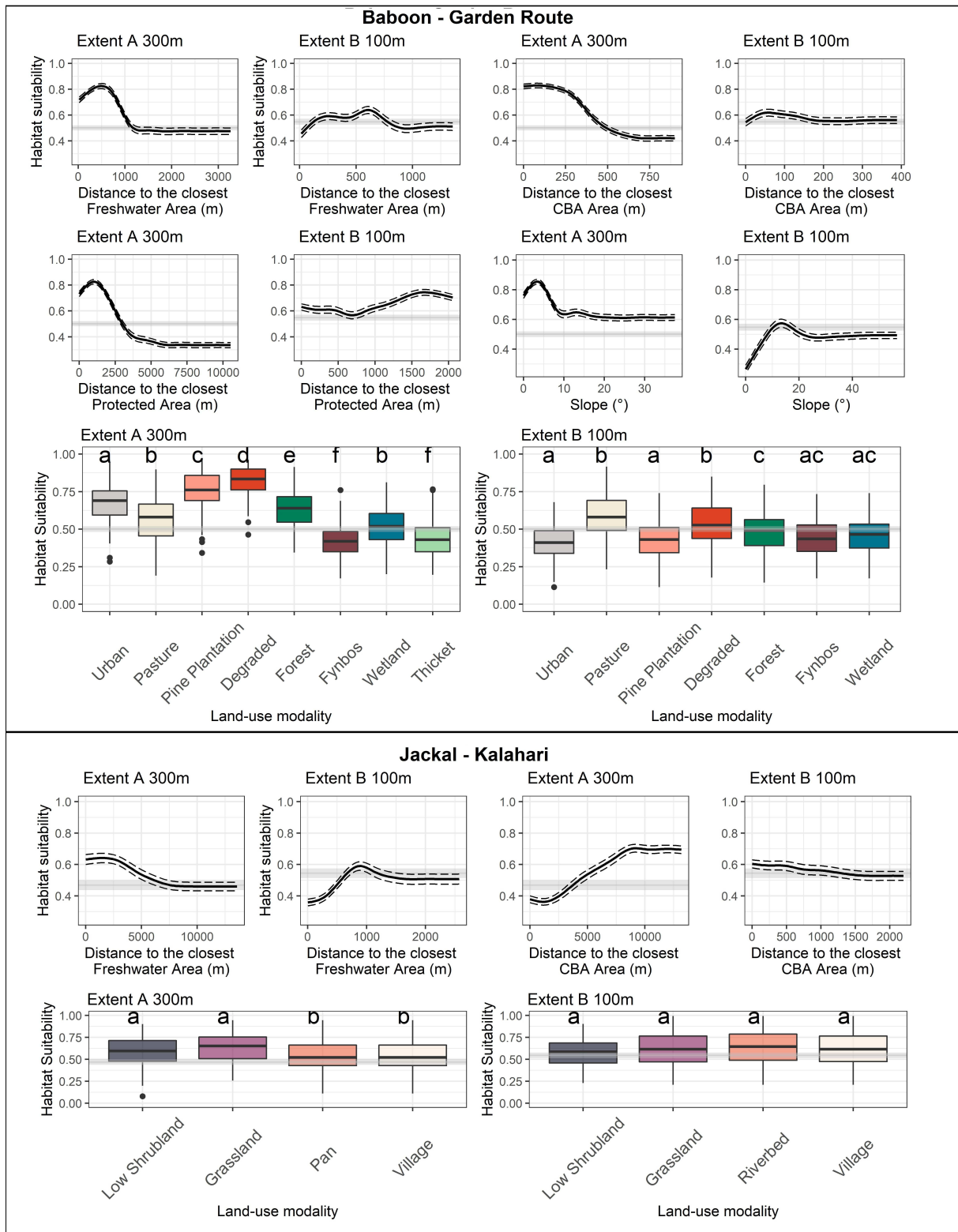


Figure 7. Responses of habitat suitability values for each variable modelled using the Random Forest (RF) modelling technique for Baboon-Garden Route and Jackal-Kalahari. For boxplots of land-cover modalities, pairwise student t-tests were performed. A significant difference between the two modalities is represented by two different letters. The same letter means there is a significant difference between the two modalities.

Baboon habitat suitability is negatively correlated to the distances to the closest freshwater body, protected area and critical biodiversity area, the curve falling below the presence threshold when passing 1100, 500 and 2500 meters, respectively, for the Extent A-300m (Figure 7). The slope does not affect presences predictions but only causes a neat decrease in habitat suitability for slopes above 10 degrees. Degraded land cover is the most attractive modality at the Extent A-300m, followed by planted, urban, forest, wetland and pasture land-cover units. Wetlands and thickets are not suitable for a baboon. Pastures and degraded land-cover units are the only suitable ones identified for baboons when modelling at Extent B – 100m.

In GR, for the baboon, the process underlined by the variable Distance Protected is effective at both extent A 300m and Extent B 100m. In contrast, those behind the variables Distance CBA, Water and Slope are more important at Extent B 100m (Figure 7). The Land-Cover is the only variable being more critical at extent A 300m rather than Extent B 100m. For KH, the Land-Cover variable is crucial for the jackal at spatial extents and resolutions. The Distance CBA variable is more critical at extent A 300m, whereas Distance Water is more important at Extent B 100m. When choosing a spatial scale for a given species, the results, especially the geographical projection, must be interpreted carefully and relativised to avoid misinterpretation and unsuitable conservation planning strategy.

In KH, for the Jackal (Figure 7), habitat suitability is negatively correlated to the Distance to the closest freshwater body (presence threshold reached at 750m) Extent A-300m and positively related to the Distance to the closest biodiversity area (3500m). At the Extent B-100m, we observe habitat suitability corresponding to the jackal's presence between 750 and 1100 meters. The distance to the closest biodiversity area at this spatial extent and resolution does not affect habitat suitability or presence. All land-cover modalities are expected to suit jackals, but low shrubland and grassland are the most suitable at A- 300m. At the other spatial extent and resolution, all land-cover modalities are suitable for the jackal, and their effect is equivalent.

4. DISCUSSION

4.1. Participatory mapping design and a priori assumptions are critical for species distribution modelling

Data collected through participatory mapping on contrasted sites and species give interesting insights concerning workshop design. The Garden Route site provided much more data (absolute and relative) than the Kalahari site. Three hypotheses potentially explain this data heterogeneity: participants' level of knowledge, the scarcity of wildlife in the Kalahari or the reporting process about landscape homogeneity. For the first hypothesis, many participants in the Kalahari are active hunters and live in open areas, often walking in the bush to collect tubers, wood or specific nature-based food. They, therefore, have a daily "landscape practice" and thus an advanced knowledge of their environment, whereas in the Garden Route, the participants live in more urbanised landscapes. The hypothesis of the level of knowledge is not supported to explain these differences in data collection between the two sites. The scarcity of wildlife should not be a valid reason either, as camera trap data in the area show a high abundance of mammals (Pardo et al., 2021). In terms of reporting, the homogeneity of the landscape can be of substantial influence as aerial photographs provide fewer landmarks, which can lead to a more difficult geographical reporting of sightings and, thus, their omission. Moreover, there can be a difference related to the participants between the two sites, mapping being potentially easier for Garden Route participants. Therefore, this omission can be caused by the context of the observation itself or the participatory mapping design. Adding more landscape features on aerial pictures in homogenous landscapes to help the memorisation process can maximise the collected data volume and focus on a single species or restricted species group to intensify the memorisation process to get more data. A similar exercise on the Garden Route for baboons yielded 6.02 observations per km² (Pédarros et al., 2020) compared to 2.40 for this species in our multi-species exercise. The saturation of the information reporting is an essential parameter when designing a participatory mapping workshop, especially if the selected species is rare or elusive. Only four out of seven observations for leopards on the Garden Route at the extent B-100m were correctly reported on the extent A-300m despite the request to report on both maps.

Furthermore, our results show that data density affects models' performance. However, our analysis using TSS, and coefficients of variation indicates two different tendencies. Firstly, variation coefficients for the two sites stagnate in the Garden Route for data density greater than 0.1 observations per km² and 0.03 for the Kalahari. It corresponds to threshold values of 55 and 17 observations for robustness (but still lower repeatability, i.e., higher CV. It appears easier (less data needed) for the modelling technique to predict habitat suitability in homogenous landscapes with fewer features than in heterogeneous landscapes. However, the higher the data density, the higher the TSS, hence the ability to discriminate true positives and negatives, and the lower the CV. Therefore, even if the relative improvement induced by more data is lower in a homogenous environment, having enough data to reach TSS >0.5 and CV lower than 30% should be the aim of any participatory mapping exercise. It is, therefore, essential in preparing the participatory mapping exercise to ask the following general questions: is the landscape relatively homogeneous or heterogeneous? This will also indicate the amount of data required for relevant modelling and, therefore, the adjustment of the time given to data collection. Are the species of interest in the study common or elusive? Generalist or specialist? This will also help to consider the effort required by participants and consider this in the mapping exercise's design.

Our results imply that the preparation and design of participatory mapping workshops require in-depth work to ensure adequate and relevant data collection.

4.2. The inclusion of landscape and species attributes is necessary for model interpretation

Landscape heterogeneity in land cover appears to be a determinant of the modelling performance. Our results show that the performance, as TSS indicates, is higher in homogenous landscapes (Kalahari site) than in heterogeneous landscapes (Garden Route) for a given species. The link between these two parameters allows us to counter one or another potential weakness by acting on the other through the design of the participatory mapping exercise to get robust models. Moreover, heterogeneous landscapes integrate more complexity in understanding habitat suitability with potential interaction effects. Modelling species distribution in homogenous landscapes implies a sensibility to the dataset size (smaller coefficients of variation) which is important to

consider during the design of data collection. Thus, even with high statistical validity, habitat suitability must be understood as a situated outcome.

The spatial extent and resolution of the study can significantly affect the potential understanding of species distribution modelling. An environmental predictor can demonstrate different processes at different scales for distinct species or an expression of the same process acting differently. Adopting a complex and contextualising approach is essential to understanding habitat suitability while going beyond the result of associated metrics, which can only be quantifying qualitative processes that may be integrated or offset in a complex network. Our study shows that spatial extent and resolution constrain the modelling output. These parameters of landscape heterogeneity or spatial extent and resolution are interdependent and interact depending on the study species considered.

For example, the significant difference between gemsbok and jackal in the relative importance of the Distance CBA variable for the extent and not the resolution advocates locals' contexts of habitat use which corroborates the difficulty of proposing globalised conservation strategies (Pollock et al., 2020). In the case of vervet, the distance to the closest protected area is less influential for the model in Extent B at a resolution of 100m than at 300m. However, the land-cover variable is more influential at a resolution of 100m than at 300m. This difference in variable hierarchies between resolutions for the same extent can express different spatial effects of the same process or the existence of two different processes associated with the same variable. This nuance in interpreting the relative variable influence depending on the spatial resolution is crucial in conservation. If one variable expresses different processes at different resolutions, the consequences of global conservation strategies should be discussed accordingly: in our case study, at the highest resolution, protected areas can be considered as refuge areas for vervet (e.g. Guerbois et al., 2012 for elephants) in human-dominated landscapes, while at the lower resolution, the interactions with humans and their activities correspond to a differentiated use of the land-cover to persist in this anthropogenic matrix. Therefore, the study site extent and resolution must be carefully chosen to avoid misinterpretations of a specific geographical context. Modelling species distribution aims to know and understand their use of the landscape. Because of the strong links between the degree of homogeneity of the landscape, the resolution and the spatial extent related to the species,

taking these parameters into account is crucial to apprehend most of the underlying processes and prevent misinterpretations leading to erroneous general conclusions.

4.3. Participatory mapping and multi-species approach for human-wildlife coexistence in anthropogenic landscapes

At the Extent A-300m, participatory mapping modelling shows the high importance of protected areas in predicting baboon habitat suitability which is consistent with similar studies underlying the importance of the distance to refuge sites (Pédarros et al., 2020). It has been found as a critical determinant of the occurrence of potential conflicts with other mammal species (Guerbois et al., 2012; Osborn & Parker, 2003). The distance to the closest critical biodiversity area is more important in predicting the baboon's habitat suitability at Extent B. This mismatch between these two potential refuge areas depending on the scale highlights the complementarity of these conservation devices, which act at different scales on the process of refuge areas. Baboon's flexibility in using steep areas and their preference for Afromontane Forest could be due to the human occupation of the lower-sloped regions. It could also be an adaptive response to the nutrient-poor local lowlands vegetation (Cowling et al., 1996) by making greater use of abundant Indigenous fruit-bearing trees in the Afromontane forest (Pebsworth, 2020). The distance to freshwater may be related to the CBA often designed around water courses constituting natural ecological corridors. The use of *Pinus* sp. (plantations) and *Acacia* sp. areas is consistent with previous studies showing the importance of exotic vegetation as baboons' foraging source (Hoffman & O'Riain, 2011; 2012; Pebsworth et al., 2012). It questions the consequences of the spread of invasive species in terms of human-wildlife coexistence. Interestingly, compared with the previous study conducted in 2018 (Pédarros et al., 2020), the land cover has much more importance in the presented results than in 2018 using similar methodologies. It could result from land-cover changes due to significant fires at the end of 2018, which could have induced habitat used by baboons not revealed by including a fire variable in the model because of the rapidity of this sudden change.

In the Kalahari, for the jackal, the importance of the water to the largest extent can be interpreted as a survival constraint in these arid landscapes. However, at the smallest extent, the positive correlation with the distance to the closest freshwater body could

express the avoidance of competition or predation with species similarly attracted to these waterbodies in that area. It again underlines the importance of considering cross-scale analysis in species distribution modelling (Fournier et al., 2017; Penjor et al., 2021). The distance to the closest critical biodiversity area at extent A positively correlates to the jackal's habitat suitability but seems neutral at Extent B. It could be due to avoidance at the landscape scale if critical biodiversity areas host higher competitor or predator densities, although finer scale adjustment at the studied local extent, which characterises multiscale threshold effects. It suggests that a process is essential at a given scale and functions as a linear feature. However, it is a constant at a different scale, and the effect on habitat suitability is less critical. It is homogenised throughout the study site as a threshold feature. Although not the most important variable, it is interesting to note that land-cover categories at the largest scale show that the jackal is ubiquitous but to a lesser extent in urban areas. We could characterise this species as a generalist with opportunistic behaviour. Thus, local measures of human-activities adaptation, such as poultry fencing, could efficiently mitigate potential coexistence issues. In the case of the baboon, which is more related to a human-dominated landscape, appropriated measures should be more systemic than symptomatic. Integrating distinct species in participatory mapping exercises, for example, by organising independent species-focused workshops to avoid memorisation saturation, could be a promising way to integrate participatory mapping in elaborating conservation strategies advocating the complexity of the social-ecological system, especially in anthropogenic landscapes.

Despite the calibration of data density between species and their comparison within the same site, some significant differences between species are shown in the TSS analysis at different spatial extents and resolutions. These differences could be related to the width of their niche: the narrowest the niche, the highest the TSS because of the modelling ability to detect and discriminate clear and net signals of habitat suitability. Otherwise, or additionally, processes not considered in the modelling, such as biotic interactions, could influence the ability to predict habitat suitability. For example, at Extent A, the baboon's TSS is higher than the vervet; at Extent B, it is the opposite, with a significant increase in the vervet's TSS. It could be related to increased species interactions locally through the dominance of baboons on vervets. The literature shows that the latter avoid overlapping baboon' territory (Findlay & Hill, 2020) because of direct competition. The extent B, focusing on Wilderness, is characterised by the presence of

several troops of baboons particularly active in foraging on anthropogenic food (Mazué et al., 2022), potentially restricting the use of the territory for vervet. By reducing their niche, baboons can influence vervet habitat suitability by restraining vervet to specific areas explaining the increase in TSS observed to this extent. Integrating biotic interactions in the model could be particularly interesting, especially for formulating conservation strategies above the species-centred approach. Our study highlights this importance in species distribution modelling by comparing the relative variable importance between species. For example, few significant differences exist between the importance of bushbuck and vervet species variables, suggesting a potential niche overlap. Vervet is often associated with costs to human activities, e.g., crop-raiding (Mamo et al., 2021). If focused on bushbuck unilaterally, conservation strategies could increase the extent of human-vervet coexistence issues.

III. From a cartesian conception of space to a relational landscape conception

1. Participatory maps as boundary objects

The participatory mapping tool mobilised in the previous section has shown its capacity to bring out wildlife observations made by various stakeholders. We can therefore ask ourselves whether its use in this context makes it a "boundary object". A boundary object is an object that different communities can share but use and conceive differently depending on their worldviews (Star & Griesemer, 1989). According to Bowker and Star (1999), these boundary objects are defined by three dimensions and an ensemble of dynamics.

Firstly, boundary objects are characterised by their interpretative flexibility (Bowker & Star, 1999). For instance, the participatory map of species observations can be interpreted for some participants as the reflection of hunting areas and, for others, as the expression of potential damages for their households. This interpretative flexibility has been the primer of the "constructivist" approach in social sciences (Bowker & Star, 1999). It has been well-developed in the literature compared to the other dimensions of the boundary objects (Bowker & Star, 1999).

Moreover, the notion of "border" is not considered in its limited sense but describes a shared space here, as Star (2010) emphasised. These boundary objects constitute borders between groups because of their shared flexibility and structure (Star, 2010). In the case of our participatory mapping exercises, for instance, Khoï people and property owners encounter around the map to promote the discussion.

Finally, the term "object" designs the materiality emerging from action, not from the matter itself (Star, 2010). Participants' reflections emerge through the map, but the map itself is just a catalyst. They further add that the object is situated between different social worlds and needs to be better structured (Star, 2010). Different groups work on this object when necessary, which keeps its vague identity of ordinary objects such as maps or timelines (Star, 2010).

In contrast, groups give a more specific meaning to the object adapted to a particular context, thus, are more helpful than non-interdisciplinary work (Star, 2010): it is the way the object is appropriated by the participants that is interesting much more than the data obtained during the exercise. Moreover, groups that cooperate without

consensus alternate between these two forms of the object. This definition of boundary objects suggests that weaving different knowledge systems around a specific object (apply task; Tengö et al., 2017), for example, participatory mapping, cannot necessarily be considered a boundary object. Interpretative flexibility is not considered in species distribution modelling when translated into statistical considerations because participant groups' interpretations are standardised. It is the difference between what we can call a "cartesian geographic space" conception and a relational landscape conception, which supposes diverse looks at the landscape. Including local participants in conservation science is insufficient to effectuate what Stenseke (2018) calls the "relational turn" in conservation sciences. It is not a question of setting aside the ecological and biogeographical considerations of the information obtained but rather of enriching it by the diversity of interpretations that can be made of it. The data obtained during participatory mapping methodologies should be, as we highlighted it, contextualised for consistent interpretations. The substantial number of observations obtained during our participatory mapping exercises, as well as the exchanges between participants and their feedback on the modelling outputs, together with the focus group discussions, allowed us to maximise the potential of participatory mapping as a boundary object. Moreover, the focus on biodiversity and conservation has stimulated the participants' interest, especially around the relational values associated with these human-wildlife relationships that we will develop further in the following chapters.

2. Social-ecological keystone species

The "species" focus during participatory mapping emerged during the preliminary interviews. Accordingly, the observations informed during the participatory mapping exercise result from different interactions between participants and the species considered. It underlines the social-ecological aspect of wildlife that cannot be approached solely by focusing on the ecological subsystem. According to Winter et al. (2018), the importance of specific species in a system has been first described by Paine (1969) under the name of ecological "keystone species" as occurring when the dynamic of a single species influences global ecological dynamics. Coe and Gaoue (2020) highlighted that in the early 2000s, ethnobotanists introduced the cultural keystone species concept (Burquez & Quintana, 1994; Cristancho & Vining, 2004; Gaoue et al., 2017;

Garibaldi & Turner, 2004; as cited in Coe & Gaoue, 2020) as a complementary approach to the conservation of social and ecological systems. Cultural keystone species, according to the report of several definitions by Coe and Gaoue (2020), are “*culturally salient species that shape in a major way the cultural identity of a people, as reflected in the fundamental roles these species have in medicine, materials, diet, and/or spiritual practices*” (Garibaldi & Turner, 2004; as cited in Coe & Gaoue, 2020) or “*species whose existence and symbolic value are essential to the stability of a culture over time*” (as cited in Cristancho & Vining, 2004; as cited in Coe & Gaoue, 2020). These species have significant importance for human societies and their structure. They influence culture and language; therefore, according to Garibaldi and Turner (2004), these species' loss is predicted to affect cultural integrity significantly. It highlights the importance of specific elements of the system for its structure, characterising the relational constitution of social-ecological systems.

The emergence of specific species during the preliminary interviews invites us to rethink the status of the spatial attributes informed during participatory mapping. Common, cryptic and more charismatic species are structuring the network of relationships and are part of the definition of the relational landscape. Although Coe and Gaoue (2020) highlighted that quantitative analysis of species' cultural importance is common in ethnobiology (Albuquerque et al., 2014; as cited in Coe & Gaoue, 2020), the purpose here is to underline the importance of considering this spatial attribute of our participatory mapping exercises not only as an object to understand the ecological subsystem but part of the social-ecological system influencing the methodological process itself.

3. Landscape values and approaches of spatialised human-wildlife relationships

If we understand the "species focus" as a way to consider relational values through participatory mapping, a trivial question would be: why not map values directly during the participatory mapping exercise? A large amount of literature on value mapping has been investigating these methodologies. To clarify the relevance of direct relational value mapping to our research, we will detail the thinking behind such methods, including their advantages and disadvantages. Brown et al. (2020) highlighted ten lessons on value mapping.

Firstly, the spatial results of the value mapping reflect the diversity and complexity of the network of relationships (Brown et al., 2020). Because place values are relational, significant variability in mapped values can be expected among participants, even when mapping is conducted on the exact geographic location (Brown et al., 2020). This implies that the geographic landscape is only one way to bring out these relational values (Brown et al., 2020). In unique geographical study sites, different values overlap.

Moreover, Brown et al. (2020) argue that the “*geographic or spatial discounting theory*” considers that people are closer to what they like and further to what they dislike (Hannon, 1994; as cited in Brown et al., 2020), which suggests that place values are related to the “sense-of-place” around participants’ home (Norton & Hannon, 1997; as cited in Brown et al., 2020).

Furthermore, because the distribution of human populations is never completely homogenous, the values mapped from a random participants sample in the geographic area do not relate to the actual spatial distribution of the people because of the “*spatial discounting effect*” (Brown et al., 2020). This outcome is problematic if place values are to inform decisions in areas with low participant density areas such as the Kalahari site.

Additionally, mapping place values provides information about the collective sense of place, which can provide a risk assessment of landscape changes that would influence the expression of relational values (Brown et al., 2020). This could be very promising for issues such as human-wildlife coexistence to identify land uses more at risk of crop foraging.

Brown et al. (2020) further noticed that mapping place values provides insight into “*the predisposition of an individual toward various land uses in the absence of more direct measures in the survey instrument*”. Thus, based on the mapped distribution of place values, they argue that reasonable interpretations can be made about the social acceptability of different land uses. In addition, they emphasise that the mapping of values based on the agreement can be used to identify the potential for landscape-related conflicts and their resolutions.

However, Brown et al. (2020) consider that mapping values can provide an understanding of the potential “good” and “bad” land uses because they are direct measures of potential conflict. A practical implication in mapping values is paramount to adopting a complex and adaptative social-ecological system.

Brown et al. (2020) note that to the extent that the mapped geographic values are associated with physical features of the landscape, it is possible to transfer the expressed values and extrapolate them to other locations where value data have not been collected, which is an important observation for the complex and adaptive approach of social-ecological systems to study issues of coexistence between human populations and wildlife. Substantially, Brown et al. (2020) argue that mapping place values in more “natural” landscapes to inform and orient practices can be irrelevant and should be considered thoroughly.

Moreover, Brown et al. (2020) highlight that despite variability in values mapping resulting from data collection, the accuracy is convenient for diverse land use applications such as conservation planning (Brown et al., 2015; as cited in Brown et al., 2020) and urban and regional planning (Brown et al., 2018; as cited in Brown et al., 2020).

However, Brown et al. (2020) emphasise that mapping values do not have spatial precision related to physical landscape features (e.g., roads, urban areas, vegetation type). However, the authors balance this observation because high spatial accuracy is unnecessary for landscape issues decisions. The authors argue that value mapping has external validity because the process is replicable in different geographies (Brown et al., 2020).

Finally, Brown et al. (2020) argue that mapping values make them tangible and, therefore, more relevant to decision-making than intangible, theoretical values. (Gould et al., 2019; as cited in Brown et al., 2020).

According to these ten lessons presented by Brown et al. (2020), mapping values directly would suppose an a priori conception of the values attributed to wildlife. This reflexive process could influence the understanding of human-wildlife relationships. Mapping values is a central tool within human-wildlife relationships' sense-of-place approach. West et al. (2018) identified the differences between the sense of place, dwelling and biocultural approaches. The sense-of-place approach tends to consider relational values in a methodological sense (Masterson et al., 2017; West et al., 2018). In the case of the participatory mapping methodology, and according to a sense-of-place perspective, the physical dimension represented through the map is a way to reflect on values and express them. There are thus three cognitive steps for the participant: first, thinking about what values are, then reflecting on the map and then, through a reflexive process, giving sense to these values. The sense-of-place approach is thus based on the

reflexivity of participants on their values and the landscape as a promoter of this reflection.

In our focus on human-wildlife relationships and coexistence, the sense-of-place approach can bias identifying relational values related to a shared landscape. Indeed, as we have seen on several occasions, the notion of nature is strongly historically and socially constructed. Within a group with different stakeholders, this aspect of reflection on values, this double movement, could smooth out individual positions to obtain an artificial consensus on relational values that is socially acceptable. However, our case aims to avoid creating first-hand agreement but to identify the diversity of relational values within a given social-ecological system. Dwelling perspectives, by contrast, are more likely to use the relational term in an ontological sense, as they attempt to understand relationships in a more recursive way between environment and values associated (West et al., 2018) towards “*the creative potential of a dynamic field of relationships*” (Ingold, 2004). Thus, focusing on species during participatory mapping exercises or on the events structuring the temporalised relationships with the landscape is, according to a dwelling perspective, pertinent to address relational values embedded in the nodes of the network rather than derived from them because they are emergent properties of the dynamic relationship with physical reality and specific world construction. As noted by the ethnologist Haudricourt (1962), there is a link between animal domestication, plant cultivation and the treatment of others. From a dwelling perspective, focusing on the relationships between humans and wildlife and the associated relational values is particularly suitable to address coexistence in complex and adaptative SES.

We have therefore highlighted the need to consider the context of data generation for habitat suitability modelling by assuming both the density of observations, the heterogeneity of the landscape and the species focus. However, more than obtaining data from local knowledge is required to view this methodology as a boundary object allowing the collaboration of knowledge systems and thus the adoption of a complex approach of the SES, allowing to approach the problems of human-wildlife coexistence.

CHAPTER III - NATURE OF HUMAN-WILDLIFE RELATIONSHIPS AND ADEQUACY OF CONSERVATION STRATEGIES



A baboon walking on the Nelson Mandela University roof
in George, 2022 ©Élie Pédarros

Through the investigation of the epistemological and methodological aspects associated to a transdisciplinary approach of CAS for conservation sciences and practices we clarified the operational aspects of this collaboration. However, this epistemological and methodological redefinition is due to a change in conservation objects, an ontological redefinition. We will first outline how the literature is considering human-wildlife relationships, especially the shift from conflict to coexistence. This shift implies change in the way we consider the nature-culture divide and allows us to introduce the concept of “dwelling”. Through this concept, we will question the idea of coexistence in our two study sites and analyse existing literature to question the relevance of the techno-scientific approach to conservation, highlighting the close relationship between policy and science in this field.

I. Coexistence, conflicts and Human-wildlife visions

1. Human-wildlife relationships conceptions in conservation sciences

Investigating human-wildlife relationships in conservation sciences has often focused on conflicts between wildlife and human populations and is a topic of primary interest in conservation sciences and practices (König et al., 2020). Human-wildlife conflicts (HWC) are defined as “*an interaction between wildlife and humans with a negative outcome*” (Madden, 2004b). These conflicts may occur when wildlife invades agricultural fields to feed or threaten or kill people (König et al., 2020). Some authors recognise HWC as one of the most important issues for conservation. Furthermore, the terminology of conflict in conservation implies using technical approaches for mitigation as wildlife stakeholders are not proper antagonists to resolve the designated conflict (Peterson et al., 2010). Unfortunately, Bhatia et al. (2020) emphasise that resolving these conflicts is rare, even where such strategies have been implemented. Despite these critics, the focus on HWC is still firmly anchored in conservation sciences.

Peterson et al. (2010) proposed that human-wildlife conflict narratives tend to consider animals as “*consciously combating people*” led by a naturalist ontology (Descola, 2005). The interpretation of human-wildlife relationships and their qualification is decisive for conservation management (Bhatia et al., 2020). Human-wildlife conflicts can be differentiated between human-wildlife impacts and human-human or conservation conflicts (Bhatia et al., 2020). As Bhatia et al. (2020) highlighted, the literature on human-wildlife relationships and conservation focuses mainly on the conflictual aspect of the issue. However, few studies refer to human-human conflict and analyse that it may be counterproductive to conservation as it biases our understanding of human-wildlife relationships (Bhatia et al., 2020). A more relevant approach to studying human-wildlife relationships would be to consider the diversity of attitudes along a gradient, according to Bhatia et al. (2020). This would allow for a more comprehensive understanding of the various relationships and the need for a complex and adaptive social-ecological system.

Moreover, mitigation measures focusing only on the ecological subsystem of the broader social-ecological system commonly emphasise protecting nature from people (Büscher & Fletcher, 2019; as cited in Bhatia et al., 2020). This “protected from” position implies a dichotomic perspective of humans and wildlife supposing the conflict. In this sense, we raise the performative character of a “conflict” approach to human-wildlife

relationships, especially from Western ontologies, and applied in other regions. In the Kalahari, San people do not perceive human-wildlife conflicts, although wildlife often takes their food stocks (e.g. caracals and jackals on poultry, mice on seeds). The unbalanced consideration of SES promoted by conservation sciences and practices on HWC imposes specific relational values. The study of the mechanisms of human-wildlife coexistence through the semantic shift from the notion of conflict to that of coexistence is increasingly present in the literature (Madden, 2004a, 2004b; Peterson et al., 2010) and coexistence is often equated with the notion of tolerance to describe a diversity of human-wildlife relationships (Frank, 2016).

2. From conflict to coexistence: an extension or a reversal of human-wildlife relationships?

Shifting the investigation of human-wildlife relationships in conservation sciences and practices from a conflict to a coexistence perspective suggests an extension of the community and, thus, a change in human-wildlife relationships. Acknowledging a diversity of worldviews implies a shift from rationalism to relativism.

Ingold (1993) proposes the concept of "inversion" to analyse this shift. Knudsen (1998) describes this inversion as a decontextualisation of local knowledge and discourse by Western observers who retransmit it through the filter of their worldview as a reflection of their own culture. Following this, Knudsen (1998) reports that Ingold (1993) argues that *"it is the logic of inversion" that "has set the terms for the never-ending and singularly futile epistemological debate between the advocates of rationality and relativism"*. According to Knudsen (1998), Ingold considers that when we move from a rationalist to a relativist position, we think we are doing a translation when we only do an inversion. To avoid this inversion bias, Ingold (1993; as cited in Knudsen, 1998) proposes to assume that every position is perspectival, and that the world is a *"continuous and unbounded landscape"*. However, rather than an approach centred on distinct cultures, Ingold, according to Knudsen (1998), envisages a continuous world where people adopt points of view in the world and where, instead of different worlds, it is *"the same world seen from another point of view within it"*. Viveiros De Castro (1998) calls this approach a multinaturalism to criticise the multicultural logic typical of Western contemporary academic thinking (Kohn, 2013). The notion of a continuous world renders relativistic

and rationalist positions obsolete and, as a result, also dissolves the translation problem (Knudsen, 1998). However, Knudsen (1998) notes that, on the other hand, the process of inversion is the origin of the translation problem, and translation is thus an "artificial reconstitution" of fragmentation created by inversion.

Considering coexistence as a simple extension of the community of living beings in a shared geographic space would be an inversion of rationalism and not a shift. In this case, coexistence is considered a solution to conflicts. The other side of the same coin is a unidirectional coexistence without operating and generating the conditions for coexistence, which is to say, new modes of human-wildlife relationships, a reciprocal coexistence.

The example of König et al. (2021) highlights this point. They proposed a framework for moving from conflict to coexistence conceptions in addressing the case of the wolf issue in Germany. In this case study, they offered to promote governance capacities and capacity building to integrate a specific diversity of stakeholders and implement practical damage prevention through technic-based mitigation measures. In this case, the move from conflict to coexistence is adaptive to consider, as mentioned by the authors, local legal frameworks, knowledge and technical equipment (capacities and capabilities). Stakeholders may choose damage prevention measures to cope with wolves and adopt a holistic approach to the social-ecological system (König et al., 2021). This example is important because it shows that coexistence can be employed without necessarily aiming to profoundly redefine the nature of human-wildlife relationships. All the integrative approaches are not necessarily going further in the redefinition of the relationships and are confined to the practical and physical implications of coexistence. They tend to resolve conflicts by using the coexistence concept with an extension of the human community while respecting the human-wildlife dichotomy without translating and redefining the conditions for coexistence.

3. Dwelling to build coexistence

To overcome these difficulties in characterising human-nature relationships and especially human-wildlife relationships, Knudsen (1998) emphasises that Ingold borrows the term "dwelling" from Heidegger's essay "Building Dwelling Thinking" (1971). As

Ingold used, the concept of dwelling reverses the ontology of building ~ dwelling; for him, dwelling precedes building (Knudsen, 1998).

According to Knudsen (1998), dwelling is the fundamental metaphor for Ingold's reversal of the constructivist paradigm: firstly, to adopt a point of view "*on the world*" ("dwelling"); secondly, to appreciate "*what the world looks like from that place*" ("construction") (Ingold, 1993). "*Cultural construction*" is thus an end and not the beginning of the process (Ingold, 1993). It is a perspective reversal from simply promoting the social system within a social-ecological system. This framing reflects that humans are mentally, materially, and physically immersed in their immediate environments and, thus, in interaction (Knudsen, 1998). Relativist perspectives focus on attitudes, values and beliefs, which tend to construct the "human" around the mind rather than the body (Knudsen, 1998). Subsequently, Ingold's analysis by Cooke et al. (2016) shows that "*interactional philosophy positions the environment as an independent biophysical reality that humans act upon rather than a world where humans act in concert with non-humans*". This is a radically different perspective on how the system is understood. In terms of governance, this perspective risks privileging knowledge of a biophysical reality derived from expert knowledge and implemented through technological fixes and centralised solutions (Stirling, 2010; as cited in Cooke et al., 2016). The environment is thus an "*array of features*" that exist through the different co-constituted activities of humans and other living and non-living entities (Ingold, 2000; as cited in Cooke et al., 2016). As a result, Cooke et al. (2016) interpret dwelling as describing humans as active participants in making the biosphere while recognising that people's experiential knowledge shapes their understanding of it (Cloke & Jones, 2016; Macnaghten & Urry, 1998 as cited in Cooke et al., 2016). Therefore, dwelling is "*to act in the world is to be interwoven with other material elements rather than to inscribe pre-determined ideas onto the biophysical environment*" (Cooke et al., 2016). Dwelling contributes to defining the "environment" as the biophysical landscape to avoid the dichotomy between nature and humans (Ingold, 2011).

Dwelling does not readily translate into a definition with fixed and specific attributes or benchmarks. This criticism toward rationalism and relativism has shaped the reflection around the redefinition of human-wildlife relationships, especially by investigating other modes of human-wildlife relationships, such as Indigenous ontologies, especially in anthropology (De Castro Viveiros, 2014; Descola, 2005; Kohn, 2013).

According to the previously mentioned definitions of other authors, coexistence is multifaceted, integrating the operational means of forming a broad community and the proposal of a new ontology going beyond animist, totemist, analogist or, more specifically, naturalist ontologies. Coexistence in complex and adaptive SES should not be considered as a coalition of diverse stakeholders to force coexistence with wildlife, as advocated by König et al. (2020). It would only consider coexistence as an HWC outcome by using more integrative decision-making without redefining the contours of human-wildlife relationships. According to these reflections, adopting a coexistence framework for resolving HWC is a dead end because it does not allow a shift in conservation paradigms to update the temporary state of relationships that remain the same.

According to a dwelling perspective, coexistence is thus based on the relation. It implies reconsidering the concepts used by social-ecological studies. It seems the most relevant approach to deal with human-wildlife coexistence issues according to the previously given definitions of SES from a CAS perspective. The stewardship position should be radical enough to transform relationships with humans and wildlife to address coexistence issues (Mathevet et al., 2018a). The biophysical environment is an active agent in shaping management practices, not a base map (Cooke & Lane, 2015; Ingold, 2000).

Reconciliation ecology proposes examples highlighting this extended community's possibility. It provides the raw material to elaborate the practical means of reconciliation in anthropised habitats, allowing both people and biodiversity to flourish (Rosenzweig, 2001). However, reconciliation ecology not only understands coexistence as a patchwork of different entities. It conditioned coexistence possibility by the creation of the conditions allowing this reconciliation. As advocated by Ducarme and Couvet (2020), the idea of reconciliation ecology does not directly challenge the status and importance of protected areas. Still, it puts them into perspective within a broader set of conservation strategies (Ducarme & Couvet, 2020). The reconciliation ecology idea is thus one among other possibilities to embody coexistence practically and to make this idea tangible. In the following section, we will implement this dwelling approach by providing a social-ecological analysis of the dynamics within shared spaces by mobilising both the methodology of participatory mapping and group discussions to identify stewardship positions. Confronting this modelling of the relational landscape with these stewardship

positions from distinct environmental discourses aims to bring a more integrative approach to conservation science and practice.

II. Investigating coexistence in human-dominated landscapes through a social-ecological lens: a co-constructive, participatory and relational approach

Élie Pédarros^{*1;2;3}; Hervé Fritz^{1;2}; Chloé Guerbois^{1;2}

¹ REHABS, CNRS - Université Lyon 1 - Nelson Mandela University, International Research Laboratory, George Campus, Madiba Drive, George, South Africa

² Sustainability Research Unit, Nelson Mandela University, George Campus, Madiba Drive, George, South Africa

³ Laboratoire de Biométrie et Biologie Evolutive, CNRS UMR 5558; Université Claude Bernard Lyon 1; Villeurbanne Cedex, France

Article info

Research co-design
Social-ecological
Complexity
SDM
Stewardships
Coexistence

Abstract

The intertwining of societal and ecological issues, particularly in conservation science, has been accompanied by a redefinition of concepts and ways of understanding human-wildlife relationships, particularly in a complex and adaptive approach to SES. Consequently, methods of understanding the dynamics of landscape use by the broader community of living organisms and the appropriateness of proposed conservation strategies in complex systems are now central issues in conservation sciences and practice. In this study, which we co-designed and co-constructed with various stakeholders from two sites in South Africa, we approach the social-ecological requirements of wildlife in human-dominated landscapes from a relational landscape perspective by mobilising a participatory mapping methodology. Besides evaluating the importance of the co-construction and co-design of research for understanding social-ecological dynamics and coexistence, we raise in this study the significance of the confrontation of the interpretations of the modelling results obtained with different stewardship positions. Including biotic factors in species modelling distribution better integrates the system's complexity and improves the model's performance in human-dominated landscapes. The diversity of stewardship positions identified through group discussions around conservation and coexistence, which are characterised by various human-wildlife relationships, highlights the importance of confronting these outputs with the values associated with stewardship positions. Integrating biotic relationships into modelling the social-ecological dynamics of a relational landscape within a co-designed and co-constructed project is decisive in assessing the legitimacy, credibility and salience of conservation strategies among diverse values for coexistence in human-dominated landscapes.

1. INTRODUCTION

The current biodiversity crisis is often conceived as an issue about natural spaces (Ellis et al., 2021) to counter through policymaking approaches, often adopting a narrow

set of values (Chan et al., 2016). However, current biodiversity losses are usually not related to human conversion or degradation of pristine ecosystems but rather to the recent “*appropriation, colonisation, and intensification*” of landscapes inhabited by human population for millennia (Ellis et al., 2021). According to Ellis et al. (2021), humans have been transforming the Earth for at least 12,000 years. Reconciliation ecology proposes “*inventing, establishing and maintaining new habitats to conserve species diversity where people live, work or play*” (Rosenzweig, 2003a). It aims to practically redefine the modes of coexistence between humans and other living beings and thus adopt a social-ecological approach to these systems. A particular characteristic of social-ecological systems (SES) is their social-ecological intertwinedness, reflecting the co-constitution of social and ecological systems (Folke, 2016).

Understanding how wildlife species thrive in human-dominated landscapes thus requires integrating the dynamic characters of human-environment relations through bridging relational thinking in landscape research (Stenseke, 2018). According to Stenseke (2018), this relational turn emerged in social sciences and called for recoupling humankind and “nature”. However, this epistemological turn needs more implementation in landscape ecology and an understanding of coexistence processes within human-dominated landscapes. This study aims to respond to this need for more implementation of relational landscape concepts in landscape ecology.

Adopting a relational landscape approach implies considering the adequation of landscape ecology outcomes and their corresponding interpretations with local stakeholders' positions. These positions, corresponding to a shared way of understanding the world, can be characterised by diverse environmental discourses (Dryzek, 2013), constituting and determining stewardship action (Mathevet et al., 2018a). Environmental discourses can be categorised following four categories emerging from the combination of two dimensions that are the extent of the departure from the current system (reformist or radical) and the nature of the actions implemented to make this departure effective (prosaic or imaginative) (Dryzek, 2013). Reformist (reformist prosaic), sustainability (reformist imaginative), adaptive (radical prosaic) and transformative (radical imaginative) stewardships positions are supposed to condition and initiate different modes of coexistence between humans and other living beings (Mathevet et al., 2018a) and influence the social-ecological dynamics in human-dominated environments (Enqvist et al., 2018). Involving local stakeholders in research provides significance, credibility,

and legitimacy to the project, which is essential for conservation efforts (Cash & Belloy, 2020). Emphasising the importance of co-constructing and co-designing research to integrate scientific and societal goals is crucial.

However, the first difficulty encountered in this effort of plurality and inclusiveness for understanding the system is the collaboration of knowledge systems (Tengö et al., 2014, 2017). Knowledge collaboration has been recognised as critical for emerging common understandings and is supported by boundary objects (Tengö et al., 2017). Boundary objects are “*valued on both sides*” of the boundary (Star & Griesemer, 1989). For landscape ecology research on species habitat suitability, participatory mapping methodologies could fulfil the role of boundary objects by incorporating local knowledge in scientific methods (Pédarros et al., 2020). However, using presence-only data from participants' observations implies methodological issues to consider in interpreting the habitat suitability of a given species in human-dominated landscapes (Barbet-Massin et al., 2012; Elith et al., 2006; Pédarros et al., 2020).

We conducted preliminary discussions with various stakeholders in two contrasted sites of South Africa: the Garden Route Biosphere Reserve and the #Khomani Cultural Landscape, to identify issues at stake locally to co-design and co-construct the research while identifying species of interest for participatory mapping sessions to perform species distribution modelling. In addition, we identified the stewardship positions among participants characterising the different stakeholders' categories to confront social-ecological dynamics interpretations with various stewardship actions. This study aims (i) to assess the importance of research co-construction and co-design for the understanding of social-ecological dynamics and coexistence, (ii) to understand the social-ecological requirements of wildlife species in human-dominated landscapes according to a relational landscape perspective applied to species distribution modelling and (iii) to measure in what extent different stewardship positions for conservation action can support this understanding of social-ecological dynamics.

2. METHODS

2.1. Sites description

The study area of George municipality (542.96 km²) (Figure 2) is established between the Indian Ocean and the Outeniqua mountains in the Garden Route. The area is

distinguished by its mountains, valleys, and coastal plains (Baard & Kraaij, 2014). Average annual rainfall is between 800 and 1100mm, with temperatures ranging between 18 and 25 °C (Baard & Kraaij, 2014). The area is renowned for its biodiversity and high level of endemism (Vromans et al., 2010; as cited in Baard & Kraaij, 2014). However, due to the booming forestry sector in the '70s, the Indigenous vegetation is at risk with the increasing presence of invasive exotic species, mainly represented by *Pinus* and *Acacia* species (Baard & Kraaij, 2014). The Garden Route National Park (1210 km²) provides a unique example of a social-ecological conservation approach (Palomo et al., 2014), characterised by a network of protected areas connected by multiple corridors in a mosaic of land uses. The area is home of baboon (*Papio ursinus ursinus*), vervet monkey (*Chlorocebus pygerythrus*), predators such as honey badger (*Mellivora capensis*), common genet (*Genetta genetta*), leopard (*Panthera pardus*) and caracal (*Caracal caracal*), antelope species such as bushbuck (*Tragelaphus scriptus*) and blue duiker (*Philantomba monticola*) but also bushpig (*Potamochoerus larvatus*).

The Kalahari study site is in the arid savannas and dunes systems landscape of the southern Kalahari around Askham in the Dawid Kruiper municipality (Northern Cape, 542.88 km²). The area belongs to the †Khomani San community, which claimed and obtained six farms and a part of the Kgalagadi Transfrontier Park in 1999. Human density is very low and concentrated in small settlements (mixed formal and informal) on old farms like Andriesvale or Witdraai. The population is composed mainly of Khoï and San people, Afrikaans speakers, and named the †Khomani San Community. The Kalahari's South-African section is the region's driest part, with an average rainfall of 150-300 mm per annum (Kepe et al., 2005). For the temperatures, there are two important patterns: hot during summer (min: 20.4±1.2°C, max 38.1±1.8°C) and cold during winter (min: 0.6±0.8; max: 23.8±1.4)(Noakes & McKechnie, 2020). The economic activity is dominated by extensive mixed grazing of sheep (*Ovis aries*), cattle (*Bos taurus*) and goat (*Capra hircus*) (Wasiolka & Blaum, 2011). The Kgalagadi Transfrontier Park is home to the typical Kalahari mammals, including rodents, small and large carnivores and large herbivores. The park is fenced on the South-African side; thus, very few large predators roam freely outside the park. Small carnivores such as cats (caracal, *Caracal caracal*; African wild cat, *Felis lybica*), foxes (cape fox, *Vulpes chama*; bat-eared fox, *Otocyon megalotis*) or mongooses (yellow mongoose, *Cynictis penicillata*; common slender mongoose, *Herpestes sanguineus*) but also large herbivores such as Kudu (*Tragelaphus strepsiceros*), Gemsbok

(*Oryx gazella*) and Elands (*Taurotragus oryx*). There are few movements of animals in and out of the park.

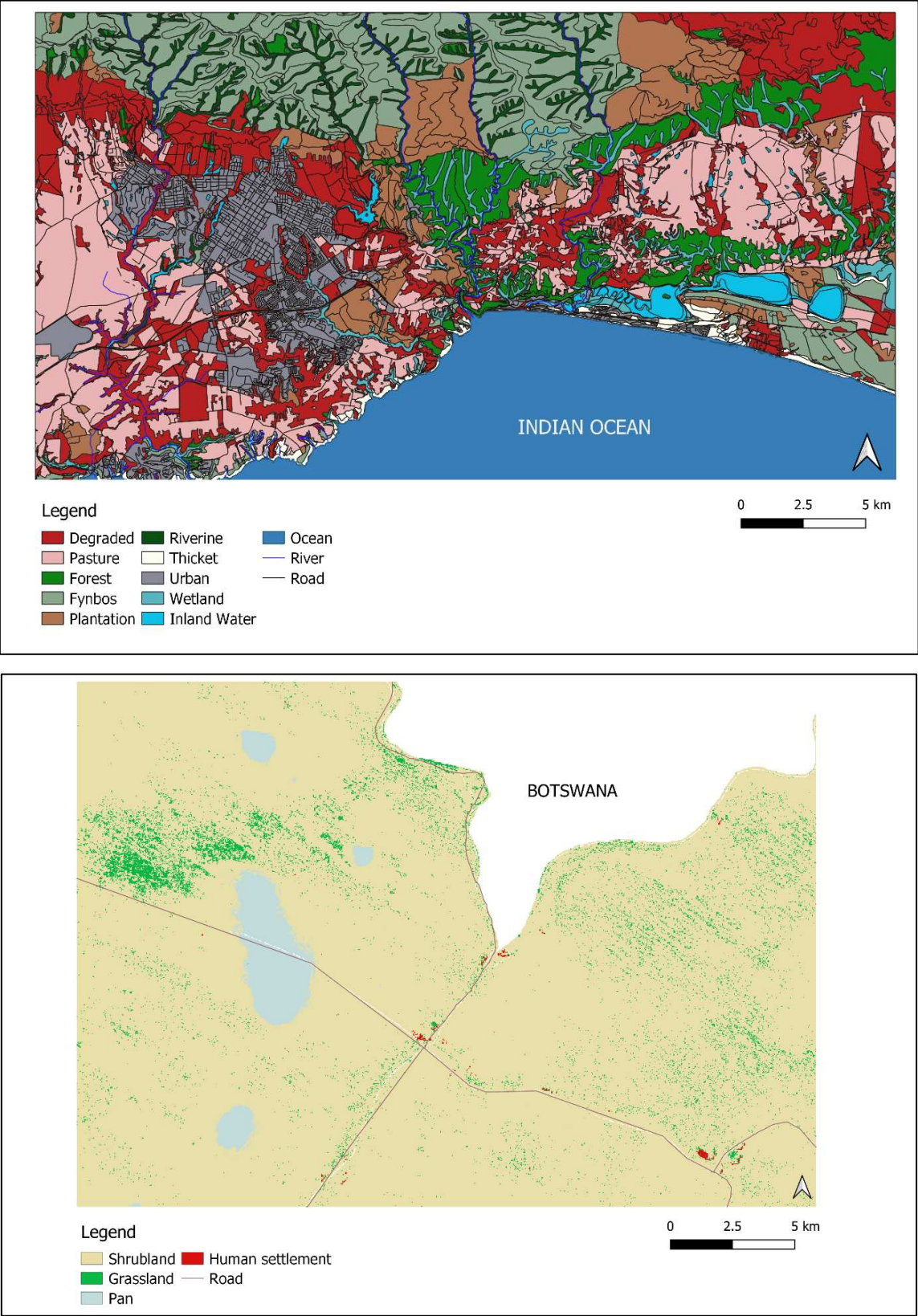


Figure 1. Study sites of the Garden Route (above) and Kalahari (below) with the land cover used for modelling occurrence or habitat suitability

We can identify unique and common traits by comparing the Garden Route and Kalahari sites, which have different landscape structures and social-ecological dynamics. This will help us make recommendations for using participatory mapping methods to study how humans and wildlife coexist.

2.2. Participants' selection

This study is part of a collaborative research project which received ethical clearance from Nelson Mandela University (H20-SCI-SRU-003). We engaged with key stakeholders (Table 1) following a stratified purposeful sampling among four categories: governance, conservation organisations, residents, and Indigenous communities. The stratified sampling was adopted to target persons or groups of people knowledgeable about the area and interested in wildlife. This first step of preliminary discussions had two objectives: (a) epistemological, by adopting a complex approach, we aim to go beyond the holism and reductionism approaches which can lead to a truncated perception of problematics at stake for conservation locally (Colloff et al., 2017; Pullin et al., 2004) and (b) to create engagement, by involving local stakeholders in the research to give salience, credibility and legitimacy to the project which is fundamental for conservation action (Cash & Belloy, 2020). We conducted semi-structured interviews to identify questions and processes at stake, streamline our methodologies, and select focal species (Appendix I). We extended the stratified purpose sampling by snowballing (Goodman, 1961) to increase participants number for data collection.

2.3. Qualitative analysis on preliminary discussions and stewardships positions

Based on a semi-structured questionnaire (Appendix I), we identified various representatives of stakeholders involved in the preservation of large mammals. Discussions were conducted in the preferred language of the informant (Afrikaans or English) and analysed with Atlas.ti software and thematically coded in an iterative process. After a first reading of the transcripts, without coding, a second reading was carried out, and thematic coding was performed. Recurring themes were identified, as well as the issues raised. A third, more detailed coding specifying previously established recurring themes completed the analysis phase. We analysed both preliminary

discussions and stewardship positions thematically to consider a comprehensive data understanding (Braun & Clarke, 2006).

In the second data collection phase, we used a nominal group technic (NGT) approach to elicit stakeholders' judgement (Hugé & Mukherjee, 2018). Participants were placed in groups of six or seven, following the stratified purposive sampling categories (Table 1). Two questions were asked: "What is conservation" and "What could be human-wildlife coexistence?". People were asked to write down or think about their answers for 5 minutes before debating the solutions within each group for 20 minutes and presenting a common answer listened to by the other groups before the global discussion. These two voluntary broad questions overlap the theoretical and practical aspects of stewardship action favouring biodiversity conservation in shared landscapes.

Table 1. Participants' description for discourse analysis

Site	Stakeholder group	Potential landscape area conservation influence	Number of participants (Mapping/Discussions)	Female/Male ratio (Mapping/Discussion)	Main age class
Garden Route	Pacaltsdorp	Pacaltsdorp township (Khoi community)	7/6	0.57/0.50	40-50
	Municipality	George	0/4	0.00/0.75	40-50
	Property owner	Private properties	14/3	0.43/0.00	>50
	Informal settlement	Wilderness camp	6/3	0.50/0.00	20-30
	Commercial farmer	Commercial farms	1/0	1.00/0.00	>50
	Conservancy	Conservancies	3/4	0.33/0.50	40-50
	Academic	Potential facilitators	2/1	1.00/1.00	20-30
	Conservation institution	Protected areas	2/4	1.00/0.50	30-40
	Free access to mapping in the venue	NA	14/NA	NA	NA
	Total identified			35/25	0.60/0.44
Kalahari	Witdraai	Witdraai farm	12/10	0.75/0.70	40-50
	Andriesvale	Andriesvale farm	8/8	0.50/0.50	>50
	Askham township	Askham township	4/4	0.00/0.00	20-30
	Askham town	Askham town	4/0	0.66/0.00	40-50
	Rietfontein	Rietfontein	3/4	0.33/0.50	20-30
	Total			31/26	0.55/0.50

We realised different rounds of thematic coding using Atlas.ti qualitative data analysis software. The aim is to create codes enabling the synthesis into themes for interpretation (Castleberry & Nolen, 2018; as cited in Hakkarainen et al., 2022).

2.4. Participatory mapping

We adopted a participatory mapping methodology to allow knowledge co-production to understand better species' habitat use—the participatory mapping aimed at collecting and sharing informant's sightings in the area. We organised one data-collection participatory mapping workshop at each site. For each site, we defined the global extent of the study area, with observations mapped at the resolution of a 300x300m grid, which proved adequate in a previous study (Pédarros et al., 2020). We chose this resolution to filter observations to avoid spatial autocorrelation (Fourcade et al., 2013; Kramer-Schadt et al., 2016). The base maps were A0 prints from aerial imageries of the study area (1/45000). Aerial images were provided by SANParks GIS services, where main roads, rivers and inland water were displayed to ease location. A printed georeferenced grid (300x300m) was placed underneath the map to collect the informant's data. The map and grid were clipped on solid support (Pédarros et al., 2020). We organised groups with diverse stakeholder categories to maximise cross-interactions between participants. Each informant first informed sites visited at least twice a week (households, work, regular leisure activities using a flat pin) to define the area of intensive observation sampling and then locate their sightings over the past three years using round pins. A specific pin colour identified each species, and boards with species names (Scientific name, English, Afrikaans, Xhosa), pictures and pin colour were displayed to ease the process. Species in the Garden Route included Baboon (*Papio ursinus ursinus*), Vervet (*Chlorocebus pygerythrus*), Caracal (*Caracal caracal*), Bushbuck (*Tragelaphus scriptus*), Bushpig (*Potamochoerus larvatus*), Leopard (*Panthera pardus*), Genet (*Genetta genetta*), Honey Badger (*Mellivora capensis*) and the Blue Duiker (*Philantomba monticola*) and in the Kalahari included Gemsbok (*Oryx gazella*), Eland (*Taurotragus oryx*), Kudu (*Tragelaphus strepsiceros*), Black-backed Jackal (*Lupulella mesomelas*), Caracal, Leopard and Honey Badger. Several maps were proposed on separate tables to speed up the workshop mapping process. All information from the pins was reported on the grid underneath using colour pens and signs. Data was captured from these datasheets onto

georeferenced cell matrices. We performed GIS analysis using Quantum GIS 3 (QGIS 3.10.0) and R (R 4.2.0) software.

2.4.1. Species Distribution Modelling

As a spatial reference system, we used the datum WGS84 calibrated on the 23° East meridian. An in-depth literature survey selected a set of independent variables (Table 2). We controlled for correlation between variables to decrease model collinearity (Barbet-Massin & Jetz, 2014)(Appendix III).

To select the best modelling techniques (Elith et al., 2006), we performed species distribution modelling using the BIOMOD 2.0 multimodal platform (Thuiller et al., 2009). BIOMOD allows us to compare the most frequently used techniques in species distribution modelling (Barbet-Massin et al., 2012; Harmange et al., 2019; Monnet et al., 2015). We retained Random Forest models (RF) from the selection analysis because they show high True Skill Statistics ($TSS = \text{Sensitivity} + \text{Specificity} - 1$; Allouche et al., 2006) and high sensitivity. As we only have presence data, we created pseudo-absences datasets with equal presences and pseudo-absences as recommended in the literature (Barbet-Massin et al., 2012). For each modelling, we ran 40 pseudo-absences datasets (Barbet-Massin et al., 2012) and replicated them three times (Thuiller et al., 2009). For each species dataset, we obtained a combination of 120 models. BIOMOD randomly subset the dataset in a training dataset, used to build the model, and in a testing dataset, used to evaluate the model according to a data split coefficient.

The recommended data split coefficient is 70%, meaning 70% of the total dataset is used as training data and the remaining 30% as testing data (Thuiller et al., 2009). We performed species distribution modelling on all species of each site to get a distribution map. When the modelling failed three times in a row for species with insufficient observations, we slightly increased the split (by 1% at a time) to increase the training dataset without significantly changing the density of the training dataset at the study site scale. We considered TSS as the models' metric evaluation.

We realised Spearman's correlation analysis between species distribution maps within each site to determine which species to include as a biotic factor in modelling. For each pair of correlated species, we chose to keep as a biotic factor the distribution map optimising the TSS value of the modelling.

2.4.2. Bias correction

As described in the literature, we considered species detectability as a function of different factors integrating the diversity of potential biases associated with citizen data (Pédarros et al., 2020; Skroblin et al., 2021; Stern & Humphries, 2022). Therefore, for a given pixel unit, detectability was defined as:

$$D_i = S_i \times V_i \times R_i$$

i : pixel unit. $D(i)$: detectability within pixel i . $S(i)$: spatial sampling intensity for pixel i .
 $V(i)$: visibility within pixel i . $R(i)$: proximity of pixel i to the closest main road.

We created a distance matrix for tarred roads to define the likely bias associated with higher traffic and relative accessibility (R_i). A target (~one meter high) was randomly placed for each habitat's visibility. The distance at which the target disappeared from the observer was measured 20 times for each habitat (Valeix et al., 2011). The relative visibility for each habitat (V_i) is given by the average visibility distance of the open environment as the reference for the highest visibility. We considered the mean interdunes distance as the maximum visibility for the low shrubland cover in the Kalahari, dominated by high sandy dunes. Each matrix bias follows a standardised normal distribution rescaled between 1 and 20 (Elith et al., 2010).

We considered the product of these standardised bias correctors as a proxy of species detectability within the landscape (Appendix V).

Table 2. Abiotic variables used for species distribution modelling

Variable		Description	Reference	Layer	Site
Land cover (Categorical)	Urban	Urban area	Vlok et al. (2008) Vromans et al. (2010)	Urban	GR
	Pasture	Rural residential area and commercial agriculture		Farm	
	Plantation Degraded	Plantation areas Degraded areas mainly dominated by invasive species		Plantation Degraded	
	Forest Fynbos Wetland	Afrotropical forest Fynbos (shrubland) Hygrophilous vegetation		Forest Fynbos/grassland Drain	
	Thicket	Dune and coastal vegetation		Thicket/marine	
	Low shrubland	Low woody shrubland communities characterising dunes vegetation	SANLC (2020)	8	KH
	Grassland Dry riverbed	Indigenous grassland Bare riverbed		13 30	
	Pan Village	Dry pans depression Built-up areas are primarily associated with scattered rural settlements and related utilities.		26 55;56	
Landscape metrics (Quantitative)	Protected area	Distance to the closest Protected area (m)	SANBI (2002) & Cape Nature (2017)	Protected Area	GR
	Critical Biodiversity Area	Distance to the closest CBA (m)	Northern Cape Department of Environment and Nature Conservation (2016) & Cape Nature (2017)	Critical Biodiversity Area	KH, GR
	Water	Distance to the closest freshwater body area (m)	SANLC (2020) & Ahrend (2018)	River, Inland water, Dry Riverbeds	KH, GR
	Slope	Average slope for each pixel (°)	Danielsen and Gesch, 2011	Relief 10m contours	GR

3. RESULTS

3.1. Preliminary discussions

The environmental issues identified as crucial in the Garden Route were primarily related to human presence and activities, including landscape fragmentation and the increasing presence of humans in all habitat types. To a lesser extent, fire and resource exploitation were identified as potential threats. As the theme of the study focused on mammals, the recurrence of invasive plants in the discussions shows a significant concern on this subject. Participants regularly mentioned baboon, bushbuck and bushpig as problematic species. The state of their population does not worry the participants, but their presence creates many problems of coexistence. The responses envisaged are diverse in the means implemented depending on the species considered. Baboons crystallise the tensions: from the lethal solution to the use of means promoting coexistence, they polarise positions. Damages are multiple and affect all categories of inhabitants, regardless of their activity. Participants regularly mentioned leopard and caracal, although rarely seen. They are not considered to pose any particular coexistence issue in Wilderness. Nor does it pose a security problem, as no attacks have been reported. As farms in the study area are mainly fields and pastures, caracals do not pose any particular problems apart from predation on domestic cats. The scale of nuisance is therefore restricted to the household. There is a solid attachment to the area among the participants and a strong emotional dimension, positive or negative, towards other living beings. Given human pressures, sharing the territory is an ideal strategy, but it takes more work. Several participants widely discussed the aspect of the way of life associated with the place. The recent immigration of people from Johannesburg and Cape Town with an anxiety-provoking view of the outside world leads to a translation of values not adapted to this place. It was mentioned by commercial farmers, informal settlement residents, and the Khoi community. It is reflected on the ground in constructing fences and gates that reinforce the isolation of private property and prevent the free movement of wildlife within the landscape. The Khoi community is in the process of structuring itself with several upcoming meetings aimed at self-determination. The Khoi claimed to have been victims of colonisation and were undermined. They expressed their willingness to



















perform a theatre play to all the participants to highlight their political struggle and the embeddedness of ecological dynamics.

In the Kalahari, participants were concerned about climate change and erosion of the landscape but did not mention any human-wildlife coexistence issues. Participants identified Jackal, Caracal and Honey Badger as a potential threat to poultry, but the phenomenon is not considered an issue. Eland has been evocated as scarce and is the emblem of the community. The primary concern was about #Khomani San culture's persistence and role in the current system. The access to the Kgalagadi Transfrontier Park, from which they theoretically own a part, is linked to this problem through the ability to effectively access the park to collect tubers and other vegetal products for medicine together with the hunting ability to transfer this knowledge to younger generations. The role of researchers has also been widely evocated through their disappointment toward those who engaged with the community and left the area, letting the community live in harsh conditions. Another critical point was the ability of some community members to return to living in the park, which led to various discussions about human-wildlife relationships and community heterogeneity in terms of the ability to live there.

3.2. Participatory mapping and modelling

3.2.1. Mapping process

Table 3. Observations summary of the participatory mapping process in the Garden Route (GR) and the Kalahari (KH). Silhouette images coming from ©Phylopic

GR										Total
	64	11	22	66	110	120	12	128	30	
KH										
	25	0	19	15	22	23	21	24	149	

The participatory mapping exercise was quickly realised by all the participants and allowed them to exchange in the context of observation, knowledge and experiences about studied and non-studied species (Table 3). However, the blue duiker confused some

participants who needed clarification on this species with the Cape Grysbok (*Raphicerus sharpie*). Therefore, we decided not to include blue duiker observations in the analysis.

3.2.2. Single species modelling and correlations

Participatory mapping data in modelling habitat suitability (Table 4) resulted in a good performance of the models with TSS above the value of 0.5, identified as an acceptance threshold in the literature (Dang et al., 2020). Kalahari modelling performed better than Garden Route modelling due to a more homogenous landscape facilitating extrapolation. The correlation analysis performed between pairs of species distribution maps (Appendix III) indicated that the different species distributions were very similar from one to another. To avoid spatial correlation between variables, we kept the distribution variables performing the best when implemented in our focused-species modelling.

Table 4. Modelling performance for species habitat suitability with only abiotic variables

Model	TSS	Sensitivity	Specificity	Threshold
Bushbuck ~ Environmental predictors	0.598 ± 0.015	0.792 ± 0.016	0.804 ± 0.018	0.506 ± 0.019
Honey Badger ~ Environmental predictors	0.565 ± 0.029	0.746 ± 0.032	0.817 ± 0.028	0.557 ± 0.033
Baboon ~ Environmental predictors	0.564 ± 0.015	0.797 ± 0.018	0.764 ± 0.021	0.490 ± 0.024
Leopard ~ Environmental predictors	0.540 ± 0.036	0.758 ± 0.043	0.778 ± 0.041	0.542 ± 0.034
Bushpig ~ Environmental predictors	0.537 ± 0.017	0.782 ± 0.022	0.751 ± 0.021	0.471 ± 0.019
Vervet ~ Environmental predictors	0.535 ± 0.015	0.716 ± 0.023	0.816 ± 0.021	0.548 ± 0.025
Genet ~ Environmental predictors	0.513 ± 0.034	0.694 ± 0.037	0.817 ± 0.028	0.564 ± 0.028
Caracal ~ Environmental predictors	0.480 ± 0.029	0.720 ± 0.039	0.757 ± 0.041	0.505 ± 0.037
Model	TSS	Sensitivity	Specificity	Threshold
Eland ~ Environmental predictors	0.665 ± 0.030	0.842 ± 0.031	0.816 ± 0.035	0.485 ± 0.036
Kudu ~ Environmental predictors	0.664 ± 0.028	0.865 ± 0.028	0.790 ± 0.031	0.427 ± 0.031
Honey Badger ~ Environmental predictors	0.583 ± 0.029	0.752 ± 0.032	0.829 ± 0.030	0.553 ± 0.034
Genet ~ Environmental predictors	0.526 ± 0.022	0.734 ± 0.025	0.789 ± 0.025	0.538 ± 0.020
Caracal ~ Environmental predictors	0.489 ± 0.029	0.746 ± 0.041	0.743 ± 0.037	0.514 ± 0.033
Jackal ~ Environmental predictors	0.468 ± 0.028	0.753 ± 0.039	0.715 ± 0.041	0.534 ± 0.032

3.2.3. Multiple species modelling

Given preliminary discussion orientations, we focused respectively on the Garden Route and the Kalahari on baboon and jackal (common species potentially problematic for human-wildlife coexistence) and leopard and eland (elusive and charismatic species). These species are interesting to compare because they embody a diversity of interactions and perceptions with human populations. According to the correlation analysis between distribution projections and modelling performance analysis (Table 5), we retained the following models:

Baboon habitat suitability ~ Abiotic variables + Bushpig habitat suitability

Leopard habitat suitability ~ Abiotic variables + Baboon habitat suitability

Jackal habitat suitability ~ Abiotic variables + Genet habitat suitability

Eland habitat suitability ~ Abiotic variables + Badger habitat suitability

We observed a clear improvement in modelling performance for all the focus species when a biotic variable is included in the modelling process (Table 5). This inclusion led to a change in response curves and variable importance. The biotic variable is the most important and thus diminished the other variables' importance. However, global patterns of variable importance remain the same. It indicates the influence of the biotic variable as a provider of non-considered variables for the studied species and commonalities regarding landscape use. For example, for baboons, the distance to the closest protected area, paramount in predicting the baboon's habitat suitability, diminished its importance when the biotic factor is included.

Table 5. Multiple species modelling selection

Model	TSS	Sensitivity	Specificity	Threshold
Baboon ~ Environmental predictors + Bushpig	0.628 ± 0.014	0.845 ± 0.015	0.781 ± 0.017	0.524 ± 0.021
Baboon ~ Environmental predictors + Bushbuck	0.625 ± 0.013	0.822 ± 0.015	0.802 ± 0.016	0.537 ± 0.025
Baboon ~ Environmental predictors + Vervet	0.607 ± 0.015	0.810 ± 0.017	0.796 ± 0.019	0.523 ± 0.027
Baboon ~ Environmental predictors + Caracal	0.605 ± 0.014	0.816 ± 0.020	0.787 ± 0.019	0.541 ± 0.026
Baboon ~ Environmental predictors + Honey Badger	0.601 ± 0.015	0.849 ± 0.015	0.752 ± 0.018	0.509 ± 0.024
Baboon ~ Environmental predictors + Genet	0.596 ± 0.016	0.809 ± 0.017	0.786 ± 0.017	0.539 ± 0.023
Baboon ~ Environmental predictors + Leopard	0.592 ± 0.015	0.810 ± 0.017	0.781 ± 0.018	0.540 ± 0.024
Leopard ~ Environmental predictors + Baboon	0.772 ± 0.034	0.910 ± 0.027	0.860 ± 0.026	0.636 ± 0.025
Leopard ~ Environmental predictors + Bushbuck	0.745 ± 0.034	0.901 ± 0.030	0.841 ± 0.030	0.617 ± 0.027
Leopard ~ Environmental predictors + Caracal	0.717 ± 0.039	0.837 ± 0.032	0.873 ± 0.031	0.612 ± 0.031
Leopard ~ Environmental predictors + Bushpig	0.716 ± 0.038	0.873 ± 0.029	0.838 ± 0.035	0.637 ± 0.024
Leopard ~ Environmental predictors + Vervet	0.710 ± 0.038	0.868 ± 0.033	0.842 ± 0.034	0.603 ± 0.030
Leopard ~ Environmental predictors + Honey Badger	0.683 ± 0.035	0.844 ± 0.036	0.838 ± 0.029	0.611 ± 0.027
Leopard ~ Environmental predictors + Genet	0.611 ± 0.038	0.809 ± 0.041	0.801 ± 0.036	0.635 ± 0.026
Model	TSS	Sensitivity	Specificity	Threshold
Eland ~ Environmental predictors + Honey Badger	0.741 ± 0.030	0.839 ± 0.029	0.902 ± 0.023	0.511 ± 0.043
Eland ~ Environmental predictors + Genet	0.701 ± 0.031	0.834 ± 0.031	0.864 ± 0.027	0.529 ± 0.043
Eland ~ Environmental predictors + Caracal	0.699 ± 0.028	0.827 ± 0.030	0.872 ± 0.027	0.543 ± 0.043
Eland ~ Environmental predictors + Kudu	0.688 ± 0.030	0.850 ± 0.028	0.835 ± 0.037	0.506 ± 0.047
Eland ~ Environmental predictors + Jackal	0.675 ± 0.030	0.852 ± 0.031	0.817 ± 0.032	0.491 ± 0.041
Jackal ~ Environmental predictors + Genet	0.521 ± 0.034	0.731 ± 0.037	0.787 ± 0.036	0.535 ± 0.037
Jackal ~ Environmental predictors + Honey Badger	0.504 ± 0.028	0.728 ± 0.036	0.776 ± 0.034	0.555 ± 0.039
Jackal ~ Environmental predictors + Eland	0.489 ± 0.033	0.714 ± 0.042	0.770 ± 0.038	0.572 ± 0.036
Jackal ~ Environmental predictors + Caracal	0.478 ± 0.030	0.686 ± 0.040	0.790 ± 0.036	0.578 ± 0.037
Jackal ~ Environmental predictors + Gemsbok	0.477 ± 0.029	0.716 ± 0.039	0.760 ± 0.036	0.531 ± 0.036
Jackal ~ Environmental predictors + Kudu	0.473 ± 0.033	0.707 ± 0.042	0.764 ± 0.043	0.558 ± 0.039

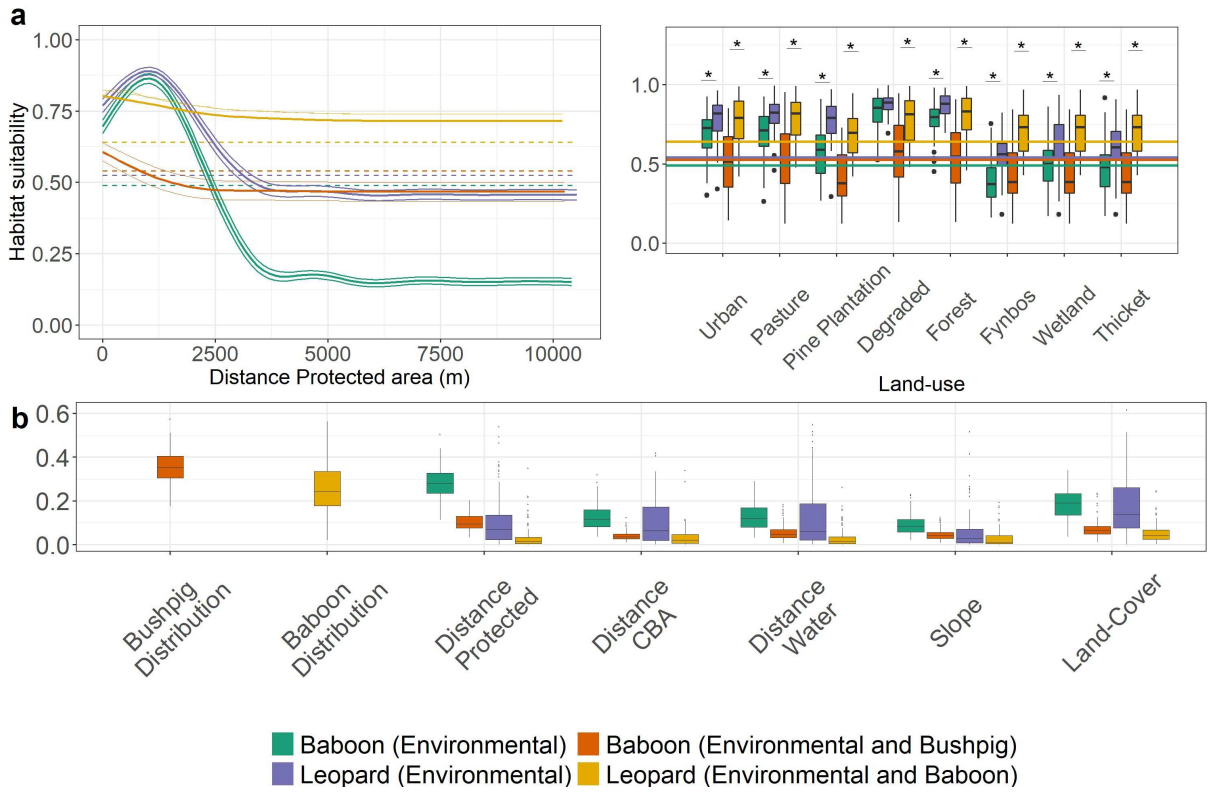


Figure 2 (a) Response curves for the two most important abiotic variables (Distance to the closest protected area and land use) and (b) variable importance in the Garden Route. (* : pvalue<0.05).

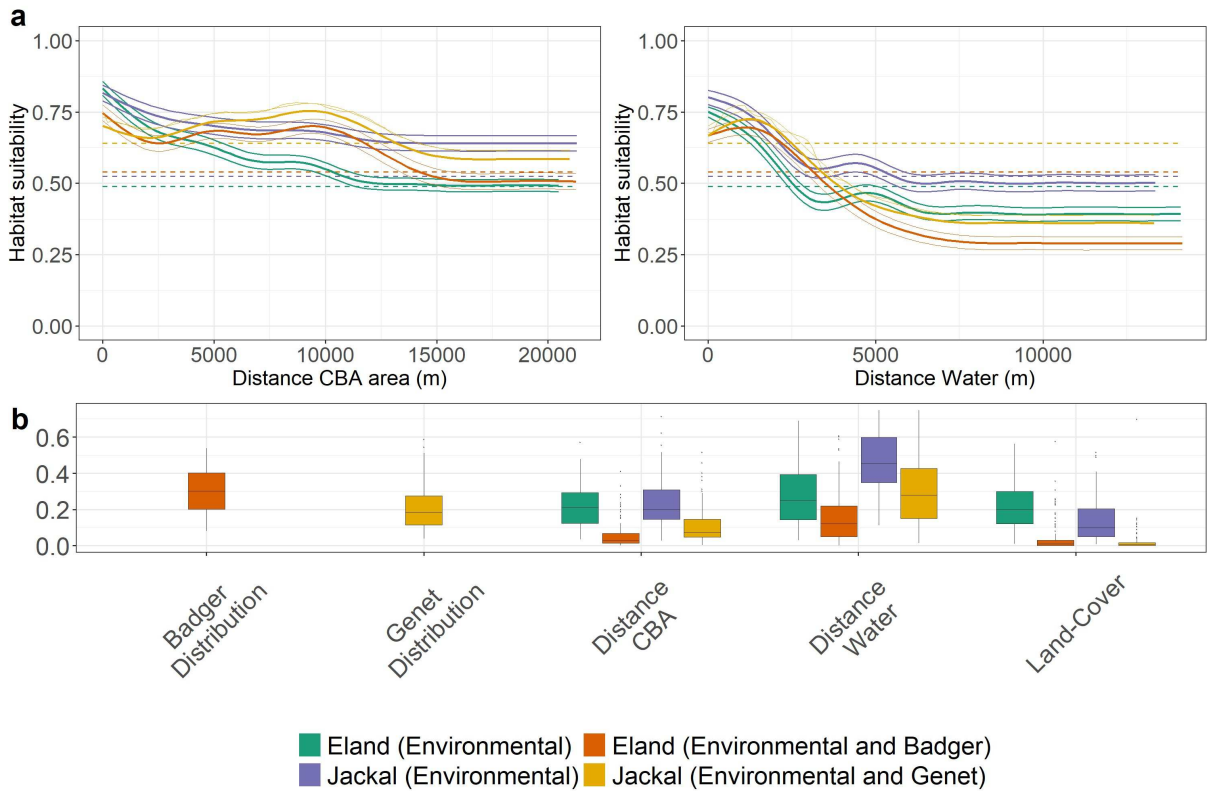


Figure 3 (a)Response curves for the two more important abiotic variables (Distance to the closest critical biodiversity area and water) and (b) variable importance in the Kalahari

In the Garden Route, the two main variables for baboons and leopards' models (with and without biotic factors) were the distance to the protected area and the land cover (Figure 3a), apart from biotic variables, which were the most important for the modelling performance. Including the biotic factor does not change the variables' importance patterns. The results in variables' importance for baboons' modelling with and without bushpig distribution show that bushpig distribution extends the prediction of available landscape areas for potential baboons' use. The distance to the protected area for presence prediction is more restrictive when including a biotic factor for the baboon's modelling without modifying the variable importance rank. We observed no difference in the response of jackals toward this variable nor the distance to water.

In the Kalahari, the two main variables for elands and jackals' models (with and without biotic factors) were the distances to critical biodiversity areas and water. Similarly to the Garden Route site, including the biotic factor does not change the variables' importance patterns. For elands' and jackal's modelling, including the biotic variable leads to lower importance of abiotic variables than environmental-variables-only models.

3.3. Stewardship analysis

The stewardship analysis shows an essential heterogeneity within stakeholder groups in the Garden Route and the Kalahari (Figure 5 and Appendix VII). Most stakeholder groups are within a reformist discourse category, represented by prosaic and imaginative discourse categories, namely reformist and sustainability stewardship categories. In the Garden Route, property owners, for instance, vary along all the dimensions of environmental discourses identified by Dryzek (2013), from adaptive to reformist and sustainability stewardship. Conservancies' active members privileged a reformist stewardship similarly to informal settlements residents who formulated an economical-based reformist stewardship. The municipality adopted an adaptive position. Pacaltsdorp people were the only group adopting a radical imaginative discourse characterising transformative stewardship. Witdraai, Andriesvale, and Askham township residents formulated this type of stewardship in the Kalahari site. This shared position between these two groups is also visible when looking at their diversity of positions, from reformists to sustainability and transformative stewardships. Rietfontien people situated

themselves in the reformist stewardship category and Askham township people in both reformist and transformative types.

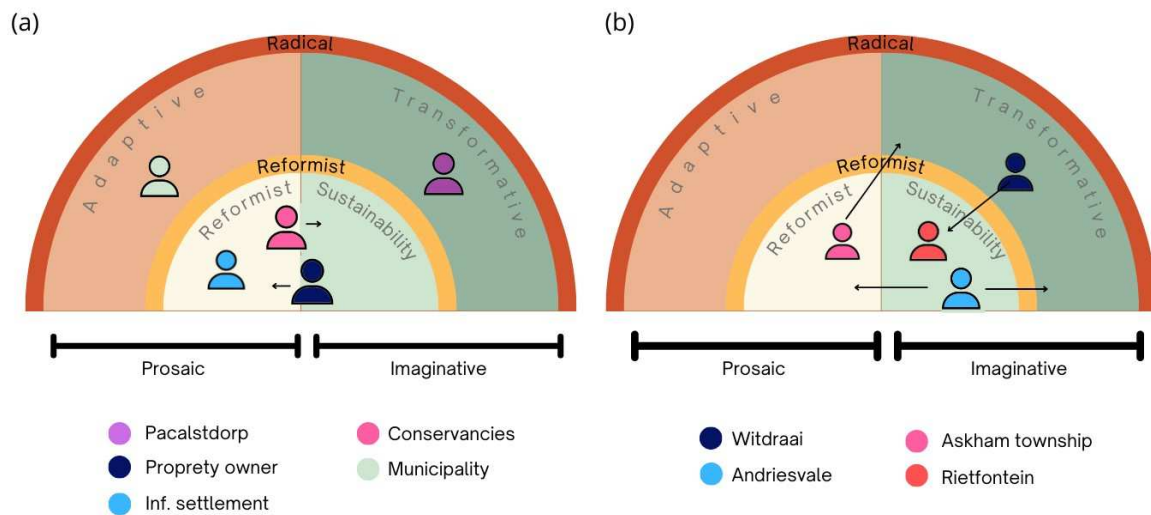


Figure 4. Representation of stewardship types according to environmental discourses dimensions (a) Garden Route (b) Kalahari. Arrows represent a stakeholder's tendency to develop arguments toward another stewardship type.

4. DISCUSSION

4.1. Adopting a complex approach of social-ecological systems to investigating human-wildlife coexistence requires adapting and redefining methodologies

Decision quality increases when stakeholder interest diversity is expressed through extensive information sharing and exploration (Curşeu & Schruijer, 2017). However, engaging with different stakeholders implies power relationships (Brisbois & de Loë, 2016) which can compromise the outputs of the collaboration. Moreover, these power relationships can distort consensus and lead to maladapted practices (Curşeu & Schruijer, 2017). Thus, researchers must apprehend these difficulties ahead of research conduction when engaging in a specific social-ecological system.

The co-construction and co-design of the research through preliminary discussions is an efficient approach to overcome these issues. Our preliminary discussions gave us a glimpse of the power relationships between stakeholders. As a result, we could adjust our approach to better integrate groups on the sidelines of current debates about conservation and coexistence. Maintaining a unique two-way relationship between the

researcher and participants allowed us to establish trust and take the heat from the following debates by listening and understanding struggles and group-specific issues. For example, the Khoï theatre forum and the †Khomani San film emerged from the preliminary discussion. They gave carte blanche for these groups to express their struggle publicly during the first data collection workshop. During the second workshop, these groups were very much involved in discussing coexistence issues and relationships between humans and other living beings. Delineating stakeholder groups is also problematic and paramount for the research output. Preliminary discussions gave essential insights into engaging with these groups by presenting the research proposal, the core subject and its potential redefinition informally. The debate about local issues in the area allowed us to identify social-ecological processes and discuss, propose and listen to design suitable methodologies.

Moreover, Kronenberg et al. (2017) note that conservationists select specific species to target conservation objectives (Clucas et al., 2008; Tisdell & Nantha, 2006; as cited in Kronenberg et al., 2017). This species choice is based on *a priori* assumptions, which can bias conservation purposes towards ineffective actions (Kronenberg et al., 2017). It implies carefully selecting the species under investigation for conservation purposes (Kronenberg et al., 2017). Species mentioned during the preliminary discussion allowed us to align with participants' interests and extend the research on under-studied species in human-dominated landscapes. The differential mentioning of species during the participatory mapping process is related to human issues locally and confirms the social importance of the species cited and their ecological role. Participatory mapping methodologies to gather data for species distribution modelling are increasingly mobilised to understand specific species' ecological requirements (Stern & Humphries, 2022). However, these methodologies are also means of public participation and expression of a relational landscape transferred into mathematical conceptions of space by interweaving different knowledge systems. Species observations are thus not only of particular ecological interest (Pédarros et al., 2020) but translate a mesh of relations between humans and other living beings. Extending the ecological keystone species concept to one of the social-ecological keystone species (Winter et al., 2018) appears particularly relevant to understanding the nature of participatory mapping products. A social-ecological keystone species is a species which has a significant influence on biocultural diversity (Winter et al., 2018). Species mentioned during the participatory

mapping methodologies, emerging from participants' practice of the landscape, are eminently social-ecological keystone species because they embody the object of social dynamics (e.g. baboons and vervet monkeys are structuring wildlife policies and conversations between landscape inhabitants) and ecological dynamics. Adopting a social-ecological keystone species approach calls for considering the landscape as a set of relations by assuming the temporality of every existence, process and relations (Setten & Brown, 2013; as cited in Stenseke, 2018).

4.2. Extending the spectrum of relationships within the system to consider an extended community of living organisms allows the reconsideration of coexistence dynamics

The joint species distribution modelling drastically improves the ability to predict habitat suitability (De Araújo et al., 2014). The Eltonian noise hypothesis advocates that biotic interactions influence species distributions only at local geographical scales (Dormann et al., 2018). However, several studies have shown that biotic interactions improve models even at large scales (da Cunha et al., 2018; De Araújo et al., 2014; Dilts et al., 2019; Lemoine, 2015 as cited in Dormann et al., 2018), suggesting the need to integrate biotic factors in species distribution modelling, especially for conservation sciences and practices whose strategies and policies have implications at various scales. Although it is difficult to identify the nature of interspecific interactions when using species distribution modelling (Dormann et al., 2018; Zurell et al., 2018), the inclusion of a biotic variable in the modelling process conveys information about the environmental predictors implemented or not in the modelling process (Dormann et al., 2018). Their inclusion potentially confounds their role as environmental indicators with that of biotic interactors, which require in-depth analysis (Dormann et al., 2018).

Including biotic factors refined the distribution of given species, and the analysis of variable importance patterns delivered interesting insights regarding multispecies dynamics. For baboons and elands, the inclusion of bushpig and badger distributions, respectively, informed the potential availability of the landscape for those species by refining and maximising the habitat suitability range without explicitly highlighting any particular interactions. Although no interaction between elands and honey badgers has been found in the literature, the variables' importance patterns and eland's modelling tend to suggest unconsidered environmental indicators expressed by honey badger

distribution. Elands are nomadic species roaming freely across the landscape (Augustine, 2010) and interact with cattle on extensive commercial farms (Ferris et al., 1989). Farming areas strongly attract honey badgers (Kheswa et al., 2018). In addition, in the Kalahari, elands show increased tolerance to the distance to critical biodiversity areas and water when badger distribution is included. It is consistent with the hypothesis of unconsidered variables, for instance, artificial waterholes. Indeed, critical biodiversity areas in the Kalahari are located around riverbeds. Therefore, the improved performance of eland's modelling with badger distribution could be the output of an unconsidered variable, such as artificial waterholes destined to cattle.

Moreover, baboons and bushpigs are known to be opportunistic and generalist species (Mamo et al., 2021). Without inferring a biotic interaction between the two species, bushpig distribution could explain baboons' observations linked to opportunistic behaviour in foraging and thus extend the understanding of baboons' habitat suitability. Testing *a priori* interactions when including a biotic factor can be limited in joint species distribution modelling, as we showed that including biotic factors could strongly inform unconsidered abiotic factors. For instance, the improved modelling performance suggests a finer prediction of baboons' landscape requirement and the paramount role of protected areas as a refuge, as shown in other studies (Guerbois et al., 2012; Pédarros et al., 2020). For the leopard, including baboon distribution, leads to another understanding of the role of protected areas in predicting its distribution. Although a limiting variable, the distance to the protected area does not influence the leopard's habitat suitability when considering the baboon's distribution. Protected areas appear as a structuring factor rather than a limiting factor for leopards which has important implications for conservation strategies in human-dominated landscapes focusing on leopards only. All the relative importance of land-cover categories decreases with the inclusion of the biotic factor for the baboon's modelling except the fynbos, which increases significantly. Previous studies mobilising only abiotic factors highlighted this avoidance of baboons for nutrient-poor fynbos (Pebsworth et al., 2012; Pédarros et al., 2020). However, the increase of the fynbos category suggests a maximisation of landscape use for baboons which could use fynbos areas as corridors to move within the landscape. For leopards, thickets, wetlands and fynbos become predictors of habitat suitability when the biotic factor is included, expressing the large spatial niche that can occupy leopards.

However, the presence of competition is described in the literature as improving the ability to use measures of the abiotic environment to predict suitable environments (Godsoe & Harmon, 2012). Jackals and genets have been described as competitors in other parts of the continent (Amroun et al., 2006), and leopards are predators of baboons (Bidner et al., 2018), another non-neutral interaction. However, we observed a decrease in the importance of abiotic variables when a biotic factor is included for these two species. Areas designated for conservation purposes (protected areas and critical biodiversity areas) are essential for wildlife habitat suitability in human-dominated landscapes, given their relative importance for all species distributions in the two sites. However, overall distributions suggest that their role is complementary to other land uses as habitat suitabilities are not restricted to these areas. In leopards, baboons, jackal and eland cases, protected areas are structuring rather than limiting species' distribution, although their importance remains high. In human-dominated landscapes, protecting areas should be understood as a complementary feature of a complex landscape rather than a primary natural habitat, which would only be suitable for wildlife conservation. This observation aligns with the reconciliation ecology idea advocating the importance of protected areas and anthropised landscapes (Rosenzweig, 2003b). It questions the efficiency and relevance of fenced protected areas compared to unfenced ones.

Another essential idea of reconciliation ecology is deconstructing the dichotomy between artificiality and the naturalness of infrastructures favouring wildlife persistence. The importance of water proximity for elands and jackals distributions corroborates this idea. The everyday use of artificial water sources in commercial farming areas and the importance of social-ecological processes behind this result could explain the surprising effect of badger distribution on elands modelling performance. The homogenous use of the landscape in the two sites suggests the possibility of human-Wildlife coexistence under the condition of acknowledging other living beings in the social sphere. Moreover, distributions are very similar geographically, meaning that focusing on a single species in a human-dominated landscape is not pertinent from a conservation point of view. Our study suggests that wildlife can thrive in different land uses where “*people live, work and play*” (Rosenzweig, 2003a), both for common species (baboons or jackals) and more elusive species (leopard or eland). The question is thus not to understand how social spheres can persist next to other living beings (usually described as the “natural world”)

and vice-versa but more precisely how social spheres can integrate other living beings within them (Latour, 2004).

This set of relations is paramount to understanding how wildlife species thrive in human-dominated landscapes, and the inclusion of biotic factors in the species distribution modelling highlighted this importance. While integrating species distribution as a biotic factor in modelling a specific species drastically increases the model's performance, it also gives another reading of social-ecological processes behind species distribution.

4.3. The confrontation of species distribution modelling results with the diversity of stewardship positions makes it possible to formulate credible, legitimate and salient conservation strategies.

The confrontation of species distribution modelling and stewardship analysis gives essential perspectives on conservation strategies. In the Kalahari, most participants belong to the #Khomani San community. Yet we can observe a great diversity of stewardship positions ranging from reformist to sustainable and transformative. Interestingly, many positions in our results could be related to multiple positions. This mismatch seems to correspond to the analysis grid, which considers the transformative position when a diversity of values and relationships to “nature” is recognised. However, the rest of the discourse is very different, and the typology needs to be adapted more finely to the specificities of Indigenous populations and local communities. Considering the mode of dwelling would be more relevant since, in our case, it makes it possible to identify the different stewardship positions more clearly: those who wish to live apart from wildlife (reformists), those who want to live with wildlife (sustainable) and those who consider the system as an inseparable whole (transformative). These three positions identified through the analysis of stewardship positions are crucial for proposing coherent conservation strategies. Moreover, the preliminary discussions inform us even more about the social-ecological context, particularly regarding the institutional rigidity of the Kgalagadi Transfrontier Park and the difficulty for the community to access its part of the park. By linking these three stages of the analysis, we can conclude that the Kgalagadi Transfrontier Park structural and institutional hermeticism does not seem suitable to consider the diversity of human-wildlife relationships expressed at its edge. For the #Khomani San, access to the claimed part of the park is still tricky and subject to

administrative procedures, making it difficult to access their land. Among reformist stewardship positions, living with potentially threatening wildlife is unthinkable. There is, thus, a challenge of finding a win-win response, primarily through the agency dimension of stewardship, to allow more flexible representations concerning park access. A suggestion for further practical investigation would be to propose new conservation strategies that are less segmented and weight of the community in the decision-making context.

Using the same analytical path as above in the Garden Route, we see that the issue is quite different. Indeed, while Kalahari participants recognise the diversity of stewardship positions (everyone realises that some want to live with the animals, others do not, and others consider the whole indivisible), the participants' positions in the Garden Route are more compartmentalised. Although the opening of the Garden Route National Park is a significant step in the coexistence process, the values associated with this park, its fauna, and the social-ecological system still need to be clarified to formulate conservation strategies considering the complexity of the social-ecological system. How human-wildlife relationships are framed affects how these are interpreted and managed (Bhatia et al., 2020). Integrating the diversity of environmental discourses and associated stewardship action positions is thus needed to inform conservation strategies. Our study corroborates that promoting a narrow set of values conditioning conservation strategies may fail to achieve conservation goals which require credibility, legitimacy and salience (Cash et al., 2003; Chan et al., 2016). Acknowledging the need for a diversity of human-nature visions does not mean replacing one idea with another; the critical point is the collaboration of this diversity around a common objective. The biodiversity concept complements interests within the conservation movement (Pascual et al., 2021). The assumption of a singular way of conceptualising biodiversity means that the predominance of a standard scientific interpretation can lead to ineffective conservation actions that can pit people with different values against each other (Pascual et al., 2021). Although all stewardship positions except transformative ones have excluding edges in acknowledging a diversity of human-nature visions, moving towards transformative stewardship could be an integrative way of bridging different positions. Extending (and not restricting) the current definition of biodiversity to the relationships humans maintain with other living beings could bring reformist, adaptive and sustainability stewardship objectives together with transformative ones without reducing their

specificities. Furthermore, this comparison between the results of the interactional landscape modelling and the stewardship positions informs us about the leverage points on which it would be wise to focus within conservation strategies. This analysis also calls into question "one size fits all" conservation "solutions" as we have identified different stewardship positions concerning potential conservation strategies in this study. The diversity of these positions leads us to emphasise the importance of contextualising these conservation measures.

III. Relevance of conservation strategies in human-dominated landscapes

1. Technoscientific conservation

This investigation of human-wildlife coexistence in the Garden Route and the Kalahari gives essential insights concerning the way conservation sciences and practices are conducted to deal with biodiversity in anthropogenic landscapes. It differs from the rationalism of technoscientific conservation in its methodologies and approaches. However, it is essential to note that the techno-scientific approach is central to conservation science (Devictor, 2018, pp. 36-47). As Devictor (2018, p. 36) highlights through the work of Hays (1999), technical and scientific approaches motivated the emergence of the XXth century conservationist movement. As Devictor (2018) reports, the driving force behind conservation policies is not the reflection on the ethics of resource distribution but rather the belief in the undeniable legitimacy of conservationists on these matters. According to Devictor (2018, p. 38), the biodiversity crisis is used to justify controlling political issues related to conservation. This control is driven by a techno-scientific approach that ignores the need for a political perspective. As a result, the scientific elite becomes the main decision-makers in addressing these problems.

Nowadays, techno-scientific approaches are still at the heart of conservation sciences and ecology, in particular within the framework of ecological monitoring using camera traps, animal trapping or VHF radio collars which impose a specific training of conservation actors (Stern & Humphries, 2022). These techno-scientific approaches to conservation are controlled and part of the conservationist's toolbox. They reflect a particular conception of human-wildlife relationships, a certain distance, and mechanisms beyond the reach of direct interactions of conservation sciences. Resolving the ecological question of the decline of a species affected by human activities poses a significant challenge, further exacerbating the biodiversity crisis beyond traditional resource management (Devictor, 2018, p. 39). The main obstacle identified by Devictor (2018, p. 39) is precisely that a species is not a resource. Therefore, the techno-scientific approach seems no longer appropriate within this complex and adaptive approach to social-ecological systems (Devictor, 2018).

Another particularly problematic turning point highlighted by Devictor (2018, p. 40) for technoscientific conservation is the shift from an equilibrium approach to a stochastic one that coincides with a biodiversity crisis leading, according to him, to a rethinking of the notion of the ecosystem. It calls for new paradigms in the understanding of social-ecological systems, and the adoption of the complex and adaptive approach could be a response to this need. Devictor (2018, pp. 77-88) further explains that quantifying biodiversity is challenging. The translation to a quantitative understanding results from more than simple archiving because power relationships emerge from the data collection (Devictor, 2018, p. 64). Concerning this quantification, Devictor (2018, pp. 77-88) concludes that biodiversity is a techno-political construct highlighting once more the embeddedness of conservation sciences and practices within a social and political context. The main difference between technoscientific conservation and the CAS approach of SES is not the objectives themselves but the politico-scientific relations, which modify the relationships between actors, the interpretation of data and, therefore, the methodologies that will allow the data collection required to answer these new questions.

2. The reversal of political-scientific relations in conservation sciences

The shift from a rationalist conception of the functioning of “nature” to a relativistic concept of the social-ecological system does not fundamentally call into question the perception of a system's capacity for change. In one case, it is a matter of conservation (enclosing and acting) to achieve an ideal state. In the other case, it is a matter of considering the diversity of perspectives on nature by understanding these positions as the essence of cultural contexts. However, the CAS approach to SES, recognising complexity and prediction difficulty due to systems’ “unstable” and uncertain nature, seeks to change individual and collective dispositions towards change. It implies different means of action, as described by the typology of stewardships. These dynamic relationships to change differ depending on conservation sciences and practices movements, more so than the inclusion or not of stakeholders or the methodology used.

The term “transformative” may seem overused in the institutional vocabulary and needs to clarify its practical implications. In a linear conception of the trajectory of ecological and social systems, the term “transformative” is superimposed on the standard

definition of change. In this case, the transformative character is only a more or less accurate qualifier of a particular linear dynamic. It makes it a “standard” term for an idea falsely revolutionary in its definition and capacity for action. The word “transformative” qualifies as a change, a break in a trajectory, thus appearing as a stylistic effect. However, if we assume it is considered a particular perspective of change rather than the change itself, considering the contingency of social-ecological systems, their unpredictability, and the result of the relationships within elements. In that case, it becomes practically operational because it does not describe the change but the disposition toward change. Furthermore, suppose we assume that the shift between rationalism and relativism does not allow acknowledging elements’ relationships within the system. Thus, transformability cannot be operative in that case because precisely this diversity of positions and relative strength of relationships within the system makes it worth its stewardship typology.

The notion of change is, therefore, fundamental in conservation research. The biodiversity crisis has made it possible to refine the view of the complexity of system dynamics and thus modify the relationships between stakeholders. Therefore, stakeholders’ participation in conservation should not be considered a virtue but a means of recognising and evaluating the power relationships within this changing dynamic. The mere extension of the diversity of stakeholders makes it possible to obtain diverse perspectives on the issue of human-wildlife coexistence, the contours of which are already defined. This practical and real transformative stance in the face of change allows the system to be thought outside the reversal between rationalism and relativism. More precisely, these contours must be interrogated following’ a transformative approach to conservation. As we stressed earlier in the practical implementation of a social-ecological approach to conservation, the aim of considering the positions of IPLC is not to promote these positions in place of others but rather to understand how these other modes of relating to the world could make it possible to collectively make this shift to adopt a genuinely transformative vision and analysis of change.

The term “transformative conservation” is an oxymoron that demonstrates the nature of the changes in the conception of conservation sciences and practices in recent decades. Conservation is then understood as a disciplinary envelope that brings together actors, whether scientists, managers or citizens, to consider the modes of relationships

within the social-ecological system for its resilience. To conserve and preserve imply the existence of an original state, whereas resilience means a dynamic, a change of state, or a transformation. Thus, it operates the passage from unidirectional causality to multidirectional relationships, allowing in particular to consider and justify transdisciplinarity. Whether techno-scientific or not, conservation measures should not be regarded as solutions or answers to coexistence issues but rather tools to be mobilised according to their capacity to be integrated into a given place; considering the relational landscape in which they are inserted, it implies questioning the unilaterality of specific conservation strategies and taking a critical look with the help of extra-disciplinary considerations. It underlines the importance of transdisciplinarity in conducting critical and ever-challenging (adaptive) reflection. The challenge is to consider a social-ecological issue not as a definite problem to be solved but as answers to a problem whose contours constantly change. It also implies thinking and admitting the properly situated and historical dimension of the responses to the social-ecological crisis and thus continuously questioning the relational and ethical dimensions of coexistence and of the way the problem is managed.

CHAPTER IV- RELATIONAL AND ETHICAL DIMENSIONS OF COEXISTENCE AND ASSOCIATED STEWARDSHIP STRATEGIES



Elia Festus just before a walk in Miershoorpan, 2021
©Élie Pédarros

The relationships occurring within the extended community of living beings is fundamental for the understanding of the social-ecological system and thus to promote resilience. This chapter will delve deeper into coexistence ethical and relational aspects to understand what shape the trajectory of the system. Our approach will be critical towards conservation, often rooted in a Western ideology promoting a specific way of dwelling. Our research in two study sites aims to compare the relative distribution of the “care” aspects with the transformative position expressed by the participants. These communities are often marginalised from decision-making processes, which raises ethical and justice questions. It is needed to highlight the importance of relational values for conservation to suggest responses to social and ecological justice issues in conservation and especially for coexistence. After analysing case studies and scientific literature, we will examine the link between ethics of care and conservation practices and the connection between care and the CAS approach.

I. Decompartmentalising, decolonising and deconstructing conservation

1. Colonial conservation

The social-ecological crisis, some aspects of which we have seen in the previous chapters, is associated with certain ways of dwelling on the Earth that are specific to the last centuries, as advocated by Ferdinand (2022; p. 20), suggesting that the ways of dwelling contributed to today's ecological, social and political situation and could give important insights into social-ecological conservation sciences and practices. We will explicit this question of colonial conservation mainly through the important work of Ferdinand (2022). In this effort, Ferdinand (2022) defines the double colonial and environmental divide as the origin of the emergence of a particular way of living. This double fracture erases the continuities where humans and non-humans were confused (Ferdinand, 2022; p. 22). This fracture could be resolved by redefining dwelling (Ferdinand, 2022). According to Ferdinand (2022; pp. 53-54), European colonisation violently implemented a particular way of dwelling on the Earth that he calls colonial dwelling:

« Bien que la colonisation européenne soit plurielle par ses nations, ses peuples et ses royaumes, par ses politiques, ses pratiques et par ses différentes périodes, l'habiter colonial dessine une trame commune [...]. Si Martin Heidegger a bien montré qu'habiter et bâtir ne sont pas des activités circonstancielles de l'homme, mais constituent au contraire une modalité indépassable de son être, il ne permet pas de comprendre l'habiter colonial » ["Although European colonisation is plural in its nations, peoples and cultures, colonial dwelling allows us to describe a common framework. If Heidegger has shown that dwelling and building are not circumstantial activities of humans but, on the contrary, constitute an unsurpassable modality of their being, it doesn't allow the understanding of the colonial dwelling"]¹⁰.

This importance of the dwelling is a further justification for mobilising the “dwelling” perspective in this thesis. It considers human-wildlife relations ontologically, allowing for a profoundly social-ecological and integrative approach in all senses.

¹⁰ Free translation from French

Ferdinand (2022) gave an interesting analysis of the current social-ecological crisis by invoking the specificities of a particular dwelling: the colonial dwelling. For him, the colonial way of dwelling could explain the roots of the problem. The vocabulary used during the colonial period demonstrates the importance of the colonial conception of dwelling on the land, which needs to be understood to highlight the link between dwelling and the social-ecological crisis (Ferdinand, 2022; p. 59) and notes that plots intended for plantation in the colonies were referred to as “*habituated land*” characterising the order of building ~ dwelling described by Heidegger and Ingold. In his conception of the act of dwelling, Heidegger does not allow for an understanding of dwelling with the rest of the co-present community and therefore does not integrate the colonial dwelling in his analysis (Ferdinand, 2022; p. 54). Thus, colonial dwelling designates a singular conception of the existence of certain humans on Earth and their relationships with other humans and living beings (Ferdinand, 2022).

According to Ferdinand (2022; p. 55), the main characteristic of the colonial dwelling is that it is considered a limited space. On the other hand, the colonial dwelling depends on another place (Ferdinand, 2022; p. 55). This characteristic of dependence between areas is particularly striking in the case of African protected areas, which owe their subsistence to a dynamic tourism industry. The difficulties encountered by the protected area model during the COVID-19 pandemic due to the suspension of tourism and world trade illustrate this dependence between areas. According to Ferdinand (2022; p. 57), the third principle of colonial dwelling is the altercide, i.e. the refusal of the possibility of dwelling on the Earth in the presence of another. According to the author, the central ontological violence of colonial dwelling is the dialectic by which the other is recognised in that it will no longer become the other (Ferdinand, 2022; p. 57). Ferdinand notes that dwelling is not self-evident and, therefore, not reducible to a simple prolonged presence in a geographical space; it is a co-construction of the place, which gives insights concerning our analysis of human-wildlife coexistence and the prism of conflict (Ferdinand, 2022; p. 59). This irreducibility of dwelling to geographical presence highlights the importance of relational dimensions in SES understanding.

The settlers implement specific actions within their space, which are the precursors of colonial dwelling (Ferdinand, 2022). Ferdinand (2022; p. 59) notes three main acts consecrating the colonial dwelling’s principal violence: taking, clearing and violence to local populations. Therefore, Ferdinand (2022; p. 62) envisages dwelling as

understood in the sense of fabrication: the institution of private property, the plantation as the primary occupation, and the exploitation of human beings.

From this description of colonial dwelling, we can see the deep entanglements of this double ecological and colonial fracture in the ways of dwelling in the two sites described in this thesis, particularly those of Indigenous People and local communities. The eviction of the Bushmen from the area now designated as the Kgalagadi Transfrontier Park is a glaring example. Their expulsion isolates them from their dwelling. The inhabitants are relegated to the margins of the newly demarcated space. This region of the Kalahari, now delimited by the park, which could be described as a "plantation" within this conception of colonial dwelling, has as its objective the protection of biodiversity, which is now the primary inhabitant of this region. This "park plantation" is subordinate to another space, that of those who have, i.e. tourists from southern Africa and from all over the world, but also researchers. Following this hypothetical structure of the colonial dwelling, the Kgalagadi Transfrontier Park could be considered a plantation depending on the economic activity of landscape consumption, photography and integration into a more comprehensive network of global biodiversity, biodiversity without humans. This endeavour cannot be complete without altercide and the great divide between the "others" (the Bushmen and the Mier) and the wilderness Kgalagadi region. The land grab within this ecological policy of redefining ways of living is not only about the park as a plantation but also about the adjacent land subdivided and demarcated into extensive farms where the new Afrikaner arrivals have carried out extensive livestock activities. This land grab thus characterises the plantation as a space subordinated to other forms of dwelling and a colonial dwelling with farms. The clearing described by Ferdinand is, in this case, the transformation of what is geographically similar to the Kgalagadi Transfrontier Park into land uses that aim to make the dwellers prosper by geographically extending this control of the land by defining the Bushmen as non-habitants. The *baaskap* (boss-ship) embodies this relationship between the dwelling minority and the "others", the Bushmen and the Miers. The *baaskap* is a form of paternalism that profoundly affects the Khoisan and Mier people's lives, emerging during apartheid (Plotkin, 2003). The *baasskap* is common in Southern Africa (Dieckmann, 2007; Guenther, 1996; Sylvain, 2001 as cited in Koot, 2016). Sylvain (2001) explains that these relationships went far beyond a simple work relationship; it was a system in which the owner had rights in every aspect of the workers' life (Du Toit, 1993 as cited in Sylvain, 2001). Furthermore, Sylvain (2001)

reports that the South African system is patriarchal, and the boss is a "father" commanding respect from his "children" (Van Onselen, 1992; as cited in Sylvain, 2001). Suzman (2020) explains that Namibian farmers still consider Bushmen workers as a "*child race: they could not take responsibility for a job or money, drink too much and therefore had to be disciplined*". Of course, according to Sylvain (2001, 2005), farm workers had the opportunity to negotiate with the owner. Still, the ultimate power was in his hands, being the primary service provider and controlling most resources. The author adds that the farmer functions like a local authority with little or no state intervention, similar to semi-autonomous political communities (Rutherford, 2008; as cited in Sylvain, 2001). Although it is always difficult to apply a theoretical framework to a study site without being tempted to over-interpret specific characteristics of the system to fit the established categories, it does provide important insights into the analysis of the system.

A story called "cup after cup" is often told by #Khomani San members at night around the fire, making the concept of altercide and violence particularly telling. It is the true story of a Bushman who participated in the research. A Bushman worked during apartheid as a gardener for a cattle farm owner's home. Discreetly, while trimming the green hedge in the middle of this desert of vegetation, he overhears a conversation between the owner and the owner of a neighbouring farm, sitting on a sofa drinking tea. The first asks the other to guess why the Bushmen could not access paradise. Hilariously, the second said it was because they were too ugly. However, the answer to the riddle was not this. The Bushmen do not go into heaven because they stay at the gates of it, trying to find out what happens there. The solution was given by turning to the gardener, who was busy trimming the hedge. Then the two "dwellers" resumed their conversation, drinking cup after cup of tea. It is just one example of the violence of everyday life, the denial of their ability and right to inhabit the Earth. This story is not just about a one-off event but about a way of relating. The land claim has nevertheless resulted in the return of some land to the #Khomani San community and even a portion of the park. However, to access it, they still have to show their credentials (when they manage to access the park gates) and make an appointment to borrow the key to the land, which is theirs but remains with the park administration. It is clear from these examples that the "doing" of living is still not a reality despite the measures for the restitution of land. In this respect, this social-ecological approach to conservation actions gives a different perspective. It is not a question of questioning certain benefits for biodiversity as such. Still, instead of

underlining the primary motivations, the tangible emanation of historical processes that are not neutral and so rooted in these global policies of biodiversity decline that they are rarely questioned or challenged. However, this tends to change, mainly through the emergence of a social-ecological conception of conservation, integrating a diversity of stakeholders with specific values, rules and knowledge (Colloff et al., 2017).

The case of the Garden Route is less of a caricature of this colonial dwelling compared to the Kalahari: the Garden Route National Park is unfenced, with many sections open to the public. However, colonial living could also have strongly modified the ways of dwelling. Most of the Khoi are at Pacaltsdorp, on the other side of the highway, close to the cliffs and separated from downtown and economic areas. Although what is Pacaltsdorp today was inhabited by the Khoi when the settlers arrived, development projects are slowly eating away Khoi dwelling. The latest example is the removal of the communal restaurant "Oom Bull", where community meetings and play rehearsals are held, in favour of a high-standing and secure housing estate, despite protests from the residents. The demarcation and "clearing" of the Khoi "dwelling" are ongoing. Khoi people are thus slowly evicted from the area, and their way of life changes profoundly (discussions with the participants), which constitutes a change in the dynamics of social and environmental co-construction characterising dwelling. Altercide through violence is rooted in the long term, as shown by various examples reported by Khoi participants. Suppose this colonial dwelling is more difficult to perceive in George because of the solid urban character and anchored in what can now be considered a metropolis. In that case, the living conditions of the Indigenous populations and local communities bear traces of this colonial dwelling which is updated today.

2. Decompartmentalising and decolonising conservation

Biodiversity conservation, which has long compared protected areas such as Eden to be separated from external threats, can be compared to Lovelock's Gaia hypothesis (Lovelock, 1987; Ferdinand, 2022; p. 324). This conception of biodiversity conservation has much to do with the central idea of the ecosystem in ecology—a system with stability, which is self-regulating. Ferdinand (2022; p. 324) compares this conception of conservation to the story of Noah's Ark, which involves the steps of separation,

reorganisation and hierarchisation of life forms in response to external threats. It is a fundamental political and social critique of "fortress conservation".

Therefore, the effort of social-ecological studies is to consider these subjects through a joint and interdependent analysis of social and ecological subsystems. The concept of conservation based on protection and enclosure is no longer the alpha and omega of conservation approaches, despite their importance in understanding landscape structure and its capacity to respond to specific ecological challenges. It is, therefore, not a question here of carrying out a unilateral critique of conservation strategies based on protected areas but instead of placing this conception in the broader range of conservation tools. It is possible by adopting a relational approach to overcome this double social-ecological divide that Ferdinand refines by proposing the notion of colonial dwelling. It will enable us to analyse these complex and adaptive SES locally. These joint approaches to relational landscapes and ways of dwelling in the world make it possible to replace the term *oikos* in ecology and conservation sciences. An *oikos*, from the ancient Greek *οἶκος*, "house", "heritage", is the set of goods and people attached to the same place of habitation and production, a "household" which could be extended to the idea of "community". In this way, it constitutes a kind of extended family. Taken in this way, the semantic meaning of ecology, "the discourse on the *oikos*", may seem challenging to find in conservation strategies based on protected areas and the eviction of local populations. Indeed, the different movements of conservation sciences related to the relationship between humans and the environment often considered the social and ecological components as compartmentalised, thus failing to consider an extended community. As highlighted by Ferdinand (2022; pp. 307-309), the movement of the social-ecological approach to conservation can, therefore, only be decolonial to denounce situations of environmental colonialism where a specific model imposes a use of the Earth that, according to Ferdinand, usurps common goods for private resulting in the degradation of the living environment of local dwellers. Ferdinand (2022; p. 313) adds that it also calls into question the legacy of colonisation, the collective imagination by which specific spaces are considered as margins, where it is permissible to do what is unacceptable at its centre. This decolonial conservation questions the violence of the colonial dwelling inflicted on humans and non-humans. To avoid betraying this need to decentralise perspectives, the social-ecological approach to conservation must adapt its concepts to include different worldviews without distorting them, avoiding the pitfall of translation

and distortion in the analysis as much as possible. In this respect, transdisciplinarity aims to “de-compartmentalise” the knowledge of natural and human sciences relative to systems' complexity.

3. The inclusion of integrative concepts

Deepening the study of relationships within a social-ecological approach to conservation requires summoning a diversity of “natures” from human perspectives and operationally enabling the synthesis of these perspectives by mobilising concepts that do not distort these conceptions during analysis. We have therefore mobilised the ideas of the ethics of care to undertake this study of human-wildlife relations. The characteristics of the ethics of care integrate different values pertinent to this effort to enlarge worldview diversity to avoid the mobilisation of a narrow set of values. The ethics of care (Gilligan, 1982; Tronto, 2008) initially comes from feminist theorists and makes it possible to put the concern for the other back at the centre of attention, regardless of their identity within an extended living community (Alarcon, 2020, p. 53). According to Tronto (2008), care integrates political, moral and practical dimensions and is, therefore, a unifying concept of several movements to fight against the excesses of the current system. In her work, Alarcon (2020, pp. 45-48) highlighted the link between care, relational values and conservation. In particular, Alarcon (2020, p. 45) highlights the growing recognition of the importance of relational values in the scientific literature on biodiversity conservation issues (Chan et al., 2016) has made it possible to raise awareness of these alternative ethics, which distinguish themselves from philosophical mainstream currents. Going above the dichotomy between humans and nature to focus on the concern for the elements of these categories, the care concept seems relevant to analysing human-wildlife relations since it is general enough and broadly present in human relations to avoid the anthropocentric fallacy. According to the philosopher Tronto (2008), care can be translated as a gradient from solicitude to practical action. Solicitude connotes a different form of commitment than concern, as it encompasses long-term attention to a need and identifying a pattern.

Alarcon (2020, p.52) highlights that the philosopher Laugier (2011) proposes that care can be formulated in several ways. For example, care emerges from interest and attention to particular situations and is also what we care about and depend on. This

practical aspect of care appears promising for conservation practices because it allows the merging of conservation practices and ethical dimensions of conservation. Alarcon (2020, p. 256) highlights through the work of Molinier (2010) that studying care is studying the underlying practices and activities. Furthermore, Alarcon (2020, p. 52) notes that according to the philosophers forging care ethics, care is often associated with the private sphere in Western societies. Thus, this notion aligns with the purpose of social-ecological systems and issues related to equity and justice. Through enlarging the purpose of conservation sciences and practices, the adoption of the care concept promises to merge biodiversity crisis issues with social and environmental justice and acknowledge diversity in all its forms. Moreover, the displacement of the investigation framing towards the domestic links these ethics to the concept of dwelling proposed by Ingold (1995). Thus, care can be considered an integrative concept to mobilise for the benefit of conservation sciences and practices according to a complex and adaptive approach to social-ecological systems.

Moreover, to avoid the pitfalls of interpretation categories, mobilising stewardship to consider the diversity of positions towards change in the social-ecological system is an essential analytical tool. Stewardship actions are particularly evident between humans and nature, which is interesting to mobilise when studying issues of coexistence between humans and wildlife (Darnhofer et al., 2016; Jackson & Palmer, 2014; as cited in West et al., 2018). Stewardship actions encompass relational values diversity and link these values with adaptive efforts towards change. In the following section, we will investigate these relational values from a care perspective to question the relationship between care, understood as a relational value, and stewardship action.

II. Adopting a care perspective in multi-stakeholder collaborative research allows an in-depth relational values approach in social-ecological research for stewardship action

Élie Pédarros*^{1;2;3}; Hervé Fritz^{1;2}; Nelly Parès⁴; Fraser Bitu^{1;2}; Chloé Guerbois^{1;2}

¹ REHABS, CNRS - Université Lyon 1 - Nelson Mandela University, International Research Laboratory, George Campus, Madiba Drive, George, South Africa

² Sustainability Research Unit, Nelson Mandela University, George Campus, Madiba Drive, George, South Africa

³ Laboratoire de Biométrie et Biologie Evolutive, CNRS UMR 5558; Université Claude Bernard Lyon 1; Villeurbanne Cedex, France

⁴ Center for Ecology and Conservation Sciences CESCO (CNRS, MNHN, SU), National Museum of Natural History, Paris, France

Article info

Stewardship
Relational values
Care
Indigenous People
Local communities
SES

Abstract

Stewardship is defined as a planning approach that contributes to the trajectory of a social-ecological system favouring its resilience. Questions of ethics arise when it comes to stewardship and protecting nature. It is important to consider a wide range of values towards nature to truly resonate with diverse perspectives. "Relational thinking" describes approaches that emphasise mutual consideration of social and ecological entities in stewardship research. The dimension of care can be considered a particularly relevant relational value in a complex and adaptive approach to social-ecological systems. In this study, we focused on the link between care and stewardship. This article aims to explore the multiple expressions of care and to understand and highlight the importance of the dimension of care for stewardship action. We focused on two contrasted South African sites involving diverse stakeholders. We highlight the diversity of the mobilisation of care, from empathic to practical mobilisations and the variety of stewardships identified in study sites. Depending on the care aspects mobilised, different stewardship positions were formulated, and only Indigenous people adopted a transformative stewardship position through normalising the perception commitment. It calls for more inclusion in conservation without essentialising positions, which could lead to erroneous conclusions and promoting conservation strategies at odds with desirable futures. Furthermore, we sought to characterise the paramount importance of Indigenous people's and local communities' voices in conservation debates for sustainability.

1. INTRODUCTION

Effective management and governance of social-ecological systems (SES) require the consideration of multiple perspectives (Hakkarainen et al., 2022). Given these systems' complexity and adaptive nature, it is crucial to include diverse views to

accurately represent them (Berkes et al., 2003; Preiser et al., 2018; Schoon & Van Der Leeuw, 2015). Social and ecological systems in SES are interrelated (Berkes et al., 2003). This allows social aspects to be understood by considering the necessary ecological processes and vice versa (Preiser et al., 2018). Social-ecological systems are often investigated towards using different knowledge systems to stimulate the emergence of understudied networks of relationships (Hakkarainen et al., 2022). SES and environmental governance highlight the need to make different knowledge systems work together (Fazey et al., 2020; as cited in Hakkarainen et al., 2022).

In the context of SES, stewardship is defined as a planning approach that contributes to the trajectory of a social-ecological system favouring its resilience (Chapin et al., 2009). However, the conditions of its formulation still need to be clarified. This concept can be considered a boundary object (Cooke & Lane, 2015), enabling collaboration and dialogue between different actors allowing for differences in its use and perception relative to specific ethics, motivation, action and outcome, as shown by Enqvist et al. (2018). To connect these multiple meanings of stewardship, the dimensions of care, knowledge and agency have been defined as shaping the concept (Enqvist et al., 2018; West et al., 2018). Understanding the processes behind stewardship action and the ways they can emerge from a diversity of stakeholders representing a diversity of worldviews could benefit the resilience of SES, especially relationships with other living beings.

Many policymakers tend to rely on their values without considering the wide range of values held by others, which can result in decisions that are not appropriate for everyone involved (Chan et al., 2016). Policymakers often ignore values associated with Indigenous people and local communities' worldviews (Pascual et al., 2021). Worldviews are a shared way of understanding the world (Dryzek, 2013) and contain ideas about what is real or not (ontology), how we know the world (epistemology), and how it shapes our values and judgement (ethic)(Dilthey et al., 1954 as cited in Preiser et al., 2021b). The debate of whether to protect nature for human use (instrumental values) or nature for its own sake (intrinsic values) can limit our comprehension of the various values people hold towards nature (Chan et al., 2016). The focus on ethics based on the dichotomy between nature and culture (Descola, 2005), among other possibilities of relationships, may promote worldviews not corresponding to the ethic of justice and “*desirable futures*” (Chan et al., 2016). To integrate this plurality of worldviews, it is necessary to see beyond the dualism between nature and culture. In the field of sustainability science, there has

been a growing focus on "relational thinking" (Stenseke, 2018) as a key methodology for taking a complex and adaptative social-ecological approach to SES (West et al., 2018). This requires considering the context of these socio-ecological systems and the knowledge emerging from these systems (Tengö et al., 2017). Many Indigenous populations have worldviews based on their knowledge systems, which they use to create ways of living that prioritise harmony with their environment (McGregor, 2018a, 2018b; Ruru, 2018; as cited in Hakkarainen et al., 2022). It is, therefore, not rational for these populations to rely on these economic and political frameworks for a sustainable future (McGregor et al., 2020).

In this study, we focused on the link between the dimension of care and stewardship action, especially the role of care in influencing the conditions of stewardship formulation for action among Indigenous people and local communities (IPLC). The care dimension has been recognised as paramount in stewardship literature. However, only some studies investigated the relationship with stewardship action (Enqvist et al., 2018; West et al., 2018). This article has three objectives: (i) to explore the multiple expressions of care, (ii) to understand and highlight the importance of the care dimension for stewardship action through a focus on IPLC, and (iii) to characterise the paramount importance of IPLC presence and voice in conservation debates for a sustainable coexistence with other living-beings in relational landscapes. We hypothesise that the care dimension that IPLC expresses in multi-stakeholder discussions is paramount to understanding what shapes stewardship action positions.

We studied two contrasted SES in South Africa localised in the Garden Route and the Kalahari. These two UNESCO sites, the Garden Route Biosphere Reserve and the #Khomani Cultural Landscape are very contrasted regarding stakeholders and issues as well as the overall dynamics of the SES. We engaged with a broad set of stakeholders, including Khoisan communities on the two sites and focused on coexistence issues with other living beings in shared landscapes. Exploring diverse relational values in these contexts becomes relevant for understanding the link with stewardship action by adopting a conversational evidence-based approach. By focusing on the discourse of Indigenous people and local communities amidst a larger stakeholder assemblage of private land owners, practitioners or institutions, we aim to contribute to the discussion on stewardship action in SES and inclusive conservation processes.

2. THEORETICAL FRAMEWORK

2.1. Relational values

Values are “*conceptions of what is ultimately good, proper, or desirable in human life*” (Graeber, 2001; as cited in Jax et al., 2018) and are essential for action (Enqvist et al., 2018; Ernoul et al., 2018; West et al., 2018). The categorisation of values as relational values aims to diversify how nature is valued, especially reconnecting intrinsic and instrumental values rather than polarising them (Chan et al., 2016). According to Chan et al. (2016), reframing individual preferences or societal choices is possible by assessing their compatibility with various values. These values are directed towards “a good life” (Chan et al., 2016). It is important to note that relational values are based on tangible objects and are therefore rooted in reality (Chan et al., 2016).

Tronto and Fisher (1990) consider care as a “*generic activity that includes everything we do to maintain, perpetuate and repair our "world" so that we can live in it as well as possible*”. Care can be motivated by various factors, not always related to concern. Its definition can span from perception and engagement to the possibility of practice. This concept of “care ethics” has been, according to Jax et al. (2018), introduced by feminine philosophers to address moral considerations (e.g. responsibility for others) neglected by approaches that focus on justice or utility (Held, 2006 as cited in Jax et al., 2018). The feminist perspective on care presents commonalities with perspectives critical of the Western paradigm and can be seen as a concept acting as a bridge between different struggles (Tronto, 2009). In Indigenous and non-Western discourses, the concept of human individuals navigating a network of relationships with the living world and their surroundings is prevalent (Jax et al., 2018). Many care approaches towards nature hold a distinct perspective from the Western belief that humans are rational beings (Jax et al., 2018). Tronto (2009) integrates political, moral and practical aspects in her care definition. In her care typology, care aspects vary from solicitude to practical action. Care aspects are “caring about”, “caring of”, “caregiving”, and “care receiving”. “Caring about” describes the emotional part of care through a perception commitment. It implies the acknowledgement of the necessity of care. “Caring of” is the normalisation of the “caring about” aspect. It means assuming responsibility towards an identified need and considering that we can act effectively. “Caregiving” describes a practical aspect of care.

This means a direct encounter with the needs of care. "Care receiving" describes feedback on "caregiving" by acknowledging the latter's effect on adjusting practical care. Based on these definitions, care aligns totally with relational values. Therefore, our study will consider care as a relational value dimension.

2.2. Care, Knowledge, Agency and Stewardship framework

To understand what shapes stewardship action in SES, Enqvist et al. (2018) investigated the literature to define its components. When exploring the various interpretations of stewardship, which is referred to as a "boundary object", four distinct meanings were identified by Enqvist et al. (2018): ethic, motivation, action and outcome. They developed a framework by connecting these meanings around three dimensions: care, knowledge and agency. Complementary to one another, the care dimension has been highlighted as critical for further stewardship research (Enqvist et al., 2018). The care concept includes personal choices and subjective opinions, which makes it a normative aspect (Enqvist et al., 2018). Most of the work on stewardship action has been performed by considering the knowledge and agency dimensions and, to a lesser extent considering care (Enqvist et al., 2018). According to Enqvist et al. (2018), agency refers to the ability of an individual, a group of individuals, or an institution to take action and create an impact on the world through stewardship action. The knowledge dimension refers to crucial information and understanding of objects and relationships that structure the system encompassing an understanding of the system's dynamics (Enqvist et al., 2018). This framework is critical for understanding the notion of care in all its social-ecological implications. In this study, we focused on identifying the diversity of care aspects, their link with stewardship action and characterising the importance of IPLC for transformative action.

2.3. Stewardship action

Stewardship actions derive from environmental discourses (Mathevet et al., 2018a). According to Dryzek (2013; as cited in Mathevet et al., 2018a), a discourse is "*a shared way of understanding the world*". Mathevet et al. (2018a) suggest that these discourses are performative and have environmental and social consequences as they

influence our values and perceptions of the world (Redclift & Woodgate, 2010; as cited in Mathevet et al., 2018a). Dryzek (2013) stated that environmental discourses are a departure from industrialism as a type of production. We will understand this statement in this study more as a departure from capitalism because the debate is now posed as societal change rather than only production. This departure can be reformist (i.e. small changes within the current system) or radical (i.e. significant changes) (Mathevet et al., 2018a). The second dimension emphasises that departures from capitalism can be prosaic (actions are defined by and within capitalism without aiming to produce a new type of society) or imaginative (environmental problems are seen as a trigger to redefine society) (Mathevet et al., 2018a). These two dimensions, when combined, form the four categories of environmental discourses: prosaic reformist, imaginative reformist, prosaic radical and imaginative radical (Mathevet et al., 2018a).

Mathevet et al. (2018a) defined a stewardship typology based on the environmental discourses typology: reformist, sustainable, adaptive and transformative. The term "stewardship" has been commonly used, with its definition varying depending on the context (Mathevet et al., 2018a). Reformist stewardships aim to ensure that a system continues to provide ecosystemic services in the long term by maintaining its trajectory (Chapin et al., 2009; Jepson et al., 2017; as cited in Mathevet et al., 2018a). Sustainable stewardship involves undertaking various actions to protect the environment and being accountable for every decision that may impact the trajectory of the social-ecological system (Barrett & Grizzle, 1999; di Paola, 2015; as cited in Mathevet et al., 2018a). Adaptive stewardship aims to adopt a sustainable system trajectory through adaptation towards change (Mathevet et al., 2018a). Transformative stewardship involves bringing about significant changes in the system by introducing innovative knowledge and practices (Mathevet et al., 2018a). The process involves rethinking the values, rules, and knowledge that shape the decision-making context (Colloff et al., 2017). This approach allows for multiple perspectives (Mathevet et al., 2018a); they are integrative and consider a diversity of worldviews.

3. METHODS

3.1. Sites description

South Africa's settlement history is often portrayed as the arrival of different groups who later fought for control. This narrative is still used today to highlight the

particular nature of colonisation in the region. However, the archaeological sources show that the area was inhabited by millennia by populations practising hunting and gathering activities, creating a concrete proximity with the Khoisan-speaking people living in the area (Fauvelle, 2006; p. 117). This linguistic group comprises Khoi populations, herders-hunter-gatherers, and San populations practising only hunting and gathering (Sadr, 2003). The Khoisan language group's similarities have led to their recognition as the Indigenous people of South Africa. Khoisan are among the last groups on the planet to practice this mode of subsistence and have been thoroughly studied by the anthropologists of the XXth century (Barnard, 1992; Lee & DeVore, 1968; Marshall, 1976 as cited in Fauvelle, 2006; p. 119). These groups were victims of colonisation and apartheid, marginalised, reduced to poverty, rape, murder and contempt (Fauvelle, 2006; p. 130). Today, the San are mainly present in Namibia, Botswana and to a lesser extent in South Africa, representing about 100,000 people (Fauvelle, 2006; p. 119). The arrival of Bantu-speaking herders increased the number of villages in the region (Fauvelle, 2006, p. 144). Khoisan and Bantu communities eventually interacted, and integrated language clicks into Bantu languages. The exchange mutually incorporated customs and traditions (Fauvelle, 2006; p. 149).

During the 15th century, the Portuguese and other European nations went around Africa to access their trading outposts and colonies in the East Indies. Occasionally, they briefly stopped at the Cape of Good Hope without establishing settlements (Fauvelle, 2018; p. 104). The first European settlement in South Africa was established in 1652 by the Dutch East India Company. In 1685, 156 Huguenots arrived seeking refuge from the revocation of the Edict of Nantes. They were welcomed by the United Provinces and given passage to the colonies (Fauvelle, 2006; p. 159). This community was at the origin of the Afrikaner community (Fauvelle, 2006; p. 160). The United Kingdom arrived in Southern Africa in 1795, settled in the Cape colony, and brought in 5000 settlers in 1820 (Fauvelle, 2006; p. 165). Tensions between Afrikaner and British communities led to multiple republics after the Great Trek in the 1830s (Fauvelle, 2006; pp. 169-171). Afrikaners left the Cape Colony in search of peace, facing opposition from Khoisan and Bantu communities. (Fauvelle, 2006). According to Fauvelle (2006, p. 172), the formation of these republics marked the start of the tensions that arose at the start of the 20th century. Great Britain merged four white political entities in 1910, including two colonies and two former republics that lost their independence during the Anglo-Boer War (Fauvelle, 2006;

p. 171). After the white Transvaal Republic, a new entity was named the Union of South Africa. It became a republic in 1961 and is now known as the Republic of South Africa (Fauvelle, 2006; p. 175). African populations were moved to reserves by the Republic to separate colonists from African people. This move marked the beginning of apartheid ideology implementation, as noted by Fauvelle (2006; p. 97). The people in these reserves had to fight for their rights and recognition as South Africans. Finally, in the early 1990s, after years of non-violent and armed resistance, they were acknowledged and gained recognition (Fauvelle, 2006; p. 422).

The Kalahari site (542.88 km²) is located around Askham, part of the Dawid Kruiper Municipality, 60 km south of the Kgalagadi Transfrontier Park, which is fenced off on its South African side (Figure 4). The region is a semi-arid savannah, typical of the southern Kalahari landscape, with a dune system that shapes its structure (Wasiolka & Blaum, 2011). The area is mainly dominated by large commercial livestock farms, with scattered areas of human settlement structured as a mosaic of formal and informal settlements (Figure 5). The Afrikaner people created farms that employed the San people, a local group of hunter-gatherers belonging to the N|u language group, also known as #Khomani San and Mier communities (Grant & Tomaselli, 2022). Mier community origin comes from the people of Captain Vilander, who escaped the Cape Colony in 1865 (Thondhlana et al., 2011). They settled in the Kalahari in Rietfontein. Mier people are predominantly farmers (Thondhlana et al., 2011). In 1931, the Gemsbok Park was created in South Africa, and the government evicted San and Mier's communities living on the park's territory, whereas some stayed there (Sylvain, 2002). Since the 1950s, the small San and Mier groups that remained were classified as "coloureds" during the apartheid era, which is still used for administrative purposes today. As a result, they were relocated to remote areas in the Northern Cape (Sylvain, 2002). In the 1970s, they were compelled to vacate the park due to further restrictions imposed on their rights, specifically hunting and gathering (Carruthers et al., 2003). Dawid Kruiper and a group of Bushmen claimed ownership of previously government-owned and Afrikaner-farmed land after the end of apartheid. This created tension with another San family, the Vaalbooï (Robins, 2001).

The Kgalagadi Transfrontier Park was established in 1999, taking over the former South African Gemsbok Park in 1930. It is now jointly managed by the South African National Parks (SANParks) and the Department of Wildlife and National Parks of Botswana. Six farms were granted to the #Khomani San people as part of the park,

amounting to 34728 hectares. These farms were later transferred to the Common Property Association (CPA) for management (Thondhlana et al., 2011). In 2002, they also obtained 57903 hectares of land in the Kgalagadi Transfrontier Park, the Ae!Hai Kalahari Heritage Park, owned by the #Khomani San and Mier communities. Today, the San people are settled in different areas. The Witdraai farm is home to most of the Kruiper family and relatives who prefer to live in a "traditional" way. The Vaalbooi family and their relatives reside on the Andriesvale farm, where they live in a more contemporary manner. The people in Askham town live in informal and formal settlements. Additionally, some business owners from Afrikaner farming families operate their businesses on the other side of the road in Askham.

A Dutch trading post was established in George in 1772 to utilise local timber resources and aid in the city's development. They interacted with Khoïkhoï tribes, including the Gouriquas, Attequas, and Korana, who were converted to Christianity (Bell & Bowman, 2002). During the apartheid, Pacaltsdorp was considered a township for "coloured people", including Khoï people, the racialist categorisation for no Bantu, Asian or "white" people. The Garden Route site (542.96km²), including George municipality, is established from the South to the North between the Indian Ocean and the Outeniqua mountains. As part of the Greater Cape floristic region, the area presents high levels of biodiversity with many endemic species (Vromans et al., 2010). The Garden Route National Park consists of multiple sections not fully enclosed by fences, allowing residents and visitors to access most areas freely. While there are some controlled access zones, the park is mainly open (Roux et al., 2020). The park has various protected areas, such as Afromontane forests, fynbos, lakes, marine ecosystems, and semi-urban and agricultural landscapes (Roux et al., 2020). George urban area (193,672 permanent inhabitants, George census, 2011) is a mid-size metropolitan area with significant agricultural development on the west and high-density settlement areas to the south. Victoria Bay, Wilderness, Hoekwil, and Kleinkrantz are semi-urban areas and prominent tourism destinations that offer a unique blend of coastal and semi-rural lifestyles with ongoing development (Guerbois et al., 2019). Wilderness is a hilly area with farm-like communities and a small city centre by the seaside. Most property owners are of Afrikaner and British descent. Some property owners have formed local conservancies to collectively manage their plots for conservation purposes.

The different stakeholder groups were drawn up according to two main factors: participants' self-identification and potential geographical influence (at different scales) for conservation. The result was the formation of groups combining spatial influence and socio-cultural aspects, making exploring the links between value systems and stewardship action possible. In the Garden Route, we retained the following stakeholders' categories: Khoi people from Pacaltsdorp, property owners, mainly from Wilderness, active members of local conservancies, residents of the informal settlement of Wilderness established on an old farming property, George municipality, academics from the Nelson Mandela University and conservation institutions. In the Kalahari, we retained the categories of Witdraai, Andriesvale, Askham township, town residents, and Mier people.

In this study, we understand the distinct cultural entities resulting from a shared history, a complexity linked to the cultural, linguistic and genetic hybridisation between groups and not as an essence. This approach follows Bensa's (2006) position on the biases of analysis emerging from considering societies as a cultural totality with an irreducible specificity with the idea of actors' positions being predetermined by a functional or structural order.

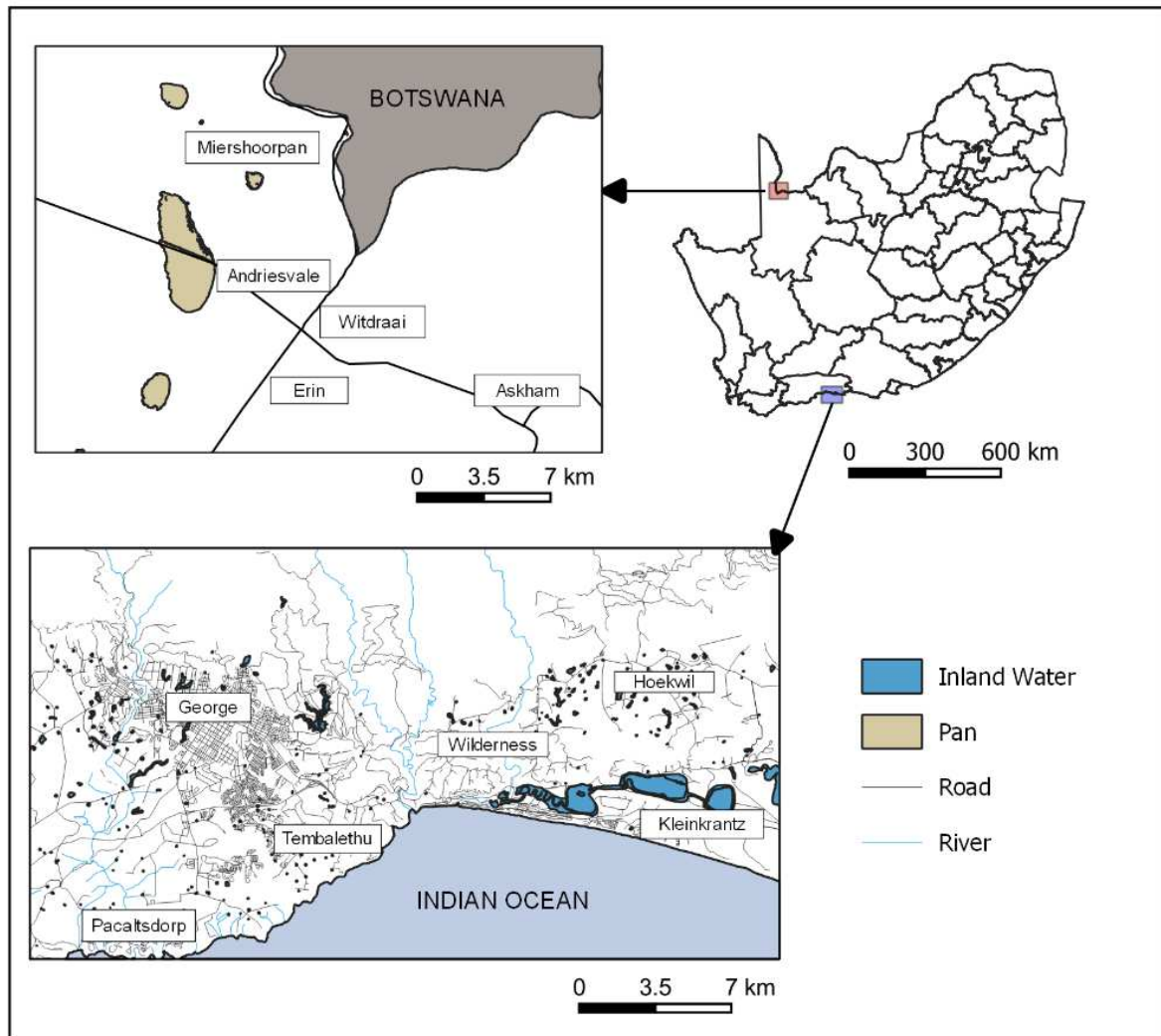


Figure 1. Study sites of the Kalahari and the Garden Route

3.2. Data collection

We used a case study approach to explore real-world phenomena, considering the complex human dimensions involved (Yin, 2013). Examining the system's less explored relationships, these qualitative studies help identify crucial leverage points for positive change (Abson et al., 2017; Hague et al., 2022; Hakkarainen et al., 2022).

The study has been granted ethical clearance from the Nelson Mandela University ethic committee (H20-SCI-SRU-003). Consent has been obtained from all the participants. Data collection was conducted in three phases for each site. Firstly, we conducted preliminary discussions with key stakeholders from four groups: governance, conservation organisations, residents, and Indigenous communities, before collecting data. The stratified sampling was adopted to target persons or groups of people

knowledgeable about the area and interested in it. These preliminary discussions had two objectives: (a) epistemological, by adopting a complex approach, we aim to go beyond the holism and reductionism approaches which can lead to a truncated perception of problematics at stake for conservation locally (Colloff et al., 2017; Pullin et al., 2009) and (b) to create engagement, by implying local stakeholders in the research to give salience, credibility and legitimacy to the project which is fundamental for conservation action (Cash et al., 2003). We extended the stratified purpose sampling by snowballing (Goodman, 1961) to increase participants number for data collection. Secondly, during the first workshop, Garden Route (N=50) and Kalahari (N=31) participants (Table 1) filled out post-it notes to inform temporalised elements of personal biography, environmental events, meaningful wildlife interactions and changes related to human demography to stick it on a common panel forming the collaborative timeline. Combined with a participatory mapping exercise, the groups comprised one or two participants from each stakeholder category to avoid any attention saturation depending on the order of completion of the data collection steps (other exercises being participatory mapping and collaborative timeline). The timeline tool we developed aimed to integrate the temporal dimension in social-ecological studies. The subjective temporality of social action is well-known in the social sciences (Wood, 2008). Anticipation of the future and memory influence social construction and motivations (Hall, 1984). Thus, having a common understanding of time is essential (Wood, 2008). Finally, we used a nominal group technic (NGT) approach during a second workshop to elicit stakeholders' judgement (Hugé & Mukherjee, 2018). Participants were placed in groups of six or seven, following the stratified purposive sampling categories (Table 1). Two questions were asked: "What is conservation" and "What could be human-wildlife coexistence?". People were asked to write down or think about their answers for 5 minutes before debating the solutions within each group for 20 minutes and presenting a common answer listened to by the other groups before the global discussion. These two voluntary broad questions overlap the theoretical and practical aspects of stewardship action favouring biodiversity conservation in shared landscapes.

Table 1. Participants' description

Site	Stakeholder group	Potential landscape area conservation influence	Number of participants (Timeline/Discussions)	Female/Male ratio (Timeline/Discussion)	Main age class
Garden Route	Pacaltsdorp	Pacaltsdorp township	7/6	0.57/0.50	40-50
	Municipality	George	0/4	0.00/0.75	40-50
	Property owner	Private properties	14/3	0.43/0.00	>50
	Informal settlement	Wilderness camp	6/3	0.50/0.00	20-30
	Commercial farmer	Commercial farms	1/0	1.00/0.00	>50
	Conservancy	Conservancies	3/4	0.33/0.50	40-50
	Academic	Potential facilitators	2/1	1.00/1.00	20-30
	Conservation institution	Protected areas	2/4	1.00/0.50	30-40
	Free access to the timeline in the venue	NA	14/NA	NA	NA
	Total identified			35/25	0.60/0.44
Kalahari	Witdraai	Witdraai farm	12/10	0.75/0.70	40-50
	Andriesvale	Andriesvale farm	8/8	0.50/0.50	>50
	Askham township	Askham township	4/4	0.00/0.00	20-30
	Askham town	Askham town	4/0	0.66/0.00	40-50
	Rietfontein	Rietfontein	3/4	0.33/0.50	20-30
	Total			31/26	0.55/0.50

3.3. Analysis

We analysed timeline and NGT data thematically to consider a broad diversity of relational values and stewardship positions (Braun & Clarke, 2006). We realised different rounds of thematic coding to refine themes using Excel software for timeline data and Atlas.ti qualitative data analysis software for NGT data. We focused on the dominant and less common perspectives during the coding process. This approach allowed us to approach the system's complexity and address the essential aspects of our research objectives (Braun & Clarke, 2006). We compiled data patterns through coding (Hakkarainen et al., 2022). The typology was formed when the interactions with other living beings linked to the notion of coexistence concerning personal history could be identified. The relational values analysis followed the relational values described in the literature (Chan et al., 2018; Horcea-Milcu et al., 2022; Knippenberg et al., 2018). For stewardship analysis, we used the typology of Mathevet et al. (2018a) based on identifying four dimensions: visions of human-nature interactions, agents and their motives, facilitators and governance and dominant knowledge. After identifying the different modalities, we determined the relative stewardship positions according to discourse analysis and definitions of Mathevet et al. (2018a).

4. FINDINGS

4.1. Relational values emerging from the representation of the time spent in the area

From a methodological perspective, timeline exercises with different groups of stakeholders allowed to gather a broad spectrum of information, including relational values but also biographic elements (dates and places of birth, immigration or emigration), wildlife sightings (often dated with a species name), climate change, political events, or infrastructure changes. Among relational values, the expression of care is multifaceted, following a gradient of moral virtue to practices varying depending on the stakeholder category. The analysis of relational values among different groups of stakeholders collaborating on a standard product to “think” their landscape allows practically bridging the “idea” of relational values with relational thinking in landscape research and addressing this relational turn in SES. It is important to note that the

heterogeneity of stakeholder groups cannot make it possible to assign a specific set of values to one group but rather to take an interest in the plurality of care aspects.

Research collaboration and co-design of the methodologies allowed targeting themes about social-ecological changes and coexistence at the landscape scale and stakes in the study sites. This broad theme identification and practical-only guidelines allowed us to analyse the share of relational values among other information without an *a priori* orientation towards relational values (Figure 2). In the Garden Route, the stakeholders' categories of property owners, informal settlement residents, Pacaltdsorp people, and property owners actively part of a conservancy refer mainly to relational values to describe the temporalised landscape of the Garden Route. Landscape structure observations, biological observations, population dynamics and hazards follow it. The reference was mainly to landscape structure descriptions for farmers, academics and conservation institutions.

In the Kalahari, all the stakeholders prioritised relational values in their contribution to the timeline (Figure 2). As the ice-breaking step for this methodology was to contribute to the timeline by informing biographical elements, the corresponding coding is thus a good proxy of participation and a threshold of commitment assessment for other themes. All the stakeholder groups only have the "relational value" coding above the "biographic" one. It is the only coding in this position for all the groups except for Askham town residents, who also have wildlife sightings. In the Kalahari, the exercise was mainly undertaken by participants adopting a relational values perspective constituting the timeline, and this approach was homogenous among stakeholder groups. Relational values expression structured the representation of the time spent in the landscape. The temporalisation of these experiences through the realisation of this exercise allows us to gather various and quantity relational values expression.

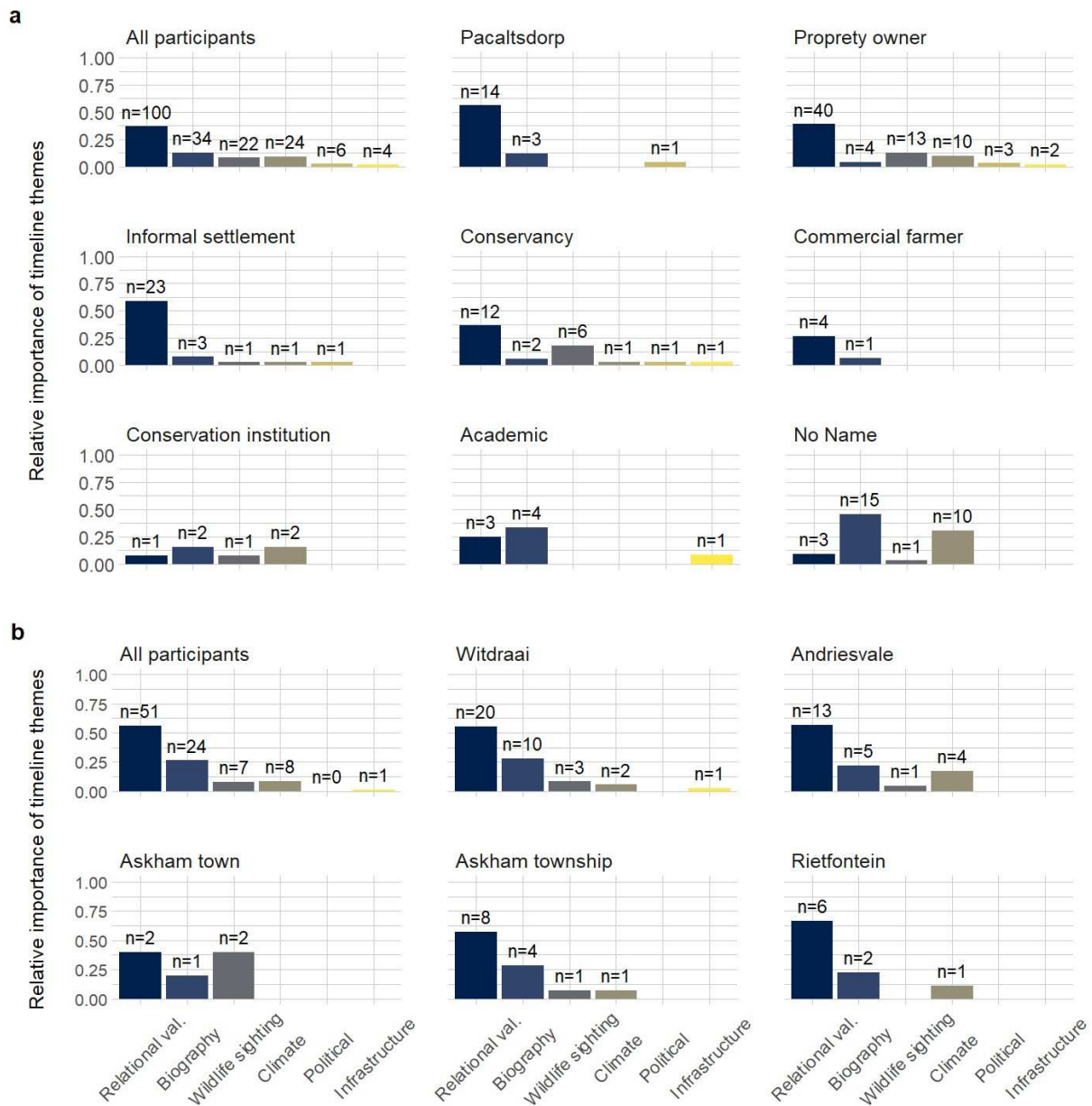


Figure 2. Distribution of the themes of the collaborative timeline post-it notes according to the stakeholder category in the two sites: (a) the Garden Route and (b) the Kalahari

When looking at citations expressing the care relational value, it is possible to characterise different care aspects described by Tronto (2009) corresponding to a gradient of "practical wisdom". Within these care citations, we distinguished the aspects of "caring about", "caring of", "caregiving", and care receiving", respectively :

"Sweet water, green field, animals beautifully fat and happy"
Askham town resident, Kalahari

"Hunting of wild animals must stop"

Rietfontein resident, Kalahari

"Established Indigenous nursery started planting in cleared areas of Drie Valley"

Active member of a local conservancy, Garden Route

"More wildlife frequency since the rehab of natural vegetation"

Property owner, Garden Route

These care aspects vary differently regarding the stakeholder group (Figure 3). Within this framework, the transition between empathic feeling and practice is incomplete for most of the stakeholders' groups except for the property owner of the Garden Route and residents of the Witdraai area in the Kalahari. The "caring about" rate, i.e. the perception commitment of a need, is the most common aspect of the care value except for active members of conservancies in the Garden Route and residents of Askham (town and township) and Rietfontein in the Kalahari. The normalisation of this perception of "care receiving" varies differently regarding the stakeholder group (Figure 3). Concerning "caregiving", as expected, active members of conservancies were the most cited stakeholder group. Pacaltsdorp people did not express "caregiving" aspects during this exercise. For the Kalahari, Askham township and Rietfontein residents said most of the "caregiving" citations. In contrast, other stakeholders categories such as Witdraai and Andriesvale (one citation each) or Askham town residents (no citation) hardly expressed any "caregiving". However, Witdraai residents said the "care receiving" aspect to the same extent as property owners and conservancies in the Garden Route.

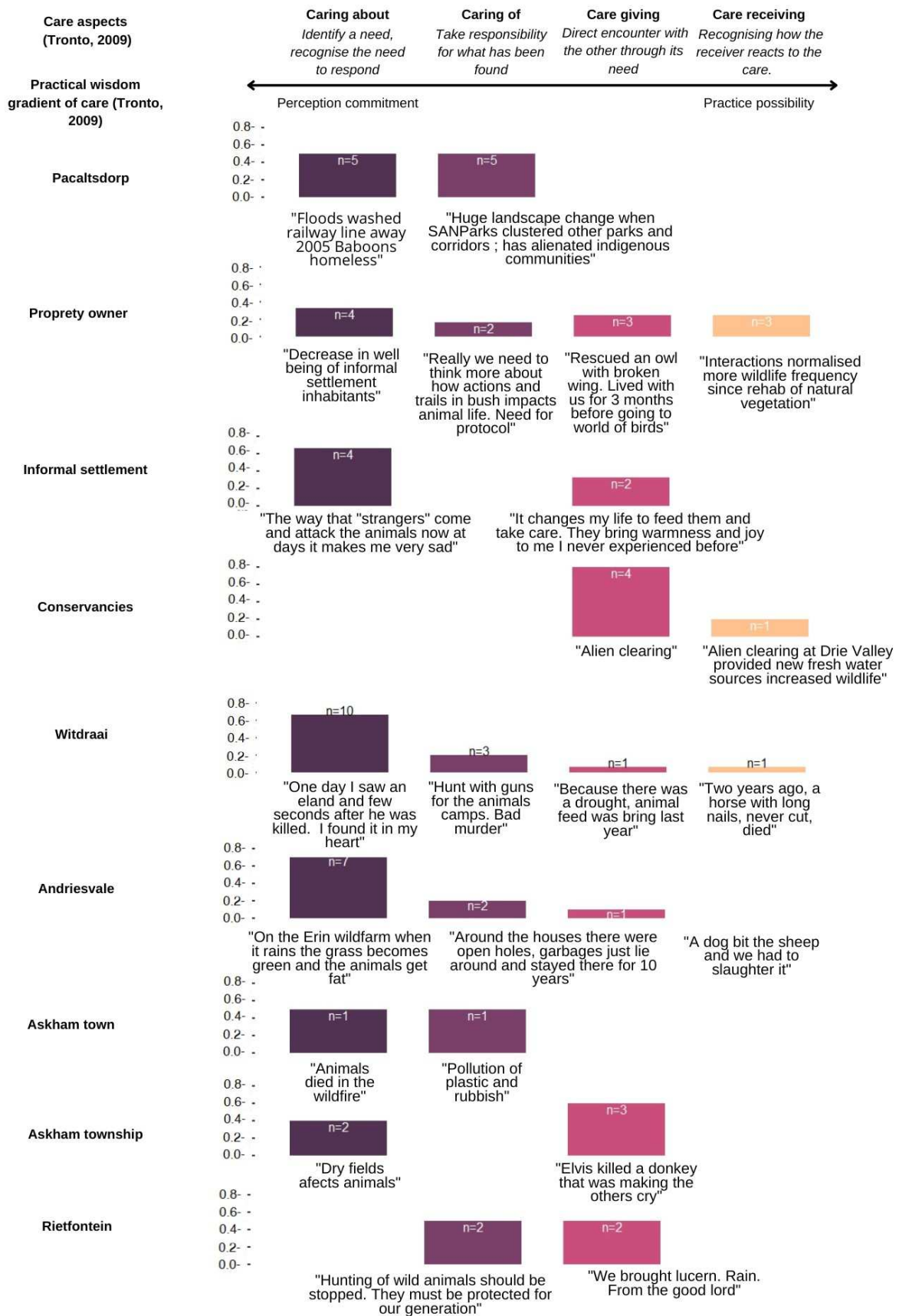


Figure 3. Distribution of the care aspects (relative citation among total care relational value codings) regarding stakeholder groups for the two sites.

4.2. Stewardship typologies of multiple stakeholders and discourse co-construction

The stewardship analysis shows heterogeneity within stakeholder groups in the Garden Route and the Kalahari (Figure 4 and Appendix VII). Most stakeholder groups are within a reformist discourse category, represented by prosaic and imaginative discourse categories, namely reformist and sustainability stewardship categories. In the Garden Route, property owners, for instance, vary along all the dimensions of environmental discourses identified by Dryzek (2013), from adaptive to reformist and sustainability stewardship. Conservancy members and informal settlements residents formulated reformist stewardship (conservancies tending towards sustainability), and the municipality adopted an adaptive position. Pacaltsdorp people were the only group adopting a radical imaginative discourse characterising transformative stewardship. Witdraai, Andriesvale, and Askham township residents formulated this type of stewardship in the Kalahari site. This shared position between these Kalahari participants categories is also visible in their diverse positions, from reformist to sustainability and transformative stewardships. Rietfontein people situated themselves in the sustainability stewardship category, and Askham township people in both reformist and transformative types.

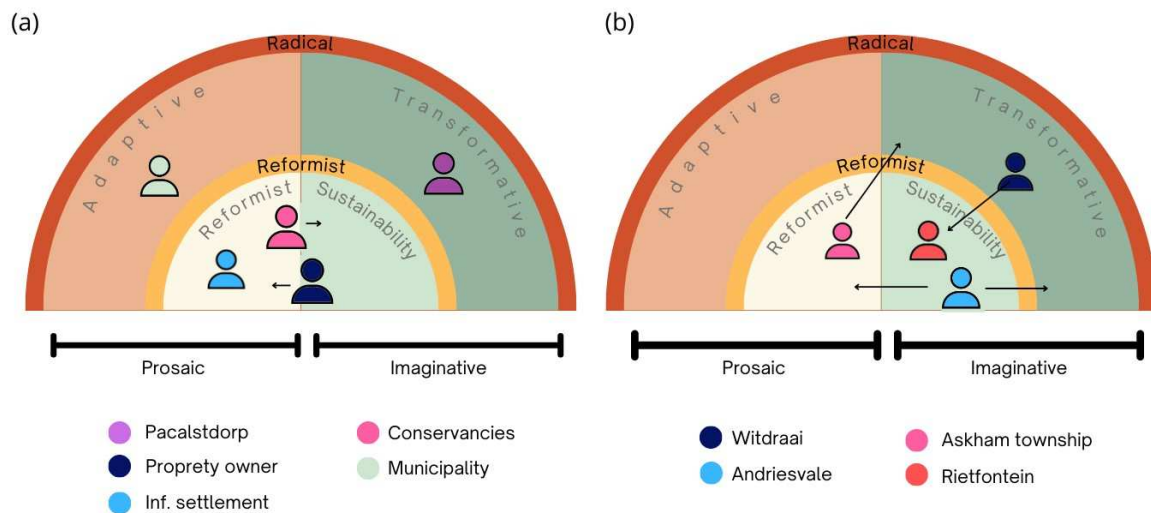


Figure 4. Representation of stewardship types according to environmental discourses dimensions formulated by each stakeholder group for the two sites: (a) the Garden Route and (b) the Kalahari. Arrows represent a stakeholder's tendency to develop arguments toward another stewardship type.

The co-construction of discourses during the nominal-group technic around the issue of coexistence allowed us to identify the critical “files” at stake locally. Interestingly, in both sites, human-wildlife conflicts were not discussed except by the Mier community to denounce the killing of jackals and caracals by farmers protecting their livestock. The essential subjects of discussion in the Garden Route were the mobility allowance for humans and other living beings. The question of the fencing and the access to some parts of the park or critical biodiversity areas for human populations materialised this subject.

In the Garden Route, there was no formulated disagreement except Pacaltsdorp residents towards the Municipality about the potential development of George municipality, fearing a “fourth industrial revolution” (Appendix VIII). In the Kalahari, we observed more disagreement concerning the way of life †Khomani San should pursue. This challenge has crystallised around the question of the ability of people to thrive without electricity and Western development standards. The positions vary from the possibility of surviving, the difficulty and time needed to undertake this process, to the impossibility of living as their ancestors. Above these potential responses appear more transformative answers, such as reinventing and revitalising the bushman way of life, knowledge and worldviews, and the challenges of contemporary life. While this revitalisation of the Bushman way of life may suggest restoration rather than transformation, the involvement of a diversity of worldviews and values at the institutional level implies a transformative stance towards change if these are considered.

4.3. Relationship between care and stewardship type

While it is difficult to establish a relationship between care as a whole and the type of stewardship preferred, the distribution of the concept on a “practical wisdom gradient” (Tronto, 2009) makes it possible to identify salient patterns. Stakeholders groups referring mainly to more emotional than practical aspects of care, primarily when empathic (“caring about”) and normalised (“caring for”) aspects are associated, comprise transformative positions. The normalisation of perception commitment is not necessary to perform an act of care, and this phenomenon is evident for township residents in the two sites. We can consider the care aspects according to two categorical systems: firstly, emotional and practical aspects (respectively including “caring about” and “caring of” aspects on the first hand and “caregiving” and “care receiving” on the other hand) and

secondly engagement and reflexive aspects (respectively “caring about” and “caregiving” on the first hand and “caring of” and “care receiving” on the other hand). To understand the relationship between care and stewardship positions in Indigenous communities, the other groups' care aspects patterns and stewardship positions can contribute to its understanding.

The hypothesis that a single emotional care aspect (“caring about” or “caring of”) allows the adoption of a transformative stewardship position is rejected as all the groups except conservancies expressed at least one of these emotional aspects without adopting a transformative approach. Another hypothesis would be to consider that transformative positions are related to expressing a combination of engagement and reflexive care aspects. Again, this hypothesis is rejected because conservancies members expressed a reformist stewardship position while expressing “caregiving” and “care receiving” aspects. These results suggest that mobilising emotional engagement and reflexive care could relate to formulating transformative stewardship positions. Stakeholders groups characterising conservation action in the Garden Route, conservancies, are unsurprisingly focusing on practical aspects of care and carry a reformist discourse. This observation is consistent with the recognised need to find coherent responses while acting within a pre-existing institutional framework. The lack of the municipality in the two sites during timeline workshops prevents any interpretation of the relationship between care aspects and adaptive stewardships. Moreover, the conservation institutions group is not robust and representative enough to allow interpretation.

5. DISCUSSION

5.1. Participatory methodology processes with different stakeholders' groups to investigate relational values

Local stakeholder groups involve different social interests (Tengö et al., 2014). For the process to be efficient, it is essential to consider a specific diversity represented by consistent groups (García-Nieto et al., 2015) to allow the co-construction of discourses and to highlight these different social interests in the debate. The analysis of stewardships among diverse groups regarding their potential conservation influence (at different scales) is consistent with this objective in the Garden Route. We observed a clear and

unique position regarding stewardship for most groups. However, the group selection should have been slightly different for property owners and conservancies because of different stewardship positions depending on individuals (e.g. sustainability or transformative). This inconsistency regarding the link between a group and a position can be linked to the group formation, thus to individuals' positions, and the co-construction of the position through the exercise and interactions with other stakeholders. It is interesting to note that these discrepancies are always relative to another group's position. These discrepancies can be argumentative elements to facilitate the discussion to find common ground for further discussion. However, in the Kalahari, the stewardship typology was more difficult to apply with complex positions often overlapping subcategories of stewardship types proposed by Mathevet et al. (2018a) within the same individual. This challenge resides in the adequacy of the typology, especially the vision of human-nature relationships, for non-Western communities. If #Khomani San's positions relative to this relationship appear transformative for Westerners because of humans' embodied nature with other living beings, the subtleties specific to each group would be invisible according to this typology. Refining the category of the human-nature relationship would be, for example, to consider the ways of dwelling: living apart from wildlife? Living between? Living with? Applied to our case, these three ways of living with others correspond with the different stewardships we identified: reformist, sustainability and transformative.

Analysing the implications of relational values on stewardship positions deserves to investigate the interrelations of scales between individuals and groups of individuals. The individual-only analysis of stewardship regarding relational values would have given other findings. The co-construction of environmental discourses is more complex than a linear relationship between individuals' values and the possibility of action. It would be worthwhile to investigate these individual and group effects further to identify better and understand the possible leverage points and their application scale. In our study, through mixing group and individual scales, we observed heterogeneity regarding care aspects within individuals of the same group. However, the overall pattern of these aspects gives a consistent overview of stewardship positions. It underlines that stewardships are co-constructs and group positions are not the sum of individual positions.

The study found that Indigenous People, here #Khomani San and Korana Khoi communities, adopt a broad diversity of positions regarding relational values and

stewardship preferences. It is evident within the Kalahari site where #Khomani San subdivided themselves into diverse groups. It is thus imperative, in the effort of social-ecological studies, to integrate a diversity of worldviews and environmental justice, to acknowledge this individual and group diversity. Essentialising Indigenous peoples, considering them historically homogeneous, would result in the incomplete integration of IPLCs in conservation processes. If the term Indigenous People in social-ecological research is helpful when used as a descriptive term to support the need for inclusivity in conservation, it should stop at this point and not become a normative category. Another pitfall in essentialising Indigenous People would be to deny historical processes conducted to these identities by removing them from the temporal scale.

Furthermore, Tronto (2009) analyses the notion of care as devalued in the case of Western societies, and so are the people who do the work of care. Not only are these jobs low-paid and lack prestige, but the association of these people with relationships to the body further lowers their value (Tronto, 2009). They are seen as "more natural". It gives critical insights into the current "inclusivity" of Indigenous people in conservation especially concerning the modes of inclusivity proposed by the institutions as housecleaners or workers in the park. The inclusion of IPLCs in specific care aspects of conservation (field rangers, tourist accommodation workers, conservation office cleaners) may be questioned in the face of social justice and the desire to integrate conservation institutions.

5.2. The relevance of the care perspective in social-ecological research

As care as a relational value has been identified as an essential component of stewardship positions (Enqvist et al., 2018; West et al., 2018), investigating more deeply the aspects of the concept concerning the care perspective of Tronto (2009) allowed understanding better what shape stewardship which is fundamental for environmental action. The different combinations of care aspects, from a perception commitment to a possibility of action, are related in our case study to specifically formulated stewardships. Moreover, care informs the nature of issues at stake locally. In the Kalahari site, where individuals expressed the more empathetic values of care, the main problem highlighted through the discussions was their community's position in the global society. Assuming or not, the great divide raised by the westernisation of lifestyles is deeply a relational

question rather than a material development issue. This issue emerging from the discussion in the Kalahari calls into question deep leverage points. It touches significantly on the design of the social-ecological system in terms of social structures and institutions that manage feedback and parameters (Abson et al., 2017). In the Garden Route, we observed the same processes for the Khoï community, whereas other groups focused on the practical application of care aspects. Issues at stake relative to the mobility of living beings within anthropogenic landscapes focused on practical elements of the landscape (e.g. fencing or law enforcement). Whereas some aspects of Khoï people's discourse were incorporated into other stakeholders' arguments, the intent behind the preferred stewardship remains unclear, consistent with the distribution of care aspects. It calls into question deep leverage points (Abson et al., 2017). Regarding system characteristics, the intent relates to the worldviews embodied within the system and derived from the paradigms mobilised to investigate the system (Abson et al., 2017). Exploring relational values and especially care aspects is thus not only a theoretical task but also has substantial effects on the ability of a system to change.

Another crucial point the study raises concerns the motivations behind caregiving and receiving. In its formulation, we highlighted that the care aspects pattern can be incomplete but achieve reasonable care. In some cases, we observed that care was given without formulating commitment perception or normalising the latter. We identified two elements allowing the understanding of the motivations behind caregiving. Firstly, care expressed in its emotional dimension is not (or difficultly) valued within current institutions which recognise humans as autonomous rational beings (Jax et al., 2018). It could then be a lack of care expression, with practical aspects of care being more valorised and streamlined than the empathetic aspects.

Additionally, we can ask ourselves about the nature of the motivation behind caregiving. Is it motivated by self-discipline (ethic), or is it by a discipline given by society (moral)? The format of our methodology, with short sentences written on post-it notes, does not allow interpretation of motivational processes, although the focus on the individual, relational values may promote ethical motivations. However, there is a need for further study of the motivational aspects of providing and receiving care. Other relational values, such as cultural identity or beliefs, may complement the chain of care aspects to offer caregiving. Understanding the interrelationships between relational values will help define what drives environmental action.

Although care is paramount in defining stewardship, the potential actions it takes work to address social-ecological resilience strategies. Furthermore, the theoretical framework proposed by Enqvist et al. (2018) highlights the interweaving of care, knowledge and agency. By referring to the abilities and capacities of individuals, organisations and collaborative networks to engage in stewardship action, the agency allows acting on the care relational value in its globality, especially by enabling institutions to receive care as an additional mode of justification of the conservation discourse (Jax et al., 2018). Enlarging social organisations and institutions to this kind of justification would allow care perspectives to propose other stewardship positions. Knowledge helps to relate the motivational aspects of care (empathetic) and caregiving (outcomes) (Enqvist et al., 2018). Focusing on the knowledge component may act on the "caring of" aspect of care, the normalisation of the empathetic care aspect. This part has been identified as key in formulating transformative stewardship in our study. Focusing on the knowledge component, especially the experience of nature, would "structure" environmental emotions to move to more transformative scenarios regarding our relationship with the environment.

5.3. Stewardship, relational values and conservation

Our study highlights that Indigenous people are more prone to adopt a transformative stewardship position. This transformative position appears through three main dimensions: communication between living beings, acknowledgement of the "other", and institutional recognition of Indigenous people. As highlighted by Khoï and San participants, enlarging the way we interact with other living beings is key :

"When we speak, we touch the tree speaking back to us since childhood; it hurts me when somebody breaks a tree. When we are talking about sustainability [it is] not only of the town but its people, wildlife, and co-existence."

Pacaltsdorp resident participant

"If we must stay between the animals, as we are doing now, the animals will get angry and hurt us. Because animals and people are meant to live together in nature, yes, we can live together in nature."

Witdraai resident participant

However, This communication is not achieved by homogenising the interlocutors but by recognising them as “others” by acknowledging their specificities:

“We also climbed the trees as the baboons climbed. We also jump as they jump, we mimic them, and they think they mimic us.”

Pacaltdorp resident participant

Both of you [i.e. animals and humans] must respect each other's space [...]. So it's also a way of learning to live with your nature. It's also something you must learn. It is not enough to go into nature and know something. The scorpion will sting you because you must learn through your mistakes.”

Witdraai resident participant

This transformative position is not just a question of a minority worldview about hegemonic ones. It is also a question of recognising the other at the institutional and decision-making levels and, therefore, of proposing new forms of governance:

“With all due respect, George municipality does not do enough to incorporate First Nation Aboriginal people into those conversations.”

Pacaltdorp resident participant

“And if we must find people who can run [conservation] as Bushmen, that then we have to do it, but give us the right to get our place back.”

Witdraai resident participant

Transformative stewardship understands the environmental problem, notably as an issue of values plurality (Mathevet et al., 2018a). In contrast, other stewardships understand it as the ability of social spheres to regulate nature and, more precisely, sustainability stewardship through governance issues. In the context of biodiversity conservation, this difference between transformative stewardship and others raised the question of the object of conservation efforts. In transformative stewardship, humans and other living beings are part of the same relationship network. Therefore, the effort is on maintaining and fortifying these relationships, offering pluralistic perspectives. In considering nature as a force to be regulated by the social sphere, biodiversity is externalised from the human sphere and becomes an object to protect. The popularity of the biodiversity concept rests on the fact that it encompasses a wide variety of interests within the modern conservation movement (Pascual et al., 2021). The conservation objectives, its own issues identification and the related potential solutions have significant effects on people (Pascual et al., 2021).

Although reformist discourses constitute the majority of environmental discourses, Indigenous peoples' groups (in their diversity and complexity) were the only ones in our study to defend their preference for transformative stewardship, adopting an imaginative and radical environmental discourse. The challenge of transformative stewardship is related to the relationships between knowledge and social-ecological systems (Mathevet et al., 2018a). Transformative stewardship can improve a social-ecological system's resilience by mobilising science and social learning (Mathevet et al., 2018a). It may consider the power relationships among diverse groups focusing on worldviews and must, therefore, continually be debated and reassessed by stakeholders (Mathevet et al., 2018a). As Colding et al. (2006) highlighted, power imbalances are inevitable; thus, transparency is critical. Considering ecological and social interdependencies within a community enlarged to non-humans then merges social and environmental justice. It is embodied by communities that suffered from colonisation and still suffer from more insidious elements of neo-colonisation (Ferdinand, 2022), which are also reflected in ecological issues by endangering the plurality of values and ways of relating to the environment.

Nevertheless, is it possible to form an extended community with different stewardship positions with different objects? In other words, can reformist and transformative positions pursue social-environmental objectives together? Given its many different interpretations, the concept of biodiversity must also be flexible enough to recognise this diversity of discourse (Pascual et al., 2021). It should be an opportunity to acknowledge people's perspectives on what should be conserved and why. Suppose the concept of biodiversity is to be helpful as a conceptual tool for conservation. In that case, it must become part of a broader engagement with diverse knowledge and value systems about nature (Pascual et al., 2021). It would facilitate new alliances among various interest groups to pursue fairness in conservation (Wyborn et al., 2021; Wyborn et al., 2020; as cited in Pascual et al., 2021). It was visible in the workshops we held with different stakeholder groups on both sites. It brought a range of relational values, care aspects and stewardship positions to the fore but exchanged constructively and in general agreement. Of course, the power issues at stake in these exchanges are not to be overlooked, but they nevertheless provide interesting leads for research in social ecology and also call for more inclusive and plural action.

III. Care and conservation

1. Is conserving caring?

According to Larrère (2012), most environmental ethics could claim to be based on care oscillating from individualist to universalist schemes (as cited in Alarcon, 2020, p. 54). However, as highlighted by Alarcon (2020, p. 54), Larrère (2012) considers that conservation has failed to promote a proper ethic of care because of the special place occupied by the concept of wilderness in the thinking of Western managers and scientists. Alarcon (2020, p. 54) highlights that Larrère takes up some of Plumwood's criticisms of the concept of wilderness (1998). In this sense, the author noticed that Plumwood shows how particular works emphasise masculine values in the world of the wilderness. According to the author, it implies that this concept remains fundamentally dualistic. Alarcon (2020, p. 55) noted from Larrère's work (2012) that the idea of care is an antagonist to that of wilderness. In fact, according to Alarcon (2020, p. 55), adopting a caring approach to human-wildlife relationships allows us to move from a distant nature to an interactional one. Still, according to Alarcon's (2020, p. 55) analysis of Larrère (2012), this interactional nature implies other models of environmental ethics. Larrère (2012) thus writes that the ethics of care invites us back to the garden. Comparing this sentence with Petrarch's evocation of nature from the 14th century is significant. Indeed, Petrarch, in his ascent of the Mont Ventoux, leaves the city. He looks into the distance and provides the first description of a landscape distinguished by its duality between physicality and humanity (Lévy, 2001). This distancing, the basis of the idea of nature and naturalist ontology, invites us to return home. Nevertheless, on the other hand, Alarcon (2020, p. 55) notes that, according to Gaard and Gruen (1993), care is relevant to the study of relationships of domination between humans. Valuing care for conservation, therefore, means promoting the experience of nature, putting the senses back at the core of the relationship (Alarcon, 2020, p. 271).

However, there is evidence of a progressive decline in positive human-nature interactions, the "extinction of experience", with potentially severe consequences for health, childhood development and concern for biodiversity conservation (Gaston & Soga, 2020; Soga et al., 2015). As underlined by Gaston and Soga (2020), today's children have less direct contact with nature than before (Pergams & Zaradic, 2006; Soga & Gaston,

2016; Clements, 2004; Hofferth, 2009). Soga et al. (2016) highlight that although there is still an essential debate about the issue, children are increasingly experiencing an "extinction of experience" of nature (Miller, 2005; Pyle, 1993; as cited in Soga et al., 2016). The frequency and intensity of nature experiences in childhood are correlated to people's connection with nature (Hinds & Sparks, 2008; Zhang et al., 2014; as cited in Soga et al., 2016), so experiential nature education is fundamental to creating emotional connections with nature (Cheng & Monroe, 2010; Soga & Gaston, 2016; Wells & Lekies, 2006; Zhang et al., 2014 as cited in Soga et al., 2016). According to Soga and Gaston (2016), previous studies highlighted that people who were not often in contact with nature during their childhood exhibit less positive feelings towards it (Hinds & Sparks, 2008; Wells & Lekies, 2006 as cited in Soga et al., 2016).

Eventually, one of the main assumptions is that we can only care about something if we perceive it. Therefore, this question of perception is fundamental to care and its implications for conservation. Our results in the previous study highlight a diversity of care dispositions, but above all, the influence of this diversity of care aspects on stewardship positions. For example, in the distinction between emotional care (related to sensibility) and practical care action, we can distinguish quite different conceptions of change, notably between a reformist and a transformative understanding. Suppose caring is a matter of individual and collective dispositions, i.e. emerging from an experience with nature acquired individually and collectively through relationships with nature. In that case, conservation is not necessarily caring. The difference lies in the modes of justification for conserving nature, mainly in the internality or the externality of its origin for the individual. Rationalism, coming from scientific evidence, can be one of the justification modes. It is then external to experience. Judeo-Christian justification, which is also very visible in South Africa, particularly concerning the creation of life by God, are all modes of justification that we will describe as external. On the other hand, the modes of justification based on the experience produced individually or collectively through a practice of nature can be considered internal to the subject. They emanate from the subject and differ from one individual to another. By mobilising one or the other type of justification, we can see that conservation is not necessarily linked to ethics.

However, while considering these justifications according to their externality and internality is interesting from an analytical point of view, they are not mutually exclusive. The final rationale for biodiversity conservation will likely be the product of these

different justifications. It is, therefore, not a question of replacing one mode of justification with another but instead of underlining the importance of this justification experience for conservation that considers the complexity and adaptability of SES. The results and their interpretation from our two study sites suggest that conservation is not necessarily caring, despite a particular concern for nature and biodiversity.

2. The care concept in conservation

In this thesis, we described several concepts that allow us to understand more fully the issues of human-wildlife coexistence and conservation within a complex and adaptive social-ecological system. However, despite the common problems and the link between the research questions to which these concepts relate, their articulation still needs to be clarified. We have already shown social-ecological systems' complex and adaptive nature through the existing literature. However, integrating the care concept in these systems and their dynamics still needs to be established. In this section, we will take up the conceptual typology of the general organisational principles underlying complex adaptive systems (CAS) characteristics highlighted by Preiser et al. (2018) and explain them according to the care approach to determine the latter's implications in SES.

First of all, complex systems are constituted relationally. Care is, according to this principle, quite quickly mobilised since care is conceived as a particular disposition towards a relationship. Therefore, it is a relational value. In a complex system, care has the quality of orienting certain relationships between entities and influencing their intensity or existence. Care thus appears, when considered in a social-ecological system, as the "connecting rod" of the relationship.

Complex systems also have an adaptive capacity. As a reminder, adaptive components allow the system to auto-organise in response to perturbations (Preiser et al., 2018). It means that CAS possesses memory and the ability to learn from previous situations and configurations and thus influence and shape the current and future trajectories of the system. As conceptualised by West et al. (2018), care depends on knowledge and agency components. It also depends on our dispositions to perceive the environment and the relationships it constitutes. The empirical character of acquiring knowledge and its reciprocal influence on care makes it an additional characteristic of a

complex system. Indeed, if care is a relational value, it also depends on our a priori relationships with nature.

As we have seen with the idea of the extinction of the experience, the nature of care seems to be actualised according to the context favouring or not its realisation. In this, care structurally comprises a great adaptive capacity and the ability to meet a need, considering the context. Tronto's definition of care (2009) exemplifies this adaptive capacity specific to care. For example, if we are concerned about the living conditions of children in another region, an act of care could be to send money through an association. However, if we know that the money passing through the association will never reach the structures ensuring the well-being of these children, we will not send this money (example from Tronto, 2009). Care is, therefore, not only action but also adjustment, according to the actual conditions of its implementation, the aspect of care-receiving (Tronto, 2009).

The dynamics of complex systems put aside the notion of balance of the system to always think of it in movement, in change. The care concept also corresponds to this dynamic because of its ability to mobilise different stewardship positions. In our study sites, we identified the link between the association of the emotional and normative aspects of care and the adoption of a transformative position of change, i.e. realising a reversal of our ability to see the world. However, other aspects of care were mobilised to express more reformist stewardship positions. Care is thus part of the system's dynamics. However, the link between care and stewardship could be reciprocal, but this would require a more in-depth study.

We also know that CAS are open systems (Preiser et al., 2018). In other words, there is always a flow of information and matter through relationships between the system and its environment (Preiser et al., 2018). This relationship is understood ontologically if care is understood from a dwelling perspective, caring for wildlife. It means that care is a value that can be applied in other environments, even if its emergence belongs to this given system. Relational values, especially care, are radically open (Preiser et al., 2018).

CAS are also determined based on context; the structure of the CAS comes from the dynamic interactions between elements themselves and with the environment (Preiser et al., 2018), unlike systems characterised by linear processes, which can be effectively isolated from any external influence (Preiser et al., 2018). Following this analysis of

Preiser et al. (2018) and as we have seen through the work of West et al. (2018), care and agency are interdependent. In addition to the cultural dimension of the care emergence, the institutional context, in particular, can modify the different aspects of care and determine it contextually.

The aspects of care mobilised depend on the context. An example is the differences observed between †Khomani San groups in the Kalahari. Depending on the categories of stakeholders, the aspects of care were mobilised differently. In addition to a typical “culture”, these categories differed concerning the individual and collective interests specific to the participants, particularly about the diversity of personal trajectory depending on their level of inclusiveness in an institutional context.

Ultimately, as advocated by Preiser et al. (2018), causal interactions in CAS are “*not unidirectional or linear but marked by causal pathways complex recursive*” (Rasch & Knodt, 1994; as cited in Preiser et al., 2018). The system exhibits these emergent properties and cannot be attributed to the individual components' properties. Moreover, systems cannot be understood or their predicted behaviour solely on information about their parts. Human-wildlife relationships and care emerge from these new qualities of the complex system. It means that care can be understood as an emergent system quality. From this analysis, we can hypothesise that care is both emerging from complex systems and structuring them, particularly in the orientation of the nature of the relationships that structure the social-ecological system. This double structural and emergent position places care as a fundamental and integrative dimension of the social-ecological system. Furthermore, its study makes it possible to render explicit the human-wildlife relationships in the social-ecological system and thus to understand better the implications of this systematic approach for conservation sciences and its importance in practice. Stewardship is considered a specific disposition towards change, and the trajectory of a social-ecological system does not alone make it possible to define the breaking points allowing these changes.

The leverage points proposed by Donella Meadows (1999) are particularly pertinent to mobilise for this. Abson et al. (2017) defined leverage points as characterising places in complex and adaptive social-ecological systems where a small perturbation can create fundamental changes. Abson et al. (2017) revisit these leverage points to address the points driving sustainability strategies by contrasting “highly tangible but essentially weak ones”, which are conservation actions easily doable but with little influence for

profound transformation. They argue that there is a need to focus on other less visible points that would have profound importance for the change of the system. Abson et al. (2017) propose focusing on three dimensions of leverage: “*re-connecting people to nature, re-structuring institutions and re-thinking how knowledge is created and used*”. They further add that Meadows formalised twelve leverage points ranging from “shallow” to “deep”. There are four key system characteristics of Meadows' leverage points that interventions can focus on (from shallowest to deepest): parameters, feedback, design and intent (Abson et al., 2017). Parameters are characteristics that can be modified to influence the system, such as rules, laws or market flows (Abson et al., 2017). Feedbacks are interactions within the system that change the overall dynamics of the system (Abson et al., 2017). Design characteristics are related to the structure of the system and how information is exchanged (Abson et al., 2017) and “intent” characteristics relate to the worldviews embodied within the system and derived from the paradigms mobilised to investigate the system (Abson et al., 2017). The intent directs the system (Abson et al., 2017). It is “*an emergent property arising from the multiple, potentially conflicting sets of worldviews, goals and purposive behaviours within a given system of interest*” (Abson et al., 2017). “Shallow” interventions should be then understood in support of “deep” ones and not as solutions to transformation (Abson et al., 2017). Conducting preliminary interviews and analysing the relational values within a diversity of stakeholders allowed us to determine specific characteristics of the system which seem relevant to identify the deep leverage points to mobilise to make the changes occurring in the system understood as transformative.

In the case of the Kalahari, the synthesis of our analyses, therefore, establishes that the main difficulty in the operation of a transformative change position lies in the design of the system, particularly the social and institutional structures that manage the feedback and parameters of the system. This characteristic of the system in the Kalahari, mainly of design, allows us to focus on the deep leverage points related to the structure of the information flow (access to information in particular) and the system's rules (incentives and constraints). If we define stewardship as the interdependence of care, knowledge and agentivity, we intend to focus on the agentivity that defines stewardship (Enqvist et al., 2018). As we have previously seen, care aspects are embedded and emerge from the social-ecological system. Adopting these leverage points will therefore influence the care mobilised. This possibility of indirect action on care is significant in conservation

strategies since acting on care directly appears to be a difficult task and results from the individual and collective experience, the product of internalised and externalised modes of justification. To show that these theoretical aspects have real, practical implications, we can imagine that the institutions of the Kalahari, the park and its institutional structure, the common property association and the municipality could extend the modes of justification for biodiversity conservation to more emotional and relational considerations that are care. In this way, it would be possible to exercise care in its practical dimension, especially for Indigenous populations and local communities. However, it will only be possible if institutions are flexible enough to accommodate these modes of justification in their structure, the rules they implement, and their capacity to add, modify or self-organise the system structure. This institutional restructuring of the agency will substantially weaken colonial dwelling, the contours of which are particularly identifiable in this study site.

In the case of the Garden Route site, conversely, the synthesis of our analysis indicates the importance of the "intent" of the system. It means setting a defined course of conservation on the Garden Route that considers the diversity of natures and practically assesses the outcomes of potential trajectories of the social-ecological system. Indeed our analysis shows various views regarding trajectory, which sometimes seems contradictory regarding values associated with nature conservation in this anthropised space, oscillating between the desire to preserve and develop together. The knowledge component, therefore, seems attractive to mobilise, particularly in recognising this diversity of visions of the world. Indeed, embracing this diversity of natures, notably through the mobilisation of various stakeholders and deconstruction of Nature, seems to define a more transformative position towards change according to our analysis of the relevant system.

3. The general and unifying principle of care for social and ecological struggles

Environmental care is, therefore, not an application of care as a specific ethic but as a particular activity encompassing the fundamental principles of care (Tronto, 2009). According to Tronto (2009), care encourages us to see the way of life of the privileged as possible through a care activity conducted by the dominated, but also by the resources of

the remaining population, which ensure the maintenance of life and the standard of living of Westerners.

The current debates on climate change and the nations which are primarily and historically responsible for it, and which attempt to make all the populations of the world bear the weight and the responsibility for the transformations restored by their development, are characteristic of an ethical-political conception indifferent to care and therefore unjustly fundamental. As Tronto suggests, the approach is not universalist from the point of view of its construction but radical and vast in terms of its effects. Finally, the challenge is to get citizens to recognise their global responsibilities (Tronto, 2009). Alarcon (2020, p. 52) highlights that research on the role of women and marginalised populations in everything that allows society to maintain itself are all means of shedding light on the issues of "sustainable development" and providing their limits.

It was interesting to note that women participating in the different workshops were very involved, especially women from Indigenous communities. They were actively part of the organisational process and were also in the Kalahari facilitating the discussion informally by recentring the different debates during the focus group discussions. Moreover, even if the research project's purpose was centred around biodiversity and human-wildlife coexistence, participants were willing to share their struggles as women concerning domestic burdens and responses to this with the structure in the Kalahari of a "women group". This women's group aims to create a bond between women of the community to find collaborative solutions towards specific issues that women can encounter, particularly rape, domestic violence or food-related issues in this area where food is scarce to harvest, hunt legally or buy. This women's group organised its participation in the workshops through a WhatsApp group. In the Garden Route, the theatre show was led and managed by women who decided to include children to give the process an educational dimension. As the theoretical foundations of care expressed in the literature have shown (Larrère & Larrère, 2018), there are commonalities between these coexistence issues and women's issues that care could help to exemplify and investigate.

CHAPTER V - PERSPECTIVES ON SOCIAL-ECOLOGICAL RESEARCH FIELDWORK



First workshop in the Kalahari, 2021
©Élie Pédarros

This chapter is a reflection on the adoption of a CAS approach for social-ecological systems in conservation sciences and practices. Embracing the complexity of reality implies complexity in the scientific approach and raises questions about the researcher's place in these processes. The objective is here to provide a guideline for future research using the same approach: reaching out to participants, relationships involved and challenges in coordinating workshops. Moreover, we will critically discuss the findings of this research and the implications for conservation sciences and practices and especially for coexistence.

I. Complexity of reality, complexity of social-ecological research fieldwork

Apart from these results, the originality of this work lies in the realisation of co-constructed and co-designed research by the participants in a collaborative effort of knowledge systems. As both a means and a product of the study, it is appropriate to return to this process more reflectively to underline the interest and the difficulties in its realisation. Because the aim is to consider the complexity of the social-ecological system, the approach adopted was to be as permeable as possible to the various recommendations and wishes of the participants in the broad biodiversity conservation framework. Apprehending the complexity of reality also implies a certain complexity of the fieldwork. Through a critical description of the process, this section aims to provide recommendations for future research projects wishing to adopt a complex social-ecological approach to conservation. The first difficulty in carrying out this work is the institutional academic agenda. Indeed, the research process must be exceptionally detailed, especially for the search for funding, institutional validation and research permits. Because this research is deeply inductive, the research questions, as did the methodological protocols, emerged during the project. Writing a research project that accounts for its feasibility can be complicated, as the general objectives are preliminary and refined through feedback. Concerning what this work previously highlighted, this research project is a research object since it also requires a certain institutional flexibility to be carried out, which becomes an epistemological constraint. In the context of multidisciplinary committees, this inductive approach may seem unscientific or, in extreme cases, journalistic. The first difficulty is having one's research project approved by peers. One solution is to vaguely present the project's inductive aspect and support the more conventional aspects of the collaboration, particularly in scientific knowledge modes. This solution seems relevant in particular because it provides a plan B on which to rely if the difficulties in the field that we will describe later become such that the conduct of the collaborative project becomes impossible.

To stimulate the relevance of this collaborative approach and present its main difficulties, we will follow a chronological plan following the conduct of the project. It will initially be a question of taking an interest in contacting the various parties concerned,

explaining the research structure in workshops and finally questioning the scientist's position in this process.

1. Getting in touch

Contact with the various stakeholders preceded participation in the workshops. It was decisive in the conduct of the project. Discussions, structured according to a semi-structured interview, had the main objective of introducing the project to arouse or not the interest of the parties considered but, above all, to create a relationship. Therefore, these discussions were conducted in their structure as informally as possible so that everyone could identify each other, their expectations, their vision of the project and the compatibility of these objectives. The individualisation of these interviews made it possible to establish a special relationship with each party. Furthermore, the context in which these interviews were carried out, generally at the participant's home or on the organisation's premises, made it possible to decentralise the power relations that may exist or be perceived during the integration of participants in scientific research. This spatial shift was also crucial in establishing a certain familiarity in the exchanges that would be important for the further multistakeholder workshops to allow marginalised participants to feel in a safe place.

The presentation of clear objectives, the challenges of this collaborative research approach, and the ethical framework imposed by the university system made it possible to reassure the participants about their participation and to be more open and attentive to the project. The success of the collaborative process, taking up the critical aspects developed by Tengö et al. (2017), therefore depends on the spontaneity and well-being of the participants. It is based on two fundamental axes: the relationships between the participant and the researcher and between the participants. These preliminary discussions made it possible to identify the questions at the heart of the local issues of human-wildlife coexistence. They often broadened the conception of these issues to social-ecological issues, particularly inclusiveness, recognition and justice. These discussions also helped identify stakeholder groups not apparent during the scoping phase regarding the research topic. For example, the conversation with the Wilderness informal settlement representative while preparing the dinner led to a description of

what was being prepared, the recipes used, and their cultural grounding. Of this, he mentions the Khoï population living in the municipality of George. Identifying potential parties interested in the project made it possible to contact this person and identify the ramified network of the Khoï community of the Garden Route by a snowballing approach, namely individuals located in Kleinkrantz, Blanco and mostly from Pacaltsdorp. This Khoï community, which is not very visible, is, in fact, in the process of being structured, in particular by establishing links at the level of tribal houses, made up of chiefs, at the level of the Garden Route. In the Kalahari, the questions of the joint administration of the part of the park returned to the San and the Mier, lively questions about the recognition of the San and the Mier in the decision-making process. It made it possible to get in touch with the Mier community, which, despite the distance, has invested tremendously in the realisation of this project. The community representative also mentioned that it was the first time that the Mier were associated with research projects in the Kalahari, unlike the San, who were primarily involved.

One of the significant difficulties faced by this project was the fatigue towards the commitment to scientific projects, particularly in the Kalahari. Many research projects, particularly on the part of sociologists and anthropologists, have been carried out on the #Khomani San community, often with little benefit. What has often been criticised was the unidirectionality of the process with the knowledge that emerged from local populations, and which was transformed into academic titles afterwards for the sole benefit of the researcher. Scientific research is therefore seen as a pump. A sure consistency was then required in the visits and time spent on site, within the community and not in one of the lodges reserved for tourists and hunters. What was then envisaged from the outset by the representatives of the community was the sharing and recognition of their knowledge and their participation as actors in the project. This difficulty was raised thanks to a research project a year earlier. I participated in particular by conducting numerous interviews, which allowed me to know and meet many community members. Returning to the site for my thesis project was therefore seen as a sure consistency over the long term. One of the names to qualify me was “//aip”, which means “oryx”, to qualify that I leave but always come back to the water point according to their explanation.

Whether short or long, the repetition of stays has made it possible to establish this relationship in the medium/long term both in the Kalahari and on the Garden Route. The

purpose of these stays was as much to prepare data collection and workshop organisation as in the sharing of situations which may appear outside the traditional scientific framework but which were decisive in the realisation of this project: sharing of daily life, meals, discussions around the fire, collection of tubers, walking in the Kgalagadi Transfrontier park, funerals, help with collecting firewood, occasional logistical help, drinks at the local tavern, rehearsals of the play, visits to the workplace of some participants, help with the soup kitchen and service. So many activities made it possible to create a natural bond of trust that had real functional utility in the conduct of this project.



Picture 1. (A) Informal settlement resident cooking for the soup kitchen ; (B) Soup kitchen queue ; (C) Tuber gathering (!goegap for blood pressure issues) ; (D) Discussion around the fire in Miershoorpan ; (E) Coffee in Witdraai ©Élie Pédarros

However, establishing an individual link with the community was also done by provoking situations in which I had the impression that the purpose was to put me to the test. In the Kalahari, it is accepted that within the #Khomani San community, there are those from Witdraai who live traditionally and those from Andriesvale who have a way of

life that aspires more to the standards of modernity. It was determined that it was vital for me to spend time with these two groups, who both show an informal reconciliation, the relationship remaining cordial in everyday life. On their initiative, we organised the first stay with members of the Kruiper family from Witdraai for four days in the park to walk, camp and share their fauna and flora knowledge. It was an opportunity to illustrate the difficulties in the relationship with the park, particularly in access to the part that belongs to them, but also the significant challenges of the community as a whole and the various rivalries. We finally camped in an adjacent farm that belongs to them, named Miershoorpan, because the visit to the Imbewu camp located in the park had worried the San, who had noticed the regular presence of lions in this interdune and traces within the boma. The nights in Miershoorpan and the days of walking in the park have been conclusive. The decision was made to return to the park with representatives from the other part of the community, the camp in the park having been identified as potentially unifying. During the organisation of the expedition a few months later, initial reluctance, imperceptible at the time but which took on its whole meaning in the course of events, complicated this stay.

On the commonly chosen day before departure, only the Andriesvale part was available. The Witdraai party invoked professional obligations that day and the postponement of their departure three days later at a set time. On the Andriesvale side, the departure had to be done this day as agreed. The park being located 60 km from the two residential areas, we left, and I undertook to return three days later at the said time to seek the representatives of Witdraai. Arrived on site, the camp for educational purposes of Imbewu where we were to stay was destroyed, the roof of branches pierced by lions which had remained in the camp before us. The giant paw prints everywhere in the sand confirmed this hypothesis. We searched for a suitable place to set up camp for hours before finding a site located within Miershoorpan, between two dunes, which was favourable. I had the misfortune to say that this was precisely the site on which we had established our camp a few months ago with the other participants. It deeply displeased them, as did the confirmation of the impossibility of camping in Imbewu. During the walks in the park, known to be home to a large population of lions, leopards and hyenas, I relied on their knowledge of the area. They walked without means of defence in case of attacks, such as rifles, spears or bows. Due to the heavy rains, the grasses were particularly tall at

this time of the year. During the walk, I learned to recognise many animal tracks and had me explain hunting techniques, sacred places and other ancestral graves. However, the recommendations towards lions were continually reminded, "Do not run, do not look in the eyes, and everything will be fine unless there are curious lion cubs there. We will have to face the fear ". They added that "the Bushmen are not afraid of lions because lions are lazy and know that we are animals, so they do not care about us, that is why there is never attacks of Bushmen, only whites and blacks because they clash in the landscape. Do we continue walking? ».

I continued walking, thinking about the park official with a missing arm who gave us the key to access Imbewu. Later that day, I returned to Witdraai to seek out the rest of the community. I was surprised to see them mending holes in their clothes and preparing dinner. They no longer wanted to come for reasons of incompatibility of agenda. After lengthy discussions, I abandoned and set off again for Miersshoorpan, where the rest of the participants were waiting for me. What a surprise when I saw my tent on top of a thorny acacia, which had pierced the canvas. I was told that a gust of wind had propelled my tent (although heavy because containing my belongings) to the top of this tree. Despite everything, they seemed embarrassed, and I understood that they had expressed their disagreement with the arrival of the Witdraai people. I then decided to mark the occasion of this provocation and ended the journey. The return was made in silence, and I moved to a campsite in Askham to isolate myself and show them my disagreement with this kind of hostile action. I stayed there for a few days, meeting them occasionally when I went around Andriesvale and Askham, greeting them from afar, neutral. On the fourth day, one asked me to accompany him to look for tubers. I seized the opportunity, and he explained the reasons for the situation in Miersshoopan, particularly related to the relationship difficulties between the two groups. I specified my position and externality to these problems, the objectives of my presence here and my desire to bring together elements relevant to everyone within the limits of my duties. Following this stay, I was renamed "!"Au" by one of them, meaning "hunter". I then took all these events as a crisis that made it possible to break down barriers.

During this park episode, I lost my position as a researcher, which I had to quickly resume to ensure the project's credibility and reaffirm during the explanations. This fieldwork in the Kalahari and on the Garden Route has made it possible to see that there

is a constant back and forth of construction and deconstruction of this posture, which must be accepted to ensure both certain credibility and feasibility of the project while keeping a certain familiarity allowing the emergence of salient points. I also understood that listening to these specific problems does not mean interfering either by giving my opinion (which I have never done) or participating in any event related to these phenomena. It is essential to highlight this subtle nuance in such projects where human investment is significant while accepting this balance between the researcher and non-researcher, which is inevitable in such systems.

The process of making the play in the Garden Route is another example of this. A few days before the first workshop, when the play and its staging were finally ready, I received a rather outrageous quote from the Khoï, including the play's writing and performance. It presented a dilemma between the integrity of the collaborative process and institutional pressure as the collaborative production was now an integral part of the project and, more specifically, of the thesis objectives. After much deliberation, I chose to re-explain to the Khoï what the project's original goals were and that the play was not about performance alone but the message they wanted to convey. Moreover, paying for a service distorts the approach of giving carte blanche to this community since it gives a commercial dimension. Service is rendered while the main benefit, the non-commercial one, that of expression, belongs to them. Therefore, I refused to pay for the service (only for logistical support), leaving them free to do the play or not, while hoping that this would not jeopardise the organisation of the workshop itself and their presence at it. A few days later, they said they would do the play anyway. The community reported this episode at the end of the second workshop:

"We need to look at everything constructive, and I thank you from the bottom of my heart. You have no idea of the intensity of what you are doing with your doctorate or by studying by doing your PhD on wildlife and coexistence in this manner. You have made a huge impact by forcing a conversation and a positive. I've spoken to you before you said something like, "I'm not here to patronise you". This is what I'm talking about. What you have done is you have drawn people who are so polarised that you have drawn them together. You have laid a foundation for a conversation. This constructive conversation will

ensure the biodiversity that will provide the sustainability of a society that can co-exist. And I want to thank you for that for you".

It illustrates that the collaboration of knowledge systems is also a negotiation. As shown by Tengö et al. (2017), negotiation is a crucial aspect of this process, and disagreement doesn't necessarily hinder collaboration. The initial theoretical goals should be used as a guide to conduct this negotiation, much more than the data collection aspects. It is normal to have this type of negotiation, primarily when the protagonists are affiliated with an institutional framework and the other is not. The negative response to the paying theatre play legitimised the project and gave it another dimension. This response also highlighted their role as project actors and not contributors.

2. Workshop organisation

The main advantage of data collection structured by the organisation of workshops is to promote dialogue between the various stakeholders and to bring out relevant elements through the co-construction of discourses. Another significant advantage is the concentration of the data collection period in a few days. However, these workshops require a great deal of organisation to be effective, with the risk of the project appearing uninteresting, painful or a source of conflict. To this end, we will provide a critical description of the organisation and conduct of the two workshops held at each site. Some points will seem trivial, but they deserve our attention because it is from specific organisational details that the successes but also the failures of these workshops emerged.

Firstly, the choice of the date is decisive because it will condition the time needed for the logistical and scientific organisation of the workshop, which is always longer than expected. Moreover, a weekday or a weekend is decisive for stakeholders' diversity. For example, many organisation representatives want to refrain from participating in events related to their professional occupation on the weekend, which is the opposite for participants whose participation is unrelated. The choice should therefore be made according to the project's objectives but also in a consultative way to avoid the concomitance of other events, which could reduce participation. Therefore, finding a date

and determining the criteria (more or less institutional or individual participants) is crucial. Furthermore, for some communities, the weekend may be a time of “relaxation” that does not allow participants to engage in the proposed cognitive exercises fully, so choosing a weekday far enough away from the weekend is advisable. An example of a concurrent side event that somewhat disrupted the workshop was the second workshop in the Kalahari. The workshop was held on pension payday and therefore led to demobilisation, and it took a considerable effort to mobilise participants. The choice of the date is thus crucial for the workshop's outcome.

The time spent on each exercise must also be well thought out to allow the participants to provide as much information as possible while avoiding a certain saturation and a progressive loss of interest, which would negatively influence the following exercises and the general appreciation of the workshop and the project. The feasibility of the exercises is crucial in the collaboration of knowledge systems. Therefore, it is advisable to carry out tests beforehand with people not involved in the project to ensure the minor technical details and evaluate the cognitive effort these exercises require. Ensuring that the exercise aligns with the general population is also essential. For example, when conducting pre- and post-workshop questionnaires in the Kalahari, two effects were noted that should be avoided for future workshops. Firstly, a large proportion of the participants were not at ease with writing or needed to be more literate, which created discomfort and was not immediately visible, as the participants preferred to wait alone until the end of the session. Secondly, the post-workshop questionnaire came after a long half-day in the sweltering heat, the response rate was shallow, and only some of the responses were complete. Despite the concentration of data collection in a short period, it is understandable that there is a tendency to diversify the exercises and the data to be obtained. However, it is better to consider fatigue, the quality of the data obtained and the fluidity of the whole. The post-workshop questionnaires were also poorly filled in the Garden Route, despite a visibly higher literacy rate than in the Kalahari.

Another essential aspect of organising the workshops that emerged shortly beforehand was transport, which was one of the significant difficulties in successfully bringing together large numbers of people. In the Garden Route, the task was relatively easy, using a van to collect members of the Khoï community from various locations in George and people from the informal areas of Wilderness. However, it is a significant

amount of time to consider in the organisation, and it is best to designate one person to be fully responsible for this time-consuming aspect. In the Kalahari, the task was more complicated due to the geographical distance between the different settlements and the scattered distribution of the other "sub-communities". In the first workshop, finding the people who wanted to participate was tough, and the transportation of people before and after the workshop also took up much time. For the second workshop, a better organisation made it possible to mitigate this influence of transport on the workshop. Referents were appointed in each area with a specific list of participants. A place and time were given according to a precise itinerary. The referents were responsible for passing on the information to the participants and looking for them well before departure to ensure their presence. Despite some limited and occasional difficulties in gathering the participants, this organisation made the day run more smoothly. The punctuality of the Mier, supervised by the community representative despite the distance between Rietfontein and Askham, contributed to the initiative to organise the transport for the second workshop in this way. In addition to this logistical fluidity, this organisation also has the advantage of making the community an active participant in the organisation of the workshop and simplifying the direct injunction relationship with the researcher during the collection.

Apart from the questionnaires, the participants received the methodologies well, with good feedback on these methodologies. The fun aspect of the participatory mapping, which focused on animals, was well appreciated with a large amount of data obtained. The concrete aspect of the methodology and the mobilisation of experiential knowledge contributed to this success. During this exercise, stakeholder groups were mixed into "teams" to maximise the interactions between different groups. Based on a rolling process, each team had to realise all the exercises (mapping and timeline) in a specific order. The aim was also to avoid the bias of favouriting one group in a particular exercise, realised firsthand to have homogenous participation of stakeholder groups in each exercise. The assistants around each map did not notice any specific difficulties concerning the orientation on the map or problems in understanding the guidelines, except for a few individuals. Because of the arrangement of participants around the maps, this exercise favoured exchanges concerning the observations, a contextualisation of

these or discussions without direct connection with the subject between different stakeholders.

During the second workshop, the maps from the participatory mapping modelling were presented to the different groups. They were asked to discuss the relevance of the maps among themselves to identify the correct or erroneous elements of the validation. It made it possible, on the one hand, to validate the modelling post-hoc and, on the other hand, to be a catalyst and promoter of discussions on the issues of coexistence. Overall, for both sites, the maps were relevant to the observers. Only certain areas with very little information suffered from a bias in detectability and, therefore, in prediction.



Picture 2. Participatory mapping exercises in the Garden Route (A) and the Kalahari (B)
©Élie Pédarros

The collaborative timeline was also well done with minimal difficulty. The information on the individual post-its notes was the subject of numerous comments and questions from other participants, which fuelled the collective discussion and the overall

understanding of the project. As indicated in the previous chapter, this methodology was relevant for collecting elements of relational values from various stakeholders, an aspect highlighted as lacking by the scientific literature.

The discussions during the second workshop can have significant difficulty involving various parties concerned whose power relations can distort the information emerging from the process or favouring or make certain positions invisible. In a trust relationship, it is critical to try not to erase this bias but to consider it, identify it and minimise it as much as possible. During these discussions, we used the nominal group technique, explained above, which consisted of organising the debate at different scale levels: individual, intra and intergroup. By proceeding this way, the objective is to trace individual information as much as possible to the inter-group level to identify, in particular, the differences in positions between groups and within the group. Thus, this structuring also allows equal speaking time between groups, preventing one from taking up all the space in the discussion. This way of organising the discussion also has the advantage of focusing the subject on the research theme and avoiding digressions that are too far from the issue without restricting the floor, thus making it possible to approach the theme according to a complex approach. Despite the diversity of stakeholders whose positions are diverse and varied, as we have seen during the identification of stewardship positions, they did not give rise to notable divergences in the Garden Route despite quite transformative positions, particularly on the part of the Khoi. It would be simplistic to interpret this consensus as the result of the benefits of the participatory approach as its evaluation. Indeed, observing a smoothing of positions can avoid conflicts when the positions are highly divergent. The apparent consensus is, therefore, not a criterion for evaluating the success of these participatory processes and should not be assimilated to a maieutic of common discourses. Once again, the contextualisation of the collaborative process is decisive. One could say that the success of a collaborative process lies more in the fact that it frees itself from the researcher than in the results that will produce its analysis. For example, at the end of the workshop, on the initiative of the residents of the informal areas of Wilderness, an outing with the Khois was organised to walk in Wilderness. They wanted to show them their place of life, the informal camp and exchange insights. This workshop, therefore, followed a common reappropriation of the space, which is now covered, outside the usual compartmentalisation of neighbourhoods and

communities. The various stakeholders were also in favour of the regular organisation of this type of workshop, which would take place in each place specific to the different communities. This initiative came from the Khoï and has mainly been validated, in form, by the owners of Wilderness, active members of conservancies, the municipality and even SANParks. However, this initiative has not yet materialised more than six months later.

In the Kalahari, a strong consensus was also apparent. However, there were considerable differences regarding the way of life of the Bushmen in the future. The different positions could be summarised as those who wish to live indistinctly in and outside the park and to live with the fauna (transformative positions), those who want to live next to the animals and outside the park with more fluid access (sustainability position) and those who want to live outside the park and keep this hermetic vis-à-vis wildlife at all costs (reformist position). These salient points in the deliberative and discursive process are not representative of the geographical distribution of their actors.

Nevertheless, it is interesting because it calls into question the different separations between actors favoured during the land-claim process that Robins (2001) interpreted as being superficial and produced by argumentative choices.

Integrating this methodological corpus of a collaborative production was originally very exploratory and oriented towards its analysis. The Khoï wanted to make a play to present to all the participants during the first workshop. The objectives mentioned by the community were to explain aspects of their culture and their history to the broader world, to federate the different Khoï communities around this project and above all, to integrate young adolescents and children to integrate them into this process. The play was written entirely by Quaanitah Simons and directed and performed by Mona Oligslaander. One of the first concerns was that this play, by raising many political questions, could be divisive and lead to a loss of support for the project on the part of the other participants. The play was performed at the end of the first workshop before the closing meal. All the participants and a delegation of Khoï from Cape Town attended the performance. The reactions were quite heterogeneous, with some finding this play out of place about the project and not understanding the links between biodiversity conservation and Khoï political demands. On the other hand, some were delighted with the piece, having learned elements related to the Khoï culture. Still, others had more complex reactions that unfolded over several days.

The film followed a different process as there was more active participation from our side, especially in the technical aspect. The process of making this film was long-term and resulted from many discussions. They desired to involve all the families of #Khomani San. However, it wasn't straightforward to get them to contribute together. Time was therefore spent with the different protagonists who constructed the scenes they wanted to make appear. A proposal for editing was then proposed to each party and modified, considering the other suggestions. The participants requested the title, the scenes, the music, and the techniques used (close-up, use of drone). It was interesting to see that this project was oriented in a very secure and sure way by the participants, who are used to being in front of cameras and acting in many films. Some participants wanted a rendering close to "The Gods must be Crazy" with a presentation of traditional Bushmen practices with American-style landscape shots. Others preferred a more documentary format in the form of interviews. So all this was done together. The choice of music was also intended to illustrate the community's feelings with the location of the shots. For example, in the first scenes, Elia Festus wanted slightly scary music when introducing Andriesvale to show that this place had been imposed and did not reflect the San way of life. The choice of film was motivated by the desire to convey something with movement. Knowledge is passed on among the Bushmen through experience. It is not, for example, a catalogue of animal tracks but an experience through the bush, illustrated by the encounter with tracks which are contextualised, the animal's behaviour described, and its state of mind at the time of the track analysed. The choice of the film's title proposed by Elia Festus, "The Burn of a Nation", was widely accepted and supported by all community members. In addition to its impact, it is interesting to see a similarity with the title of David Griffith's film "The Birth of a Nation" (1915), released precisely fifty years after the end of the American Civil War. "The Birth of a Nation" tells the conflict and Reconstruction story. The film adopts the Southern and revisionist viewpoint that sees African-Americans as inferior and threatening whites' rights. The film's popularity led to the revival of the Klan, which had disappeared then. For these reasons, the film was banned in several American cities. The title, which I am not sure explicitly refers to Griffith's eminently racist film, is an interesting tacit reference.

To conclude, the organisation of workshops is complex and decisive in the conduct of the project since it is the culmination of participatory research, the backbone

of it. They require an exact and long-term organisation because this is a critical factor in the fluidity and pursuit of collaboratively determined objectives. Like any system and subsystem, its description and evaluation must be taken broadly enough to understand its proper scope. Thus the results of a workshop cannot be considered as only a collection of data which will be evaluated according to the quantity of data collected. The simpler, the better. The simpler it is (and not necessarily in its organisation), the more the fluidity of exchanges will be favoured, and the quality of diverse data's quality will be appreciable. These collaborative processes, both in their definition and in their structural unity that were the workshops, impose to question the researcher's place among these stakeholders and the more or less central position they occupy dynamically. The film was first presented for validation to those who wanted to participate in the film. It was then presented to the whole community during the last workshop. The community very much appreciated the film. Some participants expressed their feeling of belonging to a large and cohesive community despite the daily difficulties and the importance of representing certain practices that constitute the San identity, such as gathering or hunting and transmitting this knowledge.

3. The researcher's position

When working with Indigenous peoples and local communities, particularly in a project that may be similar to action research, the researcher's position can be complicated to understand. Indeed, during the various discussions with these communities, strong expectations have been formulated, particularly from the point of view of development or the resolution of societal and political problems. It is particularly complicated to manage because it is necessary to limit one's action to the objectives of the scientific project without being indifferent to the issues raised. The fundamental question is then to understand how to remain in one's place as a researcher and catalyst of a general and complex reflection on the social-ecological system without taking on the role of a leader and development NGO. It is difficult to precisely answer this question because it is rooted in the local context and its adaptation capacity. For my part, I chose to listen to and take to heart everything told to me while setting the limits of the project and its primary vocation. Therefore, financial issues or conflict resolution were quickly

evacuated about the potential responsibility of the university. It was, therefore, a question of distancing oneself from these development aid activities while remaining involved in the complexity of what was being raised. However, this aspect of the researcher's position within the actors around local communities and Indigenous peoples is challenging. During the second workshop, which focused on fairly broad discussions, this position was well understood and internalised, as it did not emerge from the discussions.

On the other hand, the continuity of research projects was raised, particularly concerning the need for these communities to readapt to each new project with new students and researchers. It is a particularly thorny issue as it depends not only on researchers but also on the logistical and financial possibilities of carrying out such projects. One recommendation would therefore be to hold preliminary meetings with the principal investigators of the research project with local representatives, apart from the student carrying out the project, to give a sure consistency to the project in the long term that does not depend on the student in question. Moreover, it allows different projects to be seen as part of a larger project and the result of institutional collaboration. It was done in the Kalahari and proved helpful in gaining acceptance for the project and legitimising it to the broader community.

Therefore, the conduct of this research mobilised processes of co-design of the study, mainly due to the preliminary discussions. It enabled the confrontation with the scientific literature and the formalisation of research resulting from a collaboration of knowledge systems. However, it is also a co-creation of the research since the participation of the different stakeholders allowed the emergence of the salient points of this research. These aspects of co-design and co-creation of knowledge have been fundamental to the continuation of this project.

II. General discussion

1. A complex and adaptive perspective on social-ecological systems implies recognising the diversity of worldviews and thus reconsidering the ontology of conservation sciences and practices

This work has identified some of the challenges facing conservation sciences and practices. By mobilising a complex and adaptive approach to social-ecological systems and concepts that reconsider the modes of relationships between humans and wildlife, this work has made it possible to envisage potential responses to the social-ecological crisis to which the biodiversity crisis is linked. Decentring the objects of conservation and putting them into a historical and anthropological perspective leads to a redefinition of human-wildlife relations and, thus, their ontology. As shown by Ingold's dwelling approach, this was initiated by a shift from the rationalism of conservation sciences and practices to an inversion towards a more relativistic perspective. This inversion, however, does not call into question the conception of human-wildlife relations. It is, therefore, a question of going beyond this multiculturalism and considering other forms of relationships between wildlife and human populations. This ontological reconsideration, thus, implies a modification of how we know the world and understand it. Approaching conservation science from a complex and adaptive approach to social-ecological systems means an epistemological reversal. Knowing differently implies a redefinition of the methodologies derived from rationalist paradigms to embrace the complexity of social-ecological systems to respond to this enterprise's new objects and objectives.

The central premise of this thesis is that the relationship between humans and wildlife is a situated process governed by different ways of seeing the world and contingent. Through participatory approaches, the diversity of these relationships could be addressed. Far from being understood as a difficulty in the causal understanding of social-ecological systems, this diversity of relationships invites us to redefine the terms of the system in a broader and non-polarised way. Considering the human-wildlife dichotomy as one type of ontology among others is not only a semantic exercise. It opens up the field of conservation research to other ways of seeing the world and thus fulfils both the objectives of epistemological validity and ethical design of these systems. The questioning of the ontology defining human-wildlife relationships is, by definition, rooted in reality. By modifying what we conceive as accurate, we can provide other answers to

the social-ecological crisis, particularly the biodiversity crisis. This complex and adaptive approach to social-ecological systems attempts to anchor conceptions of biodiversity protection on the reality of divergent worldviews and not on partly constructed and quasi-metaphysical presuppositions. Questioning the interest of a social-ecological approach to conservation by certain actors in conservation sciences and practices concerning the alleged social-ecological over-theorisation and its off-the-ground or ascientific character (as a truth value) is unacceptable. In the first chapter, we showed how compatible the concerns of scientists and other stakeholders could be in formulating research objectives but that these were nonetheless viewed differently by different actors. It is this “whole” of divergent worldviews and, thus, wildlife relationships that reconciliation ecology attempts to mobilise by proposing a multitude of empirical evidence to maintain its complexity of dimensions.

The analysis of reconciliation ecology has thus made it possible to consider the treatment of questions traditionally dealt with by conservation biology or landscape ecology by summoning the knowledge of other disciplines making the approaches irreducible. For example, in the second chapter dealing with the statistical and methodological aspects of the interpretation of participatory mapping, we were able to question the nature of the data resulting from participatory mapping by accepting their origin from interactions.

It made it possible to make the statistical and methodological link between objects understood according to both a landscape ecology conception of the landscape and a relational conception of this landscape and thus to question the nature of these mammal observations.

In the third chapter, which deals more practically with the coexistence between humans and wildlife, we highlighted the complicated articulation between the capacity of coexistence in anthropised landscapes, conservation strategies and the relational constraint of such strategies on the relational dynamics between humans and wildlife. More than an articulation between parts, we brought out an essential property of the social-ecological system: a relationship at the scale of the community of living beings. Indeed, we demonstrated the importance of biotic relationships for modelling the distribution of wildlife species using almost the entire anthropised landscape. It suggests the existence of critical links between the system's sub-components, which further

complicates the list of potential objects of conservation science: from the gene to the ecosystem, through the individual and the population, and the relationship.

This relational dimension was further explored in the fourth chapter, particularly the question of relational values and the “direction” of these relational values on how the system is managed and, therefore, how it is inhabited. The work carried out in this chapter has made it possible to consider coexistence as more than a juxtaposition of entities living in the same geographical unit. Instead, *coexistence* is a multi-relational process that is “made” about the environment. Putting the conduct of the fieldwork in this research project into perspective illustrates this need to rethink the nature of the objects of conservation sciences and practices.

The fifth chapter highlighted this point. Indeed, we have seen that biodiversity issues, when addressed with many stakeholders, give rise to various related problems that cannot be reduced to purely ecological issues. The attention is focused on this network of multi-scale relationships by highlighting conservation issues by engaging with diverse stakeholders, including Indigenous peoples and local communities. Suppose the complex and adaptive approach to social-ecological systems suggests redefining and expanding the “list” of particular objects of conservation science and its practices. In that case, it also leads to a rethinking of the ways of knowing these systems and their epistemology.

2. The redefinition of the objects of conservation sciences and practices' study questions how we can know the system.

The CAS approach to SES implies new epistemological contours, particularly in how systems are understood since it considers both the parts and the whole. The system is neither reducible nor generalisable. This approach does not, therefore, call into disciplinary question fields such as functional, community or landscape ecology or anthropology, history or sociology. On the contrary, their articulation favours covering disciplinary blind spots and providing a more comprehensive analysis of the various multi-level relationships. This approach draws on other epistemologies to bring out something different. Adopting a CAS approach to the SES is not a new discipline, but linking disciplinary fields with their ontology, epistemology and methodology, the sum of which, like the system itself, is not equal to the whole of their joining. This approach also

redefines the researcher's place in these processes by questioning his capacity to know the system finitely, notably by explaining it through causal relations. It calls into question the researcher's ability to solve problems beyond their competence, hence the importance of interdisciplinary collaboration. More broadly, it modifies the relationship between science and society, particularly the authority of scientific knowledge towards experiential knowledge, that of Indigenous populations and local communities, hence the importance of the transdisciplinary dimension. The approach is, therefore, more inductive than deductive, even if it can mobilise knowledge from this deductive approach.

During the preliminary discussions, the research questions emerged from the collaboration of scientific and local knowledge systems, which gave these questions a local anchor at the heart of social-ecological issues. This approach thus made it possible to anchor the scientific approach, giving it a certain legitimacy concerning local actors and credibility and salience. Integrating this stage of co-elaboration of the research, the study of SES takes an additional step in moving from theory to practice, a pitfall often noted in the scientific literature.

In the second chapter, we considered the data that enabled the statistical modelling in the context in which it was obtained. While methodologies aimed at assessing the biases involved in getting data from participatory mapping aim to standardise the data by detaching it from the context in which it was generated, we have, while considering this standardisation in the modelling, taking into account the spatial, quantitative and specific implications of obtaining this data. Furthermore, interpreting the results of participatory mapping modelling has allowed us to adopt a relational approach to the landscape rather than a purely Cartesian approach to data extracted from its context of generation. In chapter three, the contours of this approach became more concrete as it was applied to issues of coexistence between humans and wildlife in anthropised landscapes.

By mobilising statistical modelling methodologies of the habitat suitability of wildlife species confronted with the results of discussions among a range of stakeholders, the interpretations that can be made are certainly less definitive than more causal approaches but allow a set of relationships to be established that paramount in understanding the system and therefore in the potential conservation strategies that could be put in place.

This set of relationships is explored in more detail in the fourth chapter, where we analyse the relational values derived from the collaborative timeline methodology and the stewardship positions identified in the group discussions. Considering the relational values of the actors in the landscape is not only to consider a diversity of dispositions towards the system and the wildlife, which would be informative and allow the contextualisation of the implementation of defined conservation strategies. In addition, it will enable one to study a more critical set of relations constituting the system. If we place this study within the social-ecological system, we can establish a relationship between relational value and stewardship action. Stewardship actions are, by definition, actions that contribute to the system's dynamics. Thus, the inter-individual relationships expressed by relational values influence the system's overall dynamics, further demonstrating these systems' complex character with inter-relationships between levels. The epistemology of these approaches thus makes it possible to consider relationships that would remain invisible according to purely reductionist or holistic approaches.

3. Adopting a complex and adaptive approach to social-ecological systems in conservation sciences and practices involves rethinking methodologies and their articulation to consider a broader set of relationships that constitute the system

Another way of conceiving reality implies another way of knowing. It also means methodologies that allow us to understand the system's complexity and formulate responses that promote its resilience. Participatory methodologies will enable us to move from interdisciplinarity to transdisciplinarity and thus to access a whole range of other relationships that constitute the system, which is more challenging to access interdisciplinarily because of the contingent and situated nature of certain relationships specific to the system that may prove decisive in understanding it. In the second chapter, the redefinition of the data status, whose generation context is considered here, implies not other methodologies but the deepening of existing methodologies to vary the considered parameter and quantify its effect on the modelling results. Changing these different parameters has made it possible to highlight the relationship between the density of observations obtained and the heterogeneity of the landscape. As data density has the statistical capacity to homogenise the landscape, this guides the data collection

and the measures to be taken when the quantity of data influences the homogeneity of the landscape.

Furthermore, the observation data about the species in question must be interpreted since the other parameters mentioned above can vary depending on its spatial ecology or relationship with the informant. Thus, the principles outlined in reconciliation ecology provide a starting point for linking conservation science's practical and theoretical implications by suggesting a social-ecological approach to system thinking. Finally, reconciliation ecology allows us to put aside constructed concepts to rethink conservation based on a set of facts. Thus, it aims to deconstruct the sciences of conservation and its practices to reconstruct it with the same bricks but differently. That is, it does not reject the broad outlines of conservation science as it is but instead calls for its restructuring as a response to the social-ecological crisis rather than a construct disconnected from reality that is built on beliefs.

Participatory mapping, the methodology mobilised in chapters two and three, demonstrates its relevance in the study of coexistence principles because it allows many dimensions of the social-ecological system to be called upon. Its results and their interpretation have made it possible to highlight spatial co-occurrence as a tangible expression of coexistence and not as coexistence itself, given the diversity of mechanisms enabling it. By contextualising the data obtained through participatory mapping, we identified the structural existence of a relational landscape through the expression of knowledge derived from experience and interactions between elements of the wider living community. We also showed through the variability of specific landscape parameters that these interactions are directly and reciprocally linked with the environment. This hypothesis of an extended community of living organisms within the social-ecological system was corroborated by the relevance of integrating biotic relations in modelling habitat suitability within an anthropogenic landscape whose land use expresses relations with humans. Indeed, starting from a dichotomous vision between human populations and wildlife, between wild and urban, the suitability of habitats for a large diversity of species does not respect these dichotomies. Some species are strongly present in landscapes with high human activity, whereas they could be considered as assigned to "natural" areas. This general land use by wildlife species in our two study sites indicates that land use is also related to other species.

Given these conclusions, it must be admitted that the modelling results are only to be understood as an overview of a set of relationships and, therefore, not as a definitive result of species distribution mechanisms. Suppose these selected species use a large part of the space, whether heavily anthropised or not. In that case, we can also reverse the perspective and consider that these landscape elements are part of the species' landscape perception, not an external factor. They are part of their *umwelt* (Von Uexküll, 1921). It should not be interpreted as any scepticism about the existence of the biodiversity crisis or the impact of humans on the system through their activities but rather as a possibility of coexistence between individuals in the broader community of living things (thus refuting dualistic conceptions of conservation). It is possible if, as many studies in the ecological sciences show, human populations engage in *win-win* scenarios that allow wildlife to persist in these matrices. For some species, this may involve creating protected areas or, more precisely, avoiding the connotations of the lexicon, landscapes with very little human encroachment, together with landscapes favourable to wildlife and human activities.

This overall reflection on coexistence has shown, especially in chapters three and four, that coexistence is only possible if a shared existence exists. This shared existence is possible, among other things, through developing an ethic that values specific ways of living. In this respect, the question of Indigenous populations and local communities is crucial for coexistence because it allows us to put into perspective not only the ways of living but also the place of individuals in the system. More than relativism that will enable the diversity of the objects of study of conservation sciences to be extended, it is a position towards change that would be transformative that could allow for a recasting of both agentivity, knowledge and care dimensions. It would allow for a transformative stewardship position that would “reform” our ways of dwelling. In chapter four, we explored relational values in our relationships with wildlife and the landscape more generally. As a multi-faceted relational value, care is not necessarily synonymous with conservation. However, our results suggest that the relational dimension at the heart of coexistence issues should be at the heart of conservation issues.

REFERENCES

- Abson**, D. J., Fischer, J., Leventon, J., Newig, J., Schomerus, T., Vilsmaier, U., von Wehrden, H., Abernethy, P., Ives, C. D., Jager, N. W., & Lang, D. J. (2017). Leverage points for sustainability transformation. *Ambio*, 46(1), 30–39. <https://doi.org/10.1007/s13280-016-0800-y>
- Adams**, W. M., Aveling, R., Brockington, D., Dickson, B., Elliott, J., Hutton, J., Roe, D., Vira, B., & Wolmer, W. (2004). Biodiversity conservation and the eradication of poverty. *Science*, 306(5699), 1146–1149. <https://doi.org/10.1126/science.1097920>
- Agrawal**, A. (1995). Dismantling the Divide Between Indigenous and Scientific Knowledge. *Development and Change*, 26(3), 413–439. <https://doi.org/10.1111/j.1467-7660.1995.tb00560.x>
- Agrawal**, A. (2002). Indigenous knowledge and the politics of classification. *International Social Science Journal*, 54(173), 287–297. <https://doi.org/10.1111/1468-2451.00382>
- Alarcon**, M. (2020). Prendre soin des plantes et des sols : caractéristiques et transformation des pratiques de care en milieu agricole [Museum national d'histoire naturelle - MNHN PARIS]. <https://tel.archives-ouvertes.fr/tel-03385689>
- Allouche**, O., Tsoar, A., & Kadmon, R. (2006). Assessing the accuracy of species distribution models: prevalence, kappa and the true skill statistic (TSS). *Journal of Applied Ecology*, 43(6), 1223–1232. <https://doi.org/10.1111/j.1365-2664.2006.01214.x>
- Amroun**, M., Giraudoux, P., & Delattre, P. (2006). A comparative study of the diets of two sympatric carnivores – the golden jackal (*Canis aureus*) and the common genet (*Genetta genetta*) – in Kabylia, Algeria / Etude comparative des régimes alimentaires de deux carnivores sympatriques – le chacal doré (*Canis aureus*) et la genette commune (*Genetta genetta*) – en Kabylie, Algérie. *Mammalia*, 70(3/4). <https://doi.org/10.1515/mamm.2006.040>
- Andelman**, S. J., & Fagan, W. F. (2000). Umbrellas and flagships: Efficient conservation surrogates or expensive mistakes? *Proceedings of the National Academy of Sciences of the United States of America*, 97(11), 5954–5959. <https://doi.org/10.1073/pnas.100126797>
- Armitage**, D., Berkes, F., Dale, A., Kocho-Schellenberg, E., & Patton, E. (2011). Co-management and the co-production of knowledge: Learning to adapt in Canada's Arctic. *Global Environmental Change*, 21(3), 995–1004. <https://doi.org/10.1016/j.gloenvcha.2011.04.006>
- Athreya**, V., Odden, M., Linnell, J. D. C., Krishnaswamy, J., & Karanth, U. (2013). Big Cats in Our Backyards: Persistence of Large Carnivores in a Human Dominated Landscape in India. *PLoS ONE*, 8(3), 2–9. <https://doi.org/10.1371/journal.pone.0057872>
- Averell**, L., & Heathcote, A. (2011). The form of the forgetting curve and the fate of memories. *Journal of Mathematical Psychology*, 55(1), 25–35. <https://doi.org/10.1016/j.jmp.2010.08.009>
- Augustine**, D. J. (2010). Response of native ungulates to drought in semi-arid Kenyan rangeland. *African Journal of Ecology*, 48(4), 1009–1020. <https://doi.org/10.1111/j.1365-2028.2010.01207.x>
- Baard**, J. A., & Kraaij, T. (2014). Alien flora of the Garden Route National Park, South Africa. *South African Journal of Botany*, 94, 51–63. <https://doi.org/10.1016/j.sajb.2014.05.010>
- Baker**, P. J., & Harris, S. (2007). Urban mammals: What does the future hold? An analysis of the factors affecting patterns of use of residential gardens in Great Britain. *Mammal Review*, 37(4), 297–315. <https://doi.org/10.1111/j.1365-2907.2007.00102.x>
- Balée**, W. (2006). The research program of historical ecology. *Annual Review of Anthropology*, 35, 75–98. <https://doi.org/10.1146/annurev.anthro.35.081705.123231>
- Balmford**, B., Green, R. E., Onial, M., Phalan, B., & Balmford, A. (2019). How imperfect can land sparing be before land sharing is more favourable for wild species? *Journal of Applied Ecology*, 56(1), 73–84. <https://doi.org/10.1111/1365-2664.13282>
- Bar-On**, Y. M., Phillips, R., & Milo, R. (2018). The biomass distribution on Earth. *Proceedings of the National Academy of Sciences of the United States of America*, 115(25), 6506–6511. https://doi.org/10.1073/PNAS.1711842115/SUPPL_FILE/1711842115.SAPP.PDF
- Barber**, M., Jackson, S., Shellberg, J., & Sinnamon, V. (2013). Working Knowledge: characterising collective indigenous, scientific, and local knowledge about the ecology, hydrology and geomorphology of Oriners Station, Cape York Peninsula, Australia. *The Rangeland Journal*, 36(1), 53–66. <https://doi.org/10.1071/RJ13083>
- Barbet-Massin**, M., & Jetz, W. (2014). A 40-year, continent-wide, multispecies assessment of relevant climate predictors for species distribution modelling. *Diversity and Distributions*, 20(11), 1285–1295. <https://doi.org/10.1111/ddi.12229>
- Barbet-Massin**, M., Jiguet, F., Albert, C. H., & Thuiller, W. (2012). Selecting pseudo-absences for species distribution models: how, where and how many? *Methods in Ecology and Evolution*, 3(2), 327–338. <https://doi.org/10.1111/j.2041-210X.2011.00172.x>

- Baynham-Herd**, Z., Redpath, S., Bunnefeld, N., Molony, T., & Keane, A. (2018). Conservation conflicts: Behavioural threats, frames, and intervention recommendations. *Biological Conservation*, 222(March), 180–188. <https://doi.org/10.1016/j.biocon.2018.04.012>
- Beck**, S., Borie, M., Chilvers, J., Esguerra, A., Heubach, K., Hulme, M., Lidskog, R., Lövbrand, E., Marquard, E., Miller, C., Nadim, T., Neßhöver, C., Settele, J., Turnhout, E., Vasileiadou, E., & Görg, C. (2014). Towards a reflexive turn in the governance of global environmental expertise the cases of the IPCC and the IPBES. *GAIA - Ecological Perspectives for Science and Society*, 23(2), 80–87. <https://doi.org/10.14512/GAIA.23.2.4>
- Bedessem**, B., & Ruphy, S. (2020). Citizen science and scientific objectivity: Mapping out epistemic risks and benefits. *Perspectives on Science*, 28(5), 630–654. https://doi.org/10.1162/posc_a_00353
- Bell**, M. E., & Bowman, J. H. (2002). Widening the Net: Extending the Property Tax into Previously Untaxed Areas of South Africa.
- Bennett**, N. J., Roth, R., Klain, S. C., Chan, K., Christie, P., Clark, D. A., Cullman, G., Curran, D., Durbin, T. J., Epstein, G., Greenberg, A., Nelson, M. P., Sandlos, J., Stedman, R., Teel, T. L., Thomas, R., Veríssimo, D., & Wyborn, C. (2017). Conservation social science: Understanding and integrating human dimensions to improve conservation. *Biological Conservation*, 205; 93–108. <https://doi.org/10.1016/j.biocon.2016.10.006>
- Bensa**, A. (2006). La fin de l'exotisme. Anarchisis.
- Bergandi**, D. (1995). "Reductionist holism": an oxymoron or a philosophical chimaera of EP Odum's systems ecology? In *Ludus Vitalis* (Vol. 3; Issue 5).
- Berkes**, F. (2004). Rethinking community-based conservation. In *Conservation Biology*. <https://doi.org/10.1111/j.1523-1739.2004.00077.x>
- Berkes**, F., Colding, J., & Folke, C. (2003). Navigating social-ecological systems: building resilience for complexity and change. Cambridge University Press.
- Berque**, A. (2015). Écoumène (2nd ed.). Belin.
- Bhatia**, S., Redpath, S. M., Suryawanshi, K., & Mishra, C. (2020). Beyond conflict: Exploring the spectrum of human-wildlife interactions and their underlying mechanisms. *Oryx*, 54(5), 621–628. <https://doi.org/10.1017/S003060531800159X>
- Biddle**, J. B. (2016). Inductive Risk, Epistemic Risk, and Overdiagnosis of Disease. *Perspectives on Science*, 24(2), 192–205. https://doi.org/10.1162/POSC_A_00200
- Bidner**, L. R., Matsumoto-Oda, A., & Isbell, L. A. (2018). The role of sleeping sites in the predator-prey dynamics of leopards and olive baboons. *American Journal of Primatology*, 80(12). <https://doi.org/10.1002/ajp.22932>
- Biggs**, R., Schlüter, M., & Schoon, M. L. (2015). An Introduction to the Resilience Approach and Principles to Sustain Ecosystem Services in Social-Ecological Systems. In R. Biggs, M. Schlüter, & M. L. Schoon (Eds.), *Principles for Building Resilience: Sustaining Ecosystem Services in Social-Ecological Systems*. Cambridge University Press.
- Biggs**, R., Clements, H., de Vos, A., Folke, C., Manyani, A., Maciejewski, K., Martín-López, B., Preiser, R., Selomane, O., & Schlüter, M. (2021). What are social-ecological systems and social-ecological research? In *The Routledge Handbook of Research Methods for Social-Ecological Systems* (Biggs R.,). Routledge. <https://www.ptonline.com/articles/how-to-get-better-mfi-results>
- Blanc**, G. (2020). L'invention du colonialisme vert. Pour en finir avec le mythe de l'Eden africain. Flammarion.
- Blandin**, P., & Bergandi, D. (1997). Entre la tentation du réductionnisme et le risque d'évanescence dans l'interdisciplinarité: l'écologie à la recherche d'un nouveau paradigme. Colloques - INRA.
- Bonneuil**, C., & Fressoz, J.-B. (2016). *The Shock of the Anthropocene The Earth, History and Us* (Translated). Verso. <https://doi.org/9781784785031>
- Bonney**, R. (1996). Citizen Science: A Lab Tradition. *Living Bird* 15.4, p. 7-15.
- Bonney**, R., Cooper, C. B., Dickinson, J., Kelling, S., Phillips, T., Rosenberg, K. V., & Shirk, J. (2009). Citizen Science: A Developing Tool for Expanding Science Knowledge and Scientific Literacy. *BioScience*, 59(11), 977–984. <https://doi.org/10.1525/BIO.2009.59.11.9>
- Bosch** D. & Hirschfeld E. (2002). The Ae! Hei Kalahari Heritage Park Bundle Commission on Restitution of Land Rights, Pretoria, South Africa
- Bowen-Jones**, E., & Entwistle, A. (2002). Identifying appropriate flagship species: The importance of culture and local contexts. *Oryx*, 36(2), 189–195. <https://doi.org/10.1017/S0030605302000261>
- Bowker**, G. ., & Star, S. (1999). *Sorting Things Out: Classification and Its Consequences*. MIT Press.
- Braun**, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology*, 3(2), 77–101. <https://doi.org/10.1191/1478088706qp063oa>

- Bretagnolle**, V., Denonfoux, L., & Villers, A. (2018). Are farming and birds irreconcilable? A 21-year study of bustard nesting ecology in intensive agroecosystems. *Biological Conservation*, 228(September), 27–35. <https://doi.org/10.1016/j.biocon.2018.09.031>
- Brisbois**, M. C., & de Loë, R. C. (2016). Power in Collaborative Approaches to Governance for Water: A Systematic Review. *Society and Natural Resources*, 29(7), 775–790. <https://doi.org/10.1080/08941920.2015.1080339>
- Brown**, G. (2012). Public Participation GIS (PPGIS) for regional and environmental planning: reflections on a decade of empirical research. *Urisa Journal*, 24(2), 7-18.
- Brown**, G. (2017). A Review of Sampling Effects and Response Bias in Internet Participatory Mapping (PPGIS/PGIS/VGI). *Transactions in GIS*, 21(1), 39–56. <https://doi.org/10.1111/tgis.12207>
https://espace.library.uq.edu.au/view/UQ:294305/UQ294305_OA.pdf
- Brown**, G., & Kyttä, M. (2018). Key issues and priorities in participatory mapping: Toward integration or increased specialization? *Applied Geography*, 95; 1–8.
- Brown**, G., Reed, P., & Raymond, C. M. (2020). Mapping place values: 10 lessons from two decades of public participation GIS empirical research. *Applied Geography*, 116; 102156. <https://doi.org/10.1016/j.apgeog.2020.102156>
- Brown**, G., Sanders, S., & Reed, P. (2018). Using public participatory mapping to inform general land use planning and zoning. *Landscape and Urban Planning*, 177; 64–74. <https://doi.org/10.1016/j.landurbplan.2018.04.011>
- Bull**, J. W., Ejrnæs, R., Macdonald, D. W., Svenning, J. C., & Sandom, C. J. (2019). Fences can support restoration in human-dominated ecosystems when rewilding with large predators. *Restoration Ecology*, 27(1), 198–209. <https://doi.org/10.1111/REC.12830>
- Burel**, F., & Baudry, J. (1999). *Ecologie du paysage. Concepts, méthodes et applications*. Tec & Doc Lavoisier.
- Burns**, M., Audouin, M., & Weaver, A. (2006). Advancing sustainability science in South Africa. *South African Journal of Science*, 102(9). <https://doi.org/10.10520/EJC96611>
- Burton**, A. C., Neilson, E., Moreira, D., Ladle, A., Steenweg, R., Fisher, J. T., Bayne, E., & Boutin, S. (2015). Wildlife camera trapping: A review and recommendations for linking surveys to ecological processes. *Journal of Applied Ecology*, 52(3), 675–685. <https://doi.org/10.1111/1365-2664.12432>
- Callicott**, J. B. (1989). *In Defense of the Land Ethic: Essays in Environmental Philosophy*. State University of New York Press.
- CapeNature**. 2017 WCBS George [Vector] 2007. Available from the Biodiversity GIS website, downloaded on 04 March 2018
- CapeNature**. CapeNature Fires - All 2021\22 [Vector] 2022. Available from the Biodiversity GIS website, downloaded on 07 July 2022
- Caro**, T., Engilis, A., Fitzherbert, E., & Gardner, T. (2004). Preliminary assessment of the flagship species concept at a small scale. *Animal Conservation*, 7(1), 63–70. <https://doi.org/10.1017/S136794300300115X>
- Carruthers**, J., Robins, S., Madzuzo, E., & Brenzinger M. (2003). An Assessment of the Status of the San. In W. Beinart & J. McGregor (Eds.), *Past and Future Landscape Ideology: The Kalahari Gemsbok National Park* (pp. 255–266). *Social History and African Environments*.
- Cash**, D., & Moser, S. (2000). Linking global and local scales: designing dynamic assessment and management processes. *Global Environmental Change*, 10(2), 109–120. [https://doi.org/10.1016/S0959-3780\(00\)00017-0](https://doi.org/10.1016/S0959-3780(00)00017-0)
- Cash**, D. W., Clark, W. C., Alcock, F., Dickson, N. M., Eckley, N., Guston, D. H., Jäger, J., & Mitchell, R. B. (2003). Knowledge systems for sustainable development. *Proceedings of the National Academy of Sciences of the United States of America*, 100(14), 8086–8091. <https://doi.org/10.1073/pnas.1231332100>
- Cash**, D. M., & Belloy, P. (2020). Salience, Credibility and Legitimacy in a Rapidly Shifting World of Knowledge and Action. *Sustainability*, 12(18), 7376. <https://doi.org/10.3390/su12187376>
- Ceballos**, G., Ehrlich, P. R., & Dirzo, R. (2017). Biological annihilation via the ongoing sixth mass extinction signaled by vertebrate population losses and declines. *Proceedings of the National Academy of Sciences of the United States of America*, 114(30), E6089–E6096. <https://doi.org/10.1073/pnas.1704949114>
- Chan**, K., Balvanera, P., Benessaiah, K., Chapman, M., Díaz, S., Gómez-Baggethun, E., Gould, R., Hannahs, N., Jax, K., Klain, S., Luck, G. W., Martín-López, B., Muraca, B., Norton, B., Ott, K., Pascual, U., Satterfield, T., Tadaki, M., Taggart, J., & Turner, N. (2016). Why protect nature? Rethinking values and the environment. *Proceedings of the National Academy of Sciences of the United States of America*, 113(6), 1462–1465. <https://doi.org/10.1073/pnas.1525002113>
- Chan**, K., Gould, R. K., & Pascual, U. (2018). Editorial overview: Relational values: What are they, and what's the fuss about? *Current Opinion in Environmental Sustainability*, 35; A1–A7. <https://doi.org/10.1016/j.cosust.2018.11.003>

- Chapin, F., Kofinas, G. P., & Folke, C.** (2009). Principles of ecosystem stewardship: Resilience-based natural resource management in a changing world. *Principles of Ecosystem Stewardship: Resilience-Based Natural Resource Management in a Changing World*, July 2015; 1–409. <https://doi.org/10.1007/978-0-387-73033-2>
- Chapman, M., Satterfield, T., & Chan, K. M. A.** (2019). When value conflicts are barriers: Can relational values help explain farmer participation in conservation incentive programs? *Land Use Policy*, 82; 464–475. <https://doi.org/10.1016/j.landusepol.2018.11.017>
- Charbonnier, P.** (2015). *La fin d'un grand partage* (Biblis). CNRS Editions.
- Clark, D., Artelle, K., Darimont, C., Housty, W., Tallio, C., Neasloss, D., Schmidt, A., Wiget, A., & Turner, N.** (2021). Grizzly and polar bears as nonconsumptive cultural keystone species. *Facets*, 6(1), 379–393. <https://doi.org/10.1139/facets-2020-0089>
- Clements, R.** (2004). An Investigation of the Status of Outdoor Play. *Contemporary Issues in Early Childhood*, 5(1). www.askatl.org.uk
- Cloke, P., & Jones, O.** (2004). Turning in the Graveyard: Trees and the hybrid geographies of dwelling, monitoring and resistance in a Bristol cemetery. *cultural geographies*, 11(3), 313–341. <https://doi.org/10.1191/1474474004eu300oa>
- Coe, M. A., & Gaoue, O. G.** (2020). Cultural keystone species revisited: Are we asking the right questions? *Journal of Ethnobiology and Ethnomedicine*, 16(1), 70. <https://doi.org/10.1186/s13002-020-00422-z>
- Colding, J., Lundberg, J., & Folke, C.** (2006). Incorporating Green-area User Groups in Urban Ecosystem Management. *AMBIO*, 35(5), 237–244. <https://doi.org/10.1579/05-A-098R.1>
- Colloff, M. J., Lavorel, S., van Kerkhoff, L. E., Wyborn, C. A., Fazey, I., Gorddard, R., Mace, G. M., Foden, W. B., Dunlop, M., Prentice, I. C., Crowley, J., Leadley, P., & Degeorges, P.** (2017). Transforming conservation science and practice for a postnormal world. *Conservation Biology*, 31(5), 1008–1017. <https://doi.org/10.1111/cobi.12912>
- Cooke, B., & Lane, R.** (2015). How do amenity migrants learn to be environmental stewards of rural landscapes? *Landscape and Urban Planning*, 134; 43–52. <https://doi.org/10.1016/j.landurbplan.2014.10.006>
- Cooke, B., West, S., & Boonstra, W. J.** (2016). Dwelling in the biosphere: exploring an embodied human–environment connection in resilience thinking. *Sustainability Science*, 11(5), 831–843. <https://doi.org/10.1007/s11625-016-0367-3>
- Couvret, D., & Ducarme, F.** (2014). Reconciliation ecology, from biological to social challenges. *Revue d'ethnoécologie*, 6; 0–16. <https://doi.org/10.4000/ethnoecologie.1979>
- Cowling, R. M., Macdonald, I. A. W., & Simmons, M. T.** (1996). Why is the Cape Peninsula so rich in plant species? An analysis of the independent diversity components. *Biodiversity and Conservation*, 5(5), 551–573. <https://doi.org/10.1007/BF00137609>
- Crespin, S. J., & García-Villalta, J. E.** (2014). Integration of Land-Sharing and Land-Sparing Conservation Strategies Through Regional Networking: The Mesoamerican Biological Corridor as a Lifeline for Carnivores in El Salvador. *Ambio*, 43(6), 820–824. <https://doi.org/10.1007/s13280-013-0470-y>
- Crooks, K. R., Burdett, C. L., Theobald, D. M., Rondinini, C., & Boitani, L.** (2011). Global patterns of fragmentation and connectivity of mammalian carnivore habitat. *Philosophical Transactions of the Royal Society B: Biological Sciences*, 366(1578), 2642–2651. <https://doi.org/10.1098/rstb.2011.0120>
- Curşeu, P. L., & Schruijer, S. G.** (2017). Stakeholder diversity and the comprehensiveness of sustainability decisions: the role of collaboration and conflict. *Current Opinion in Environmental Sustainability*, 28; 114–120. <https://doi.org/10.1016/j.cosust.2017.09.007>
- Daly, R., Smale, M. J., Singh, S., Anders, D., Shivji, M., Clare, C. A., Lea, J. S. E., Sousa, L. L., Wetherbee, B. M., Fitzpatrick, R., Clarke, C. R., Sheaves, M., & Barnett, A.** (2018). Refuges and risks: Evaluating the benefits of an expanded MPA network for mobile apex predators. *Diversity and Distributions*, 24(9), 1217–1230. <https://doi.org/10.1111/DDI.12758>
- Dang, A. T. N., Kumar, L., & Reid, M.** (2020). Modelling the Potential Impacts of Climate Change on Rice Cultivation in Mekong Delta, Vietnam. *Sustainability* 2020; Vol. 12; Page 9608; 12(22), 9608. <https://doi.org/10.3390/SU12229608>
- De Araújo, C. B., Marcondes-Machado, L. O., & Costa, G. C.** (2014). The importance of biotic interactions in species distribution models: a test of the Eltonian noise hypothesis using parrots. *Journal of Biogeography*, 41(3), 513–523. <https://doi.org/10.1111/JBI.12234>
- De Castro Viveiros, E.** (2014). Perspectivism and Multinaturalism in Indigenous America. *Journal Des Anthropologues*, 138–139; 161–181. <https://doi.org/10.4000/JDA.4512>
- De Vos, A., Joana, C. B., & Dirk, R.** (2018). Relational values about nature in protected area research. *Current Opinion in Environmental Sustainability*, 35; 89–99. <https://doi.org/10.1016/j.cosust.2018.10.018>

- Decaëns**, T., Martins, M. B., Feijoo, A., Oszwald, J., Dolédec, S., Mathieu, J., Arnaud de Sartre, X., Bonilla, D., Brown, G. G., Cuellar Criollo, Y. A., Dubs, F., Furtado, I. S., Gond, V., Gordillo, E., Le Clec'h, S., Marichal, R., Mitja, D., de Souza, I. M., Praxedes, C., ... Lavelle, P. (2018). Biodiversity loss along a gradient of deforestation in Amazonian agricultural landscapes. *Conservation Biology*, 32(6), 1380–1391. <https://doi.org/10.1111/COBI.13206>
- Descola**. (2005). *Beyond Nature and Culture* (Reprint ed). University of Chicago Press.
- Devictor**, V. (2018). La prise en charge technoscientifique de la crise de la biodiversité. 1–242.
- Devictor**, V., & Bensaude-Vincent, B. (2016). From ecological records to big data: the invention of global biodiversity. *History and Philosophy of the Life Sciences*, 38(4), 13. <https://doi.org/10.1007/s40656-016-0113-2>
- Devictor**, V., Whittaker, R. J., & Beltrame, C. (2010). Beyond scarcity: Citizen science programmes as useful tools for conservation biogeography. *Diversity and Distributions*, 16(3), 354–362. <https://doi.org/10.1111/j.1472-4642.2009.00615.x>
- Dickman**, A. J. (2008). Key determinants of conflict between people and wildlife, particularly large carnivores, around Ruaha National Park, Tanzania. *Zoological Society of London*, 1–373.
- Dormann**, C. F., Bobrowski, M., Dehling, D. M., Harris, D., Hartig, F., Lischke, H., Moretti, M., Pagel, J., Pinkert, S., Schleuning, M., Schmidt, S., Sheppard, C., Steinbauer, M. J., Zeuss, D., & Kraan, C. (2018). Biotic interactions in species distribution modelling: 10 questions to guide interpretation and avoid false conclusions. *Global Ecology and Biogeography*, 27(9), 1004–1016. <https://doi.org/10.1111/geb.12759>
- Dray**, S., & Dufour, A. B. (2007). The ade4 package: Implementing the duality diagram for ecologists. *Journal of Statistical Software*, 22(4), 1–20. <https://doi.org/10.18637/jss.v022.i04>
- Dressler**, W., de Koning, J., Montefrio, M., & Firn, J. (2016). Land sharing not sparing in the “green economy”: The role of livelihood bricolage in conservation and development in the Philippines. *Geoforum*, 76, 75–89. <https://doi.org/10.1016/j.geoforum.2016.09.003>
- Dryzek**, J. S. (2013). *The politics of the earth*. (2021 (ed.)). Oxford University Press.
- Ducarme**, F., & Couvet, D. (2020). What does ‘nature’ mean? *Palgrave Communications*, 6(1), 1–8. <https://doi.org/10.1057/s41599-020-0390-y>
- Edwards**, D. P., Gilroy, J. J., Thomas, G. H., Uribe, C. A. M., & Haugaasen, T. (2015). Land-Sparing Agriculture Best Protects Avian Phylogenetic Diversity. *Current Biology*, 25(18), 2384–2391. <https://doi.org/10.1016/j.cub.2015.07.063>
- Elith**, J., H. Graham, C., P. Anderson, R., Dudík, M., Ferrier, S., Guisan, A., J. Hijmans, R., Huettmann, F., R. Leathwick, J., Lehmann, A., Li, J., G. Lohmann, L., A. Loiselle, B., Manion, G., Moritz, C., Nakamura, M., Nakazawa, Y., McC. M. Overton, J., Townsend Peterson, A., (...) E. Zimmermann, N. (2006). Novel methods improve prediction of species’ distributions from occurrence data. *Ecography*, 29(2), 129–151. <https://doi.org/10.1111/j.2006.0906-7590.04596.x>
- Elith**, J., Kearney, M., & Phillips, S. (2010). The art of modelling range-shifting species. *Methods in Ecology and Evolution*, 1(4), 330–342. <https://doi.org/10.1111/j.2041-210x.2010.00036.x>
- Ellis**, E. C., Gauthier, N., Goldewijk, K. K., Bird, R. B., Boivin, N., Díaz, S., Fuller, D. Q., Gill, J. L., Kaplan, J. O., Kingston, N., Locke, H., McMichael, C. N. H. H., Ranco, D., Rick, T. C., Rebecca Shaw, M., Stephens, L., Svenning, J.-C. C., Watson, J. E. M. M., Klein Goldewijk, K., ... Watson, J. E. M. M. (2021). People have shaped most of terrestrial nature for at least 12;000 years. *Proceedings of the National Academy of Sciences*, 118(17), 1–8. <https://doi.org/10.1073/pnas.2023483118>
- Enqvist**, J. P., West, S., Masterson, V. A., Haider, L. J., Svedin, U., & Tengö, M. (2018). Stewardship as a boundary object for sustainability research: Linking care, knowledge and agency. *Landscape and Urban Planning*, 179(July), 17–37.
- Ernoul**, L., Mathevet, R., Wardell-Johnson, A., Sandoz, A., Willm, L., & Boutron, O. (2018). Integrative science to achieve long-term impact in conservation: The use of participatory mapping to improve trans-disciplinarity. *Frontiers in Ecology and Evolution*, 6(DEC), 2016–2019. <https://doi.org/10.3389/fevo.2018.00207>
- Fauvelle**, F.-X. (2006). *Histoire de l’Afrique du Sud* (2013th ed.). Seuil.
- Fauvelle**, F.-X. (2018). *L’invention du Hottentot*. Editions de la Sorbonne.
- Ferdinand**, M. (2022). *A Decolonial Ecology: Thinking from the Caribbean World*. Polity Press.
- Ferris**, N. P., Condy, J., Barnett, I., & Armstrong, R. B. (1989). Experimental infection of eland (*Taurotragus oryx*), sable antelope (*Ozanna grandicomis*) and buffalo (*Syncerus caffer*) with foot-and-mouth disease virus. *Journal of Comparative Pathology*, 101(3), 307–316. [https://doi.org/10.1016/0021-9975\(89\)90040-6](https://doi.org/10.1016/0021-9975(89)90040-6)
- Findlay**, L. J., & Hill, R. A. (2020). Baboon and vervet monkey crop-foraging behaviors on a commercial South African farm: preliminary implications for damage mitigation. *Human-Wildlife Interactions*, 2020; Vol.14(3), Pp.505-518 [Peer Reviewed Journal]. <https://doi.org/10.26077/5DBC-B920>

- Fischer**, J., Abson, D. J., Butsic, V., Chappell, M. J., Ekroos, J., Hanspach, J., Kuemmerle, T., Smith, H. G., & von Wehrden, H. (2014). Land sparing versus land sharing: Moving forward. *Conservation Letters*, 7(3), 149–157. <https://doi.org/10.1111/conl.12084>
- Foggin**, J. M., Brombal, D., & Razmkhah, A. (2021). Thinking Like a Mountain: Exploring the Potential of Relational Approaches for Transformative Nature Conservation. *Sustainability* 2021; Vol. 13; Page 12884; 13(22), 12884. <https://doi.org/10.3390/SU132212884>
- Folke**, C., & Berkes, F. (1998). Linking Social and Ecological Systems: Management Practices and Social Mechanisms for Building Resilience. Cambridge University Press.
- Folke**, C. (2016). Resilience (Republished). *Ecology and Society*, 21(4), art44. <https://doi.org/10.5751/ES-09088-210444>
- Folke**, C., Biggs, R., Norström, A. V., Reyers, B., & Rockström, J. (2016). Social-ecological resilience and biosphere-based sustainability science. *Ecology and Society*, 21(3). <https://doi.org/10.5751/ES-08748-210341>
- Folke**, C., Carpenter, S. R., Walker, B., Scheffer, M., Chapin, T., & Rockström, J. (2010). Resilience thinking: Integrating resilience, adaptability and transformability. *Ecology and Society*, 15(4). <https://doi.org/10.5751/ES-03610-150420>
- Fourcade**, Y., Engler, J. O., Besnard, A. G., Rödder, D., & Secondi, J. (2013). Confronting expert-based and modelled distributions for species with uncertain conservation status: A case study from the corncrake (*Crex crex*). *Biological Conservation*, 167; 161–171. <https://doi.org/10.1016/j.biocon.2013.08.009>
- Fourcade**, Y., Engler, J. O., Rödder, D., & Secondi, J. (2014). Mapping species distributions with MAXENT using a geographically biased sample of presence data: A performance assessment of methods for correcting sampling bias. *PLoS ONE*, 9(5), 1–13. <https://doi.org/10.1371/journal.pone.0097122>
- Fournier**, A., Barbet-Massin, M., Rome, Q., & Courchamp, F. (2017). Predicting species distribution combining multi-scale drivers. *Global Ecology and Conservation*, 12; 215–226. <https://doi.org/10.1016/j.gecco.2017.11.002>
- Frank**, B. (2016). Human–Wildlife Conflicts and the Need to Include Tolerance and Coexistence: An Introductory Comment. *Society and Natural Resources*, 29(6), 738–743. <https://doi.org/10.1080/08941920.2015.1103388>
- Fritz**, H. (2005). Réserves et Aires Protégées : Les échelles d'intervention et les contraintes territoriales face à la dimension spatio-temporelle des processus écologiques. In P. Marty, F.-D. Vivien, J. Lepart, & R. Larrère (Eds.), *Les biodiversités : objets, théories, pratiques* (pp. 143–156). CNRS Editions.
- Fuenmayor**, R. (1991). The roots of reductionism: A counter-ontoepistemology for a systems approach. *Systems Practice*, 4(5), 419–448. <https://doi.org/10.1007/BF01104460>
- Gaard**, G., & Gruen, L. (1993). Ecofeminism: Toward Global Justice and Planetary Health. *Society and Nature*, 2(1).
- Gaoue**, O. G., Coe, M. A., Bond, M., Hart, G., Seyler, B. C., & McMillen, H. (2017). Theories and Major Hypotheses in Ethnobotany. *Economic Botany*, 2017 71:3; 71(3), 269–287. <https://doi.org/10.1007/S12231-017-9389-8>
- García-Nieto**, A. P., Quintas-Soriano, C., García-Llorente, M., Palomo, I., Montes, C., & Martín-López, B. (2015). Collaborative mapping of ecosystem services: The role of stakeholders' profiles. *Ecosystem Services*, 13; 141–152. <https://doi.org/10.1016/j.ecoser.2014.11.006>
- Garibaldi**, A., & Turner, N. (2004). Cultural keystone species: implications for ecological conservation and restoration. *Ecology and Society*, 9(1). <https://about.jstor.org/terms>
- Gaston**, K. J., & Soga, M. (2020). Extinction of experience: The need to be more specific. *People and Nature*, 2(3), 575–581. <https://doi.org/10.1002/pan3.10118>
- Geldmann**, J., Manica, A., Burgess, N. D., Coad, L., & Balmford, A. (2019). A global-level assessment of the effectiveness of protected areas at resisting anthropogenic pressures. *Proceedings of the National Academy of Sciences of the United States of America*, 116(46), 23209–23215. https://doi.org/10.1073/PNAS.1908221116/SUPPL_FILE/PNAS.1908221116.SAPP.PDF
- Gilligan**, C. (1982). In *A Different Voice: Psychological Theory And Women's Development*. Harvard University Press. <https://works.swarthmore.edu/alum-books/2941/>
- Godelier**, M. (1984). *L'idéal et le matériel*. Fayard.
- Godsoe**, W., & Harmon, L. J. (2012). How do species interactions affect species distribution models? *Ecography*, 35(9), 811–820. <https://doi.org/10.1111/j.1600-0587.2011.07103.x>
- Goodman**, L. A. (1961). Snowball Sampling. *Annals of Mathematical Statistics*, 32(1), 148–170. <https://doi.org/10.1214/aoms/1177705148>
- Grant**, J., & Tomaselli, K. G. (2022). Rethinking Khoe and San Indigeneity, Language and Culture in Southern Africa. Taylor & Francis.

- Green, R. E., Cornell, S. J., Scharlemann, J. P. W., & Balmford, A. (2005).** Farming and the fate of wild nature. *Science*, 307(5709), 550–555. <https://doi.org/10.1126/science.1106049>
- Guerbois, C., Brady, U., de Swardt, A. G., & Fabricius, C. (2019).** Nurturing ecosystem-based adaptations in South Africa's Garden Route: a common pool resource governance perspective. *Regional Environmental Change*, 19(7), 1849–1863. <https://doi.org/10.1007/s10113-019-01508-5>
- Guerbois, C., Chapanda, E., & Fritz, H. (2012).** Combining multi-scale socio-ecological approaches to understand the susceptibility of subsistence farmers to elephant crop raiding on the edge of a protected area. *Journal of Applied Ecology*, 49(5), 1149–1158. <https://doi.org/10.1111/j.1365-2664.2012.02192.x>
- Hague, A., Fischer, A., Byg, A., Juarez-Bourke, A., Herrett, S., & Eastwood, A. (2022).** Conservation in conversation: People's perspectives on a woodland with high conservation value—A qualitative study. *People and Nature*. <https://doi.org/10.1002/pan3.10372>
- Hakkarainen, V., Soini, K., Dessein, J., & Raymond, C. M. (2022).** Place-embedded agency: Exploring knowledge–place connections for enabling plurality in governance of social–ecological systems. *People and Nature*, February 1–18. <https://doi.org/10.1002/pan3.10365>
- Hall, J. R. (1984).** Temporality, Social Action, and the Problem of Quantification in Historical Analysis. *Historical Analysis, Historical Methods: A Journal of Quantitative and Interdisciplinary History*, 17(4), 206–218. <https://doi.org/10.1080/01615440.1984.10594135>
- Harmange, C., Bretagnolle, V., Sarasa, M., & Pays, O. (2019).** Changes in habitat selection patterns of the gray partridge *Perdix perdix* in relation to agricultural landscape dynamics over the past two decades. *Ecology and Evolution*, 9(9), 5236–5247. <https://doi.org/10.1002/ece3.5114>
- Haudricourt, A.-G. (1962).** Domestication des animaux, culture des plantes et traitement d'autrui. *Homme*, 2(1), 40–50. <https://doi.org/10.3406/HOM.1962.366448>
- Hevia, V., Martín-López, B., Palomo, S., García-Llorente, M., de Bello, F., & González, J. A. (2017).** Trait-based approaches to analyze links between the drivers of change and ecosystem services: Synthesizing existing evidence and future challenges. *Ecology and Evolution*, 7(3), 831–844. <https://doi.org/10.1002/ece3.2692>
- Hill, R., Davies, J., Bohnet, I. C., Robinson, C. J., Maclean, K., & Pert, P. L. (2015).** Collaboration mobilises institutions with scale-dependent comparative advantage in landscape-scale biodiversity conservation. *Environmental Science and Policy*, 51, 267–277. <https://doi.org/10.1016/j.envsci.2015.04.014>
- Hofferth, S. L. (2009).** Changes in American children's time - 1997 to 2003. *Electronic International Journal of Time Use Research*, 6(1), 26–47. <https://doi.org/10.13085/EIJTUR.6.1.26-47>
- Hoffman, T. S., & O'Riain, M. J. (2011).** The Spatial Ecology of Chacma Baboons (*Papio ursinus*) in a Human-modified Environment. *International Journal of Primatology*, 32(2), 308–328. <https://doi.org/10.1007/s10764-010-9467-6>
- Hoffman, T. S., & O'Riain, M. J. (2012).** Landscape requirements of a primate population in a human-dominated environment. *Frontiers in Zoology*, 9(1), 1. <https://doi.org/10.1186/1742-9994-9-1>
- Horcea-Milcu, A. I., Zaman, S., Filyushkina, A., López-Rodríguez, M. D., Cebrián-Piqueras, M. A., & Raymond, C. M. (2022).** The relationship between values and knowledge in visioning for landscape management: relevance for a collaborative approach. *Ecosystems and People*, 18(1), 498–513. <https://doi.org/10.1080/26395916.2022.2108498>
- Hugé, J., & Mukherjee, N. (2018).** The nominal group technique in ecology & conservation: Application and challenges. *Methods in Ecology and Evolution*, 9(1), 33–41. <https://doi.org/10.1111/2041-210X.12831>
- Ingold, T. (1993).** The art of translation in a continuous world. In G. Palsson (Ed.), *Beyond Boundaries: Understanding, Translation and Anthropological Discourse* (pp. 210–230). Routledge. <https://doi.org/10.4324/9781003135159-10>
- Ingold, T. (1995).** Work, Time and Industry. *Time & Society*, 4(1), 5–28. <https://doi.org/10.1177/0961463x95004001001>
- Ingold, T. (2000).** *The perception of the environment: essays on livelihood, dwelling and skill*. Routledge.
- Ingold, T. (2004).** Culture on the Ground. *Journal of Material Culture*, 9(3), 315–340. <https://doi.org/10.1177/1359183504046896>
- Ingold, T. (2011).** *Being alive: essays on movement, knowledge and description*. Routledge. <https://www.routledge.com/Being-Alive-Essays-on-Movement-Knowledge-and-Description/Ingold/p/book/9781032052311>
- Iranzo, E. C., Wittmer, H. U., Traba, J., Acebes, P., Mata, C., & Malo, J. E. (2018).** Predator occurrence and perceived predation risk determine grouping behavior in guanaco (*Lama guanicoe*). *Ethology*, 124(5), 281–289. <https://doi.org/10.1111/ETH.12727>
- Irwin, A. (1995).** *Citizen Science: A Study of People, Expertise and Sustainable Development*. Routledge.

- Jaureguiberry**, P., Titeux, N., Wiemers, M., Bowler, D. E., Coscieme, L., Golden, A. S., Guerra, C. A., Jacob, U., Takahashi, Y., Settele, J., Díaz, S., Molnár, Z., & Purvis, A. (2022). The direct drivers of recent global anthropogenic biodiversity loss. *Science Advances*, 8(45). <https://doi.org/10.1126/sciadv.abm9982>
- Jax**, K., Calestani, M., Chan, K. M., Eser, U., Keune, H., Muraca, B., O'Brien, L., Potthast, T., Voget-Kleschin, L., & Wittmer, H. (2018). Caring for nature matters a relational approach for understanding nature's contributions to human well-being. *Current Opinion in Environmental Sustainability*, 35; 22–29. <https://doi.org/10.1016/j.cosust.2018.10.009>
- Johansson**, Ö., Rauset, G. R., Samelius, G., McCarthy, T., Andrén, H., Tumursukh, L., & Mishra, C. (2016). Land sharing is essential for snow leopard conservation. *Biological Conservation*, 203; 1–7. <https://doi.org/10.1016/j.biocon.2016.08.034>
- Jones**, K. R., Venter, O., Fuller, R. A., Allan, J. R., Maxwell, S. L., Negret, P. J., & Watson, J. E. M. (2018). One-third of global protected land is under intense human pressure. *Science*, 360(6390), 788–791. https://doi.org/10.1126/SCIENCE.AAP9565/SUPPL_FILE/AAP9565_JONES_SM.PDF
- Kansky**, R., Kidd, M., & Knight, A. T. (2016). A wildlife tolerance model and case study for understanding human wildlife conflicts. *Biological Conservation*, 201; 137–145. <https://doi.org/10.1016/j.biocon.2016.07.002>
- Kansky**, R., & Knight, A. T. (2014). Key factors driving attitudes towards large mammals in conflict with humans. *Biological Conservation*, 179; 93–105. <https://doi.org/10.1016/j.biocon.2014.09.008>
- Kauffman**, S. A. (2008). Reinventing the sacred : A new view on science, reason and religion. Basic Books.
- Kepe**, T., Wynberg, R., & Ellis, W. (2005). Land reform and biodiversity conservation in South Africa: complementary or in conflict? *International Journal of Biodiversity Science & Management*, 1(1), 3–16. <https://doi.org/10.1080/17451590509618075>
- Kheswa**, E. Z., Ramesh, T., Kalle, R., & Downs, C. T. (2018). Habitat use by honey badgers and the influence of predators in iSimangaliso Wetland Park, South Africa. *Mammalian Biology*, 90, 22–29. <https://doi.org/10.1016/j.mambio.2018.01.009>
- Kia-Keating**, M., & Juang, L. P. (2022). Participatory science as a decolonizing methodology: Leveraging collective knowledge from partnerships with refugee and immigrant communities. *Cultural Diversity and Ethnic Minority Psychology*, 28(3), 299. <https://doi.org/10.1037/CDP0000514>
- Knippenberg**, L., de Groot, W. T., van den Born, R. J., Knights, P., & Muraca, B. (2018). Relational value, partnership, eudaimonia: a review. *Current Opinion in Environmental Sustainability*, 35; 39–45. <https://doi.org/10.1016/j.cosust.2018.10.022>
- Knudsen**, A. (1998). Beyond cultural relativism? Tim Ingold's « ontology of dwelling ». CMI Working Paper WP. <https://open.cmi.no/cmi-xmlui/handle/11250/2436151>
- Kohn**, E. (2013). How Forests Think: Toward an Anthropology Beyond the Human. In Second Opinion. University of California Press. <https://www.ucpress.edu/book/9780520276116/how-forests-think>
- König**, H. J., Ceașu, S., Reed, M., Kendall, H., Hemminger, K., Reinke, H., Ostermann-Miyashita, E., Wenz, E., Eufemia, L., Hermanns, T., Klose, M., Spyra, M., Kuemmerle, T., & Ford, A. T. (2021). Integrated framework for stakeholder participation: Methods and tools for identifying and addressing human–wildlife conflicts. *Conservation Science and Practice*, 3(3), 1–18. <https://doi.org/10.1111/csp2.399>
- König**, H. J., Kiffner, C., Kramer-Schadt, S., Fürst, C., Keuling, O., Ford, A. T., Kramer-Schadt, S., Fürst, C., Keuling, O., & Ford, A. T. (2020). Human–wildlife coexistence in a changing world. *Conservation Biology*, 34(4), 786–794. <https://doi.org/10.1111/cobi.13513>
- Koot**, S. (2016). Contradictions of capitalism in the South African Kalahari: Indigenous Bushmen, their brand and baasskap in tourism. *Journal of Sustainable Tourism*, 24(8-9), 1211–1226. <https://doi.org/10.1080/09669582.2016.1158825>
- Koskinen**, I. (2020). Defending a Risk Account of Scientific Objectivity. <https://doi.org/10.1093/Bjps/Axy053>; 71(4), 1187–1207. <https://doi.org/10.1093/Bjps/AXY053>
- Kramer-Schadt**, S., Reinfelder, V., Niedballa, J., Lindenborn, J., Stillfried, M., Heckmann, I., & Wilting, A. (2016). The Borneo carnivore database and the application of predictive distribution modelling. *Raffles Bulletin of Zoology*, 2016(33), 18–41.
- Kronenberg**, J., Andersson, E., & Tryjanowski, P. (2017). Connecting the social and the ecological in the focal species concept: case study of White Stork. *Nature Conservation*, 22: 79–105; 22; 79–105. <https://doi.org/10.3897/NATURECONSERVATION.22.12055>
- Larrère**, C., & Larrère, R. (1997). Les philosophies de l'environnement. Presses Universitaires de France.
- Larrère**, C., & Larrère, R. (2018). Penser et agir avec la nature Une enquête philosophique (Sciences h). La découverte.
- Larrère**, C. (2012). L'écoféminisme : féminisme écologique ou écologie féministe. *Revue Tracés*, 22, 105–121. <https://doi.org/10.4000/traces.5454>

- Latour, B.** (2004). *Politics of Nature*. In *Politics of Nature*. Harvard University Press.
<https://doi.org/10.2307/j.ctv1bzfprt>
- Lentini, P. E., & Wintle, B. A.** (2015). Spatial conservation priorities are highly sensitive to choice of biodiversity surrogates and species distribution model type. *Ecography*, 38(11), 1101–1111.
<https://doi.org/10.1111/ecog.01252>
- Lévy, B.** (2001). Des humanistes suisses et européens au cœur des Alpes : perception et représentation précoces de la montagne de Conrad Gesner (1516-1565) à Rousseau. *Le Globe. Revue Genevoise de Géographie*, 141(1), 89–100. <https://doi.org/10.3406/GLOBE.2001.1440>
- Loconto, A., Desquilbet, M., Moreau, T., Couvet, D., & Dorin, B.** (2020). The land sparing – land sharing controversy: Tracing the politics of knowledge. *Land Use Policy*, 96(September), 1–13.
<https://doi.org/10.1016/j.landusepol.2018.09.014>
- Longino, H.** (1990). *Science as Social Knowledge*. Princeton University Press.
- Lovelock, J.** (1987). *Gaia : A New Look at Life on Earth*. Oxford University Press, USA.
- Lozano, J., Olszańska, A., Morales-Reyes, Z., Castro, A. A., Malo, A. F., Moleón, M., Sánchez-Zapata, J. A., Cortés-Avizanda, A., von Wehrden, H., Dorresteyn, I., Kansky, R., Fischer, J., & Martín-López, B.** (2019). Human-carnivore relations: A systematic review. *Biological Conservation*, 237(June), 480–492.
<https://doi.org/10.1016/j.biocon.2019.07.002>
- Mace, G. M.** (2014). Whose conservation? Changes in the perception and goals of nature conservation require a solid scientific basis. *Science*, 245(6204), 1558–1560. <https://doi.org/10.1126/science.1254704>
- Madden, F.** (2004a). Can traditions of tolerance help minimize conflict? An exploration of cultural factors supporting human-wildlife coexistence. *Policy Matters*, 13; 234–241.
- Madden, F.** (2004b). Creating coexistence between humans and wildlife: Global perspectives on local efforts to address Human-Wildlife conflict. *Human Dimensions of Wildlife*, 9(4), 247–257.
<https://doi.org/10.1080/10871200490505675>
- Madden, F., & McQuinn, B.** (2014). Conservation's blind spot: The case for conflict transformation in wildlife conservation. *Biological Conservation*, 178; 97–106.
<https://doi.org/10.1016/j.biocon.2014.07.015>
- Mamo, A., Lemessa, D., Diriba, O. H., & Hunde, D.** (2021). Pattern of crop raiding by wild large mammals and the resultant impacts vary with distances from forests in Southwest Ethiopia. *Ecology and Evolution*, 11(7), 3203-3209. <https://doi.org/10.1002/ece3.7268>
- Masterson, V. A., Enqvist, J. P., Stedman, R. C., & Tengö, M.** (2019). Sense of place in social-ecological systems: from theory to empirics. *Sustainability Science*, 14(3), 555–564.
<https://doi.org/10.1007/s11625-019-00695-8>
- Mathevet, R., Bousquet, F., & Raymond, C. M.** (2018a). The concept of stewardship in sustainability science and conservation biology. *Biological Conservation*, 217(March 2017), 363–370.
<https://doi.org/10.1016/j.biocon.2017.10.015>
- Mathevet, R., Bousquet, F., Larrère, C., & Larrère, R.** (2018b). Environmental Stewardship and Ecological Solidarity: Rethinking Social-Ecological Interdependency and Responsibility. *Journal of Agricultural and Environmental Ethics*, 31(5), 605–623. <https://doi.org/10.1007/s10806-018-9749-0>
- Mazué, F., Guerbois, C., Fritz, H., Rebout, N., & Petit, O.** (2022). Less bins, less baboons: reducing access to anthropogenic food effectively decreases the urban foraging behavior of a troop of chacma baboons (*Papio hamadryas ursinus*) in a peri-urban area. *Primates*. <https://doi.org/10.1007/s10329-022-01032-x>
- McGowan, J., Beaumont, L. J., Smith, R. J., Chauvenet, A. L. M., Harcourt, R., Atkinson, S. C., Mittermeier, J. C., Esperon-Rodriguez, M., Baumgartner, J. B., Beattie, A., Dudaniec, R. Y., Grenyer, R., Nipperess, D. A., Stow, A., & Possingham, H. P.** (2020). Conservation prioritization can resolve the flagship species conundrum. *Nature Communications*, 11(1). <https://doi.org/10.1038/s41467-020-14554-z>
- McGregor, D., Whitaker, S. M., & Sritharan, M.** (2020). Indigenous environmental justice and sustainability. *Current Opinion in Environmental Sustainability*, 43, 35-40. <https://doi.org/10.1016/j.cosust.2020.01.007>
- McGregor, D., Restoule, J. P., & Johnston, R.** (Eds.). (2018). *Indigenous research: Theories, practices, and relationships*. Canadian Scholars' Press.
- Meadows, D.** (1999). *Leverage Points: Places to Intervene in a System*. The Sustainability Institute.
- Miller, J. R.** (2005). Biodiversity conservation and the extinction of experience. *Trends in Ecology and Evolution*, 20(8), 430–434. <https://doi.org/10.1016/j.tree.2005.05.013>
- Moi, D. A., Lansac-Tôha, F. M., Romero, G. Q., Sobral-Souza, T., Cardinale, B. J., Kratina, P., Perkins, D. M., Teixeira de Mello, F., Jeppesen, E., Heino, J., Lansac-Tôha, F. A., Velho, L. F. M., & Mormul, R. P.** (2022). Human pressure drives biodiversity-multifunctionality relationships in large Neotropical wetlands. *Nature Ecology & Evolution* 2022 6:9; 6(9), 1279–1289. <https://doi.org/10.1038/s41559-022-01827-7>

- Monnet**, A.-C., Hingrat, Y., & Jiguet, F. (2015). The realized niche of captive-hatched Houbara Bustards translocated in Morocco meets expectations from the wild. *Biological Conservation*, 186; 241–250. <https://doi.org/10.1016/j.biocon.2015.03.013>
- Morin**, E. (1982). *Science avec conscience* (2017th ed.). Points.
- Morin**, E. (1994). *La complexité humaine*. Flammarion.
- Nègre**, E. (2022). PXE International, association de défense de patients et organisme de recherche : Intérêts épistémologiques d'une démarche de Sciences Citoyennes. Université de Lorraine.
- Nieto-Romero**, M., Oteros-Rozas, E., González, J. A., & Martín-López, B. (2014). Exploring the knowledge landscape of ecosystem services assessments in Mediterranean agroecosystems: Insights for future research. *Environmental Science and Policy*, 37; 121–133. <https://doi.org/10.1016/j.envsci.2013.09.003>
- Noakes**, M. J., & McKechnie, A. E. (2020). Phenotypic flexibility of metabolic rate and evaporative water loss does not vary across a climatic gradient in an Afrotropical passerine bird. *Journal of Experimental Biology*, 223(7). <https://doi.org/10.1242/jeb.220137>
- Northern Cape Department of Environment and Nature Conservation**. 2016 Northern Cape Critical Biodiversity Areas [Vector] 0. Available from the Biodiversity GIS website, downloaded on 02 July 2020
- Obura**, D. O., Katerere, Y., Mayet, M., Kaelo, D., Msweli, S., Mather, K., Harris, J., Louis, M., Kramer, R., Teferi, T., Samoilys, M., Lewis, L., Bennie, A., Kumah, F., Isaacs, M., & Nantongo, P. (2021). Integrate biodiversity targets from local to global levels. *Science*, 373(6556), 746–748. <https://doi.org/10.1126/SCIENCE.ABH2234/ASSET/330E1FB5-2E1A-4148-9753-1B2BAA3F2623/ASSETS/IMAGES/LARGE/SCIENCE.ABH2234-F1.JPG>
- Odum**, E., & Odum, H. (1959). *Fundamentals of Ecology* (2nd edition). W.B. Saunders. <https://www.amazon.com/Fundamentals-Ecology-Collaboration-Howard-Odum/dp/B0018QZMS0>
- Opdam**, P., Luque, S., Nassauer, J., Verburg, P. H., & Wu, J. (2018). How can landscape ecology contribute to sustainability science? *Landscape Ecology* 2018 33:1; 33(1), 1–7. <https://doi.org/10.1007/S10980-018-0610-7>
- Osborn**, F. V., & Parker, G. E. (2003). Linking two elephant refuges with a corridor in the communal lands of Zimbabwe. *African Journal of Ecology*, 41(1), 68–74. <https://doi.org/10.1046/j.1365-2028.2003.00413.x>
- Paine**, R. T. (1969). The Pisaster-Tegula Interaction: Prey Patches, Predator Food Preference, and Intertidal Community Structure. *Ecology*, 50(6), 950–961. <https://doi.org/10.2307/1936888>
- Palomo**, I., Martín-López, B., Zorrilla-Miras, P., García Del Amo, D., & Montes, C. (2014). Deliberative mapping of ecosystem services within and around Doñana National Park (SW Spain) in relation to land use change. *Regional Environmental Change*, 14(1), 237–251. <https://doi.org/10.1007/s10113-013-0488-5>
- Pardo**, L. E., Bombaci, S., Huebner, S. E., Somers, M. J., Fritz, H., Downs, C., Guthmann, A., Hetem, R. S., Keith, M., le Roux, A., Mqgatsa, N., Packer, C., Palmer, M. S., Parker, D. M., Peel, M., Slotow, R., Maartin Strauss, W., Swanepoel, L., Tambling, C., ... Venter, J. A. (2021). Snapshot Safari: A large-scale collaborative to monitor Africa's remarkable biodiversity. *South African Journal of Science*, 117(1–2). <https://doi.org/10.17159/SAJS.2021/8134>
- Pascual**, U., Adams, W. M., Díaz, S., Lele, S., Mace, G. M., & Turnhout, E. (2021). Biodiversity and the challenge of pluralism. *Nature Sustainability*, 4(7), 567–572. <https://doi.org/10.1038/s41893-021-00694-7>
- Pascual**, U., Balvanera, P., Díaz, S., Pataki, G., Roth, E., Stenseke, M., Watson, R. T., Başak Dessane, E., Islar, M., Kelemen, E., Maris, V., Quaas, M., Subramanian, S. M., Wittmer, H., Adlan, A., Ahn, S., Al-Hafedh, Y. S., Amankwah, E., Asah, S. T., ... Yagi, N. (2017). Valuing nature's contributions to people: the IPBES approach. *Current Opinion in Environmental Sustainability*, 26–27; 7–16. <https://doi.org/10.1016/j.cosust.2016.12.006>
- Pebsworth**, P. (2020). Feeding ecology of chacma baboons (*Papio ursinus*) living in a human-modified environment. *African Journal of Ecology*, 58(2), 319–326. <https://doi.org/10.1111/aje.12684>
- Pebsworth**, P. A., MacIntosh, A. J. J., Morgan, H. R., & Huffman, M. A. (2012). Factors Influencing the Ranging Behavior of Chacma Baboons (*Papio hamadryas ursinus*) Living in a Human-Modified Habitat. *International Journal of Primatology*, 33(4), 872–887. <https://doi.org/10.1007/s10764-012-9620-5>
- Pédarros**, É., Coetzee, T., Fritz, H., & Guébois, C. (2020). Rallying citizen knowledge to assess wildlife occurrence and habitat suitability in anthropogenic landscapes. *Biological Conservation*, 242(January), 108407. <https://doi.org/10.1016/j.biocon.2020.108407>
- Penjor**, U., Kaszta, Ž., Macdonald, D. W., & Cushman, S. A. (2021). Prioritizing areas for conservation outside the existing protected area network in Bhutan: the use of multi-species, multi-scale habitat suitability models. *Landscape Ecology*, 36(5), 1281–1309. <https://doi.org/10.1007/s10980-021-01225-7>

- Pergams, O. R. W., & Zaradic, P. A. (2006).** Is love of nature in the US becoming love of electronic media? 16-year downtrend in national park visits explained by watching movies, playing video games, internet use, and oil prices. *Journal of Environmental Management*, 80(4), 387–393. <https://doi.org/10.1016/J.JENVMAN.2006.02.001>
- Peterson, M. N., Birckhead, J. L., Leong, K., Peterson, M. J., & Peterson, T. R. (2010).** Rearticulating the myth of human-wildlife conflict. *Conservation Letters*, (Vol. 3; Issue 2; pp. 74–82). <https://doi.org/10.1111/j.1755-263X.2010.00099.x>
- Phalan, B. T. (2018).** What have we learned from the land sparing-sharing model? *Sustainability (Switzerland)*, 10(6), 1–24. <https://doi.org/10.3390/su10061760>
- Piaget, J. (1972).** The epistemology of interdisciplinary relationships. In L. Apostel, G. Berger, A. Briggs, & G. Michaud (Eds.), *Interdisciplinarity: problems of teaching and research in universities* (pp. 127–139). OECD.
- Pillay, R. (2022).** Humans pressure wetland multifunctionality. *Nature Ecology & Evolution* 2022 6:9; 6(9), 1250–1251. <https://doi.org/10.1038/s41559-022-01842-8>
- Platten, S., & Henfrey, T. (2009).** The cultural keystone concept: Insights from ecological anthropology. *Human Ecology*, 37(4), 491–500. <https://doi.org/10.1007/s10745-009-9237-2>
- Plotkin, H. C. (2003).** *The imagined world made real: Towards a natural science of culture*. Rutgers University Press.
- Plumwood, V. (1998).** Wilderness Skepticism and Wilderness Dualism. In B. J. Callicott & M. . Nelson (Eds.), *The Great New Wilderness Debate* (pp. 652–690). University of Georgia Press.
- Pocock, M. J. O., Chandler, M., Bonney, R., Thornhill, I., Albin, A., August, T., Bachman, S., Brown, P. M. J., Cunha, D. G. F., Grez, A., Jackson, C., Peters, M., Rabarijaon, N. R., Roy, H. E., Zaviezo, T., & Danielsen, F. (2018).** A Vision for Global Biodiversity Monitoring With Citizen Science (pp. 169–223). <https://doi.org/10.1016/bs.aecr.2018.06.00>
- Pollock, L. J., O'Connor, L. M. J., Mokany, K., Rosauer, D. F., Talluto, M. V., & Thuiller, W. (2020).** Protecting Biodiversity (in All Its Complexity): New Models and Methods. *Trends in Ecology & Evolution*, 35(12), 1119–1128. <https://doi.org/10.1016/j.tree.2020.08.015>
- Pooley, S., Bhatia, S., & Vasava, A. (2021).** Rethinking the study of human–wildlife coexistence. *Conservation Biology*, 35(3), 784–793. <https://doi.org/10.1111/cobi.13653>
- Preiser, R., Biggs, R., De Vos, A., & Folke, C. (2018).** Social-ecological systems as Complex Adaptive Systems. *Ecology and Society*, 23(4), 46. <https://dx.doi.org/10.5751/es-02857-140203>
- Preiser, R., Schlüter, M., Biggs, R., Mancilla García, M., Haider, J., Hertz, T., & Klein, L. (2021a).** What are social-ecological systems and social-ecological systems research? In *The Routledge Handbook of Research Methods for Social-Ecological Systems* (pp. 3–26). Routledge. <https://doi.org/10.4324/9781003021339-2>
- Preiser, R., Schlüter, M., Biggs, R., Mancilla García, M., Haider, L. J., Hertz, T., & Klein, L. (2021b).** Complexity-based social-ecological systems research: philosophical foundations and practical implications. In H. C. Reinette Biggs, Alta de Vos, Rika Preiser (Ed.), *The Routledge Handbook of Research Methods for Social-Ecological Systems (Handbook)*. Routledge.
- Pullin, A. S., & Stewart, G. B. (2006).** Guidelines for systematic review in conservation and environmental management. *Conservation Biology*, 20(6), 1647–1656. <https://doi.org/10.1111/j.1523-1739.2006.00485.x>
- Pullin, A. S., Knight, T. M., Stone, D. H., & Charman, K. (2004).** Do conservation managers use scientific evidence to support their decision-making? *Biological Conservation*, 119(2), 245–252. <https://doi.org/10.1016/j.biocon.2003.11.007>
- Raymond, C. M., Fazey, I., Reed, M. S., Stringer, L. C., Robinson, G. M., & Evely, A. C. (2010).** Integrating local and scientific knowledge for environmental management. *Journal of Environmental Management*, 91(8), 1766–1777. <https://doi.org/10.1016/J.JENVMAN.2010.03.023>
- Raymond, C. M., Singh, G. G., Benessaiah, K., Bernhardt, J. R., Levine, J., Nelson, H., Turner, N. J., Norton, B., Tam, J., & Chan, K. M. A. (2013).** Ecosystem services and beyond Using multiple metaphors to understand human-environment relationships. *BioScience*, 63(7), 536–546. <https://doi.org/10.1525/bio.2013.63.7.7>
- Redford, K. H., Padoch, C., & Sunderland, T. (2013).** Fads, Funding, and Forgetting in Three Decades of Conservation. *Conservation Biology*, 27(3), 437–438. <https://doi.org/10.1111/cobi.12071>
- Rega, C., Helming, J., & Paracchini, M. L. (2019).** Environmentalism and localism in agricultural and land-use policies can maintain food production while supporting biodiversity. Findings from simulations of contrasting scenarios in the EU. *Land Use Policy*, 87(October 2018), 103986. <https://doi.org/10.1016/j.landusepol.2019.05.005>
- Rényi, A. (1970).** *Probability Theory*. North Holland Publishing Company.

- Ricotta, C., Corona, P., Marchetti, M., Chirici, G., & Innamorati, S. (2003).** LaDy: software for assessing local landscape diversity profiles of raster land cover maps using geographic windows. *Environmental Modelling & Software*, 18(4), 373–378. [https://doi.org/10.1016/S1364-8152\(02\)00104-4](https://doi.org/10.1016/S1364-8152(02)00104-4)
- Robins, S. (2001).** NGOs, 'Bushmen' and Double Vision: The p khomani San Land Claim and the Cultural Politics of 'Community' and 'Development' in the Kalahari. *Journal of Southern African Studies*, 27(4), 833–853. <https://doi.org/10.1080/03057070120090763>
- Robinson, C. J., & Wallington, T. J. (2012).** Boundary Work: Engaging Knowledge Systems in Co-management of Feral Animals on Indigenous Lands. 17(2). <https://doi.org/10.5751/ES-04836-170216>
- Rocchini, D., Thouverai, E., Marcantonio, M., Iannacito, M., Da Re, D., Torresani, M., Bacaro, G., Bazzichetto, M., Bernardi, A., Foody, G. M., Furrer, R., Kleijn, D., Larsen, S., Lenoir, J., Malavasi, M., Marchetto, E., Messori, F., Montagni, A., Moudrý, V., (...) Wegmann, M. (2021).** rasterdiv—An Information Theory tailored R package for measuring ecosystem heterogeneity from space: To the origin and back. *Methods in Ecology and Evolution*, 12(6), 1093–1102. <https://doi.org/10.1111/2041-210X.13583>
- Rodary, E. (2019).** L'Apartheid et l'animal : Vers une politique de la connectivité.
- Rosenzweig, M. L. (2001).** Loss of speciation rate will impoverish future diversity. *Proceedings of the National Academy of Sciences of the United States of America*, 98(10), 5404–5410. <https://doi.org/10.1073/pnas.101092798>
- Rosenzweig, M. L. (2003a).** Reconciliation ecology and the future of species diversity. *Oryx*, 37(2), 194–205. <https://doi.org/10.1017/S0030605303000371>
- Rosenzweig, M. L. (2003b).** Win-Win Ecology: How the Earth's Species Can Survive in the Midst of Human Enterprise. Oxford University Press Inc.
- Roux, D. J., Smith, M. K. S., Smit, I. P. J., Freitag, S., Slabbert, L., Mokhatla, M. M., Hayes, J., & Mpapane, N. P. (2020).** Cultural ecosystem services as complex outcomes of people-nature interactions in protected areas. *Ecosystem Services*, 43; 101111. <https://doi.org/10.1016/j.ecoser.2020.101111>
- Rutherford, B. (2008).** Conditional Belonging: Farm Workers and the Cultural Politics of Recognition in Zimbabwe. *Development and Change*, 39(1), 73–99. <https://doi.org/10.1111/J.1467-7660.2008.00469.X>
- Sadr, K. (2003).** The Neolithic of Southern Africa. *The Journal of African History*, 44(2), 195–209. <https://doi.org/10.1017/S0021853702008393>
- Schmeller, D., Henry, P., Julliard, R., Gruber, B., Clobert, J., Dziock, F., Lengyel, S., Nowicki, P., Déri, E., Budrys, E., Kull, T., Tali, K., Bauch, B., Settele, J., Van swaay, C., Kobler, A., Babij, V., Papastergiadou, E., & Henle, K. (2009).** Advantages of Volunteer-Based Biodiversity Monitoring in Europe. *Conservation Biology*, 23(2), 307–316. <https://doi.org/10.1111/j.1523-1739.2008.01125.x>
- Scholz, R. (2011).** Environmental literacy in science and society: from knowledge to decisions. Cambridge University Press.
- Scholz, R. W., & Steiner, G. (2015).** The real type and ideal type of transdisciplinary processes: part I—theoretical foundations. *Sustainability Science*, 10(4), 527–544. <https://doi.org/10.1007/s11625-015-0326-4>
- Schoon, M., & Van Der Leeuw, S. (2015).** The shift toward social-ecological systems perspectives: Insights into the human-nature relationship. *Natures Sciences Societes*, 23(2), 166–174. <https://doi.org/10.1051/nss/2015034>
- Schulze, K., Knights, K., Coad, L., Geldmann, J., Leverington, F., Eassom, A., Marr, M., Butchart, S. H. M., Hockings, M., & Burgess, N. D. (2018).** An assessment of threats to terrestrial protected areas. *Conservation Letters*, 11(3), e12435. <https://doi.org/10.1111/CONL.12435>
- Setten, G., & Brown, K. M. (2013).** *Landscape and social justice*. The Routledge Companion to Landscape Studies, January 2012; 243–252. <https://doi.org/10.4324/9780203096925-30>
- Sidhu, S., Raghunathan, G., Mudappa, D., & Raman, T. R. S. (2017).** Conflict to Coexistence: Human - Leopard Interactions in a Plantation Landscape in Anamalai Hills, India. *Conservation and Society*, 15(4), 474–482. https://doi.org/10.4103/cs.cs_16_35
- Sinu, P. A., & Nagarajan, M. (2015).** Human-wildlife conflict or coexistence: what do we want? *Current Science*, 108(6), 1036–1038.
- Skroblin, A., Carboon, T., Bidu, G., Chapman, N., Miller, M., Taylor, K., Taylor, W., Game, E. T., & Wintle, B. A. (2021).** Including indigenous knowledge in species distribution modeling for increased ecological insights. *Conservation Biology*, 35(2), 587–597. <https://doi.org/10.1111/cobi.13373>
- Skubel, R. A., Shriver-Rice, M., & Maranto, G. M. (2019).** Introducing relational values as a tool for shark conservation, science, and management. *Frontiers in Marine Science*, 6(FEB), 53. <https://doi.org/10.3389/FMARS.2019.00053/BIBTEX>
- Smith, L. T. (1999).** Decolonising methodologies: research and indigenous peoples. Zed Books.
- Smuts, J. C. (1926).** Holism and Evolution. Macmillan & Co Ltd.

- Soga, M., & Gaston, K. J.** (2016). Extinction of experience: the loss of human-nature interactions. *Frontiers in Ecology and the Environment*, 14(2), 94–101. <https://doi.org/10.1002/fee.1225>
- Soga, M., Gaston, K. J., Koyanagi, T. F., Kurisu, K., & Hanaki, K.** (2016). Urban residents' perceptions of neighbourhood nature: Does the extinction of experience matter? *Biological Conservation*, 203; 143–150. <https://doi.org/10.1016/j.BIOCON.2016.09.020>
- Soga, M., Yamaura, Y., Aikoh, T., Shoji, Y., Kubo, T., & Gaston, K. J.** (2015). Reducing the extinction of experience: Association between urban form and recreational use of public greenspace. *Landscape and Urban Planning*, 143; 69–75. <https://doi.org/10.1016/j.landurbplan.2015.06.003>
- Soulé, M. E.** (1985). What Is Conservation Biology? *BioScience*, 35(11), 727–734. <https://doi.org/10.2307/1310054>
- Star, S.** (2010). Ceci n'est pas un objet-frontière ! *Revue d'anthropologie Des Connaissances*, Vol 4; 1(1), 18. <https://doi.org/10.3917/rac.009.0018>
- Stenseke, M.** (2018). Connecting 'relational values' and relational landscape approaches. *Current Opinion in Environmental Sustainability*, 35, 82-88. <https://doi.org/10.1016/j.cosust.2018.10.025>
- Star, S., & Griesemer, J. R.** (1989). Translation and boundary objects. *Social Studies of Science*, 19; 387–420.
- Stern, E. R., & Humphries, M. M.** (2022). Interweaving local, expert, and Indigenous knowledge into quantitative wildlife analyses: A systematic review. *Biological Conservation*, 266(February), 109444. <https://doi.org/10.1016/j.biocon.2021.109444>
- Stuber, E. F., & Gruber, L. F.** (2020). Recent Methodological Solutions to Identifying Scales of Effect in Multi-scale Modeling. *Current Landscape Ecology Reports* 2020 5:4; 5(4), 127–139. <https://doi.org/10.1007/S40823-020-00055-8>
- Subiza-Pérez, M., Marina, L. S., Irizar, A., Gallastegi, M., Anabitarte, A., Urbieto, N., Babarro, I., Molinuevo, A., Vozmediano, L., & Ibarluzea, J.** (2020). Explaining social acceptance of a municipal waste incineration plant through sociodemographic and psycho-environmental variables. *Environmental Pollution*, 263; 114504. <https://doi.org/10.1016/j.ENVPOL.2020.114504>
- Suzman, J.** (2020). The Legacy of Namibia's Landless Generational Farm-Working Community. In W. Odendaal & W. Wolfgang (Eds.), "Neither Here nor There": Indigeneity, Marginalisation and Land Rights in Post-Independence Namibia. Legal Assistance.
- Swindles, G. T., Roland, T. P., & Ruffell, A.** (2023). The 'Anthropocene' is most useful as an informal concept. *Journal of Quaternary Science*. <https://doi.org/10.1002/JQS.3492>
- Sylvain, R.** (2001). Bushmen, boers and baasskap: Patriarchy and paternalism on Afrikaner farms in the omaheke region, Namibia. *Journal of Southern African Studies*, 27(4), 717–737. <https://doi.org/10.1080/03057070120090709>
- Sylvain, R.** (2002). 'Land, Water, and Truth': San Identity and Global Indigenism. *American Anthropologist*, 104(4), 1074–1085. <https://doi.org/10.1525/aa.2002.104.4.1074>
- Sylvain, R.** (2005). Disorderly development: Globalization and the idea of "culture" in the Kalahari. *American Ethnologist*, 32(3), 354-370. <https://doi.org/10.1525/ae.2005.32.3.354>
- Swanson, S. S., & Ardoin, N. M.** (2021). Communities behind the lens: A review and critical analysis of Visual Participatory Methods in biodiversity conservation. *Biological Conservation*, 262, 109293. <https://doi.org/10.1016/j.biocon.2021.109293>
- Tappeiner, U., Leitinger, G., Zariņa, A., & Bürgi, M.** (2021). How to consider history in landscape ecology: patterns, processes, and pathways. *Landscape Ecology*, 36(8), 2317–2328. <https://doi.org/10.1007/S10980-020-01163-W/FIGURES/1>
- Tengö, M., Brondizio, E. S., Elmqvist, T., Malmer, P., & Spierenburg, M.** (2014). Connecting diverse knowledge systems for enhanced ecosystem governance: The multiple evidence base approach. *Ambio*, 43(5), 579–591. <https://doi.org/10.1007/s13280-014-0501-3>
- Tengö, M., Hill, R., Malmer, P., Raymond, C. M., Spierenburg, M., Danielsen, F., Elmqvist, T., & Folke, C.** (2017). Weaving knowledge systems in IPBES, CBD and beyond—lessons learned for sustainability. *Current Opinion in Environmental Sustainability*, 26–27; 17–25. <https://doi.org/10.1016/j.cosust.2016.12.005>
- Thondhlana, G., Shackleton, S., & Muchapondwa, E.** (2011). Kgalagadi Transfrontier Park and it's land claimants: A pre-and post-land claim conservation and development history. *Environmental Research Letters*, 6(2). <https://doi.org/10.1088/1748-9326/6/2/024009>
- Thuiller, W., Lafourcade, B., Engler, R., & Araújo, M. B.** (2009). BIOMOD - a platform for ensemble forecasting of species distributions. *Ecography*, 32(3), 369–373. <https://doi.org/10.1111/j.1600-0587.2008.05742.x>
- Tronto, J. C., & Fisher, B.** (1990). Toward a Feminist Theory of Caring. In E. Abel, & M. Nelson (Eds.), *Circles of Care* (pp. 36-54). SUNY Press.
- Tronto, J. C.** (2008). Du care. *Revue Du MAUSS*, 32(2), 243–265. <https://doi.org/10.3917/RDM.032.0243>

- Tronto, J. C.** (2009). *Un monde vulnérable : Pour une politique du « care »*. Editions La Découverte.
- Troudet, J., Grandcolas, P., Blin, A., Vignes-Lebbe, R., & Legendre, F.** (2017). Taxonomic bias in biodiversity data and societal preferences. *Scientific Reports*, 7(1), 1–14. <https://doi.org/10.1038/s41598-017-09084-6>
- UNESCO. (2017). A New roadmap for the Man and the Biosphere (MAB) Programme and its World Network of Biosphere Reserves. In *Conservation and Society* (Issue 9). UNESCO. <https://unesdoc.unesco.org/ark:/48223/pf0000247418>
- Valeix, M., Fritz, H., Sabatier, R., Murindagomo, F., Cumming, D., & Duncan, P.** (2011). Elephant-induced structural changes in the vegetation and habitat selection by large herbivores in an African savanna. *Biological Conservation*, 144(2), 902–912. <https://doi.org/10.1016/j.biocon.2010.10.029>
- Van Onselen, C.** (1992). The Social and Economic Underpinning of Paternalism and Violence on the Maize Farms of the South-Western Transvaal, 1900–1950. *Journal of Historical Sociology*, 5(2), 127–160. <https://doi.org/10.1111/j.1467-6443.1992.tb00159.x>
- Von Uexküll, J.** (1921). *Umwelt und Innenwelt der Tiere*. Dans *Springer eBooks*. <https://doi.org/10.1007/978-3-662-24819-5>
- Viveiros De Castro, E.** (1998). Cosmological Deixis and Ameridian Perspectivism. *Journal of the Royal Anthropological Institute*, 1; 4; 478.
- Vlok, J., Euston-Brown D. & Wolf T.** (2008). A vegetation map for the Garden Route Initiative (GRI) SANParks
- Vromans, D. C. C., Maree, K. S. S., Holness, S., Job, N., & Brown, E. E.** (2010). The Garden Route biodiversity sector plan for the George, Knysna and Bitou municipalities, supporting land-use planning and decision-making in critical biodiversity areas and ecological support areas for sustainable development. Biodiversity GIS.
- Wasiolka, B., & Blaum, N.** (2011). Comparing biodiversity between protected savanna and adjacent non-protected farmland in the southern Kalahari. *Journal of Arid Environments*, 75(9), 836–841. <https://doi.org/10.1016/j.jaridenv.2011.04.011>
- West, S., Haider, L. J., Masterson, V., Enqvist, J. P., Svedin, U., & Tengö, M.** (2018). Stewardship, care and relational values. *Current Opinion in Environmental Sustainability*, 35; 30–38. <https://doi.org/10.1016/j.cosust.2018.10.008>
- Wheeler, H. C., & Root-Bernstein, M.** (2020). Informing decision-making with Indigenous and local knowledge and science. *Journal of Applied Ecology*, 57(9), 1634–1643. <https://doi.org/10.1111/1365-2664.13734>
- White, P. J., Davis, T. L., Barnowe-Meyer, K. K., Crabtree, R. L., & Garrott, R. A.** (2007). Livestock loss caused by predators outside the Serengeti National Park, Tanzania. *Biological Conservation*, 135(4), 518–526. <https://doi.org/10.1016/j.BIOCON.2006.10.049>
- Whyte, K. P., Brewer, J. P., & Johnson, J. T.** (2015). Weaving Indigenous science, protocols and sustainability science. *Sustainability Science*, 2015 11:1; 11(1), 25–32. <https://doi.org/10.1007/S11625-015-0296-6>
- Wiens, J. A.** (2009). Landscape ecology as a foundation for sustainable conservation. *Landscape Ecology*, 24(8), 1053–1065. <https://doi.org/10.1007/S10980-008-9284-X>
- Williams, P. H., Burgess, N. D., & Rahbek, C.** (2000). Flagship species, ecological complementarity and conserving the diversity of mammals and birds in sub-Saharan Africa. *Animal Conservation*, 3(3), 249–260. <https://doi.org/10.1017/S1367943000000974>
- Winter, K. B., Lincoln, N. K., & Berkes, F.** (2018). The social-ecological keystone concept: A quantifiable metaphor for understanding the structure, function, and resilience of a biocultural system. *Sustainability (Switzerland)*, 10(9). <https://doi.org/10.3390/su10093294>
- Wood, C. E.** (2008). Time, Cycles and Tempos in Social-ecological. *Research and Environmental Policy. Time & Society*. <https://doi.org/10.1177/0961463x08093425>
- Woodroffe, R., & Ginsberg, J. R.** (1998). Edge effects and the extinction of populations inside protected areas. *Science*, 280(5372), 2126–2128. <https://doi.org/10.1126/science.280.5372.2126>
- Yin, R. K.** (2013). *Case Study Research: Design and Methods (Applied Social Research Methods)* (5th Editio). SAGE Publications.
- Zurell, D., Pollock, L. J., & Thuiller, W.** (2018). Do joint species distribution models reliably detect interspecific interactions from co-occurrence data in homogenous environments? *Ecography*, 41(11), 1812–1819. <https://doi.org/10.1111/ecog.03315>

APPENDIX

Data repository :

https://drive.google.com/drive/folders/1YmH944swl7wOoVys5HRChd_5q0TYhp_u1?usp=sharing

I) Preliminary discussions

Introduction

Thank you for agreeing to meet with me. Our discussion format will be as follows: I will start with a short introduction of myself and explain the outline of my project, before we move to the discussion.

My name is Élie Pédarros. I am a French student from the Nelson Mandela University, George campus, where I did my Masters's project and I am now doing a PhD. My supervisors are Dr Chloé Guerbois and Prof. Hervé Fritz.

For this project, I am interested in understanding the drivers of co-existence between large mammals and humans in a human dominated landscape. I focus on two contrasting areas: the Garden Route Biosphere Reserve (mainly George, Knysna and Bitou municipalities) and the Khomani Cultural Landscape in the Northern Cape.

I am engaging in preliminary discussions with some of the key stakeholders in these two areas to gain a better understanding.

The main objective of these discussions is to establish a list of stakeholders who will collaboratively help me to develop and refine my research questions and protocols. These preliminary discussions will contribute to a better grasp of the issues in these areas based on the key stakeholders' knowledge, the participant's interest in the topic, and their expectations of the research. These discussions will be used to propose a research agenda that will then act as a guide to this collaborative research project.

Oral consent

This project has been granted Ethic Clearance from Nelson Mandela University (ref H20-SCI-SRU-003) as well as research permits from SANParks (PEDA-E/2020-007) and Cape Nature (CN32-87-13786).

Before I start, I will ask for your consent to be interviewed. Please note that your participation is voluntary, and you may withdraw anytime. When analysing the data, your privacy and anonymity can be protected at your request. To ease the transcription, I would like to record this interview. If you agree, I must record your verbal consent before we can start the interview. Do you agree with this?

So Mr/Ms...., thank you for agreeing to talk to me. Please confirm that you have understood that this interview is recorded, your participation is completely voluntary, and that you may withdraw at any time. In processing the information for my PhD, will your anonymity be protected at your request? So agreeing, you also state that this information will be used for a PhD degree and potentially shared with a broader audience.

Is there anything that needs to be clarified?

- 1) Could you please introduce yourself and the duties/functions/responsibilities related to your position or role in the community?*
- 2) What motivates you to respond to my request?*
- 3) What do you know about large wild mammals in this area?*
- 4) How would you describe your relationship with wild mammals?*
- 5) Are there any species of particular importance to you and why?*
- 6) What are the main challenges to conserving wild mammals in (the Garden Route/Kalahari)?*
- 7) What is your view on the land-sharing (co-existence) /land-sparing (wildlife in PA) debate?*
- 8) How would you promote human-wildlife co-existence in this landscape?*
- 9) What do you, as an individual/institution, expect from this collaborative research project?*
- 10) What could we do to inspire co-existence?*
- 11) How do you think you/your institution could contribute to this research (if not discussed)? Is there any constraint or prerequisite I should be aware of?*

II) Film and theatre

I) Film link

https://youtu.be/8sf_peH8Fkk

II) Theatre play transcript *Awakenings*

written by Quaanitah Simons

Slides of an animal herd moving with sounds. The big five .

A young warrior enters the stage moving as he tracks an animal.

Singing: I am a Khoisan on the go, this is my arrow & this is my bow. Buffalo watch me shout Lion & Elephant when I shout, springbok and Leopard you better watch out!

He moves across the stage with rapid movements as he wrestles a buck to the ground.

Binds it slings it across his shoulder & carries it to the Kraal where the woman meet him & prepare the carcass to be spit braaied. The young warrior maks a fire.

Warrior: A snake pleaded with the crocodile to take it across the river on its back. "I won't bite you said the snake. Crocodile believed him. The pair set off & just as they got to the river bank the snake bit crocodile. "Ouch", shrieked crocodile. "Why did you bite me?"

"I am a snake" The snake answered. "It is in my nature." Warrior freezes.

Two girls enter singing: Ganganti kokati TI"ELO te TI"ELO te

Gizelle: You were born from the loins of a Khoï woman. Rich brown and proud. A pride that made the master see red. It made him not want to destroy the pride but the being, the being!

Friend sings: Little baby bunting your daddy's gone a hunting. To catch a boesman, put him in a box, and never let him go.

The girls chase each other mimicking animal movements i.e. .leap frog giggling & laughing. Young Warrior looks at them smiling .He places his arrow in the bow and shoots it off in the direction of the two girls. The girls shriek with delight as they watch the arrow drop. Giggling Gizelle moves forward glances over her shoulder and motions her friend to stop. She bends down to pick up the arrow. She swirls turns and holds the arrow to her heart. Her friend comes closer slowly and tugs her arm Friend: Ooooh Gizelle she shakes her hands and giggles.

Gizelle stamps her feet and dances with her arrow dreamy eyed. Gizelle : hmmm it is sooo nice. I like him.

Friend: Are you going to keep his arrow?

Gizelle: I am going to keep his arrow and put it under my pillow ,then I'll dream about him, I'm sure. She smiles

She walks to her friend and places her arm around her neck, then places her friend's flat hand on her heart.

Friend: Gizelle your heart is beating faster than a horse's hooves.

Gizelle: It is the sound of a woman, lost in love! She places the back of her hand on her forehead . Gizelle: I just cannot stand it ! She drops her friend bends and she lands on her friends back. They exit.

A woman enters with a basin on her head. Gertie: This washing seems to get heavier by the day. She puts down the basin and sits next to it singing: Sida,sida,ga re soa,soa.Sida,sida,ga re soa, soa.

Another woman enters with her basin on her hip and greets waving her hand. Meit:Gai//tses khoeses Gertie matisa my aborina sister.

Gertie: Gai//tses My aborina sister it is so nice to see you. I was just thinking about the dark cloud that is hanging over this place. Our happy days are gone now that these people have taken over here. She sighs. Then they say it is for our good? Nobody asked me about my good. She sighs shaking her head.

Meid: This morning when I woke my boy to fetch water from the spring, he found that the spring was enclosed with wire. He said that he had to make a hole to get through.

Gertie: I called sally because I had to milk her to churn butter for the bread I had baked. The cow was nowhere to be seen. I thought she had wandered off again. I think her calf makes her so tired, sometimes, she just needs to take a break, you know. I looked thinking she might be with the goats. When I got there. The goats were gone as well. I walked and walked calling "Sally.Moo,Moo,Moo....bokkies kom nou,waar is ma se kinnertjies" My heart stopped beating and my blood ran cold. I have to find them before it gets dark and I started climbing that hill. I stumbled and crawled, knees bleeding I got to the top. She places her hand above her eyebrows looking into the distance.

Meid: Agh Shame man. Did you find them?

Gertie: Sliding to the bottom I rushed to the enclosure I had seen. Sally Mooed the goats skipped but landed against the wire and as I was about to open the gate. I heard a voice saying "Ich vuren" I looked into the twin barrel of the rifle pointed at me . Koosie fell to his knees pleading with Baas not to shoot. He told Baas that he would stay there to look after the animals, to make sure nobody would steal them ."Please Baas just let my wife go" I wet myself ...She clutches her skirt & closes her legs. Freeze

Meid: The Khoï, The San, The Khoï Khoï & The Khoisan. Africa the cradle of humanity. The Khoï The San The Khoï Khoï & The Khoisan an African people. A beautiful, gentle African people. A people who knew no patterns of ownership. A people who knew no class distinction. A people who respected all forms of life and placed back into the earth everything they took out of the earth. Their rock paintings can be found on rock facings, river beds , caves giving no indication as to who was master and who the student.

The Khoï, The San, The Khoï Khoï & The Khoisan a Beautiful ,Gentle African .Believing IN THE CREATOR. Living in harmony with the land & nature. Respecting all forms of life and Believing that The Earth belongs to all those who inhabits it The girls enter the stage.

Friend: I just love coming to the river, the sound of the frogs croaking and I love chasing the dragonflies. Look Gizelle there's a butterfly

Gizelle: I prefer lady birds. She Moves her arms fluttering . Lady bird, Lady bird fly away, your house is on fire & your children's gone away. The girls walk over to the women.

Friend: Gai//toas Khoeses Meid. She breathes in pulling up her shoulders. Gizelle places her fingers on her friends lips. The girls start giggling. The women look at each other, then at the girls.

Meid : And what's this about, you two look like the cat who got the cream. Gizelle smiles and bashfully plays with the arrow in her hands. Wait a minute, come here child. Is that what I think it is? My child you are my honey bee. Have you tasted the love potion...she raises open hands... from whom? Gizelle nods in Gertie's direction. Her mother inhales .Oh ...eyes wide Khoeses Gertie we will have to talk. My Gizelle has picked up your son's arrow my dear. You know Gizelle is the apple of my eye. Doman has her heart.

Gertie looks up. She looks at her friend, then at Gizelle. She turns to the other girl and says...Gertie: You were there when Doman shot his arrow, why did you not pick it up instead? She looks the girl from the bottom up. Nodding her head, pointing. Yes. I would have preferred you...I've been watching my son for a while. I've seen him grow from half

man and half nothing into one of the finest, bravest warriors in this land. He is a keen hunter and a good provider.

Meid: I have raised Gizelle with kindness, after her dad left to work at sea. She became my right hand and takes good care of me. She knows how to keep the house neat .She makes beads and braids hair. A real care giver .Your son has made the best choice. He has found a good woman, who carries herself very well. My daughter will make a home for him. She will fill it with grandchildren for both you and me.

Gertie looks at Meid and steps out across the stage. She looks at the audience. Gertie: Doman is a mighty fine young man. I have always told him to love his wife. To protect and take care of and love her as he loves himself. So much has changed around here...Kosie hardly comes home anymore...Meid moves over to her and sits her down, holding her in her arms.

Meid: White man your laws have chained my man. Relentlessly, you take him from me. I the woman who tends your children while mine roam the streets. You rob, you rape, you plunder, you murder and you steal. Imposing on me your law and order. You have turned my man into less than a man. Boy you call him. A boy who has planted his seed in me and who has not seen his seed grow into saplings tall. Pause. She closes her eyes. My fantasy transports me from where I am. She interacts with Gertie. I gaze into your lovely face. With each line, I absorb you. From your well I draw my sustenance. I am jolted to a cold harsh reality. I reach for you ...and you are not there...White man your laws have chained my man. Your law and order. Your law of tyranny and your order of death! The actors scream and fall to the ground. Song plays Waiting for the world to change. John .Meyer . Song fades and Meid enters from the Back of the Auditorium. Carrying a heavy load. Look at me .Tell me what you see.

A New South African. Raging battles, waging wars. Gear, Asgisa Globalisation, Privatisation, Neo liberalisation, privatization, Biodiversity, Corruption, crime, Global warming, Landlessness, State Capture, Covid 19 Unemployment ,Poverty, Democracy, The Law. For what do we have all these laws? Fences estrange us, High walls polarize us and money categorises us. World Bank, International Monetary fund, World Trade Organisation.G20;G8 Dem'o'crazy Song: Living years -Mike & The Mechanics Song fades She moves centre stage .Why must someone print paper and hand it to us as money. They let us payback in values, resources and efforts? It is Mad. Never before was an acronym

more suited. MAD! Mutually Assured Destruction! .I will step into GOD’S pharmacy and celebrate my roots, my identity and my people.

For I will Rise .I will dance, I will laugh and I will live for I am free. I am free to be me. Sovereign Aboriginal! Do not rejoice over me my enemy I will arise and when I sit in darkness.The Lord will be a light for me.

Micah7:8

Actors step forward Animal sounds on slides in background. Gizelle and Doman are joined together with a band as they both say I do, I will every day of my life.

Doman: We did not come here to fear the future. We came to change it.

Gizelle: Merging to create what is new.

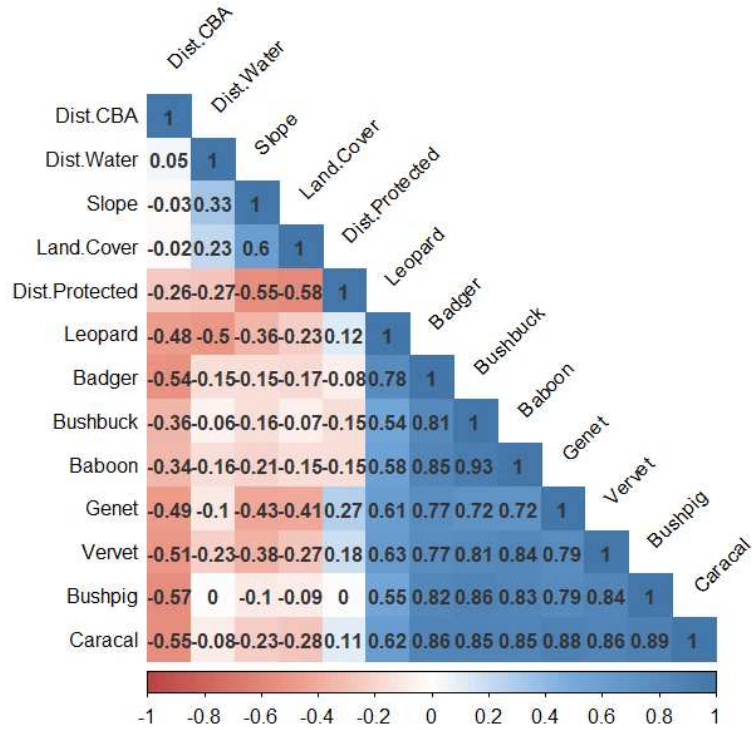
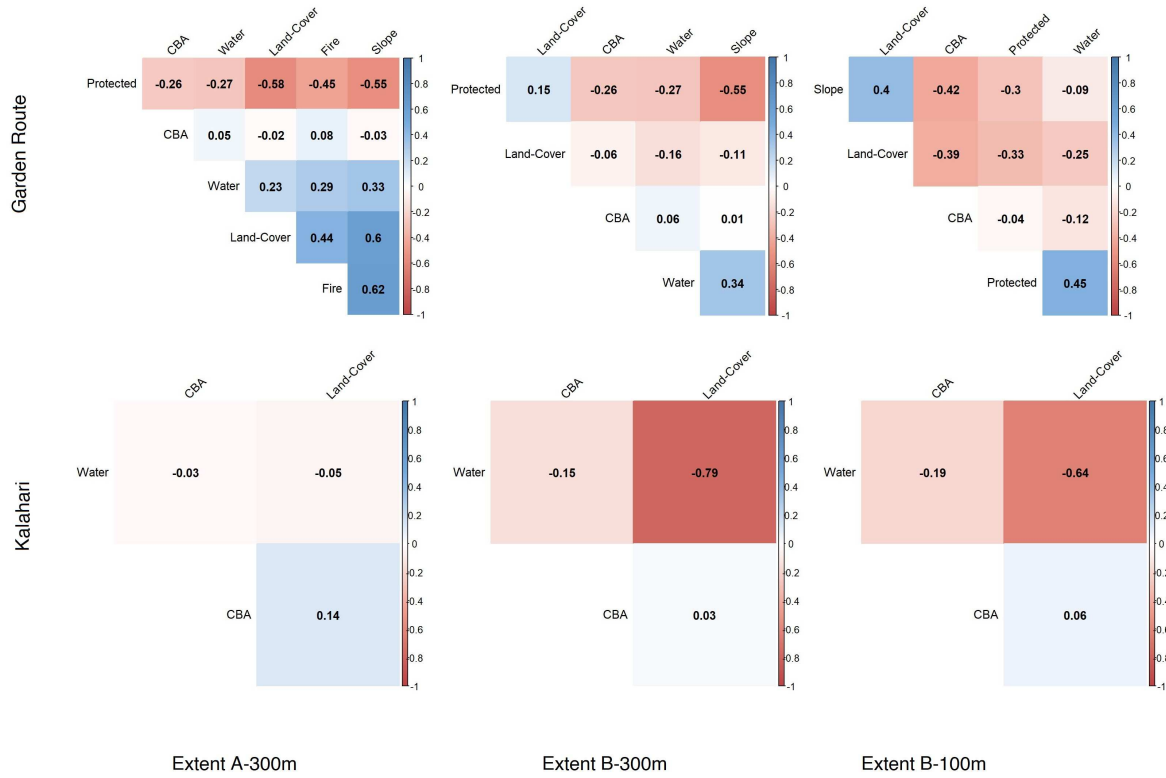
Friend: Effective, sustainable and full of promise.

Khoeses Gertie: Where our children are cherished. Our elderly respected for their Indigenous knowledge and wisdom.

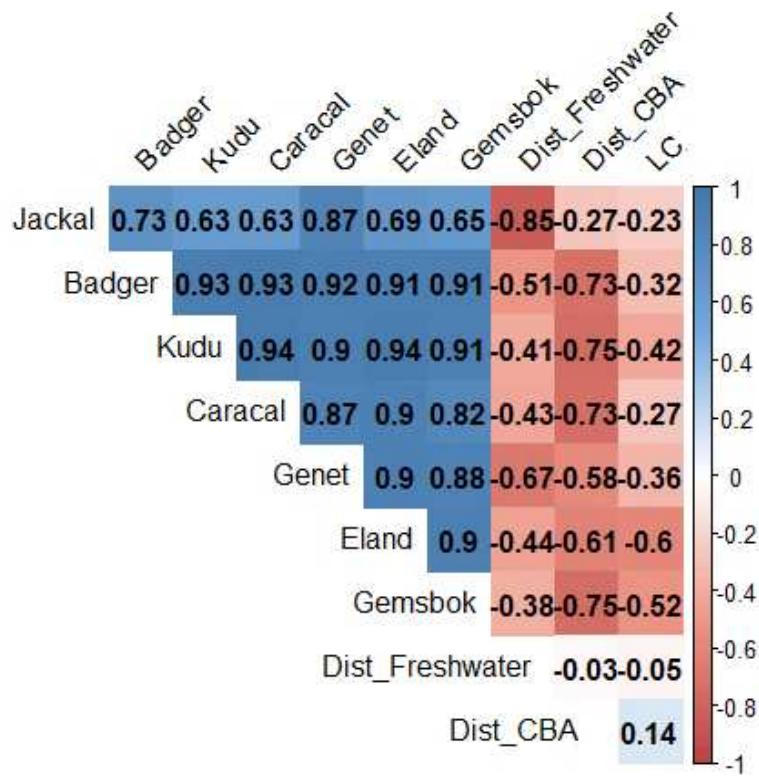
Meid: All creatures Great and small, THE LORD GOD Made them all.

Actors bow

III) Species distribution correlation

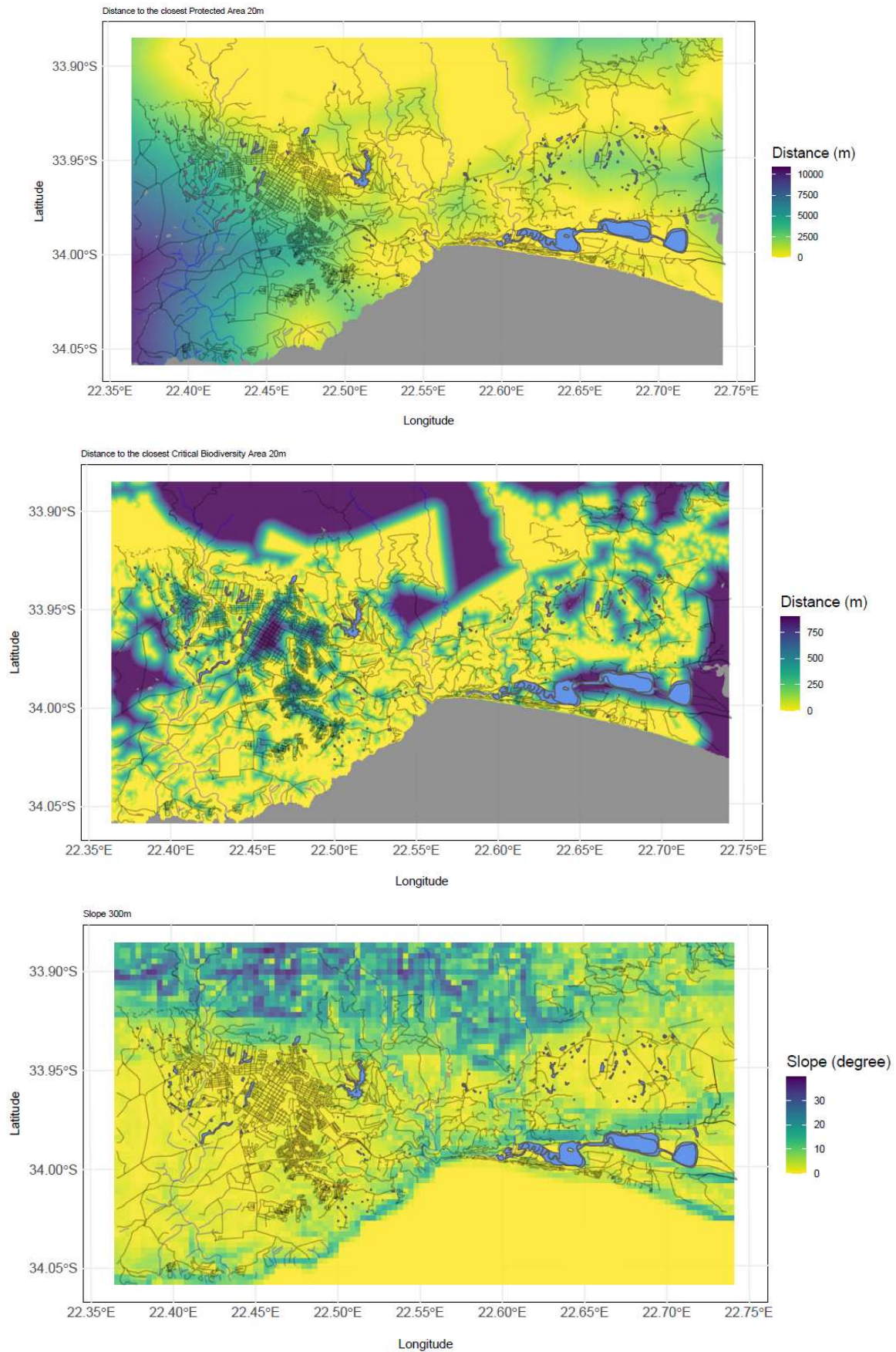


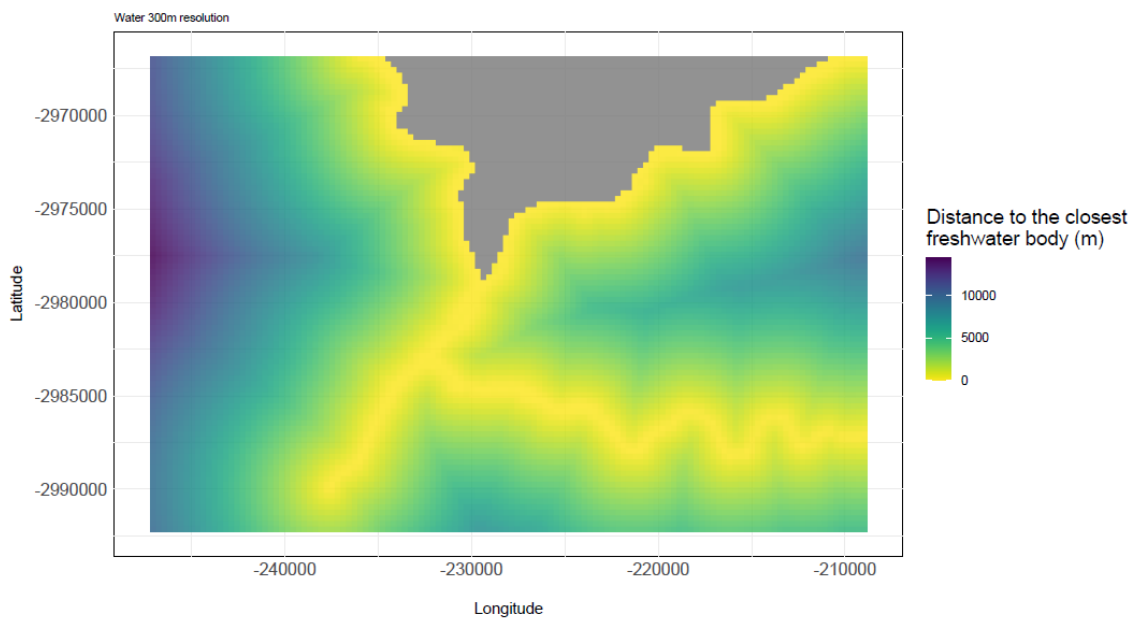
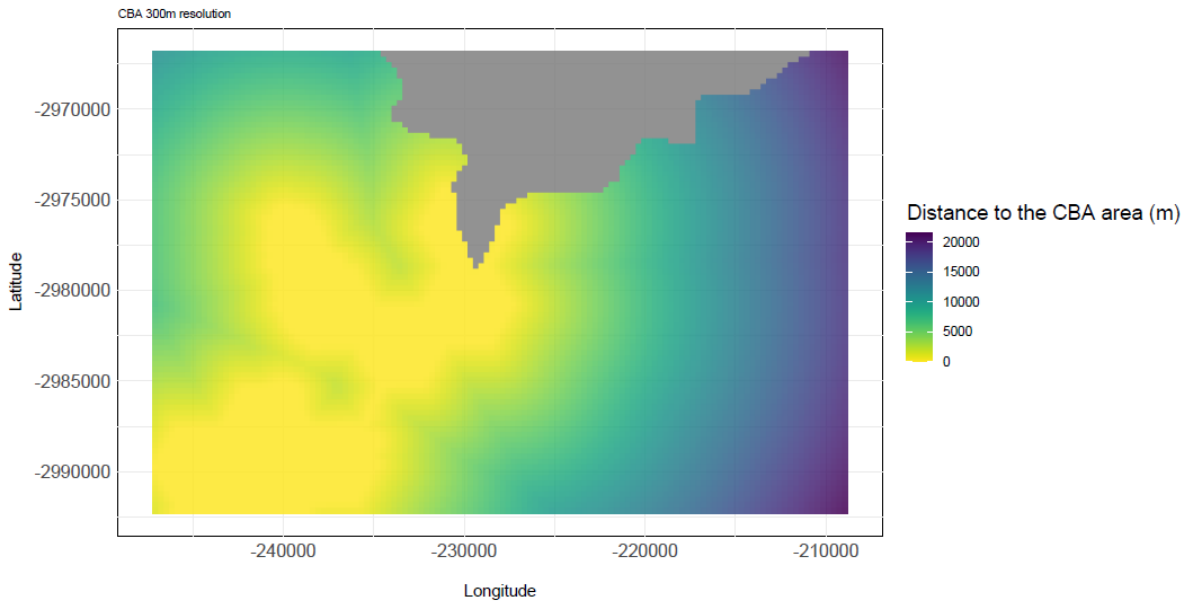
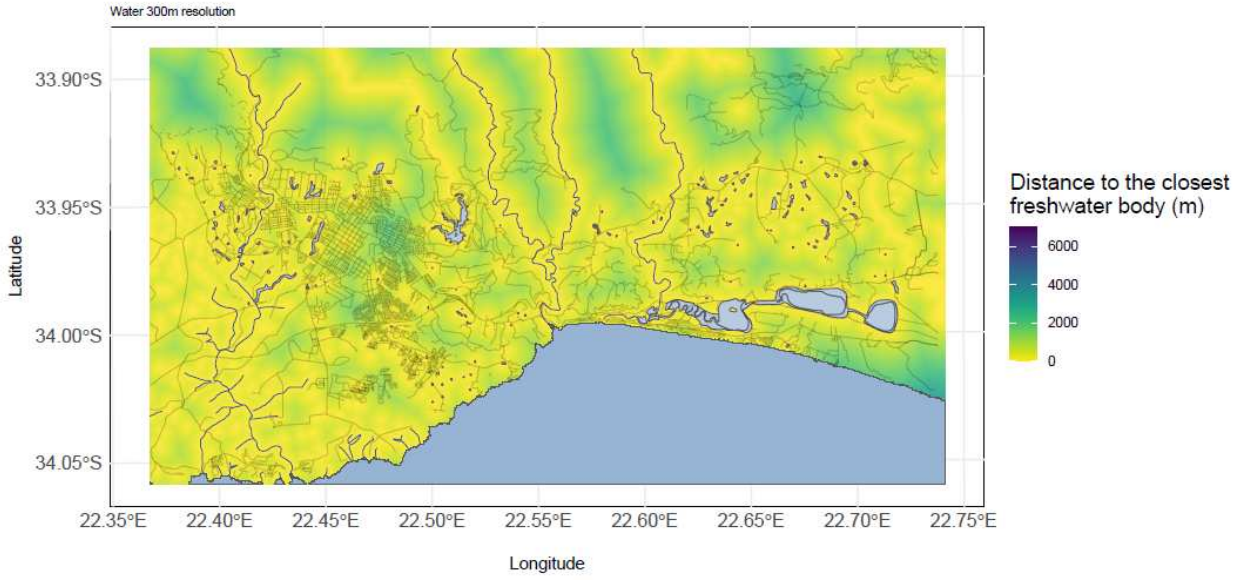
Kalahari biotic and abiotic factors correlations



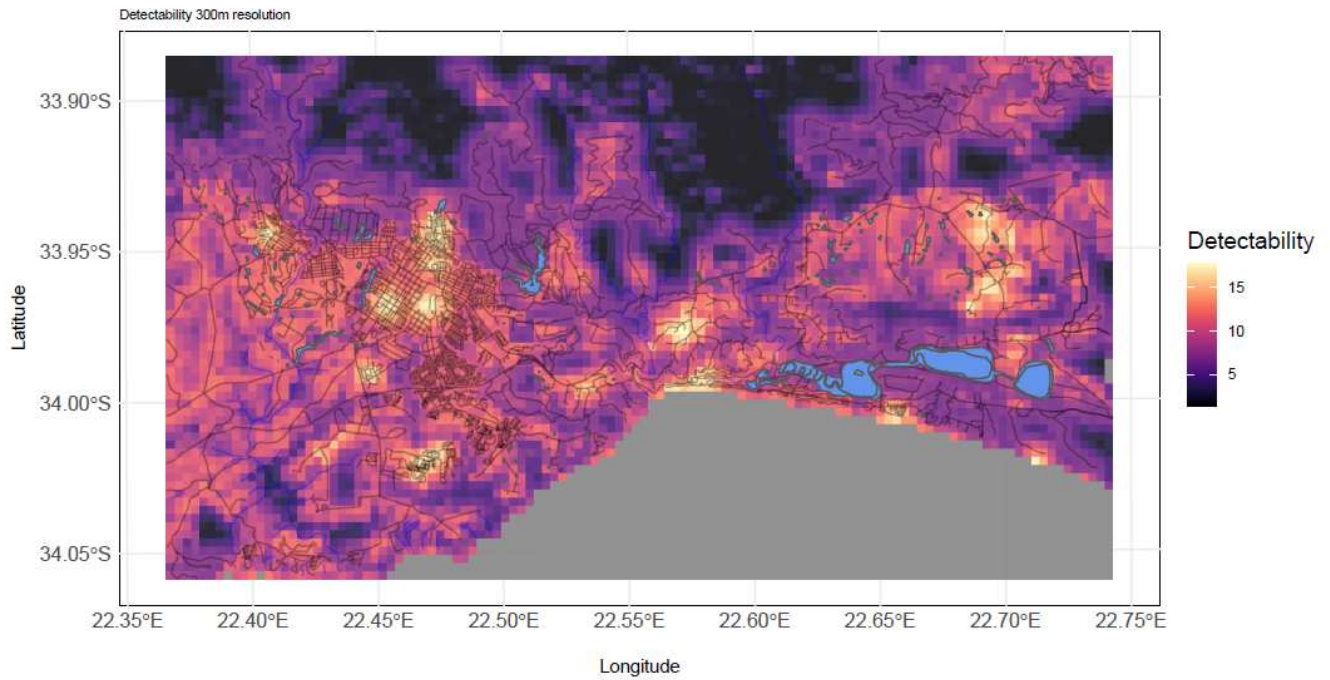
Kalahari biotic and abiotic factors correlations

IV) Variables

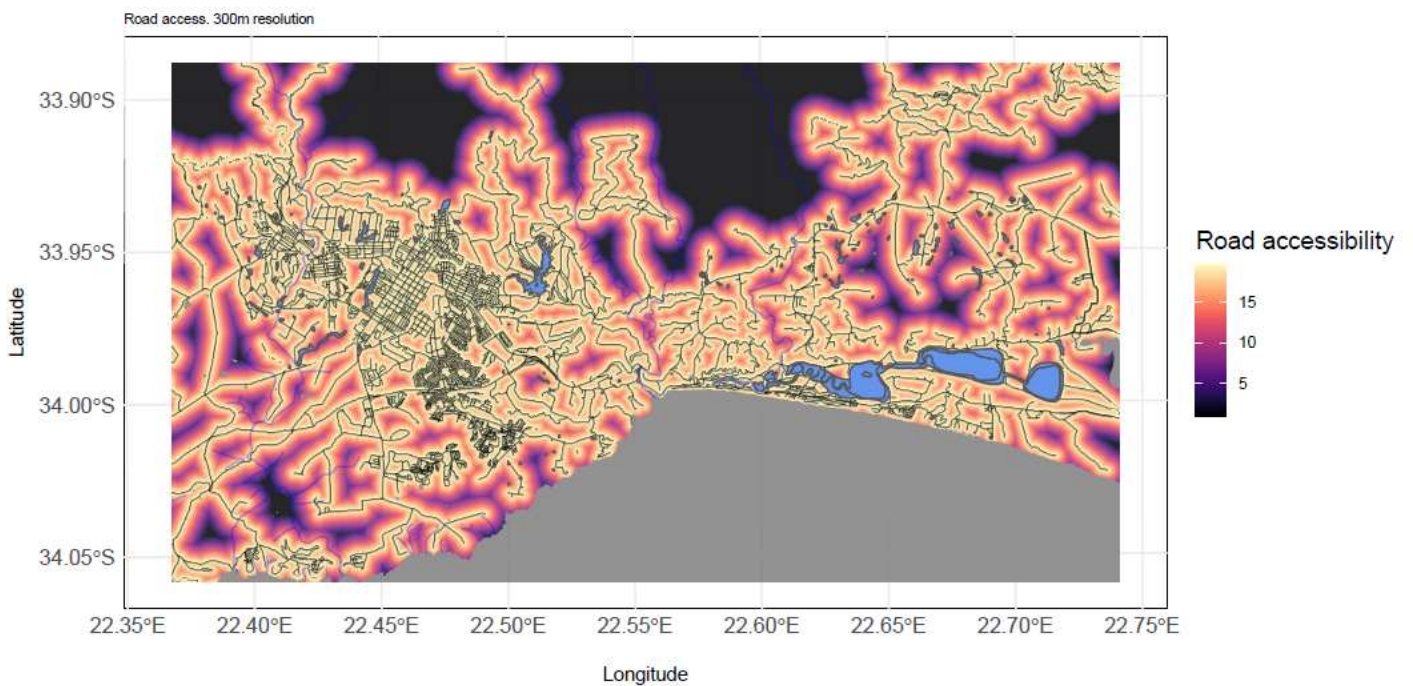




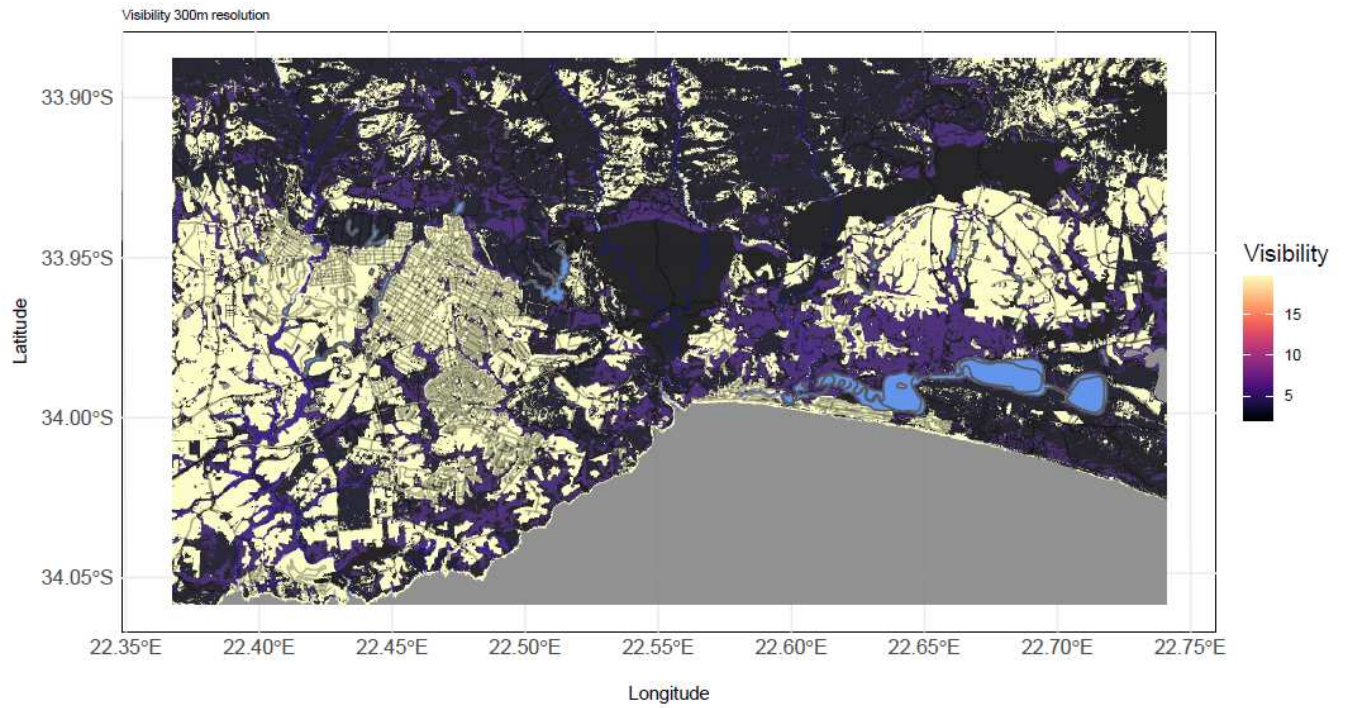
V) Detectability



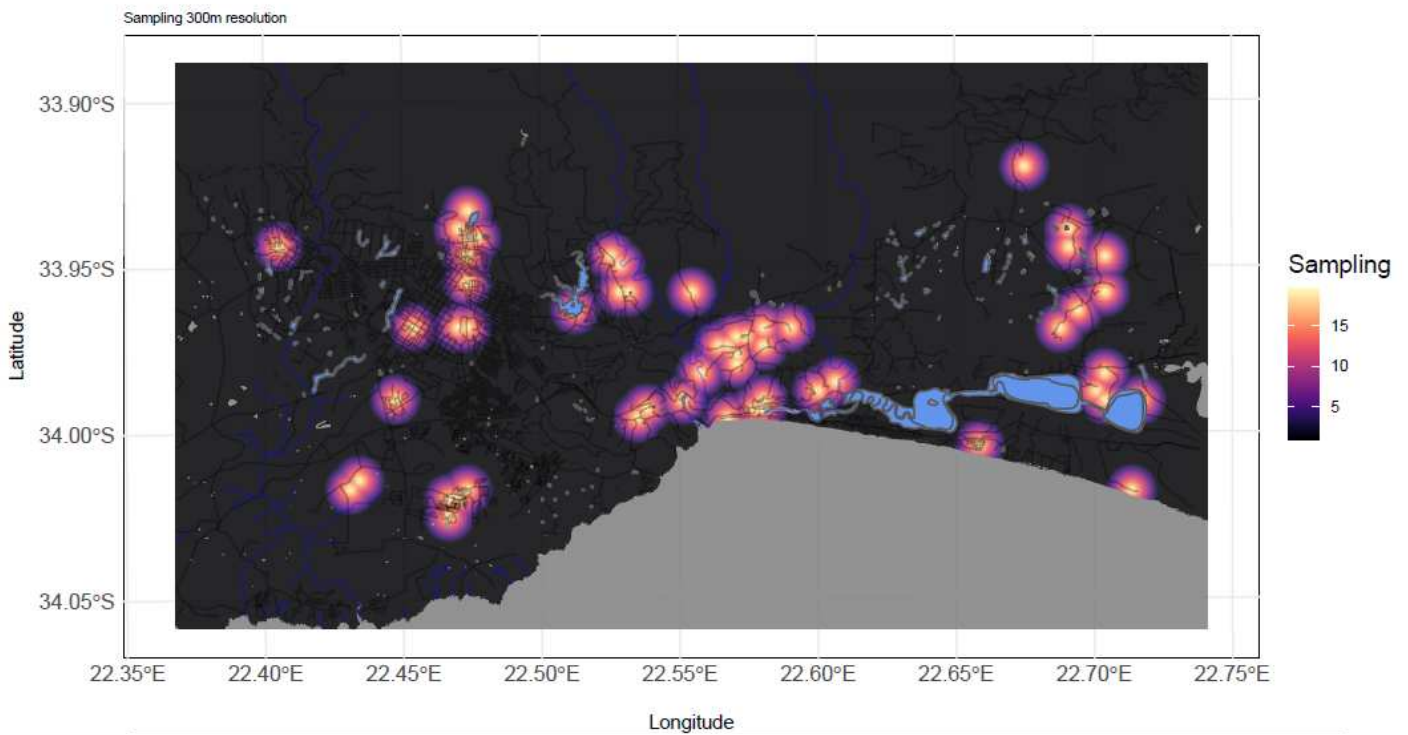
1. Garden Route: Global detectability (Product of road accessibility, sampling and visibility)



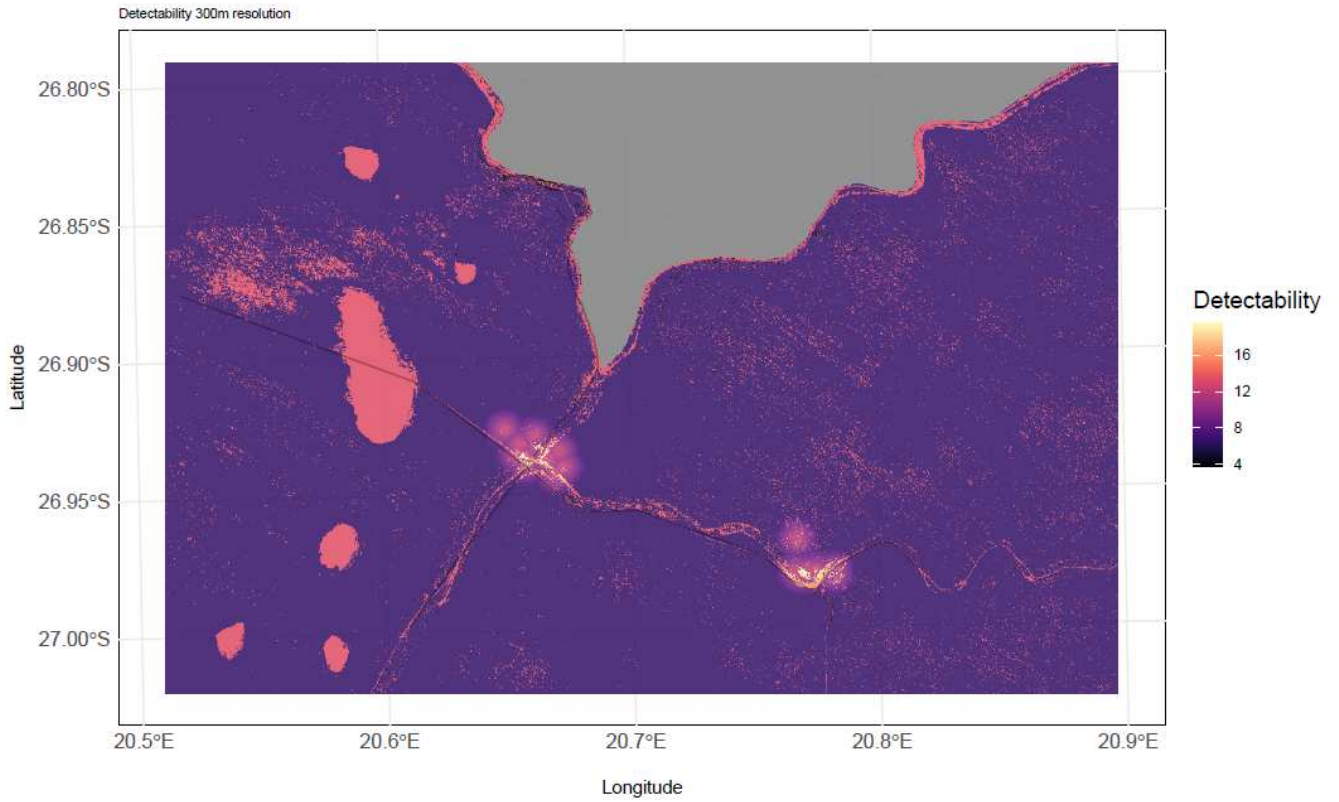
2. Garden Route: Road accessibility



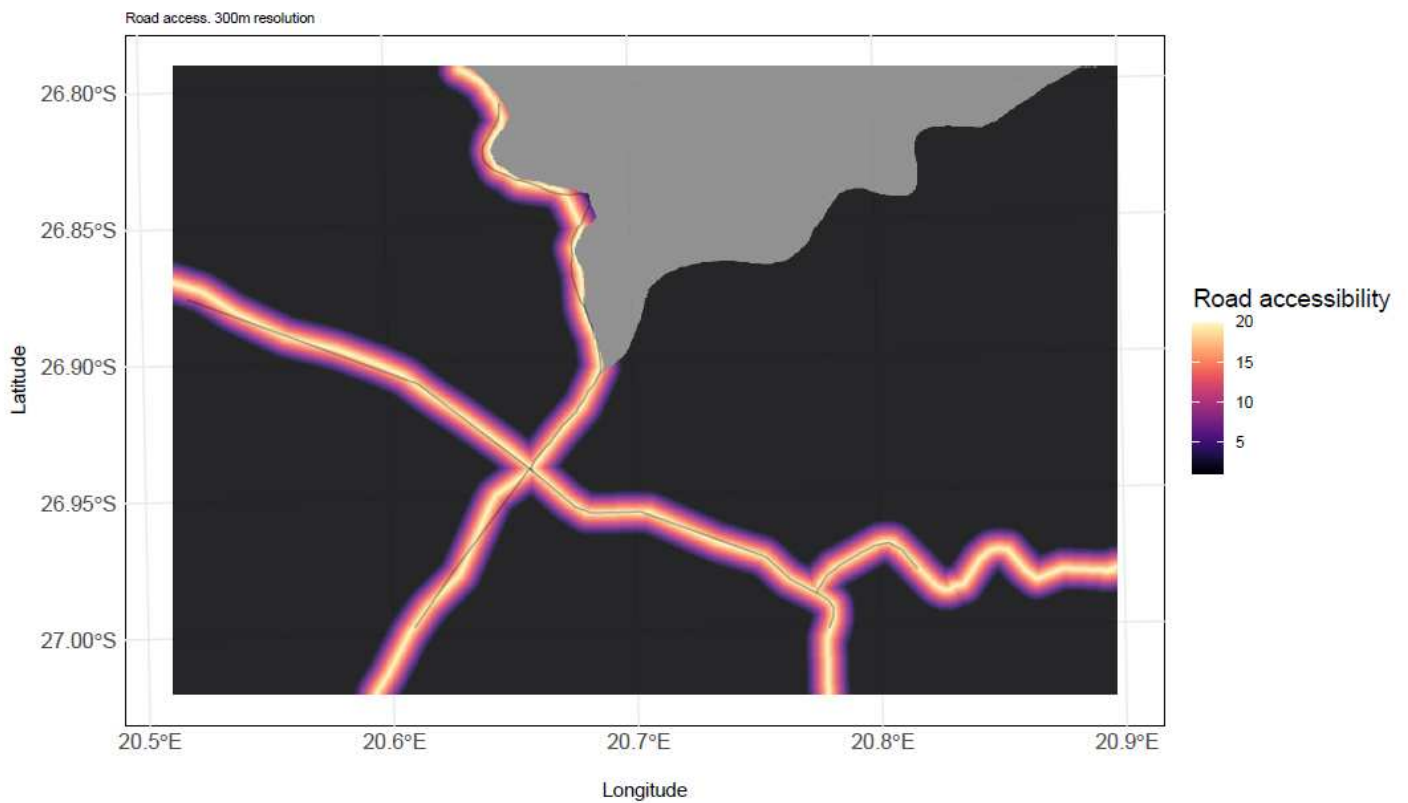
3. Garden Route: Landscape visibility based on land-uses



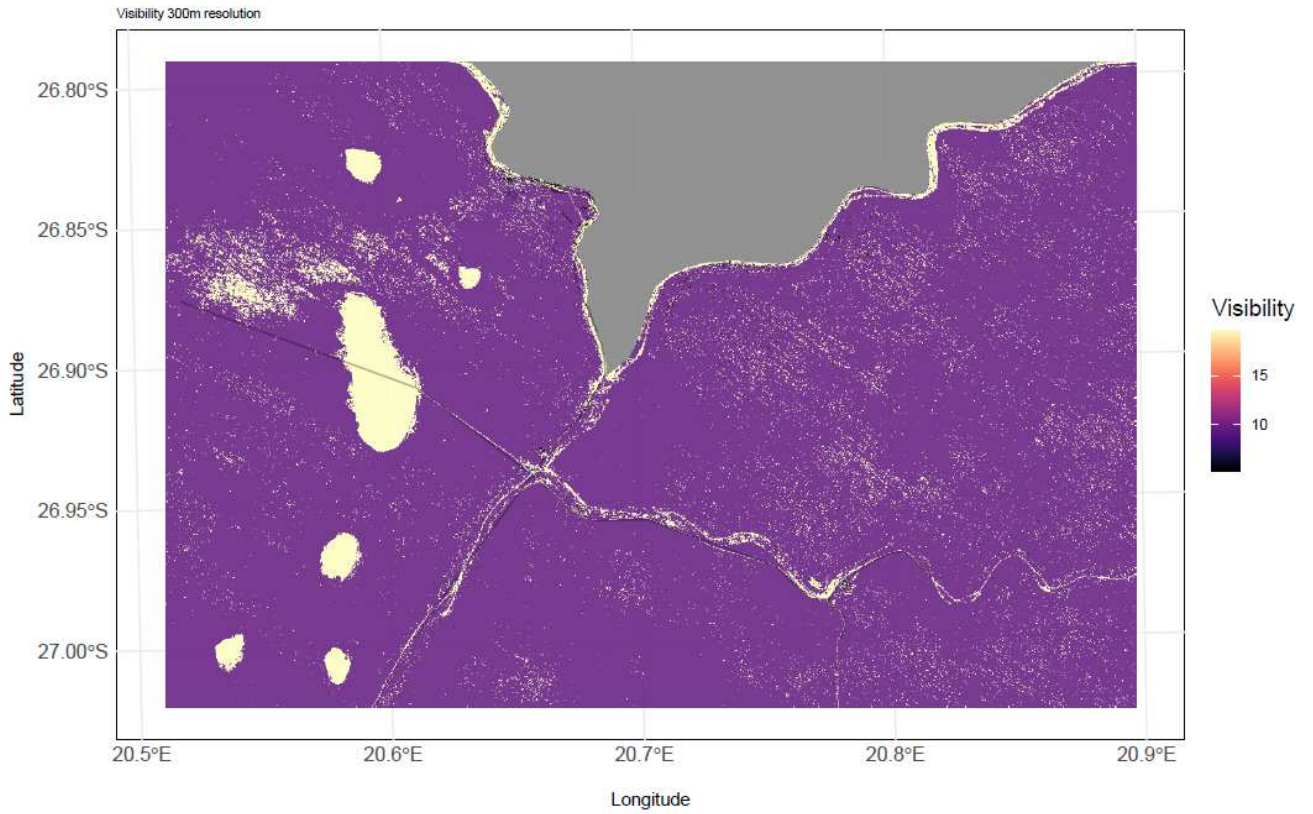
4. Garden Route: Sampling intensity based on participants' frequently visited areas



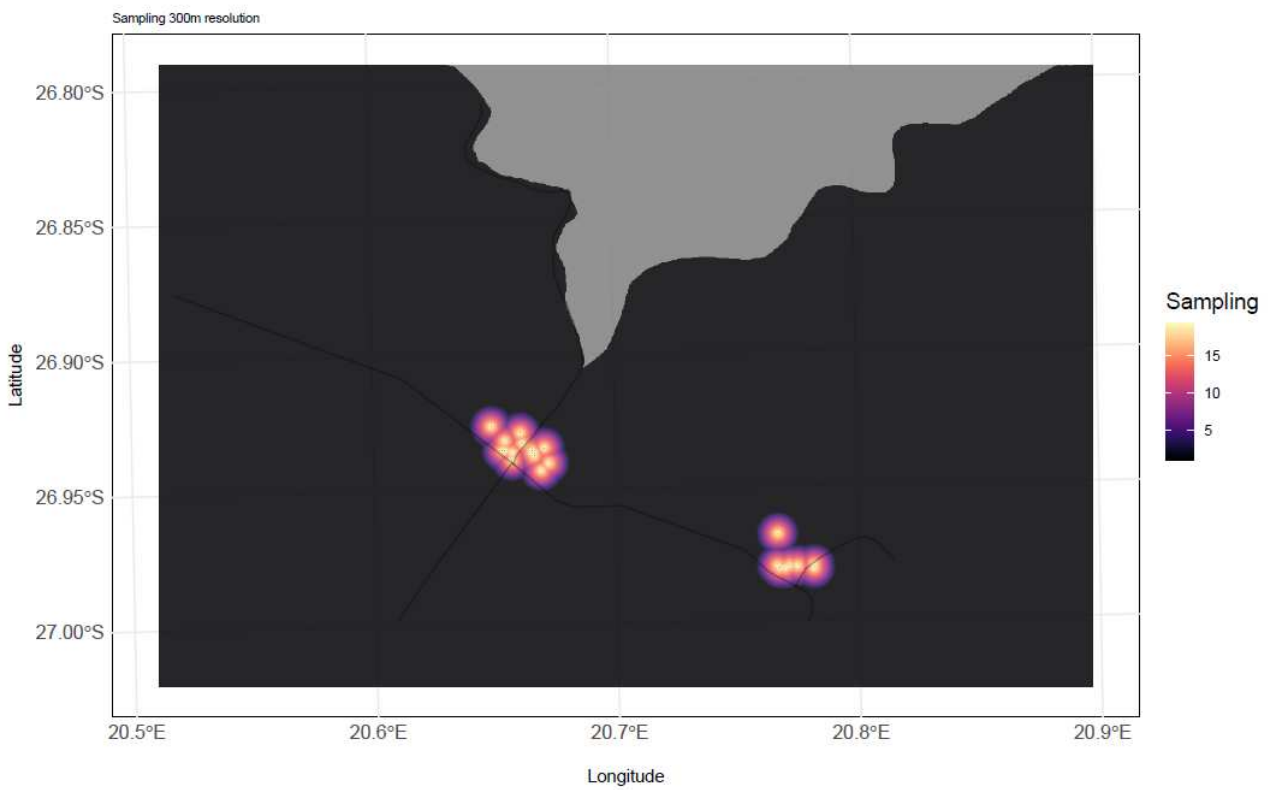
5. Kalahari: Global detectability (Product of road accessibility, sampling and visibility)



6. Kalahari : Road accessibility

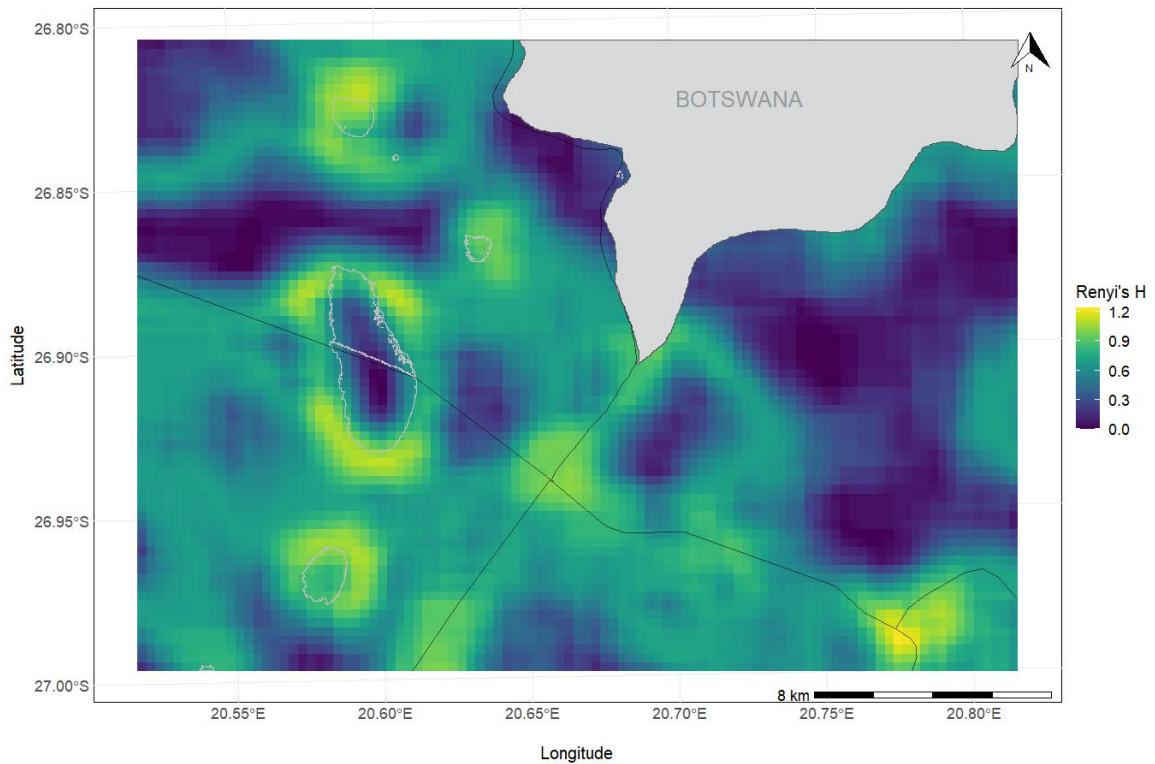
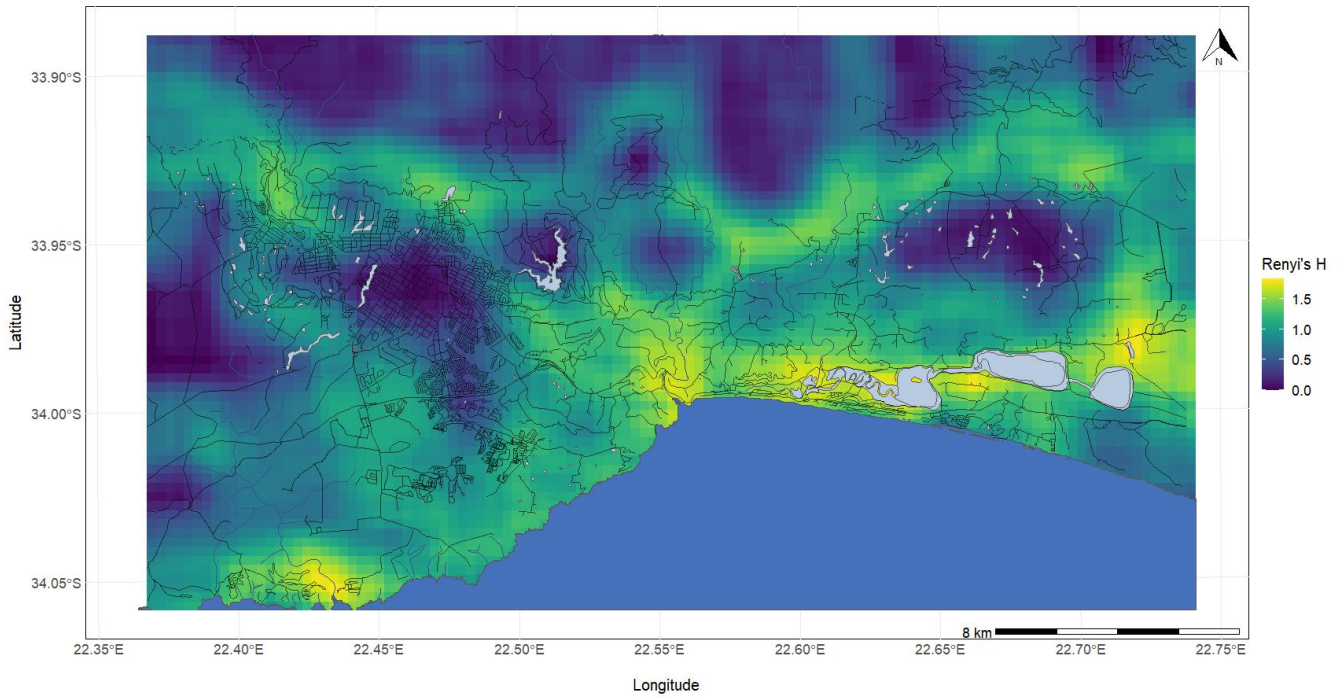


7. Kalahari: Landscape visibility based on land uses.



8. Kalahari: Sampling intensity based on participants' frequently visited areas

VI) Landscape heterogeneity



Renyi's index projection on Garden Route (above) and Kalahari (below) study sites.

VII) Stewardship analysis

Citations examples according to analytic dimensions subcategories for the two sites: (a) the Garden Route and (b) the Kalahari (based on Mathevet et al., 2018a)

(a)

Analytic dimensions	Prosaic & radical	Imaginative & Reformist	Imaginative & Radical	
	Adaptive	Sustainability	Transformative	
Vision of human-nature interactions	<p>Nature as forces to be regulated by the social sphere</p> <p>"The footprints of [George inhabitants] have been reduced to provide space for wildlife"</p> <p>Municipality</p>	<p>Nature as forces to be regulated by the social sphere</p> <p>"And all of those are things coming from nature. So, that means that's also part of money ... it's an income that they then use"</p> <p>"I think if there are people that stress, it's very good to take a walk-in nature"</p> <p>Informal settlement resident</p>	<p>Environmental problem = governance issues</p> <p>"It's about compliance and making sure people are compliant. We have rules, regulations and laws, but they are not enforced. So there is poor enforcement and poor compliance. It's great to have all the laws, but in my experience, it doesn't matter because nobody enforces them"</p> <p>Conservancy</p>	<p>Environmental problem = plurality of values and governance issues</p> <p>"We actually are the universe; everything we think of it vibrates. When we speak, we touch the tree speaking back to us since childhood it hurts me when somebody breaks a tree. When we are talking about sustainability [it is] not only of the town but its people, wildlife, and co-existence."</p> <p>Pacaltsdorp</p>
Agents and their motives	<p>Elites, scientists and policy or decision-makers, public interest defined by them</p> <p>"[For] the vision, we break it down into strategic objectives and finally into projects"</p> <p>Municipality</p>	<p>Homo economicus, self-interested</p> <p>"We have to protect it. Many tourists come from far away just to see the wildlife here. This is very good because this is how we generate money here"</p> <p>Informal settlement resident</p>	<p>Many agents at different levels, transnational and local as well as the state, motivated by the public good</p> <p>"I think [it] is a paradigm shift to landownership to custodianship [...]it's linked to this is his exclusivity going towards away from inclusivity everything keeping everything [...] those are sort of two key factors that can lead to our vision of landscape coexistence"</p> <p>SANParks</p>	<p>Human subjects more ecologically aware than others, many collective actors, multidimensional motivation</p> <p>"We also climbed the trees as the baboons climbed. We also jump as they jump, we mimic them, and they think they mimic us."</p> <p>"With all due respect, George municipality does not do enough to incorporate First Nation Aboriginal people into those</p>

Analytic dimensions	Prosaic & radical	Imaginative & Reformist	Imaginative & Radical	
				<i>conversations</i> Pacaltsdorp
Facilitators and Governance	Scientists as facilitators and public policy and adaptive management with consultation of stakeholders <i>I'm urging people to respond to influence the next set of documents which is also the integrated development plan</i> Municipality	Public policy and adaptive management with consultation of stakeholders <i>"We need to tell everybody about the wildlife in our environment and to protect that" "</i> Informal settlement resident	Conservationists and managers, mix of adaptive co-management and public policy <i>"Technology increases damage to ecosystems in the wildlife, but it also contributes to its protection. And then the true kind of parks and private land approach to exclusion to conservation."</i> Property owner	Citizen, managers and scientists, Adaptive co-management, community-based management <i>"What you've done is you've brought together people who are so polarised, you've brought them together, and you've laid the foundations for a conversation [...]</i> Pacaltsdorp
Dominant knowledge	Driven by science and expert knowledge	Driven by science and expert knowledge <i>"Tell other people about conservation and wildlife and then protecting animals"</i> Informal settlement resident.	Mix of experts, science and lay knowledge <i>"Unless it is prioritised politically, it won't happen. Maybe individuals may do something about it, taking it seriously so that there are policies in place in your mind now"</i> Conservancy	Driven by pragmatic and lay knowledge <i>"A constructive conversation that will ensure the biodiversity that will ensure the sustainability of a society that can truly coexist"</i> Pacaltsdorp

(b)

Analytic dimensions	Prosaic & Reformist	Imaginative & Reformist	Imaginative & Radical
Stewardship	Reformist	Sustainability	Transformative
Sub-categories	Democratic rationalism		
Vision of human-nature interactions	Nature as forces to be regulated by the social sphere <i>"I would say that our animals are already in captivity. There is no possibility that we can live with animals again. It is already out [...], the animal and the human. Like what the lady</i>	Environmental problem = governance issues <i>"To protect all that breathes and lives on earth from a healthy life. In other words, it is not only nature that needs a healthy life, but humans [too]"</i>	Environmental problem = plurality of values and governance issues <i>"If we must stay between the animals, as we are doing now, the animals will get</i>

	<p>said, she is so afraid of a snake, and we aren't used to growing up with them, to say, here's a snake or something. So, I would say, in this time, it's quite impossible to live again [with them]"</p> <p>Askham township</p>	<p>Andriesvale</p>	<p><i>angry and hurt us. Because animals and people are meant to live together in nature, yes, we can live together in nature"</i></p> <p>Witdraai</p>
<p>Agents and their motives</p>	<p><i>Different agents but citizen is central to self-interest and multiple conceptions of self-interest motivations</i></p> <p><i>"I'm going to make the animals sick. And I'm not lying, because they got sick when the animals ate people. So now we're only going to kill the animals, or the animals will kill us. So, let's stay in the place [...], apart from them, let them come in the evening, visit us, and leave. And we can visit them in the morning and come back"</i></p> <p>Andriesvale</p>	<p><i>Many agents at different levels, transnational and local as well as the state motivated by the public good</i></p>	<p><i>Human subjects more ecologically aware than others, many collective actors, multidimensional motivation</i></p> <p><i>"Everybody must just be careful of the animals, and animals will at the end of the day, be careful. So, I think it is workable for people and animals to coexist"</i></p> <p>Andriesvale</p>
<p>Facilitators and Governance</p>	<p><i>Public policy and adaptive management with consultation of stakeholders</i></p> <p><i>"There are no signs saying to watch out for tortoises and trucks should be fined. It is a very sad problem"</i></p> <p>Andriesvale</p>	<p><i>Conservationists and managers, mix of adaptive co-management and public policy</i></p> <p><i>"In 2016; I was in Nossob because of a training I was lucky enough to get and I am thankful to God, because when we got there, with the management of Nossob, Wilderness camp you feel like living with the animals"</i></p> <p>Witdraai</p>	<p><i>Citizen, managers and scientists, Adaptive co-management, community-based management</i></p> <p><i>"And if we must find people who can run [conservation] as Bushmen, that then we have to do it, but give us the right to get our place back"</i></p> <p>Witdraai</p>
<p>Dominant knowledge</p>	<p><i>Driven by science and expert knowledge</i></p>	<p><i>Mix of experts, science and lay knowledge</i></p> <p><i>"If you are used to living in the bush, it will not be a problem for you to live with [wild animals]... where I live, I am in the bush. I live with snakes because they move around, we see the tracks, they come in and out"</i></p> <p>Witdraai</p>	<p><i>Driven by pragmatic and lay knowledge</i></p> <p><i>"Both of you [i.e. animals and humans] must respect each other's space [...]. So it's also a way of learning to live with your nature. It's also something you must learn. It is not enough to go into nature and know something. The scorpion will sting you because you must learn through your mistakes"</i></p> <p>Witdraai</p>

VIII) Discourse analysis

Agreement between stakeholders' groups during the conservation and coexistence discussions for the two sites: (a) the Garden Route and (b) the Kalahari
(a)

<i>Agree or disagree</i>	<i>with...</i>	<i>about...</i>
Conservancy	Pacaltsdorp	<i>"It was interesting to see how they were similarities that came out in all the groups and how we are, we are land and I particularly liked what you said about we are nature and we live in nature so can ourselves call us nature"</i>
Municipality	Conservancy	<i>"I hope that in the special development framework, we will reduce the ability to fence edge to edge our properties"</i>
Conservancy	All the groups	<i>"It's wonderful having all the laws but [...] it doesn't matter because no one's enforcing them"</i>
Pacaltsdorp	Conservancy	<i>"The everyday citizen in George feels that having wildlife move through their residential area is beneficial to them and they understand why [...] coexisting with wildlife is necessary"</i>
Municipality	Pacaltsdorp	<i>"You need to have a proper solution; absolutely, you need to give for not to them [Baboons] to take from you. I support it. Thank you for the interest"</i>
Pacaltsdorp	Conservancy	<i>"It seems to me that conservation is [...] like an economical luxury whereas the vast majority of the population in South Africa and George are struggling to survive"</i>

<i>Agree or disagree</i>	<i>with...</i>	<i>about...</i>
Andriesvale	All the groups	<i>"Everything that you mentioned is an important aspect. We have all touched the same things that bother us. For example, I don't know how you physically plant in this ground. But I don't know exactly what we will do to take the story of nature conservation a lot deeper than we're doing here. And what we're doing here is nothing yet. It is nothing yet."</i>
Andriesvale	Witdraai	<i>"We saw our culture, tradition, and language become extinct, but still, people can transfer that to the children. So, I appreciate that you specifically recorded that. But, it was just as important because the discussion tells you about how we lived. We're still living like that today, without anything, so we are still trying, as always, to survive."</i>
Andriesvale	Askham	<i>A: "I would say the wildlife is already extinct" B: "Yes, I would say it won't be that possible with the wildlife"</i>
Witdraai	Askham	<i>A: "I would say that our animals are already in captivity. There is no possibility that we can live with the animals again." B: "If you are used to living in the bush, then it won't be a problem for you to live with. I live with the snakes because they move around there"</i>
Andriesvale	Witdraai	<i>A: "The fact [...] if you live with nature, nature will live with you" B: "I have to disagree. [When] you sleep at night, you don't know where the animals go. In the morning, when I wake up, I find the kudu tracks inside my yard. So, nature won't be stopped. It goes where it wants to. So, it is still with us; we're still living with nature. So, it comes to us"</i>
Andriesvale	Witdraai	<i>A: "Nature is medicine, doctor" B: "Yes, if you read the bible, it says, don't you learn from nature?"</i>
Witdraai	Witdraai	<i>A: "Give us the right to get our place back again" B: "So, you want to go to the Cape? [Parliament] [...] We won't be able to live like in 1936 or before those years like we lived then. That is one thing that we must remember. Because myself, I won't be able to live without a cellphone and a bottle of liquor"</i>
Witdraai	Witdraai	<i>"Because animals and humans go together [...] we will be able to live together [...], but in our usual and habitual life as today, we have adopted a second culture that separates us from our old habits and rights. But we have not lost what, as children, we were taught, the skill of hunting and tracking. Understand?"</i>

Andriesvale	Witdraai	<i>"We are now; humans and animal have been put in camps. Humans and animal have been put in a corner that shows that we will not be able to live like we did then. I agree with that. I won't last in the cold, with all these chronic illnesses, I will make the animals sick."</i>
Askham	Witdraai	<i>"If I speak now, you'll say I'm protecting myself. But it's just as [said], in the wilderness, many of us didn't grow up in nature. I will run around in the river bare naked; I'm not afraid"</i>
Askham	Andriesvale	<i>A: "In this society [...] the acknowledgement of those [...] feeling that they want this life that our people lived in 1936 or 1940 [...] and for those that feel that they have hybridised a bit" B: "What he said now, is right. Because humans and animal, it will take a lot to get them together again. Because life has modernised, we went over, as he said, he won't be able to go without a cell phone for seven days."</i>