

Social-ecological change: insights from the Southern African Program on Ecosystem Change and Society

Reinette Biggs, Hayley S. Clements, Graeme S. Cumming, Georgina Cundill, Alta de Vos, Maike Hamann, Linda Luvuno, Dirk J. Roux, Odirilwe Selomane, Ryan Blanchard, Jessica Cockburn, Luthando Dziba, Karen J. Esler, Christo Fabricius, Rebecka Henriksson, Karen Kotschy, Regina Lindborg, Vanessa A. Masterson, Jeanne L. Nel, Patrick O'Farrell, Carolyn G. Palmer, Laura Pereira, Sharon Pollard, Rika Preiser, Robert J. Scholes, Charlie Shackleton, Sheona Shackleton, Nadia Sitas, Jasper A. Slingsby, Marja Spierenburg, Maria Tengö & Belinda Reyers

To cite this article: Reinette Biggs, Hayley S. Clements, Graeme S. Cumming, Georgina Cundill, Alta de Vos, Maike Hamann, Linda Luvuno, Dirk J. Roux, Odirilwe Selomane, Ryan Blanchard, Jessica Cockburn, Luthando Dziba, Karen J. Esler, Christo Fabricius, Rebecka Henriksson, Karen Kotschy, Regina Lindborg, Vanessa A. Masterson, Jeanne L. Nel, Patrick O'Farrell, Carolyn G. Palmer, Laura Pereira, Sharon Pollard, Rika Preiser, Robert J. Scholes, Charlie Shackleton, Sheona Shackleton, Nadia Sitas, Jasper A. Slingsby, Marja Spierenburg, Maria Tengö & Belinda Reyers (2022) Social-ecological change: insights from the Southern African Program on Ecosystem Change and Society, *Ecosystems and People*, 18:1, 447-468, DOI: [10.1080/26395916.2022.2097478](https://doi.org/10.1080/26395916.2022.2097478)

To link to this article: <https://doi.org/10.1080/26395916.2022.2097478>



© 2022 The Author(s). Published by Informa UK Limited, trading as Taylor & Francis Group.



Published online: 14 Aug 2022.



Submit your article to this journal [↗](#)



Article views: 1288




View related articles [↗](#)



































[View Crossmark data](#) 



Citing articles: 3 [View citing articles](#) 

Social-ecological change: insights from the Southern African Program on Ecosystem Change and Society

Reinette Biggs ^{a,b}, Hayley S. Clements ^a, Graeme S. Cumming ^{c,d}, Georgina Cundill ^e, Alta de Vos ^f, Maïke Hamann ^a, Linda Luvuno ^a, Dirk J. Roux ^{g,h}, Odirilwe Selomane ^a, Ryan Blanchard ^{a,i}, Jessica Cockburn ^f, Luthando Dziba ^{j,k}, Karen J. Esler ^l, Christo Fabricius ^h, Rebecka Henriksson ^m, Karen Kotschy ⁿ, Regina Lindborg ^o, Vanessa A. Masterson ^{b,p}, Jeanne L. Nel ^{h,q}, Patrick O'Farrell ^{c,r}, Carolyn G. Palmer ^s, Laura Pereira ^{a,b,t,u}, Sharon Pollard ⁿ, Rika Preiser ^a, Robert J. Scholes ^u, Charlie Shackleton ^f, Sheona Shackleton ^r, Nadia Sitas ^{a,l}, Jasper A. Slingsby ^{v,w}, Marja Spienburg ^{x,y}, Maria Tengö ^b and Belinda Reyers ^{b,z}

^aCentre for Sustainability Transitions, Stellenbosch University, Stellenbosch, South Africa; ^bStockholm Resilience Centre, Stockholm University, Stockholm, Sweden; ^cFitzPatrick Institute of African Ornithology, DST/NRF Centre of Excellence, University of Cape Town, Rondebosch, South Africa; ^dARC Centre of Excellence for Coral Reef Studies, James Cook University, Townsville, Australia; ^eClimate Resilient Food Systems Division, International Development Research Centre, Ottawa, Canada; ^fDepartment of Environmental Science, Rhodes University, Makhanda, South Africa; ^gScientific Services, South African National Parks, George, South Africa; ^hSustainability Research Unit, Nelson Mandela University, George, South Africa; ⁱBiodiversity and Ecosystem Services Research Group, Council for Scientific and Industrial Research, Stellenbosch, South Africa; ^jConservation Services, South African National Parks, Pretoria, South Africa; ^kCentre for African Conservation Ecology, Nelson Mandela University, Port Elizabeth, South Africa; ^lDepartment of Conservation Ecology & Entomology, Stellenbosch University, Stellenbosch, South Africa; ^mCentre for Water Resources Research, University of KwaZulu-Natal, Pietermaritzburg, South Africa; ⁿAssociation for Water and Rural Development (AWARD), Hoedspruit, South Africa; ^oDepartment of Physical Geography, Stockholm University, Stockholm, Sweden; ^pDepartment of Anthropology, Rhodes University, Makhanda, South Africa; ^qEnvironmental Sciences Group, Wageningen University & Research, Wageningen, The Netherlands; ^rAfrican Climate and Development Initiative, University of Cape Town, Rondebosch, South Africa; ^sInstitute for Water Research, ARUA Water CoE, Rhodes University, Makhanda, South Africa; ^tCopernicus Institute of Sustainable Development, Utrecht University, Utrecht, The Netherlands; ^uGlobal Change Institute, University of the Witwatersrand, Johannesburg, South Africa; ^vDepartment of Biological Sciences and Centre for Statistics in Ecology, Environment and Conservation, University of Cape Town, Rondebosch, South Africa; ^wFynbos Node, South African Environmental Observation Network (SAEON), Claremont, South Africa; ^xDepartment of Sociology and Social Anthropology, Stellenbosch University, Stellenbosch, South Africa; ^yDepartment of Anthropology and Development Sociology, Leiden University, Leiden, The Netherlands; ^zFuture Africa, University of Pretoria, Pretoria, South Africa

ABSTRACT

Social-ecological systems (SES) research has emerged as an important area of sustainability science, informing and supporting pressing issues of transformation towards more sustainable, just and equitable futures. To date, much SES research has been done in or from the Global North, where the challenges and contexts for supporting sustainability transformations are substantially different from the Global South. This paper synthesises emerging insights on SES dynamics that can inform actions and advance research to support sustainability transformations specifically in the southern African context. The paper draws on work linked to members of the Southern African Program on Ecosystem Change and Society (SAPECS), a leading SES research network in the region, synthesizing key insights with respect to the five core themes of SAPECS: (i) transdisciplinary and engaged research, (ii) ecosystem services and human well-being, (iii) governance institutions and management practices, (iv) spatial relationships and cross-scale connections, and (v) regime shifts, traps and transformations. For each theme, we focus on insights that are particularly novel, interesting or important in the southern African context, and reflect on key research gaps and emerging frontiers for SES research in the region going forward. Such place-based insights are important for understanding the variation in SES dynamics around the world, and are crucial for informing a context-sensitive global agenda to foster sustainability transformations at local to global scales.

ARTICLE HISTORY

Received 6 August 2021
Accepted 30 June 2022

EDITED BY

Elena Bennett

KEYWORDS

SAPECS; social-ecological systems; transdisciplinarity; ecosystem services; human well-being; transformations; Global South

1. Introduction

A defining challenge for the coming decades is to effect large-scale societal transformations to tackle global poverty and inequality, and significantly reduce the negative impacts of our economies and other activities on the functioning of ecosystems and the Earth system (Steffen et al. 2015; Raworth 2017;

Hickel 2018). This challenge is particularly acute in sub-Saharan Africa, where about half the population lives below the World Bank's poverty line (World Bank 2018). Populations in many African countries are expected to more than double by 2050 (World Bank 2018), the continent is experiencing very rapid urban growth, and extreme climatic events such as

droughts and floods are projected to increase in magnitude and frequency due to the impacts of climate change (IPCC 2018; Otto et al. 2018; Sousa et al. 2018). These changes are likely to amplify pre-existing stresses caused by poverty, inequality, social tensions, burden of disease and social insecurity (World Bank 2018; UNDP 2020). At the same time, they will substantially increase demand for ecosystem services in the region, especially food, clean water and urban green spaces (IPBES 2018). These demands will increase pressure on the region's rich biodiversity and already-pressed agricultural systems (IPBES 2018; Archer et al. 2021). They will also affect important cultural services that underpin local identities and influence societal cohesion, affecting society's capacity to deal with social and environmental change (Archer et al. 2021). To shift regional development onto a more equitable, sustainable and just trajectory, a better understanding of and engagement with the particular social-ecological dynamics at play in the region are critical.

Sustainability science, which focuses on issues of intertwined social and ecological sustainability using transdisciplinary, problem-driven approaches, has emerged as a key research field to support sustainability transformations (Kates et al. 2001; Clark and Dickson 2003; Burns and Weaver 2008; Clark and Harley 2020). Social-ecological systems (SES) research is an important subfield within sustainability science (Clark and Harley 2020), supported by research networks such as the Resilience Alliance (RA) and the Programme on Ecosystem Change and Society (PECS) (Carpenter et al. 2012; Norström et al. 2017). While a growing body of SES work is being undertaken in the Global South, many theories and insights are still shaped by understanding and frameworks from the Global North (Collyer 2018; Nagendra et al. 2018; Pereira et al. 2020a). These are often not easily transferable to the Global South, given differing ecological, cultural and economic contexts. There is increasing recognition of the importance of understanding the particular SES dynamics of regions to support context-sensitive sustainability transformations at interconnected local to global scales (Pereira et al. 2018a).

The Southern African Program on Ecosystem Change and Society (SAPECS, sapecs.org) aims to contribute to this need by providing insights and perspectives grounded in the southern African context (Biggs and Reyers 2012; Biggs et al. *in review*). SAPECS is a leading SES research network in southern Africa and one of the first and largest regional case study networks linked to PECS. The objective of SAPECS is to build on previous and ongoing SES-related research activities in the region to advance stewardship of SES and ecosystem services in southern Africa by producing empirical evidence and

theory, synthesising and mainstreaming knowledge, and growing the regional community of practice on SES research (Biggs and Reyers 2012; Biggs et al. *in review*). Southern Africa provides an important and rich context for research on social-ecological dynamics and the relationships between ecosystems, human well-being, inequality and poverty, given its high diversity of ecosystems, climate, cultures, property regimes and levels of inequality (Burns and Weaver 2008; IPBES 2018; Archer et al. 2021; Du Toit et al. 2021). Given the relatively low levels of socio-economic development in the region, and the potential to leverage existing pockets of wealth and expertise, there is a possibility for both higher-level policy and bottom-up interventions by civil society to influence future development along more sustainable trajectories (Swilling and Anneck 2012; Pereira et al. 2019a; Swilling 2020; Archer et al. 2021). This context has the potential to provide novel insights and approaches to address the substantial sustainability challenges faced in this and other regions.

This paper synthesises key insights on SES dynamics and research that have emerged in relation to five co-created research themes around which SAPECS has been organised (Biggs et al. *in review*): (i) transdisciplinary and engaged research, (ii) ecosystem services and human well-being, (iii) governance institutions and management practices, (iv) spatial relationships and cross-scale connections, and (v) regime shifts, traps and transformations. (Figure 1). After introducing our synthesis approach, the remainder of the paper focuses on each of these themes in turn. We start by briefly introducing each theme, then discuss key insights giving examples of illustrative work in the region, and conclude with a reflection on future research directions for the theme. The paper concludes with a brief synthesis of what we see as key contributions to SES research from the southern African community, and key areas of future research. We intend this to be a useful synthesis of the contribution and frontier of SES work in southern Africa to inform SES research, policy and practice in the region, the Global South more broadly, and globally.

2. Approach

To identify the insights presented here, we asked the group of approximately 30 SAPECS members to submit references to their work and the work of their students or research teams that relate to the objectives of SAPECS. A smaller team of authors worked through the 149 submitted papers, coding them for their relevance to the five themes. Rather than attempting a comprehensive synthesis of work under each theme, we identified 3–4 key



Figure 1. Key insights with respect to the five co-created research themes of SAPECS that have emerged from work in the region.

insights where we felt the southern African context provides particularly interesting or unique perspectives that may be of relevance to other regions and inform the future SES research agenda both in southern Africa and more widely. These insights were developed and refined through an iterative process of collective discussion and sense-making among the authors of this paper, a process that has been valuable in fostering learning and further building the SAPECS community (for more detail on the development of the SAPECS network, see Biggs et al. (in review)).

We present the insights in terms of each of the five core SAPECS research themes, supporting or illustrating them with examples from the submitted papers as well as from additional relevant papers that were subsequently identified or appeared in print. The synthesis we present draws primarily on insights from work conducted by researchers linked to SAPECS, but also references other pertinent SES studies in the region, as well as literature that has been particularly influential in shaping our work. We acknowledge that there are a number of researchers not linked to SAPECS that are conducting important SES work in the region; given the focus of this paper, their work may not necessarily be cited here.

3. Transdisciplinary and engaged research

Effectively addressing sustainability challenges requires integration of knowledge across disciplines, scales, sectors (e.g. conservation, agriculture and water) and the realms of science, policy and practice (van Kerkhoff 2014). Furthermore, it requires consideration of contextually relevant and place-based societal values, policies and management practices, including those based on indigenous and local knowledge (Lutz and Neis 2008; Tengö et al. 2014; Wyborn et al. 2019). Transdisciplinary research processes aim to address these needs by drawing on and integrating perspectives and approaches from a variety of disciplines, as well as actively working with stakeholders and practitioners in the co-design, conduct, communication and application of research (Max-Neef 2005; Hirsch Hadorn et al. 2008). Through collaborative and action-oriented engagement, researchers and societal stakeholders are afforded the opportunity for their understanding of a common social-ecological issue to co-evolve, and their often diverse perspectives to be reinterpreted and reconciled (Pereira et al. 2018a). Such integrative and collaborative modes of knowledge co-production can potentially help inform and shape sustainable outcomes (Lang et al. 2012; Reyers et al. 2015; Roux et al. 2017; Sitas et al. 2019).

There has been a strong tradition of transdisciplinary research in southern Africa (Reyers et al. 2010a; Roux et al. 2010, 2017; Cundill et al. 2015; Cockburn

and Cundill 2018; Holden et al. 2019; Wolff et al. 2019; Taylor et al. 2021). Here we highlight four valuable lessons of broader significance. First, work in the region has demonstrated that transdisciplinary initiatives have the potential to shift the so-called *research-implementation gap* (see e.g. Knight et al. 2008) into a *research-implementation interface* characterised by active and iterative knowledge exchange over time (Cockburn et al. 2018a). When actors from different academic disciplines and from policy, management and/or communities work together, the researcher-practitioner dichotomy becomes less relevant (Reyers et al. 2010a; 2015; Sitas et al. 2016; Cockburn et al. 2018a; Buschke et al. 2019). This was evident, for example, in a transdisciplinary project on conserving freshwater ecosystems, for which diverse actors from academia, government and NGOs worked as a “transdisciplinary community of practice” (Cundill et al. 2015) to effect significant policy change (Nel et al. 2016, 2017). Similarly, in a transdisciplinary partnership between a local municipality and a university in Durban, South Africa, city officials worked with scientists to co-design an implementation-oriented research agenda to inform urban environmental planning and management (Cockburn et al. 2016). Transdisciplinary engagement also supported the facilitation of a complexity-based approach for integrating ecosystem services into disaster risk reduction in the Garden Route in the Western Cape province of South Africa, resulting in a sense of shared risk and responsibility in a place-based project between the private sector (short-term insurers and a major brewery), researchers, municipal officials and civil society (Nel et al. 2014; O’Farrell et al. 2015; Reyers et al. 2015).

Second, transdisciplinary research relies on skilful facilitation by “intermediaries” (i.e. boundary spanners, bridging agents and knowledge brokers). Intermediaries are skilled at creating conditions where the “weaving” of diverse social networks can emerge, building trust and creating specialised interfaces between participating actors and different sources of knowledge (Harris and Lyon 2013; Westley et al. 2013; Maag et al. 2018). Whereas it is common for academic researchers to fulfil the role of intermediaries (even during postgraduate studies (Holden et al. 2019)), work in the region has also highlighted that it is beneficial to have intermediaries embedded in implementation agencies, from where they contribute to the transformative potential and post-project sustainability (Roux et al. 2017; Taylor et al. 2021). Providing embedded researchers with appropriate financial, institutional and emotional support is critical to their effectiveness as intermediaries, and connecting them to a cohort of peers can be particularly beneficial (Taylor et al. 2021). Nourishing competencies for intermediaries in engaged,

transdisciplinary research requires “making the path by walking it” (Esler et al. 2016; Holden et al. 2019; Sellberg et al. 2021), and different people play and embody a multiplicity of roles when working in this space (Temper et al. 2019; O’Connor et al. 2021).

Third, mutual learning in transdisciplinary initiatives in the region has been enhanced by careful co-design of co-learning spaces or “third places” conducive to dialogue among diverse actors (Oldenburg 1989). In transdisciplinary research, third places are physical spaces that create an interface for learning between academia and practice, where researchers and practitioners have an equal voice when they engage to find common ground regarding a particular social-ecological issue (Roux et al. 2017, 2020a). The importance of physical considerations such as accessibility (e.g. a local school hall) and attractiveness (e.g. a meeting venue in a botanical garden), as well as seating arrangements that encourage interactions (e.g. the World Café method (Schieffer et al. 2004)) should not be underestimated. Furthermore, work in the region has highlighted that an effective transdisciplinary third place is characterised by a culture of mutual understanding and respect, explicit identification of values and ethical considerations (Wolff et al. 2019) and careful use of language to allow for more inclusive engagement between and across disciplines, cultures and social inequalities (Roux et al. 2017; Burt 2019). Work in the region has further demonstrated that engaged and action-oriented research that pays attention to the careful co-design of transdisciplinary third places, and use of methodological processes which take into account ethics, power and participants’ values, can encourage more equitable participation and agency for participants from marginalised positionalities (Cockburn et al. 2018a; Masterson et al. 2018; Wolff et al. 2019; Pereira et al. 2020a).

Finally, work in the region has shown that a focus on knowledge co-production (Norström et al. 2020; Chambers et al. 2021) can promote adoption and implementation of the products of transdisciplinary research, and can mobilise practice-based and action-oriented knowledge (Reyers et al. 2015; Sitas et al. 2016, 2019; Cockburn et al. 2020; Preiser et al. 2021). Whereas mutual learning has long been a necessary condition of transdisciplinary research (Lang et al. 2012), co-production of knowledge has largely developed as a separate strand of literature (West et al. 2019; Wyborn et al. 2019). Knowledge co-production and mutual learning are often highly complementary processes, where knowledge co-production aims to translate the shared understanding created through the mutual learning into tangible products (Armitage et al. 2011). Similar to experience elsewhere, we have found that co-produced products such as visions, maps, shared

strategies and conceptual models have not only helped to capture collective knowledge but also promote broad ownership and practical utility of transdisciplinary research products (Nel et al. 2016; Sitas et al. 2016; Turner et al. 2016; Roux et al. 2017, 2021; Cockburn et al. 2020).

An important caveat is that transdisciplinary research requires long-term commitment. Single projects (one to three years in duration) are typically too limited in scope to allow for the development of relationships and trust, problem co-framing and achieving co-learning and co-production of knowledge among diverse transdisciplinary actors (Esler et al. 2016; Turner et al. 2016; Wolff et al. 2019). A programmatic approach with assurance of long-term (>10 years) continuity, where a number of interdependent projects or studies address a specific social-ecological issue (Ommer 2007; Roux et al. 2010; Pollard et al. 2020), is probably required to realise the transdisciplinary ideals of system-wide learning and transformative change (see Pennington et al. 2013).

Looking ahead, research in the region continues to contribute to the ongoing development of transdisciplinary modes of research, potentially moving towards more transgressive approaches (Kulundu-Bolus et al. 2020) and an activist-scholar perspective (Temper et al. 2018, 2019). A specific focus is to investigate how transdisciplinary work can be conducted with integrity in the context of large societal inequalities (Wolff et al. 2019), while acknowledging the need to care for the well-being of societal partners and researchers (Sellberg et al. 2021). Such contexts pose substantial challenges, including the need for deep engagement with the ethics of working with vulnerable and marginalised groups, as expectations are set whenever research is undertaken (Tengö et al. 2017; Pereira et al. 2019a, 2020a; Wolff et al. 2019).

A further focus for the future is to offer prospective students who are pursuing transdisciplinary research institutional support and mentorship to develop competencies beyond those conventionally expected of traditional disciplinary researchers (Lotz-Sisitka et al. 2015; Cockburn and Cundill 2018; Holden et al. 2019; Biggs et al. 2021). Capacities such as epistemic flexibility and balancing the “moral burden” of responsible and ethical stakeholder engagement with that of achieving scientific excellence have been suggested as key competencies that should be nourished in young researchers both in the region and elsewhere (Sitas 2014; Cockburn and Cundill 2018; Haider et al. 2018; Sellberg 2018; Sellberg et al. 2021; Chambers et al. 2022). These capacities can be further developed and institutionalised when incorporated in learning structures outside of higher education (e.g. Duggan et al. 2021).

4. Ecosystem services and human well-being

An SES approach to ecosystem services aims to identify not only the biophysical production functions that underlie their supply but also the social factors and social-ecological interactions that are necessary for the co-production and realisation of ecosystem services for different groups of beneficiaries (Cowling et al. 2008; Reyers et al. 2013; Wessels et al. 2021a, 2021b). Mirroring developments globally (Wangai et al. 2016; IPBES 2018; Chan et al. 2020), and strengthened by a conducive decision-making environment that references ecosystem services in a number of policies (Reyers et al. 2015; Cumming et al. 2017), southern African ecosystem service research now encompasses a wide variety of ecosystem services and non-monetary valuation methods. It also focuses on the complex ways in which ecosystem services emerge and are mediated through social-ecological interactions and relationships, and the well-being and equity implications for different societal groups and geographies.

Studies from the southern African region have particularly highlighted the role of factors such as property rights, skills and access to financial and technical resources in determining ecosystem service outcomes (e.g. Henriksson Malinga et al. 2018; Sowman and Sunde 2018). These examples reveal legacies of unjust and racially discriminatory land or resource ownership and governance systems, as well as ongoing underinvestment in addressing these injustices (Venter et al. 2020; Sowman and Sunde 2021). Also key are safety and security, in that vulnerable members of society (e.g. women and children) often fear for their personal safety while harvesting natural resources, since wooded or “wild” areas are sometimes perceived to be associated with crime (de Neergaard et al. 2005; Shackleton et al. 2015, 2019a; Manyani et al. 2021). These concerns limit access to ecosystem services for the many female-headed households in the southern African region, and are often an additional driver of inequity and vulnerability in already highly unequal communities (Shackleton et al. 2014). Redressing inequalities needs careful consideration of the heterogeneity of both landscapes and people, and must account for the diverse and multi-functional ways in which ecosystem services are co-produced in the southern African region, as well as their diverse and plural values (Masterson et al. 2019a; Clements et al. 2021).

Additional insights come from research into the role of ecosystem services as a safety net in times of hardship, and as a coping mechanism for dealing with climate change and other interacting stressors (Shackleton and Shackleton 2012; Masunungure and Shackleton 2018). The safety

net function of ecosystem services in poor rural areas is widely documented; however, research in the southern African region extends these insights to wealthier rural and urban households (Shackleton and Shackleton 2004; Paumgarten and Shackleton 2009; Shackleton et al. 2015; Cilliers et al. 2018). For instance, studies in urban areas across the region (including small and medium-sized towns) show a strong reliance by urban households on public land for a range of provisioning services (such as fuelwood, medicinal plants, wild foods and grazing, among others), which make significant contributions to poverty mitigation and, at times, alleviation (Davenport et al. 2012; Kaoma and Shackleton 2015; Shackleton et al. 2018a). In addition, urban green spaces can provide situation-specific, irreplaceable regulating and cultural services to urban residents across the socio-economic spectrum (O’Farrell et al. 2012; Shackleton et al. 2015; Cocks and Shackleton 2021). These findings underscore the important role of ecosystem services to beneficiaries beyond the rural poor, especially in times of hardship or crisis, while highlighting the diversity of users and of perspectives on these ecosystem services and disservices (Thondhlana et al. 2022).

In exploring the multi-faceted linkages between ecosystem services and human well-being, research in southern Africa has spanned many spatial scales and contributed to the development of novel research methods. Innovative systems-based approaches have been useful at the local scale to explore the links between climate change, food and water security, as well as health (Pollard and De Villiers 2020). Value assessments have shown the prevalence of cultural services such as religious and ritual use, and sense of place (Cocks et al. 2008; Thondhlana and Shackleton 2015; Cundill et al. 2017; Masterson et al. 2017; 2019a; Smit et al. 2017; Henriksson Malinga et al. 2018). New assessment techniques are beginning to uncover the significance of more nuanced attachments to nature that are especially important in poverty contexts, such as finding solace and comfort in nature, and coping with conflict, disease and migration (Mandondo 1997; Lynam et al. 2003; Cocks et al. 2012; Masterson et al. 2018; Njwambe et al. 2019; Cocks and Shackleton 2021). Work in the region also highlights that if use of local provisioning services decreases (due to interventions such as social grants), the value of cultural services becomes more prominent and a driving force in linking communities to nature (Chinyimba 2012; Shackleton and Blair 2013).

At the national scale, research has shifted from mapping the supply of single ecosystem services to

a systems-inspired approach of mapping bundles of services and investigating how they are co-produced. In South Africa, for example, bundles of provisioning services were used to identify distinct SES and relate to human well-being across multiple dimensions (Hamann et al. 2015, 2016). In protected areas, Ament et al. (2017) showed that visitor preferences strongly determined the bundle of cultural services provided by South Africa's national parks, and Roux et al. (2020b) demonstrated that cultural services are outcomes of complex people-nature interactions, thus posing distinct management challenges. Zoeller et al. (2020) have shown that South African birds can be grouped into "cultural functional groups" based on the cultural services they provide, suggesting a way of simplifying the evaluation of cultural services and their integration with ecological data.

Looking to the future, more dynamic explorations of the flows, relationships and feedbacks between ecosystems and people are required to address questions about how these interactions change over time and in response to different kinds of stressors (Shackleton and Shackleton 2012; Shackleton and Luckert 2015; Mausungure and Shackleton 2018; Falyai et al. 2019; Masterson et al. 2019b; Reyers and Selig 2020; Selomane et al. *in press*). Emerging research areas include equity and social justice implications of changes in ecosystem service bundles due to changes in climate (particularly in relation to water availability), property rights, land use and development (Thondhlana et al. 2022) and access to natural resources (e.g. Krüger et al. 2016; Thondhlana et al. 2016), as well as the role of multiple ecosystem services in reducing the impacts of climate change and supporting adaptation (Rebelo et al. 2021). These are key research priorities, not just in rural areas but also in areas where urban growth is rapidly changing the social-ecological landscape, and in the context of formal vs informal development (Du Toit et al. 2018; Venter et al. 2020; Cocks and Shackleton 2021; Thondhlana et al. 2022). Innovative approaches must not only improve fine-scale spatial understanding of ecosystem services and human well-being, but also clarify the diversity of values and dimensions of well-being associated with nature across different groups, regions and time (Masterson et al. 2019b; Thondhlana et al. 2022).

A further frontier for research and policy is in the application of SES approaches to ecosystem and natural capital assessment and accounting frameworks, e.g. in the development of evidence-based policies on sustainable diets and food systems (Sobratee et al. 2022), innovations in relational approaches to sustainable development indicators (Selomane et al. *in Press*), and in the first generation of ecosystem accounts produced to move Systems of National Accounts beyond GDP to better account for the role

of ecosystem services (Nel and Driver 2015). In many of these advances, southern Africa not only offers some of the first examples of such approaches, but also does so in a context of complex socio-political legacies and in ways that bridge local-global, terrestrial-freshwater, and urban-rural divides, which have hampered ecosystem service research and practice.

5. Governance institutions and management practices

Governance strategies and practices influence how individuals and groups make decisions, share power and access resources (Bevir 2013). Such influence can be either formally recognised in the form of policies and accepted decision-making processes, or it can be subtler in the form of norms of behaviour that shape the ways in which power is shared and decisions are contested (Folke et al. 2005). How governance shapes decisions and resource use in a particular context depends on structural considerations (Ostrom 2010) as well as the roles of key individuals (Bodin and Crona 2011), shadow networks (Folke et al. 2011), social movements (Ernstson et al. 2008), traditional institutions and values (Mosimane and Silva 2015; Masterson et al. 2017) and history (Cundill and Fabricius 2010; Cockburn et al. 2019).

The interplay between structure, power and agency, particularly in the context of governance transitions, has been at the heart of work on the governance of ecosystem services in the region. In southern Africa, transitions to democracy in the last 30 years created "windows of opportunity" (Olsson et al. 2006) that opened the region to large-scale social-ecological change (Fabricius et al. 2001; Biggs et al. 2015), resulting in experimentation with a diversity of new institutions and governance systems (Campbell and Shackleton 2001; Shackleton et al. 2001). Particularly notable have been experiments in participatory approaches to natural resource management, involving many examples of devolved decision-making about natural resources. Examples include the ground-breaking work in the Campfire programme in Zimbabwe during the 1980s and 1990s (Frost and Bond 2008), the establishment of conservancies to protect Namibia's wildlife and benefit local communities (Mosimane and Silva 2015), policy shifts towards collaborative management in the context of land reform in South Africa (Kepe 2008) and development of a range of policy instruments and collaborative platforms to support stewardship of natural resources by communal and private land-owners (e.g. Barendse et al. 2016; Cockburn et al. 2018a, 2018b, 2019; de Vos et al. 2019).

The region offers several examples of innovative policies and mainstreaming initiatives that explicitly account for impacts on ecosystem services and

society (Reyers et al. 2010a; Cumming et al. 2017). Shifts in South Africa's water law, for example, prompted the establishment of Catchment Management Agencies (CMAs) and Water User Associations (WUAs) to give voice to water needs at local and landscape scales (Palmer 1999; Munnik et al. 2016; Weaver et al. 2019). Similarly, the South African government's "Working for" natural resource management programmes, such as Working for Water, arose from the alignment of biodiversity goals (reducing invasive alien plants) with development goals (growing employment and water provision) (Turpie et al. 2008; Cadman 2010; Reyers et al. 2010b). Furthermore, conservation policies in support of private and communal stewardship and conservation initiatives (e.g. Cadman 2010; Boudreaux and Nelson 2011; Barendse et al. 2016; Rawat 2017; Cockburn et al. 2018) have allowed for the establishment of a diversity of protected and other area-based conservation instruments in the region, managed by diverse stakeholders ranging from private individuals to traditional institutions and the state.

Despite such progressive and enabling policy shifts (Shackleton et al. 2001; Turpie et al. 2008; Sowman et al. 2014), actions and outcomes on the ground have not always been as expected (Young and van Aarde 2011; Roux and Nel 2013) or desired (Pillay 2004; Kepe 2008; Wilhelm-Rechmann and Cowling 2011; Isaacs and Witbooi 2019). The implementation of the current co-management policy on protected areas in South Africa, for example, has led to widespread reports of ineffective biodiversity conservation, a lack of substantive changes in power relations between communities, traditional governance structures and the state (Cundill et al. 2013; Krüger et al. 2016; Masterson et al. 2019b; Pollard et al. 2020), societal conflict (Cundill and Fabricius 2010; Thondhlana et al. 2016; Thondhlana and Cundill 2017) and unequal and insufficient benefit sharing (Bollig and Menestrey Schwieger 2014; Hauck and Wynberg 2014; Krüger et al. 2016; Cundill et al. 2017). Many water catchment management forums have proved toothless or unrepresentative (Munnik et al. 2016), and "Working for" programmes have struggled to achieve intended job creation and environmental outcomes, partly as a result of inappropriate performance indicators (van Wilgen and Wannenburgh 2016). Although South Africa's biodiversity stewardship programmes have seen significant success in collaborative public-private conservation (Rawat 2017), they have also led to a narrow view of biodiversity stewardship among conservation practitioners and the exclusion of important private or communal conservation actors (Cockburn et al. 2019).

As southern African researchers have shown, many of these issues have resulted from "missing

capacities" in many stakeholder groups (Cundill et al. 2013), often linked to the degradation of local institutions under apartheid (Weyer et al. 2019). In the case of co-management of protected areas, the lack of local capacity and agency is compounded by a lack of bridging institutions and ignorance of the multiple values of nature and traditional institutions in management decisions and policies (Cundill et al. 2017; Masterson et al. 2019a), a problem that also applies to the governance of urban green spaces (Gwedla and Shackleton 2015). In the case of negotiating governance pathways towards more participatory and equitable access to natural resources, Clifford-Holmes et al. (2016, 2018) usefully identified the "muddled middle" – the territory between "rules in form", for example the South African National Water Act 36 of 1998, and "rules in use", for example the implementation of well-managed wastewater treatment works or environmental flows – where sustainability and equity intentions flounder. Moreover, there is growing evidence of non-governmental organisations and research institutes playing an important role in facilitating collaborative resource management in instances where formal government institutions are not functioning as intended (Cockburn et al. 2018a, 2020).

The southern African SES community has made important gains in understanding the interplay of structure, power and agency to "make things happen" (Westley et al. 2013) in governance transitions. We have learned, for example, that sustainable and just landscape-level governance requires intensive engagement at local level, particularly with traditional governance systems and other traditional institutions (O'Farrell et al. 2019; Wolff et al. 2019). However, this engagement may be difficult to scale (Cockburn et al. 2018b). Whereas initiatives that seek to build sustainable resource governance can leverage existing structures and skills in some urban and agricultural landscapes (Cockburn et al. 2019; O'Farrell et al. 2019), many rural landscapes require extensive investment in the development of the necessary skills and capacities for local people to exercise agency and develop the requisite informal and structural institutions (Cockburn et al. 2018a, 2018b; Wolff et al. 2019; Pollard et al. 2020).

Several gaps remain in our understanding of just and sustainable governance of SES in southern Africa. Perhaps most fundamental is the inherent incongruity of applying natural resource management instruments that embody colonial and neoliberal values to a postcolonial state, where colonial and apartheid legacies have resulted in racially highly skewed access to natural resources and public services (e.g. Shackleton and Luckert 2015; Masterson et al. 2019a; Venter et al. 2020). Although there has been progress in understanding how to work in more

equitable and just ways within existing structures, the southern African SES research community has not yet risen to the challenge of imagining pragmatic, context-appropriate alternatives that incorporate the diverse values of nature and how they are embedded in knowledge and governance systems (Tengö et al. 2017; Masterson et al. 2019b; Merçon et al. 2019). Such alternatives (promising examples exist in food system research, e.g. Drimie et al. 2018) could guide the development of specific types of bridging institutions to navigate challenges such as widespread land reform in southern Africa (Clements et al. 2020), models of conservation that do not only rely on ecotourism and trophy hunting (Lindsey et al. 2020), providing equitable green spaces in cities (Gwedla and Shackleton 2015; Venter et al. 2020) and more sustainable governance of our oceans (Brodie Rudolph et al. 2020).

6. Spatial relationships and cross-scale connections

Cross-scale connections and feedbacks emerge when ecological and social components at different spatial or temporal scales interact, with the potential to create a range of (often unpredictable) system dynamics (Allen et al. 2016; Lindborg et al. 2017). Despite their importance in SES, cross-scale interactions and feedbacks remain challenging to identify, assess and quantify (Scholes et al. 2013; Selomane et al. 2019). Several useful insights regarding the implications of cross-scale interactions for ecosystem services and SES have emerged from southern African research, particularly in the realms of protected areas and freshwater governance, which we focus on here.

It is increasingly recognised that protected areas are SES that interact with one another, with the landscape in which they are embedded, and with a range of broader-scale patterns and processes (Cumming et al. 2015; de Vos et al. 2017). Southern African protected areas are diverse in tenure, including those governed by local, regional and national governments, private landowners and communities. This means they are influenced by political, legislative and socio-economic processes that function at different scales (de Vos et al. 2019). Protected areas are increasingly expected to justify their contributions, both to biodiversity conservation and local livelihoods (Cumming 2016). This holds particularly true in southern Africa, where protected areas have a history of displacement and exclusion of certain population groups (Spierenburg and Brooks 2014; Cundill et al. 2017), where government budgets for conservation are diminishing (Smith et al. 2021) and where the potential to generate jobs and revenues

from ecotourism and hunting is high (de Vos et al. 2015; Clements et al. 2016a).

SES research on protected areas in southern Africa, including a SAPECS-led special feature (de Vos et al. 2017), has led to several key theoretical and practical contributions on how location and spatial variation affect ecosystem service provision and societal well-being at different scales. The resilience of protected area networks is shaped by geographic proximity of different units, through the influence of proximity on both ecological connectivity and socio-economic interactions, and is enhanced by the diversity of protected area tenure types (Maciejewski and Cumming 2015a, 2015b; de Vos et al. 2019). At broader scales, protected areas in the region are influenced by shifting global societal preferences, volatile international markets, anthropogenic climate change and uncontrolled movements of species and disease (e.g. COVID-19) (Cumming et al. 2015; de Vos et al. 2016; Clements et al. 2020). Furthermore, broad-scale socio-economic factors (e.g. visitor demand to see high densities of charismatic African wildlife) have the potential to drive fine-scale ecological management. This can lead to a systemic scale mismatch that can reduce long-term sustainability in cases where economic and conservation objectives are not well aligned (Maciejewski et al. 2015; Clements et al. 2016b; Biggs et al. 2017; Mannetti et al. 2017).

Research on freshwater systems has similarly provided useful insights on spatial relationships and cross-scale connections in SES. Deterioration of water quality and quantity in water source areas, which occupy a small fraction of the land surface area but supply a large amount of water to the surrounding regions, can have a disproportionately large impact on downstream users. Nel et al. (2017) found that just 8% of South Africa's land area contributes 50% of the country's run-off, supporting at least 51% of its population and 64% of its economy, but only 13% of these key water resource areas are currently formally protected. Furthermore, land-use choices in a catchment have consequences for water quantity and quality in downstream areas (Biggs et al. 2017; Brill et al. 2017a; Alavaisha et al. 2019). The disconnect between water source and water use means that the full social-ecological impacts of development in water source areas are often not apparent to decision-makers or users. The RESILIM-O programme (Pollard et al. 2020) addressed this challenge by mediating co-learning between water users in the middle and lower Olifants River catchment, to understand how inter-basin transfers in the upper catchment and impacts of low flows in the lower catchment can have catchment-wide impacts (Pollard and Retief 2020). These types of studies

and processes can provide information and understanding that enables strategic investments in land protection in key areas to leverage benefits across much larger scales.

The spatial connectivity of freshwater ecosystems makes their governance intricate (Kingsford et al. 2011) and calls for some degree of polycentric governance arrangements with cross-scale feedbacks (Biggs et al. 2017). This can be challenging, however, when national-scale policies are perceived to restrict local-scale management autonomy (Biggs et al. 2017; Brill et al. 2017a), or where management and funding models for connecting the source and benefit areas do not exist (Nel et al. 2017). Where effective arrangements are in place, combining top-down and bottom-up management targets can create complementary feedbacks that benefit the resilience of catchments (Roux et al. 2016; Biggs et al. 2017; Cockburn et al. 2018a). Pollard and Du Toit (2011) and Pollard et al. (2014) have developed a framework for exploring cross-scale connections and their outcomes for integrated water resources management. This framework calls for reflexive institutions that can engage across scales, identify feedbacks and learn (linking to the “innovative governance institutions and incentives” theme).

Southern African research on protected areas and freshwater systems has also demonstrated that the spatial scale at which studies and assessments are done can have significant consequences and needs to be carefully considered (Hamann et al. 2015; Maciejewski and Cumming 2015a; Ament and Cumming 2016; Brill et al. 2017b). A more holistic and nuanced understanding of a particular SES often requires perspectives and insights from multiple scales (Scholes et al. 2013). Synthetic and conceptual research by the SAPECS community has identified areas of progress in accounting for cross-scale dynamics in sustainable development indicators (Reyers et al. 2017; Selomane et al. 2019; Reyers and Selig 2020); approaches for undertaking cross-scale assessments in SES (Scholes et al. 2013); and a novel framework for thinking about alternative trajectories of development and the drivers of global impacts as a function of feedbacks resulting from wealth and ecosystem service dependence (Cumming et al. 2014; Hamann et al. 2015; Cumming and Von Cramon-Taubadel 2018).

Going forward, the roles of power structures and values (Cundill et al. 2017; de Vos et al. 2018) are still poorly incorporated in most formal approaches to cross-scale interactions and SES analyses. Southern Africa is an important region for addressing this gap, given the considerable inequality and associated power asymmetries that play out across the landscape. Recent and ongoing work explores these issues in the context of land reform (Clements et al. 2021)

and access to ecosystems and ecosystem services (Shackleton et al. 2018a).

7. Regime shifts, traps and transformations

SES are complex adaptive systems that display non-linear dynamics and sometimes undergo large, unanticipated systemic changes (Scheffer 2009; Preiser et al. 2018). Two related types of systemic change are pertinent in the study of SES: regime shifts and transformations. Regime shifts are large, persistent and often sudden changes in the structure and function of SES that have been documented in many systems around the world and have significant impacts on ecosystem services and human well-being (Biggs et al. 2018). Transformations similarly involve the fundamental reorganisation of an SES into a different characteristic structure, with different feedbacks and dynamics (Folke et al. 2010; Biggs et al. 2016; Pereira et al. 2020b). The key difference is that regime shift research usually focuses on examples of inadvertent change that often leads to the loss of well-being, whereas transformation research focuses on interventions that can shift a system to a configuration that produces improved well-being outcomes. Both concepts are linked to social-ecological traps, which refer to systems “stuck” in undesirable configurations (Cinner 2011; Enfors 2013; Boonstra et al. 2016).

In southern Africa, research on social-ecological regime shifts has highlighted the impacts of these shifts on ecosystems and human well-being, particularly in the context of SES in poor, rural settings (Shackleton et al. 2014, 2018b; Blair et al. 2018). There has also been work on potential pathways to maintain or transform SES towards desired states (Luvuno et al. 2018; Achieng et al. 2020). Regime shifts in the region have been linked to long-term processes such as persistent poverty and inequality resulting from legacies of colonialism, past policies and systemically unjust processes (Hoffman 2014; Puttick et al. 2014; Shackleton and Luckert 2015; Boonstra et al. 2016; Pereira et al. 2020b). In South Africa, for example, land reform and changes in land use that came with the end of the apartheid era contributed to increased deagrarianisation and urbanisation (Hebinck et al. 2018; Shackleton et al. 2019b), with significant impacts on vegetation structure (Hoffman 2014; Puttick et al. 2014; Luvuno et al. 2018). Colonial and apartheid era land-use policies have also resulted in a legacy of unequal access to ecosystem services and a lack of social cohesion in landscapes, making it difficult to manage these landscapes equitably and sustainably (Cockburn et al. 2019). The impacts of climate change are likely to be a significant contributor to regime shifts in the

region (Jarre et al. 2013; Stevens et al. 2016; Luvuno et al. 2018; Ward et al. 2021).

Southern Africa has also been an important context for studying the dynamics of social-ecological traps and how these dynamics link to persistent poverty and a variety of sustainability challenges in the Global South (Brown 2016; Haider et al. 2018). Studies in southern Africa have deepened understanding of the interplay between fast-changing environments and slow-moving social responses, and how this may hinder sustainable development (Hänke et al. 2017; Cole et al. 2018). Drawing on multiple sources of data and a substantial body of work in South Africa, Shackleton and Luckert (2015) identified various shifts in rural livelihoods, including increased deagrarianisation, growing unemployment and less remittances, a shift away from provisioning services and an increased reliance on social grants provided through government transfers. These changes were driven by factors interacting at multiple scales, such as historical policies and erosion of social capital that hamper people's abilities to respond to local vulnerabilities. Similarly, Boonstra et al. (2016) suggest a typology of people's responses to conditions that either dampen or reinforce trap dynamics, using three cases (including one in South Africa) to show that many of the possible responses to trap conditions further entrench poverty and deagrarianisation.

At the same time, analysis of social-ecological traps in southern Africa has unlocked locally appropriate solutions. A deeper understanding of the interconnectedness of entrenched poverty, environmental degradation and hunger, for example, provided insight into how to break social-ecological traps in south-western Madagascar (Hänke et al. 2017). Similarly, a holistic perspective and gender lens on overdependence and unsustainable practices in the Barotse floodplain fishery in Zambia revealed that both social innovation (specifically around unequal gender roles) and technological innovations in fishing have the potential to provide possible escape pathways (Cole et al. 2018). Cumming (2018) used a systems perspective to show how diagnosing social-ecological traps can help to find solutions to problems of cooperation in conservation at multiple scales. In the context of agricultural transitions towards urban societies, Cumming et al. (2014) describe a model that suggests that development and urbanisation may result in weak feedbacks to the resource, which could result in trap conditions. These conditions include alienation of urban people from the ecosystems on which they depend, resulting in overexploitation of those ecosystems. Hamann et al. (2015) used this model to map and explore SES dynamics based on ecosystem service bundles,

and identified the major drivers underlying different systemic dynamics.

There is increasing work on social-ecological transformations in the region (Pereira et al. 2020a). In South Africa, alternative food system initiatives led by local entrepreneurs and activists are pushing back on the dominant food system regime with the aim of shifting towards a more locally sustainable and ethical food system (Pereira et al. 2019b). The Seeds of Good Anthropocenes project (goodanthropocenes.net) collects existing hopeful initiatives that have the potential to accelerate the adoption of transformative change (Bennett et al. 2016), including many examples from southern Africa. These "seeds" are used to develop future scenarios that paint an alternative picture to the dystopian futures that are often highlighted, and demonstrate radical options about the future (Pereira et al. 2018b; 2019a; Hamann et al. 2020). Building futures literacy in order to guide transformative change equitably through acknowledging diversity of people, perspectives and place is also critical, as demonstrated by scenario planning across a range of communities, including marginalised fishers (e.g. Gammage et al. 2021), national level stakeholder engagement around the South African food system (Malinga et al. 2013; Freeth and Drimie 2016), and providing options to decision-makers on just woodland management (Dziba et al. 2020).

Looking ahead, there is particular interest in advancing work on how to support social-ecological transformations in the region, in ways that are sensitive to the regional context, ecologically sustainable and socially just. Such research is challenging because it engages with ethical dilemmas and requires understanding of intertwined context-specific ecological, political, economic and cultural dynamics and demands the integration of diverse methodological frameworks (Pereira et al. 2019a). It also requires engaging with conflicting values and contested visions of the future (Preiser et al. 2017, 2021; Pereira et al. 2020c). In their paper on farming on the Wild Coast of the Eastern Cape in South Africa, for example, Shackleton and Hebinck (2018) suggest that there is no single pathway towards resilient livelihoods, with some people wanting to continue farming, while others are seeking a way out of an agrarian lifestyle. In another case in the Langkloof region of South Africa, the diversity of land uses and heterogeneity of land users have illustrated the importance of relational, pluralistic approaches to collaborative landscape management (Cockburn et al. 2019). Transformation in different policies, strategies and actions are needed to support each of these potential pathways and a number of them may need to be enabled simultaneously. Transformative scenario

planning and a variety of futures approaches are particularly powerful tools in this regard (Hichert et al. 2021). These tools are being applied in a variety of innovative ways in the region with the goal of facilitating and supporting transformative change (e.g. Pereira et al. 2018b; Hamann et al. 2020; Gammage and Jarre 2021).

8. Conclusion

The southern African region has become a hotspot for globally relevant SES research. SAPECS has provided an important platform to connect, leverage and advance SES research and practice in southern Africa, although much important work in the region is also being conducted outside this community. Our particular place-based context provides insights that are of relevance to informing and supporting transformation towards more sustainable, just and equitable futures in other regions in the Global South, and potentially more widely.

The southern African SES community has had a particular focus on adopting transdisciplinary approaches in the context of diverse and often conflicting stakeholder values and needs. Several important lessons have emerged from this experience, the most important of which is arguably the need for long-term commitment to a particular place to build the relationships and trust required for meaningful ongoing co-learning, action and reflection.

Another key research area of wider significance is the growing understanding of the multiple and cross-scale connections between ecosystem services and human well-being, and the far-reaching consequences of colonial histories and ongoing systems and structures of inequality. Work in the region has highlighted the need for more integrated and equitable approaches to address structural challenges in ways that link social and ecological outcomes across multiple scales. This, in turn, links directly to emerging work on knowledge co-production and supporting social-ecological transformations. The cross-scale dynamics that underlie structural challenges and outcomes of inequality highlight the need to move beyond current SES governance and management systems to approaches that embrace co-learning and polycentric governance and that challenge the status quo.

Lastly, work in the region has highlighted stark contrasts in SES governance capacity and approaches in different areas. It is clear that many areas in the region require extensive investment to develop the necessary skills and capacities to support sustainability transformations. This situation likely holds in many regions in the Global South.

Key areas of future SES work include the ongoing development of concepts, theories and methods to engage with SES dynamics, building on the strength in transdisciplinary practice in the region. Inequality and access to ecosystems and their benefits are particularly critical issues, and are closely linked to a growing focus on urban SES and rural-urban connections, decoloniality and issues of land reform, power and intersectionality, and diverse relations and understandings of people's connections to nature. These are, in turn, closely linked to a growing body of work on cross-scale social-ecological dynamics, and an emerging focus on understanding and fostering just and sustainable transformations that address the deeply intertwined social, economic and ecological challenges faced in the region.

Disclosure statement

No potential conflict of interest was reported by the author(s).

Funding

Over the course of developing this paper, Reinette Biggs has been supported through a Society in Science Branco Weiss Fellowship; the South African Research Chairs Initiative (SARChI) (grant 98766); the SIDA-funded Guidance for Resilience in the Anthropocene: Investments for Development (GRAID) project; and a Young Researchers Grant from the Vetenskapsrådet in Sweden (grant 621-2014-5137). Hayley Clements is funded by a Jennifer Ward Oppenheimer Research Grant and Kone Foundation. Laura Pereira is partially funded by the National Research Foundation of South Africa (grant 115300). Charlie Shackleton is funded by the DSI/NRF SARChI initiative (grant 84379). The RESILIM-O (Resilience in the Limpopo: Olifants) programme was funded by USAID (grant AID 674-A-13-00008) and supported work by Sharon Pollard and Karen Kotschy between 2013 and 2020. Karen Esler acknowledges support through the DST-NRF Centre of Excellence for Invasion Biology and the Working for Water programme. Regina Lindborg has been funded through the SIDA-programme Linking Public-Private Partnership to Secure Sustainable Water Resources Management. Jessica Cockburn and Alta de Vos have been supported by Rhodes University Research Committee Grants (2020–2022, and 2014–2022, respectively). Graeme Cumming, Alta de Vos and Hayley Clements have been supported by the DST/NRF Centre of Excellence at the FitzPatrick Institute and a complexity scholar award to GC from the James S. McDonnell Foundation. Maike Hamman, Vanessa Masterson, Maria Tengo and Reinette Biggs were supported by a grant from the Swedish International Development Cooperation Agency (Sida) and the Swedish Research Council (VR). Belinda Reyers acknowledges the support of the Beijer Institute of Ecological Economics, Royal Swedish Academy of Sciences.

ORCID

Reinette Biggs  <http://orcid.org/0000-0003-0300-4149>
 Hayley S. Clements  <http://orcid.org/0000-0002-7015-6532>
 Graeme S. Cumming  <http://orcid.org/0000-0002-3678-1326>
 Georgina Cundill  <http://orcid.org/0000-0002-9024-8143>
 Alta de Vos  <http://orcid.org/0000-0002-9085-4012>
 Maike Hamann  <http://orcid.org/0000-0003-2906-4043>
 Linda Luvuno  <http://orcid.org/0000-0002-8096-4138>
 Dirk J. Roux  <http://orcid.org/0000-0001-7809-0446>
 Odirilwe Selomane  <http://orcid.org/0000-0002-6892-4221>
 Ryan Blanchard  <http://orcid.org/0000-0002-3560-4133>
 Jessica Cockburn  <http://orcid.org/0000-0002-3954-7340>
 Luthando Dziba  <http://orcid.org/0000-0001-6974-5578>
 Karen J. Esler  <http://orcid.org/0000-0001-6510-727X>
 Christo Fabricius  <http://orcid.org/0000-0003-2223-5671>
 Rebecka Henriksson  <http://orcid.org/0000-0002-9949-8851>
 Karen Kotschy  <http://orcid.org/0000-0003-1536-3309>
 Regina Lindborg  <http://orcid.org/0000-0001-7134-7974>
 Vanessa A. Masterson  <http://orcid.org/0000-0002-5379-9309>
 Jeanne L. Nel  <http://orcid.org/0000-0001-6220-770X>
 Patrick O'Farrell  <http://orcid.org/0000-0002-9538-8831>
 Carolyn G. Palmer  <http://orcid.org/0000-0001-7349-1304>
 Laura Pereira  <http://orcid.org/0000-0002-4996-7234>
 Rika Preiser  <http://orcid.org/0000-0003-4159-0708>
 Robert J. Scholes  <http://orcid.org/0000-0001-5537-6935>
 Charlie Shackleton  <http://orcid.org/0000-0002-8489-6136>
 Sheona Shackleton  <http://orcid.org/0000-0002-6133-9070>
 Nadia Sitas  <http://orcid.org/0000-0003-0888-8617>
 Jasper A. Slingsby  <http://orcid.org/0000-0003-1246-1181>
 Marja Spierenburg  <http://orcid.org/0000-0003-0128-1900>
 Maria Tengö  <http://orcid.org/0000-0002-4776-3748>
 Belinda Reyers  <http://orcid.org/0000-0002-2194-8656>

References

- Achieng T, Maciejewski K, Dyer M, Biggs R. 2020. Using a social-ecological regime shift approach to understand the transition from livestock to game farming in the Eastern Cape, South Africa. *Land*. 9(4):97. doi:10.3390/land9040097.
- Alavaisha E, Lyon SW, Lindborg R. 2019. Assessment of water quality across irrigation schemes: a case study of wetland agriculture impacts in Kilombero Valley, Tanzania. *Water*. 11(4):671. doi:10.3390/w11040671.
- Allen CR, Angeler DG, Cumming GS, Folke C, Twidwell D, Uden DR, Bennett J, Bennett J. 2016. Review: quantifying spatial resilience. *J Appl Ecol*. 53(3):625–635. doi:10.1111/1365-2664.12634.
- Ament JM, Cumming GS. 2016. Scale dependency in effectiveness, isolation, and social-ecological spillover of protected areas. *Conserv Biol*. 30(4):846–855. doi:10.1111/cobi.12673.
- Ament JM, Moore CA, Herbst M, Cumming GS. 2017. Cultural ecosystem services in protected areas: understanding bundles, trade-offs, and synergies. *Conserv Lett*. 10(4):440–450. doi:10.1111/conl.12283.
- Archer E, Dziba L, Mulongoy KJ, Maoela A, Walters M, Biggs R, Cormier-Salem M-C, DeClerck F, Diaw MC, Dunham A, et al. 2021. Biodiversity and ecosystem services on the African continent – what is changing, and what are our options? *Environ Dev*. 37:100558. doi:10.1016/j.envdev.2020.100558.
- 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 Environ Change*. 21(3):995–1004. doi:10.1016/j.gloenvcha.2011.04.006.
- Barendse J, Roux D, Currie B, Wilson N, Fabricius C. 2016. A broader view of stewardship to achieve conservation and sustainability goals in South Africa. *S Afr J Sci*. 112(5–6):1–15. doi:10.17159/sajs.2016/20150359.
- Bennett E, Solan M, Biggs R, McPhearson T, Norström A, Olsson P, Pereira L, Peterson G, Raudsepp-Hearne C, Biermann F, et al. 2016. Bright spots: seeds of a good anthropocene. *Front Ecol Environ*. 14(8):441–448. doi:10.1002/fee.1309.
- Bevir M. 2013. Governance: a very short introduction. Oxford: Oxford University Press.
- Biggs R, Reyers B. 2012. Initial science plan: building a Southern African program on ecosystem change and society. Internal report. sapecs.org.
- Biggs R, Rhode C, Archibald S, Kunene LM, Mutanga SS, Nkuna N, Ocholla PO, Phadima LJ. 2015. Strategies for managing complex social-ecological systems in the face of uncertainty: examples from South Africa and beyond. *Ecol Soc*. 20(1):52. doi:10.5751/ES-07380-200152.
- Biggs R, Boonstra WJ, Peterson GD, Schlüter M. 2016. The domestication of fire as social-ecological regime shift. *Past Global Changes (PAGES)*. 24(1):22–23. doi:10.22498/pages.24.1.22.
- Biggs HC, Clifford-Holmes JK, Freitag S, Venter FJ, Venter J. 2017. Cross-scale governance and ecosystem service delivery: a case narrative from the Olifants River in north-eastern South Africa. *Ecosyst Serv*. 28(B):173–184. doi:10.1016/j.ecoser.2017.03.008.
- Biggs R, Peterson GD, Rocha J. 2018. The regime shifts database: a framework for analyzing regime shifts in social-ecological systems. *Ecol Soc*. 23(3):9. doi:10.5751/ES-10264-230309.
- Biggs R, De Vos A, Preiser R, Clements H, Maciejewski K, Schlüter M. 2021. The Routledge handbook of research methods for social-ecological systems. London: Routledge.
- Biggs R, Reyers B, Blanchard R, Clements H, Cockburn J, Cumming GS, Cundill G, de Vos A, Dziba L, Esler K, et al. In review. The Southern African program on ecosystem change and society: insights from an emergent community of practice. *Ecosyst People*.
- Blair D, Shackleton CM, Mograbi PJ. 2018. Cropland abandonment in South African smallholder communal lands: land cover change (1950–2010) and farmer perceptions of contributing factors. *Land*. 7(4):121. doi:10.3390/land7040121.
- Bodin O, and Crona BI. 2011. Barriers and opportunities in transforming to sustainable governance: the role of key individuals. In: Bodin O, Prell C, editors. Social networks in natural resource governance. Cambridge: Cambridge University Press; p. 75–94.
- Bollig M, Menestrey Schwieger DA. 2014. Fragmentation, cooperation and power: institutional dynamics in natural resource governance in North-Western Namibia.

- Hum Ecol. 42(2):167–181. doi:[10.1007/s10745-014-9647-7](https://doi.org/10.1007/s10745-014-9647-7).
- Boonstra WJ, Björkvik E, Haider LJ, Masterson V. 2016. Human responses to social-ecological traps. *Sustainability Sci.* 11(6):877–889. doi:[10.1007/s11625-016-0397-x](https://doi.org/10.1007/s11625-016-0397-x).
- Boudreaux K, Nelson F. 2011. Community conservation in Namibia: empowering the poor with property rights. *Econ Aff.* 31(2):17–24. doi:[10.1111/j.1468-0270.2011.02096.x](https://doi.org/10.1111/j.1468-0270.2011.02096.x).
- Brill G, Anderson P, O'Farrell P. 2017a. Urban national parks in the global South: linking management perceptions, policies and practices to water-related ecosystem services. *Ecosyst Serv.* 28:185–195. doi:[10.1016/j.ecoser.2017.03.023](https://doi.org/10.1016/j.ecoser.2017.03.023).
- Brill G, O'Farrell P, Anderson P. 2017b. Methodological and empirical considerations when assessing freshwater ecosystem service provision in a developing city context: making the best of what we have. *Ecol Indica.* 76:256–274. doi:[10.1016/j.ecolind.2017.01.006](https://doi.org/10.1016/j.ecolind.2017.01.006).
- Brodie Rudolph T, Ruckelshaus M, Swilling M, Allison EH, Österblom H, Gelcich S, Mbatha P. 2020. A transition to sustainable ocean governance. *Nat Commun.* 11(1):3600. doi:[10.1038/s41467-020-17410-2](https://doi.org/10.1038/s41467-020-17410-2).
- Brown K. 2016. Resilience, development and global change. London: Routledge.
- Burns M, Weaver A. 2008. Exploring sustainability science: a Southern African perspective. Stellenbosch (South Africa): Sun Press.
- Burt J. 2019. Research for the people, by the people: the political practice of cognitive justice and transformative learning in environmental social movements. *Sustainability.* 11(20):5611. doi:[10.3390/su11205611](https://doi.org/10.3390/su11205611).
- Buschke FT, Botts EA, Sinclair SP. 2019. Post-Normal conservation science fills the space between research, policy, and implementation. *Conserv Sci Pract.* 1(8):e73. doi:[10.1111/csp2.73](https://doi.org/10.1111/csp2.73).
- Cadman M. 2010. Biodiversity for development: South Africa's landscape approach to conserving biodiversity and promoting ecosystem resilience. Pretoria: South African National Biodiversity Institute.
- Campbell B, Shackleton S. 2001. The organizational structures for community-based natural resources management in Southern Africa. *Afr Stud Q.* 5(3):87–114.
- Carpenter SR, Folke C, Norström A, Olsson O, Schultz L, Agarwal B, Balvanera P, Campbell B, Castilla JC, Cramer W, et al. 2012. Program on ecosystem change and society: an international research strategy for integrated social-ecological systems. *Curr Opin Environ Sustainability.* 4(1):134–138. doi:[10.1016/j.cosust.2012.01.001](https://doi.org/10.1016/j.cosust.2012.01.001).
- Chambers JM, Wyborn C, Ryan ME, Reid RS, Riechers M, Serban A, Bennett NJ, Cvitanovic C, Fernández-Giménez ME, Galvin KA, et al. 2021. Six modes of co-production for sustainability. *Nat Sustainability.* 4(11):983–996. doi:[10.1038/s41893-021-00755-x](https://doi.org/10.1038/s41893-021-00755-x).
- Chambers JM, Wyborn C, Klenk NL, Ryan M, Serban A, Bennett NJ, Charli-Joseph L, Fernández-Giménez ME, Galvin KA, Goldstein BE, et al. 2022. Co-Productive agility and four collaborative pathways to sustainability transformations. *Global Environ Change.* 72:102422. doi:[10.1016/j.gloenvcha.2021.102422](https://doi.org/10.1016/j.gloenvcha.2021.102422).
- Chan KMA, Satterfield T, Pascual U, Pascual U. 2020. The maturation of ecosystem services: social and policy research expands, but whither biophysically informed valuation? *People Nat.* 2(4):1021–1060. doi:[10.1002/pan3.10137](https://doi.org/10.1002/pan3.10137).
- Chinyimba A. 2012. An assessment of urban residents' knowledge and appreciation of the intangible benefits of trees in two medium sized towns in South Africa [Doctoral dissertation]. Rhodes University.
- Cilliers SS, Siebert SJ, Du Toit MJ, Barthel S, Mishra S, Cornelius SF, Davoren E. 2018. Garden ecosystem services of sub-Saharan Africa and the role of health clinic gardens as social-ecological systems. *Landsc Urban Plan.* 180:294–307. doi:[10.1016/j.landurbplan.2017.01.011](https://doi.org/10.1016/j.landurbplan.2017.01.011).
- Cinner JE. 2011. Social-Ecological traps in reef Fisheries. *Global Environ Change.* 21(3):835–839. doi:[10.1016/j.gloenvcha.2011.04.012](https://doi.org/10.1016/j.gloenvcha.2011.04.012).
- Clark WC, Dickson NM. 2003. Sustainability science: the emerging research program. *Proc Nat Acad Sci.* 100(14):8059–8061. doi:[10.1073/pnas.1231333100](https://doi.org/10.1073/pnas.1231333100).
- Clark WC, Harley AG. 2020. Sustainability science: toward a synthesis. *Ann Rev Environ Res.* 45(1):331–386. doi:[10.1146/annurev-environ-012420-043621](https://doi.org/10.1146/annurev-environ-012420-043621).
- Clements HS, Baum J, Cumming GS. 2016a. Money and motives: an organizational ecology perspective on private land conservation. *Biol Conserv.* 197:108–115. doi:[10.1016/j.biocon.2016.03.002](https://doi.org/10.1016/j.biocon.2016.03.002).
- Clements HS, Cumming GS, Kerley GIH. 2016b. Predators on private land: broad-scale socioeconomic interactions influence large predator management. *Ecol Soc.* 21(2):45. doi:[10.5751/ES-08607-210245](https://doi.org/10.5751/ES-08607-210245).
- Clements HS, Biggs R, Cumming GS. 2020. Cross-scale and social-ecological changes constitute main threats to private land conservation in South Africa. *J Environ Manage.* 274:111235. doi:[10.1016/j.jenvman.2020.111235](https://doi.org/10.1016/j.jenvman.2020.111235).
- Clements HS, De Vos A, Carlos Bezerra J, Coetzer K, Maciejewski K, Mograbi PJ, Shackleton C. 2021. The relevance of ecosystem services to land reform policies: insights from South Africa. *Land Use Policy.* 100:104939. doi:[10.1016/j.landusepol.2020.104939](https://doi.org/10.1016/j.landusepol.2020.104939).
- Clifford-Holmes JK, Palmer CG, De Wet CJ, Slinger JH. 2016. Operational manifestations of institutional dysfunction in post-apartheid South Africa. *Water Policy.* 18(4):998–1014. doi:[10.2166/wp.2016.211](https://doi.org/10.2166/wp.2016.211).
- Clifford-Holmes JK, Slinger JH, De Wet C, Palmer CG. 2018. Modelling in the 'muddled middle': a case study of water service delivery in post-apartheid South Africa. In: García-Díaz C, Olaya C, editors. *Social systems engineering: the design of complexity*. Hoboken: John Wiley & Sons; p. 215–234. doi:[10.1002/9781118974414](https://doi.org/10.1002/9781118974414).
- Cockburn J, Rouget M, Slotow R, Roberts D, Boon R, Douwes E, O'Donoghue S, Downs CT, Mukherjee S, Musakwa W, et al. 2016. How to build science-action partnerships for local land-use planning and management: lessons from Durban, South Africa. *Ecol Soc.* 21(1):28. doi:[10.5751/ES-08109-210128](https://doi.org/10.5751/ES-08109-210128).
- Cockburn J, Cundill G. 2018. Ethics in transdisciplinary research: reflections on the implications of 'science with society'. In: Macleod C, Marx J, Mnyaka P, Treharne G, editors. *Handbook of ethics in critical research: stories from the field*. London: Palgrave Macmillan; p. 81–97.
- Cockburn J, Palmer C, Biggs H, Rosenberg E. 2018a. Navigating multiple tensions for engaged praxis in a complex social-ecological system. *Land.* 7(4):129. doi:[10.3390/land7040129](https://doi.org/10.3390/land7040129).
- Cockburn J, Cundill G, Shackleton S, Rouget M. 2018b. Towards place-based research to support social-ecological stewardship. *Sustainability.* 10(5):1434. doi:[10.3390/su10051434](https://doi.org/10.3390/su10051434).
- Cockburn J, Cundill G, Shackleton S, Rouget M. 2019. The meaning and practice of stewardship in South Africa. *S Afr J Sci.* 115(5/6):5339. doi:[10.17159/sajs.2019/5339](https://doi.org/10.17159/sajs.2019/5339).

- Cockburn J, Cundill G, Shackleton S, Cele A, Cornelius SF, Koopman V, le Roux J-P, McLeod N, Rouget M, Schroder S, et al. 2020. Relational hubs for collaborative landscape stewardship. *Soc Nat Resour.* 33(5):681–693. doi:10.1080/08941920.2019.1658141.
- Cocks ML, Bangay L, Shackleton CM, Wiersum FK. 2008. 'Rich man poor man' — inter-household and community factors influencing the use of wild plant resources amongst rural households in South Africa. *Int J Sustainable Dev World Ecol.* 15(3):198–210. doi:10.3843/SusDev.15.3.3.
- Cocks ML, Dold T, Vetter S. 2012. 'God is my forest' — Xhosa cultural values provide untapped opportunities for conservation. *S Afr J Sci.* 108(5/6):52–59. doi:10.4102/sajs.v108i5/6.880.
- Cocks ML, Shackleton CM. 2021. Urban nature: enriching belonging, wellbeing and bioculture. New York (NY): Routledge.
- Cole SM, McDougall C, Kaminski AM, Kefi AS, Chilala A, Chisule G. 2018. Postharvest fish losses and unequal gender relations: drivers of the social-ecological trap in the Barotse Floodplain fishery, Zambia. *Ecol Soc.* 23(2):18. doi:10.5751/ES-09950-230218.
- Collyer FM. 2018. Global patterns in the publishing of academic knowledge: Global North, Global South. *Curr Sociol.* 66(1):56–73. doi:10.1177/0011392116680020.
- Cowling RM, Egoh B, Knight AT, O'Farrell PJ, Reyers B, Rouget M, Roux DJ, Welz A, Wilhelm-Rechman A. 2008. An operational model for mainstreaming ecosystem services for implementation. *Proc Nat Acad Sci.* 105(28):9483–9488. doi:10.1073/pnas.0706559105.
- Cumming GS, Buerkert A, Hoffmann EM, Schlecht E, Von Cramon-Taubadel S, Tscharrntke T. 2014. Implications of agricultural transitions and urbanization for ecosystem services. *Nature.* 515(7525):50–57. doi:10.1038/nature13945.
- Cumming GS, Allen CR, Ban NC, Biggs D, Biggs HC, Cumming DH, De Vos A, Epstein G, Etienne M, Maciejewski K, et al. 2015. Understanding protected area resilience: a multi-scale, social-ecological approach. *Ecol Appl.* 25(2):299–319. doi:10.1890/13-2113.1
- Cumming GS. 2016. The relevance and resilience of protected areas in the anthropocene. *Anthropocene.* 13:46–56. doi:10.1016/j.ancene.2016.03.003.
- Cumming TL, Shackleton RT, Förster J, Dini J, Khan A, Gumula M, Kubiszewski I. 2017. Achieving the national development agenda and the sustainable development goals (SDGs) through investment in ecological infrastructure: a case study of South Africa. *Ecosyst Serv.* 27:253–260. doi:10.1016/j.ecoser.2017.05.005.
- Cumming GS, Von Cramon-Taubadel S. 2018. Linking economic growth pathways and environmental sustainability by understanding development as alternate social-ecological regimes. *Proc Nat Acad Sci.* 115(38):9533–9538. doi:10.1073/pnas.1807026115.
- Cumming GS. 2018. A review of social dilemmas and social-ecological traps in conservation and natural resource management. *Conserv Lett.* 11(1):e12376. doi:10.1111/conl.12376.
- Cundill G, Fabricius C. 2010. Monitoring the governance dimension of natural resource co-management. *Ecol Soc.* 15(1):15. doi:10.5751/ES-03346-150115.
- Cundill G, Thondhlana G, Sisitka L, Shackleton S, Blore M. 2013. Land claims and the pursuit of co-management on four protected areas in South Africa. *Land Use Policy.* 35:171–178. doi:10.1016/j.landusepol.2013.05.016.
- Cundill G, Roux DJ, Parker JN. 2015. Nurturing communities of practice for transdisciplinary research. *Ecol Soc.* 20(2):22. doi:10.5751/ES-07580-200222.
- Cundill G, Bezerra JC, De Vos A, Ntingana N. 2017. Beyond benefit sharing: place attachment and the importance of access to protected areas for surrounding communities. *Ecosyst Serv.* 28:140–148. doi:10.1016/j.ecoser.2017.03.011.
- Davenport NA, Shackleton CM, Gambiza J. 2012. The direct use value of municipal commonage goods and services to urban households in the Eastern Cape, South Africa. *Land Use Policy.* 29(3):548–557. doi:10.1016/j.landusepol.2011.09.008.
- de Neergaard A, Saarnak C, Hill T, Khanyile M, Berzosa AM, Birch-Thomsen T. 2005. Australian wattle species in the Drakensberg region of South Africa – an invasive alien or a natural resource? *Agric Syst.* 85(3):216–233. doi:10.1016/j.agry.2005.06.009.
- de Vos A, Cumming GS, Moore CA, Maciejewski K. 2015. Understanding the role of ecotourism attributes for the economic sustainability of protected areas. *Ecosphere.* 7:e01207.
- de Vos A, Cumming GS, Cumming DHM, Ament JM, Baum J, Clements HS, Grewar JD, Maciejewski K, Moore C. 2016. Pathogens, disease, and the social-ecological resilience of protected areas. *Ecol Soc.* 21(1):20. doi:10.5751/ES-07984-210120.
- de Vos A, Cumming GS, Roux DJ. 2017. The relevance of cross-scale connections and spatial interactions for ecosystem service delivery by protected areas: insights from Southern Africa. *Ecosyst Serv.* 28:133–139. doi:10.1016/j.ecoser.2017.11.014.
- de Vos A, Bezerra JC, Roux D. 2018. Relational values about nature in protected area research. *Curr Opin Environ Sustainability.* 35:89–99. doi:10.1016/j.cosust.2018.10.018.
- de Vos A, Cumming GS, Bridgewater P, Bridgewater P. 2019. The contribution of land tenure diversity to the spatial resilience of protected area networks. *People Nat.* 1(3):331–346. doi:10.1002/pan3.29.
- de Vos A, Clements HS, Biggs D, Cumming GS. 2019. The dynamics of proclaimed privately protected areas in South Africa over 83 years. *Conserv Lett.* 12(6):e12644. doi:10.1111/conl.12644.
- Drimie S, Hamann R, Manderson AP, Mlondobozi N. 2018. Creating transformative spaces for dialogue and action: reflecting on the experience of the Southern Africa Food Lab. *Ecol Soc.* 23(3):2. doi:10.5751/ES-10177-230302.
- Du Toit MJ, Cilliers SS, Dallimer M, Goddard M, Guenat S, Cornelius SF. 2018. Urban green infrastructure and ecosystem services in sub-Saharan Africa. *Landsc Urban Plan.* 180:249–261. doi:10.1016/j.landurbplan.2018.06.001.
- Du Toit MJ, Shackleton CM, Cilliers SS, Davoren E. 2021. Advancing urban ecology in the global south: emerging themes and future research directions. In: Shackleton C, Cilliers S, Davoren E, Du Toit M, editors. *Urban ecology in the global south.* Cham: Springer; p. 433–461.
- Duggan GL, Jarre A, Murray G. 2021. Learning for change: integrated teaching modules and situated learning for marine social-ecological systems change. *J Environ Educ.* 52(2):118–132. doi:10.1080/00958964.2020.1852524.
- Dziba L, Ramoelo A, Ryan C, Harrison S, Pritchard R, Tripathi H, Sitas N, Selomane O, Engelbrecht F, Pereira L, et al. 2020. Scenarios for just and sustainable

- futures in the miombo woodlands. In: Ribeiro N, Katerere Y, Chirwa P, Grundy I, editors. *Miombo woodlands in a changing environment: securing the resilience and sustainability of people and woodlands*. Cham: Springer; p. 191–234.
- Enfors E. 2013. Social–ecological traps and transformations in dryland agro–ecosystems: using water system innovations to change the trajectory of development. *Global Environ Change*. 23(1):51–60. doi:[10.1016/j.gloenvcha.2012.10.007](https://doi.org/10.1016/j.gloenvcha.2012.10.007).
- Ernstson H, Sörlin S, Elmqvist T. 2008. Social movements and ecosystem services – the role of social network structure in protecting and managing urban green areas in Stockholm. *Ecol Soc*. 13(2):39. doi:[10.5751/ES-02589-130239](https://doi.org/10.5751/ES-02589-130239).
- Esler KJ, Downsborough L, Roux DJ, Blignaut J, Milton S, Le Maitre D, De Wit MP. 2016. Interdisciplinary and multi-institutional higher learning: reflecting on a South African case study investigating complex and dynamic environmental challenges. *Curr Opin Environ Sustainability*. 19:76–86. doi:[10.1016/j.cosust.2015.12.002](https://doi.org/10.1016/j.cosust.2015.12.002).
- Fabricius C, Koch E, Magome H. 2001. Towards strengthening collaborative ecosystem management: lessons from environmental conflict and political change in southern Africa. *J R Soc N Z*. 31(4):831–844. doi:[10.1080/03014223.2001.9517679](https://doi.org/10.1080/03014223.2001.9517679).
- Falyai M, Shackleton SE, Cundill G, Shackleton CM. 2019. Changes in household use and sale of locally collected environmental resources over a 15-year period in a rural village, South Africa. *For Trees Livelihoods*. 28(2):90–107. doi:[10.1080/14728028.2019.1568309](https://doi.org/10.1080/14728028.2019.1568309).
- Folke C, Hahn T, Olsson P, Norberg J. 2005. Adaptive governance of social–ecological systems. *Annu Rev Environ Resour*. 30(1):441–473. doi:[10.1146/annurev.energy.30.050504.144511](https://doi.org/10.1146/annurev.energy.30.050504.144511).
- Folke C, Carpenter SR, Walker B, Scheffer M, Chapin T, Rockström J. 2010. Resilience thinking: integrating resilience, adaptability and transformability. *Ecol Soc*. 15(4):20. doi:[10.5751/ES-03610-150420](https://doi.org/10.5751/ES-03610-150420).
- Folke C, Jansson A, Rockström J, Olsson P, Carpenter SR, Stuart Chapin F, Crépin AS, Daily G, Danell K, Ebbesson J, et al. 2011. Reconnecting to the biosphere. *Ambio*. 40(7):719–738. doi:[10.1007/s13280-011-0184-y](https://doi.org/10.1007/s13280-011-0184-y).
- Freeth R, Drimie S. 2016. Participatory scenario planning: from scenario ‘stakeholders’ to scenario ‘owners’. *Environ Sci Policy Sustainable Dev*. 58(4):32–43.
- Frost PGH, Bond L. 2008. The CAMPFIRE programme in Zimbabwe: payments for wildlife services. *Ecol Econ*. 65(4):776–787. doi:[10.1016/j.ecolecon.2007.09.018](https://doi.org/10.1016/j.ecolecon.2007.09.018).
- Gammage LC, Jarre A, Mather C. 2021. Failing to plan is planning to fail: lessons learned from a small-scale scenario planning process with marginalized fishers from South Africa’s southern Cape. *Ecol Soc*. 26(4):32. doi:[10.5751/ES-12886-260432](https://doi.org/10.5751/ES-12886-260432).
- Gammage LC, Jarre A. 2021. Scenario-Based approaches to change management in fisheries can address challenges with scale and support the implementation of an ecosystem approach to fisheries management. *Front Mar Sci*. 8:600150. doi:[10.3389/fmars.2021.600150](https://doi.org/10.3389/fmars.2021.600150).
- Gwedla N, Shackleton CM. 2015. The development visions and attitudes towards urban forestry of officials responsible for greening in South African towns. *Land Use Policy*. 42:17–26. doi:[10.1016/j.landusepol.2014.07.004](https://doi.org/10.1016/j.landusepol.2014.07.004).
- Haider LJ, Hentati-Sundberg J, Giusti M, Goodness J, Hamann M, Masterson VA, Meacham M, Merrie A, Ospina D, Schill C, et al. 2018. The undisciplined journey: early-career perspectives in sustainability science. *Sustainability Sci*. 13(1):191–204. doi:[10.1007/s11625-017-0445-1](https://doi.org/10.1007/s11625-017-0445-1).
- Hamann M, Biggs R, Reyers B. 2015. Mapping social–ecological systems: identifying ‘green-loop’ and ‘red-loop’ dynamics based on characteristic bundles of ecosystem service use. *Global Environ Change*. 34:218–226. doi:[10.1016/j.gloenvcha.2015.07.008](https://doi.org/10.1016/j.gloenvcha.2015.07.008).
- Hamann M, Biggs R, Reyers B, Cebrian J, Cebrian J. 2016. An exploration of human well-being bundles as identifiers of ecosystem service use patterns. *PLoS ONE*. 11(10):e0163476. doi:[10.1371/journal.pone.0163476](https://doi.org/10.1371/journal.pone.0163476).
- Hamann M, Biggs R, Pereira L, Preiser R, Hichert T, Blanchard R, Warrington-Coetzee H, King N, Merrie A, Nilsson W, et al. 2020. Scenarios of good anthropocenes in southern Africa. *Futures*. 118:102526. doi:[10.1016/j.futures.2020.102526](https://doi.org/10.1016/j.futures.2020.102526).
- Hänke H, Barkmann J, Coral C, Enfors Kaustky E, Marggraf R. 2017. Social–Ecological traps hinder rural development in southwestern Madagascar. *Ecol Soc*. 22(1):42. doi:[10.5751/ES-09130-220142](https://doi.org/10.5751/ES-09130-220142).
- Harris F, Lyon F. 2013. Transdisciplinary environmental research: building trust across professional cultures. *Environ Sci Policy*. 31:109–119. doi:[10.1016/j.envsci.2013.02.006](https://doi.org/10.1016/j.envsci.2013.02.006).
- Hauck M, Wynberg R. editors. 2014. *Sharing benefits from the coast: rights, resources and livelihoods*. Cape Town: University of Cape Town Press.
- Hebinck H, Mtati N, Shackleton CM. 2018. More than just fields: reframing deagrarianisation in landscapes and livelihoods. *J Rural Stud*. 61:323–334. doi:[10.1016/j.jrurstud.2018.01.004](https://doi.org/10.1016/j.jrurstud.2018.01.004).
- Henriksson Malinga R, Jewitt G, Lindborg R, Andersson E, Gordon L. 2018. On the other side of the ditch: exploring contrasting ecosystem service coproduction between smallholder and commercial agriculture. *Ecol Soc*. 23(4):9. doi:[10.5751/ES-10380-230409](https://doi.org/10.5751/ES-10380-230409).
- Hichert T, Biggs R, De Vos A. 2021. Futures analysis. In: Biggs R, De Vos A, Preiser R, Clements H, Maciejewski K, Schlüter M, editors. *The Routledge handbook of research methods for social–ecological systems*. London: Taylor & Francis; p. 148–162.
- Hickel J. 2018. Is it possible to achieve a good life for all within planetary boundaries? *Third World Q*. 40(1):18–35. doi:[10.1080/01436597.2018.1535895](https://doi.org/10.1080/01436597.2018.1535895).
- Hirsch Hadorn G, Hoffmann-Riem H, Biber-Klemm S, Grossenbacher-Mansuy W, Joye D, Pohl C, Wiesmann U, Zemp E. 2008. *Handbook of transdisciplinary research*. Berlin: Springer.
- Hoffman MT. 2014. Changing patterns of rural land use and land cover in South Africa and their implications for land reform. *J South Afr Stud*. 40(4):707–725. doi:[10.1080/03057070.2014.943525](https://doi.org/10.1080/03057070.2014.943525).
- Holden P, Cockburn J, Shackleton S, and Rosenberg E. 2019. Supporting and developing competencies for transdisciplinary postgraduate research: a PhD scholar perspective. In: Kremers K, Liepins A, York A, editors. *Developing change agents: innovative practices for sustainability leadership*. Minneapolis: University of Minnesota Libraries Publishing; p. 82–101.
- IPBES. 2018. *The IPBES regional assessment report on biodiversity and ecosystem services for Africa*. Archer E, Dziba L, Mulongoy KJ, Maoela MA, Walters M, editors. Secretariat of the intergovernmental science-policy platform on biodiversity and ecosystem services. Bonn (Germany); 492 pp.

- IPCC. 2018. Global warming of 1.5 °C. An IPCC special report on the impacts of global warming of 1.5 °C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty. Masson-Delmotte V, Zhai P, H-O Pörtner, Roberts D, Skea J, PR Shukla, Pirani A, Moufouma-Okia W, Péan C, Pidcock R, Connors S, JBR Matthews, Chen Y, Zhou X, MI Gomis, Lonnoy E, Maycock T, Tignor M, Waterfield T, editors. Secretariat of the tal science-policy platform on biodiversity and ecosystem services. Bonn (Germany); 562 pp.
- Isaacs M, Witbooi E. 2019. Fisheries crime, human rights and small-scale fisheries in South Africa: a case of bigger fish to fry. *Mar Policy*. 105:158–168. doi:10.1016/j.marpol.2018.12.023.
- Jarre A, Ragaller SM, Hutchings L. 2013. Long-Term, ecosystem-scale changes in the southern Benguela marine pelagic social-ecological system: Interaction of natural and human drivers. *Ecol Soc*. 18(4):55. doi:10.5751/ES-05917-180455.
- Kaoma H, Shackleton CM. 2015. The direct-use value of urban tree non-timber forest products to household income in poorer suburbs in South African towns. *For Policy Econ*. 61:104–112. doi:10.1016/j.forpol.2015.08.005.
- Kates RW, Clark WC, Corell R, Hall JM, Jaeger CC, Lowe I, McCarthy JJ, Schellnhuber HJ, Bolin B, Dickson NM, et al. 2001. Sustainability science. *Science*. 292(5517):641–642. doi:10.1126/science.1059386.
- Kepe T. 2008. Land claims and co-management of protected areas in South Africa: exploring the challenges. *Environ Manage*. 41(3):311–321. doi:10.1007/s00267-007-9034-x.
- Kingsford RT, Biggs HC, Pollard SR. 2011. Strategic adaptive management in freshwater protected areas and their rivers. *Biol Conserv*. 144(4):1194–1203. doi:10.1016/j.biocon.2010.09.022.
- Knight AT, Cowling RM, Rouget M, Balmford A, Lombard AT, Campbell BM. 2008. Knowing but not doing: selecting priority conservation areas and the research–implementation gap. *Conserv Biol*. 22(3):610–617. doi:10.1111/j.1523-1739.2008.00914.x.
- Krüger R, Cundill G, Thondhlana G. 2016. A case study of the opportunities and trade-offs associated with deproclamation of a protected area following a land claim in South Africa. *Local Environ*. 21(9):1047–1062. doi:10.1080/13549839.2015.1065804.
- Kulundu-Bolus I, McGarry D, Lotz-Sisitka HB. 2020. Learning, living and leading into transgression: a reflection on decolonial praxis in a neoliberal world. *South Afr J Environ Educ*. 36(1):111–130.
- Lang DJ, Wiek A, Bergmann M, Stauffacher M, Martens P, Moll P, Swilling M, Thomas CJ. 2012. Transdisciplinary research in sustainability science: practice, principles, and challenges. *Sustainability Sci*. 7(1):25–43. doi:10.1007/s11625-011-0149-x.
- Lindborg R, Gordon LJ, Malinga R, Bengtsson J, Peterson G, Bommarco R, Deutsch L, Gren A, Rundlöf M, Smith HG. 2017. How spatial scale shapes the generation and management of multiple ecosystem services. *Ecosphere*. 8(4):e01741. doi:10.1002/ecs2.1741.
- Lindsey P, Allan J, Brehony P, Dickman A, Robson A, Begg C, Bhammar H, Blanken L, Breuer T, Fitzgerald K, et al. 2020. Conserving Africa's wildlife and wildlands through the COVID-19 crisis and beyond. *Nat Ecol Evol*. 4(10):1300–1310. doi:10.1038/s41559-020-1275-6.
- Lotz-Sisitka H, Wals AE, Kronlid D, McGarry D. 2015. Transformative, transgressive social learning: rethinking higher education pedagogy in times of systemic global dysfunction. *Curr Opin Environ Sustainability*. 16:73–80. doi:10.1016/j.cosust.2015.07.018.
- Lutz JS, Neis B. editors. 2008. Making and moving knowledge: interdisciplinary and community-based research in a world on the edge. Montreal: McGill-Queen's University Press.
- Luvuno L, Biggs R, Stevens N, Esler K. 2018. Woody encroachment as a social-ecological regime shift. *Sustainability*. 10(7):2221. doi:10.3390/su10072221.
- Lynam T, Cunliffe R, Mapaure I, Bwerinofa I. 2003. Assessment of the value of woodland landscape function to local communities in Gorongosa and Muanza Districts, Sofala Province, Mozambique. Jakarta (Indonesia): Center for International Forestry Research.
- Maag S, Alexander TJ, Kase R, Hoffmann A. 2018. Indicators for measuring the contributions of individual knowledge brokers. *Environ Sci Policy*. 89:1–9. doi:10.1016/j.envsci.2018.06.002.
- Maciejewski K, De Vos A, Cumming GS, Moore C, Biggs D. 2015. Cross-Scale feedbacks and scale mismatches as influences on cultural services and the resilience of protected areas. *Ecol Appl*. 25(1):11–23. doi:10.1890/13-2240.1.
- Maciejewski K, Cumming GS. 2015a. Multi-Scale network analysis shows scale-dependency of significance of individual protected areas for connectivity. *Landsc Ecol*. 31(4):761–774. doi:10.1007/s10980-015-0285-2.
- Maciejewski K, Cumming GS. 2015b. The relevance of socioeconomic interactions for the resilience of protected area networks. *Ecosphere*. 6(9):1–14. doi:10.1890/ES15-00022.1.
- Malinga R, Gordon LJ, Lindborg R, Jewitt G. 2013. Using participatory scenario planning to identify ecosystem services in changing landscapes. *Ecol Soc*. 18(4):10. doi:10.5751/ES-05494-180410.
- Mandondo A. 1997. Trees and spaces as emotion and norm laden components of local ecosystems in Nyamaropa communal land, Nyanga District, Zimbabwe. *Agric Human Values*. 14(4):353–372. doi:10.1023/A:1007498110104.
- Mannetti LM, Göttert T, Zeller U, Esler KJ. 2017. Expanding the protected area network in Namibia: an institutional analysis. *Ecosyst Serv*. 28:207–218. doi:10.1016/j.ecoser.2017.08.008.
- Manyani A, Shackleton C, Cocks M. 2021. Attitudes and preferences towards elements of formal and informal public green spaces in two South African towns. *Landsc Urban Plan*. 214:104147. doi:10.1016/j.landurbplan.2021.104147.
- Masterson VA, Tengö M, Spierenburg M. 2017. Competing place meanings in complex landscapes: a social-ecological approach to unpacking community conservation outcomes on the Wild Coast, South Africa. *Soc Nat Resour Soc Nat Resour*. 30(12):1442–1457. doi:10.1080/08941920.2017.1347975.
- Masterson V, Mahajan S, Tengö M. 2018. Photovoice for mobilizing insights on human well-being in complex social-ecological systems: case studies from Kenya and South Africa. *Ecol Soc*. 23(3):13. doi:10.5751/ES-10259-230313.

- Masterson VA, Spierenburg M, Tengö M. 2019a. The trade-offs of win-win conservation rhetoric: exploring place meanings in community conservation on the Wild Coast, South Africa. *Sustainability Sci.* 14(3):639–654. doi:10.1007/s11625-019-00696-7.
- Masterson VA, Vetter S, Chaigneau T, Daw TM, Selomane O, Hamann M, Wong GY, Mellegård V, Cocks M, Tengö M. 2019b. Revisiting the relationships between human well-being and ecosystems in dynamic social-ecological systems: implications for stewardship and development. *Global Sustainability.* 2:e8. doi:10.1017/sus.2019.5.
- Masunungure C, Shackleton SE. 2018. Exploring long-term livelihood and landscape change in two semi-arid sites in Southern Africa: drivers and consequences for social-ecological vulnerability. *Land.* 7(2):50. doi:10.3390/land7020050.
- Max-Neef MA. 2005. Foundations of transdisciplinarity. *Ecol Econ.* 53(1):5–16. doi:10.1016/j.ecolecon.2005.01.014.
- Merçon J, Vetter S, Tengö M, Cocks M, Balvanera P, Rosell JA, Ayala-Orozco B. 2019. From local landscapes to international policy: contributions of the biocultural paradigm to global sustainability. *Global Sustainability.* 2:e7. doi:10.1017/sus.2019.4.
- Mosimane AW, Silva JA. 2015. Local governance institutions, CBNRM, and benefit-sharing systems in Namibian conservancies. *J Sustainable Dev.* 8(2):99. doi:10.5539/jsd.v8n2p99.
- Munnik V, Burt J, Price L, Barnes G, Ashe B, Motloung S. 2016. Principled, pragmatic revitalisation of catchment management forums in South Africa. Report of the research project: catchment management forums: the evolving priority in effecting subsidiarity principles in water management. K5/2411. Pretoria (South Africa): Water Research Commission.
- Nagendra H, Bai X, Brondizio ES, Lwasa S. 2018. The urban south and the predicament of global sustainability. *Nat Sustainability.* 1(7):341–349. doi:10.1038/s41893-018-0101-5.
- Nel JL, Le Maitre DC, Nel DC, Reyers B, Archibald S, van Wilgen BW, Forsyth GG, Theron AK, O'Farrell PJ, Kahinda JMM, et al. 2014. Natural hazards in a changing world: a case for ecosystem-based management. *PLoS ONE.* 9(5):e95942. doi:10.1371/journal.pone.0095942.
- Nel JL, Driver A. 2015. National river ecosystem accounts for South Africa. Pretoria (South Africa): South African National Biodiversity Institute.
- Nel JL, Roux DJ, Driver A, Hill L, Maherry AC, Snaddon K, Petersen CR, Smith-Adao LB, Van Deventer H, Reyers B. 2016. Knowledge co-production and boundary work to promote implementation of conservation plans. *Conserv Biol.* 30(1):176–188. doi:10.1111/cobi.12560.
- Nel JL, Le Maitre DC, Roux DJ, Colvin C, Smith JS, Smith-Adao LB, Maherry A, Sitas N. 2017. Strategic water source areas for urban water security: making the connection between protecting ecosystems and benefiting from their services. *Ecosyst Serv.* 28:251–259. doi:10.1016/j.ecoser.2017.07.013.
- Njwambe A, Cocks M, Vetter S. 2019. Ekhayeni: rural-urban migration, belonging and landscapes of home in South Africa. *J South Afr Stud.* 45(2):413–431. doi:10.1080/03057070.2019.1631007.
- Norström AV, Balvanera P, Spierenburg M, Bouamrane M. 2017. Programme on ecosystem change and society: knowledge for sustainable stewardship of social-ecological systems. *Ecol Soc.* 22(1):47. doi:10.5751/ES-09010-220147.
- Norström AV, Cvitanovic C, Löf MF, West S, Wyborn C, Balvanera P, Bednarek AT, Bennett EM, Biggs R, De Bremond A, et al. 2020. Principles for knowledge co-production in sustainability research. *Nat Sustainability.* 3(3):182–190. doi:10.1038/s41893-019-0448-2.
- O'Farrell P, Anderson P, Le Maitre D, Holmes P. 2012. Insights and opportunities offered by a rapid ecosystem service assessment in promoting a conservation agenda in an urban biodiversity hotspot. *Ecol Soc.* 17(3):27.
- O'Connor RA, Nel JL, Roux DJ, Leach J, Lim-Camacho L, Medvecky F, van Kerkhoff L, Raman S. 2021. The role of environmental managers in knowledge co-production: insights from two case studies. *Environ Sci Policy.* 116:188–195. doi:10.1016/j.envsci.2020.12.001.
- O'Farrell P, Roux D, Fabricius C, Le Maitre D, Sitas N, Reyers B, Nel J, McCulloch S, Smith-Adao L, Roos A, et al. 2015. Towards building resilient landscapes by understanding and linking social networks and social capital to ecological infrastructure: report to the Water Research Commission. Pretoria: Water Research Commission.
- O'Farrell P, Anderson P, Culwick C, Currie P, Kavonic J, McClure A, Ngenda G, Sinnott E, Sitas N, Washbourne C-L, et al. 2019. Towards resilient African cities: shared challenges and opportunities towards the retention and maintenance of ecological infrastructure. *Global Sustainability.* 2:e19. doi:10.1017/sus.2019.16.
- Oldenburg R. 1989. The great good place: cafés, coffee shops, community centers, beauty parlors, general stores, bars, hangouts, and how they get you through the day. New York: Paragon House.
- Olsson P, Gunderson LH, Carpenter SR, Ryan P, Lebel L, Folke C, Holling CS. 2006. Shooting the rapids: Navigating transitions to adaptive governance of social-ecological systems. *Ecol Soc.* 11(1):18. doi:10.5751/ES-01595-110118.
- Ommer RE. 2007. Coasts under stress: restructuring and social-ecological health. Montreal: McGill-Queens University Press.
- Ostrom E. 2010. Beyond markets and states: polycentric governance of complex economic systems. *Am Econ Rev.* 100(3):641–672. doi:10.1257/aer.100.3.641.
- Otto FEL, Wolski P, Lehner F, Tebaldi C, Van Oldenborgh GJ, Hogesteeg S, Singh R, Holden P, Fučkar NS, Odoulami RC. 2018. Anthropogenic influence on the drivers of the Western Cape drought 2015–2017. *Environ Res Lett.* 13(12):124010. doi:10.1088/1748-9326/aac9f9.
- Palmer CG. 1999. Integrating basic and applied benthic science application of ecological research to the development of a new South African water law. *J N Am Benthological Soc.* 18(1):132–142. doi:10.2307/1468013.
- Paumgarten F, Shackleton CM. 2009. Wealth differentiation in household use and trade in non-timber forest products in South Africa. *Ecol Econ.* 68(12):2950–2959. doi:10.1016/j.ecolecon.2009.06.013.
- Pennington DD, Simpson GL, McConnell MS, Fair JM, Baker RJ. 2013. Transdisciplinary research, transformative learning, and transformative science. *BioScience.* 63(7):564–573. doi:10.1525/bio.2013.63.7.9.
- Pereira LM, Karpouzoglou T, Frantzeskaki N, Olsson P. 2018a. Designing transformative spaces for sustainability in social-ecological systems. *Ecol Soc.* 23(4):32. doi:10.5751/ES-10607-230432.

- Pereira LM, Hichert T, Hamann M, Preiser R, Biggs R. **2018b**. Using futures methods to create transformative spaces: visions of a good anthropocene in Southern Africa. *Ecol Soc.* 23(1):19. doi:[10.5751/ES-09907-230119](https://doi.org/10.5751/ES-09907-230119).
- Pereira L, Sitas N, Ravera F, Jimenez-Aceituno A, Merrie A. **2019a**. Building capacities for transformative change towards sustainability: imagination in intergovernmental science-policy scenario processes. *Elem Sci Anth.* 7(1):35.
- Pereira L, Calderón-Contreras R, Norström A, Espinosa D, Willis J, Guerrero Lara L, Kahn Z, Rusch L, Correa Palacios E, Pérez Amaya O. **2019b**. Chefs as change-makers from the kitchen: indigenous knowledge and traditional food as sustainability innovations. *Global Sustainability.* 2:e16. doi:[10.1017/S2059479819000139](https://doi.org/10.1017/S2059479819000139).
- Pereira L, Frantzeskaki N, Hebinck A, Charli-Joseph L, Drimie S, Dyer M, Eakin H, Galafassi D, Karpouzoglou T, Marshall F, et al. **2020a**. Transformative spaces in the making: key lessons from nine cases in the global South. *Sustainability Sci.* 15(1):161–178. doi:[10.1007/s11625-019-00749-x](https://doi.org/10.1007/s11625-019-00749-x).
- Pereira L, Drimie S, Maciejewski K, Biggs R, Biggs R. **2020b**. Food system transformation: integrating a political–economy and social–ecological approach to regime shifts. *Int J Environ Res Public Health.* 17(4):1313. doi:[10.3390/ijerph17041313](https://doi.org/10.3390/ijerph17041313).
- Pereira LM, Davies KK, den Belder E, Ferrier F, Karlsson-Vinkhuyzen S, Kim H, Kuiper JJ, Okayasu S, Palomo MG, Pereira HM, et al. **2020c**. Developing multiscale and integrative nature–people scenarios using the nature futures framework. *People Nat.* 2(4):1172–1195. doi:[10.1002/pan3.10146](https://doi.org/10.1002/pan3.10146).
- Pillay S. **2004**. Corruption – the challenge to good governance: a South African perspective. *Int J Public Sect Manage.* 17(7):586–605. doi:[10.1108/09513550410562266](https://doi.org/10.1108/09513550410562266).
- Pollard S, Du Toit D. **2011**. Towards adaptive integrated water resources management in Southern Africa: the role of self-organisation and multi-scale feedbacks for learning and responsiveness in the Letaba and Crocodile catchments. *Water Resour Manage.* 25(15):4019–4035. doi:[10.1007/s11269-011-9904-0](https://doi.org/10.1007/s11269-011-9904-0).
- Pollard S, Biggs H, Du Toit DR. **2014**. A systemic framework for context-based decision making in natural resource management: reflections on an integrative assessment of water and livelihood security outcomes following policy reform in South Africa. *Ecol Soc.* 19(2):63. doi:[10.5751/ES-06312-190263](https://doi.org/10.5751/ES-06312-190263).
- Pollard S, Du Toit D, Kotschy K, Williams J. **2020**. RESILIM-Olifants resilience in the Limpopo Basin Program Final Report. Hoedspruit (South Africa): Association for Water and Rural Development (AWARD). award.org.za/wp/wp-content/uploads/2020/12/AWARD-RESILIM-Olifants-FINAL-REPORT-PUBLIC-Oct-2020-web.pdf.
- Pollard SR, De Villiers A. **2020**. Dialogues for climate change literacy and adaptation. Hoedspruit (South Africa): USAID: RESILIM-O Programme, AWARD. <http://award.org.za/wp/wp-content/uploads/2020/06/AWARD-FLYER-DICLAD-2020-v2.pdf>.
- Pollard SR, Retief H. **2020**. Systemic water governance for water resources sustainability in the Olifants River Basin. Final Report PHASE II: Building systemic governance and partnerships, tools for IWRM and strengthening custodianship. Hoedspruit: USAID: RESILIM-O Programme, AWARD.
- Preiser R, Pereira LM, Biggs R. **2017**. Navigating alternative framings of human–environment interactions: variations on the theme of ‘finding nemo’. *Anthropocene.* 20:83–87. doi:[10.1016/j.ancene.2017.10.003](https://doi.org/10.1016/j.ancene.2017.10.003).
- Preiser R, Biggs R, de Vos A, Folke C. **2018**. Social–Ecological systems as complex adaptive systems: organizing principles for advancing research methods and approaches. *Ecol Soc.* 23(4):46. doi:[10.5751/ES-10558-230446](https://doi.org/10.5751/ES-10558-230446).
- Preiser R, Biggs R, Hamann M, Sitas N, Selomane O, Waddell J, Clements H, Hichert T. **2021**. Co-exploring relational heuristics for sustainability transitions towards more resilient and just anthropocene futures. *Syst Res Behav Sci.* 38(5):625–634. doi:[10.1002/sres.2815](https://doi.org/10.1002/sres.2815).
- Puttick JR, Hoffman MT, Gambiza J. **2014**. The influence of South Africa’s post-apartheid land reform policies on bush encroachment and range condition: a case study of Fort Beaufort’s municipal commonage. *Afr J Range Forage Sci.* 31(2):135–145. doi:[10.2989/10220119.2014.880943](https://doi.org/10.2989/10220119.2014.880943).
- Rawat YS. **2017**. Sustainable biodiversity stewardship and inclusive development in South Africa: a novel package for a sustainable future. *Curr Opin Environ Sustainability.* 24:89–95. doi:[10.1016/j.cosust.2017.03.003](https://doi.org/10.1016/j.cosust.2017.03.003).
- Raworth K. **2017**. A Doughnut for the Anthropocene: humanity’s compass in the 21st century. *Lancet Planet Health.* 1(2):e48–e49. doi:[10.1016/S2542-5196\(17\)30028-1](https://doi.org/10.1016/S2542-5196(17)30028-1).
- Rebelo AJ, Holden PB, Esler K, New MG. **2021**. Benefits of water-related ecological infrastructure investments to support sustainable land-use: a review of evidence from critically water-stressed catchments in South Africa. *R Soc Open Sci.* 8(4):201402. doi:[10.1098/rsos.201402](https://doi.org/10.1098/rsos.201402).
- Reyers B, Roux DJ, Cowling RM, Ginsburg AE, Nel JL, O’Farrell P. **2010a**. Conservation planning as a transdisciplinary process. *Conserv Biol.* 24(4):957–965. doi:[10.1111/j.1523-1739.2010.01497.x](https://doi.org/10.1111/j.1523-1739.2010.01497.x).
- Reyers B, Pettorelli N, Katzner T, Gompper ME, Redpath S, Garner TWJ, Altwegg R, Reed DH, Gordon IJ. **2010b**. Animal conservation and ecosystem services: garnering the support of mightier forces. *Null.* 13(6):523–525. doi:[10.1111/j.1469-1795.2010.00414.x](https://doi.org/10.1111/j.1469-1795.2010.00414.x).
- Reyers B, Biggs R, Cumming GS, Elmqvist T, Hejnowicz AP, Polasky S. **2013**. Getting the measure of ecosystem services: a social–ecological approach. *Front Ecol Environ.* 11(5):268–273. doi:[10.1890/120144](https://doi.org/10.1890/120144).
- Reyers B, Nel JL, O’Farrell PJ, Sitas N, Nel D. **2015**. Navigating complexity through knowledge coproduction: mainstreaming ecosystem services into disaster risk reduction. *Proc Nat Acad Sci.* 112(24):7362–7368. doi:[10.1073/pnas.1414374112](https://doi.org/10.1073/pnas.1414374112).
- Reyers B, Stafford-Smith M, Erb KH, Scholes RJ, Selomane O. **2017**. Essential variables help to focus sustainable development goals monitoring. *Curr Opin Environ Sustainability.* 26–27:97–105. doi:[10.1016/j.cosust.2017.05.003](https://doi.org/10.1016/j.cosust.2017.05.003).
- Reyers B, Selig ER. **2020**. Global targets that reveal the social–ecological interdependencies of sustainable development. *Nat Ecol Evol.* 4(8):1011–1019. doi:[10.1038/s41559-020-1230-6](https://doi.org/10.1038/s41559-020-1230-6).
- Rogers KH, Luton R, Biggs H, Biggs R, Blignaut S, Choles AG, Palmer CG, Tangwe P. **2013**. Fostering complexity thinking in action research for change in social–ecological systems. *Ecol Soc.* 18(2):31. doi:[10.5751/ES-05330-180231](https://doi.org/10.5751/ES-05330-180231).
- Roux DJ, Stirzaker RJ, Breen CM, Lefroy EC, Cresswell HP. **2010**. Framework for participative reflection on the

- accomplishment of transdisciplinary research programs. *Environ Sci Policy*. 13(8):733–741. doi:10.1016/j.envsci.2010.08.002.
- Roux DJ, Nel JL. 2013. Freshwater conservation planning in South Africa: milestones to date and catalysts for implementation. *Water SA*. 39(1):151–163.
- Roux DJ, Nel JL, Fisher RM, Barendse J. 2016. Top-Down conservation targets and bottom-up management action: creating complementary feedbacks for freshwater conservation. *Aquat Conserv Mar Freshwater Ecosyst*. 26(2):364–380. doi:10.1002/aqc.2577.
- Roux DJ, Nel JL, Cundill G, O'Farrell P, Fabricius C. 2017. Transdisciplinary research for systemic change: who to learn with, what to learn about and how to learn. *Sustainability Sci*. 12(5):711–726. doi:10.1007/s11625-017-0446-0.
- Roux D, Clements H, Currie B, Fritz H, Gordon P, Kruger N, Freitag S. 2020a. The GRIN meeting: a 'third place' for managers and scholars of social-ecological systems. *S Afr J Sci*. 116(3–4):1–2.
- Roux DJ, Smith MKS, Smit IP, Freitag S, Slabbert L, Mokhatla MM, Hayes J, Mpapane NP. 2020b. Cultural ecosystem services as complex outcomes of people–nature interactions in protected areas. *Ecosyst Serv*. 43:101111. doi:10.1016/j.ecoser.2020.101111.
- Roux DJ, Nel JL, Freitag S, Novellie P, Rosenberg E. 2021. Evaluating and reflecting on coproduction of protected area management plans. *Conserv Sci Pract*. 3(11):e542. doi:10.1111/csp2.542.
- Scheffer M. 2009. *Critical transitions in nature and society*. Princeton: Princeton University Press.
- Schieffer A, Isaacs D, Gyllenpalm B. 2004. The world café: part one. *World Bus Acad*. 18(8):1–9.
- Scholes RJ, Reyers B, Biggs R, Spierenburg MJ, Duriappah A. 2013. Multi-Scale and cross-scale assessments of social-ecological systems and their ecosystem services. *Curr Opin Environ Sustainability*. 5(1):16–25. doi:10.1016/j.cosust.2013.01.004.
- Sellberg MM. 2018. *Advancing resilience practice: bridging social-ecological resilience theory and sustainable development practice [Doctoral dissertation]*. Stockholm: Stockholm Resilience Centre, Stockholm University.
- Sellberg MM, Cockburn J, Holden PB, Lam DPM. 2021. Towards a caring transdisciplinary research practice: navigating science, society and self. *Ecosyst People*. 17(1):292–305. doi:10.1080/26395916.2021.1931452.
- Selomane O, Reyers B, Biggs R, Hamann M. 2019. Harnessing insights from social-ecological systems research for monitoring sustainable development. *Sustainability*. 11(4):1190. doi:10.3390/su11041190.
- Selomane O, Reyers B, Biggs R. *In press*. A relational approach to assessing ecosystem change and its societal consequences. *Global Environ Change*.
- Shackleton S, Campbell B, Cocks M, Kajembe G, Kapungwe E, Kayambazinthu D, Jones B, Matela S, Monela G, Mosimane A, et al. 2001. Devolution in natural resource management: institutional arrangements and power shifts: a synthesis of case studies from Southern Africa. Bogor (Indonesia): CIFOR.
- Shackleton CM, Shackleton SE. 2004. The importance of non-timber forest products in rural livelihood security and as safety nets: a review of evidence from South Africa. *S Afr J Sci*. 100:658–664.
- Shackleton SE, Shackleton CM. 2012. Linking poverty, HIV/AIDS and climate change to human and ecosystem vulnerability in southern Africa: consequences for livelihoods and sustainable ecosystem management. *Int J Sustainable Dev World Ecol*. 19(3):275–286. doi:10.1080/13504509.2011.641039.
- Shackleton CM, Blair A. 2013. Perceptions and use of public green space is influenced by its relative abundance in two small towns in South Africa. *Landsc Urban Plan*. 113:104–112. doi:10.1016/j.landurbplan.2013.01.011.
- Shackleton S, Cobban L, Cundill G. 2014. A gendered perspective of vulnerability to multiple stressors, including climate change, in the rural Eastern Cape, South Africa. *Agenda*. 28(3):73–89. doi:10.1080/10130950.2014.932560.
- Shackleton S, Chinyimba A, Hebinck P, Shackleton C, Kaoma H. 2015. Multiple benefits and values of trees in urban landscapes in two towns in northern South Africa. *Landsc Urban Plan*. 136:76–86. doi:10.1016/j.landurbplan.2014.12.004.
- Shackleton SE, Luckert M. 2015. Changing livelihoods and landscapes in the rural Eastern Cape, South Africa: past influences and future trajectories. *Land*. 4(4):1060–1089. doi:10.3390/land4041060.
- Shackleton SE, Hebinck P. 2018. Through the 'thick and thin' of farming on the Wild Coast, South Africa. *J Rural Stud*. 61:277–289. doi:10.1016/j.jrurstud.2018.01.012.
- Shackleton CM, Blair A, De Lacy P, Kaoma H, Mugwagwa N, Dalu MT, Walton W. 2018a. How important is green infrastructure in small and medium-sized towns? Lessons from South Africa. *Landsc Urban Plan*. 180:273–281. doi:10.1016/j.landurbplan.2016.12.007.
- Shackleton RT, Biggs R, Richardson DM, Larson BMH. 2018b. Social-ecological drivers and impacts of invasion-related regime shifts: consequences for ecosystem services and human wellbeing. 2018. *Environ Sci Policy*. 89:300–314. doi:10.1016/j.envsci.2018.08.005.
- Shackleton RT, Shackleton CM, Kull CA. 2019a. The role of invasive alien species in shaping local livelihoods and human well-being: a review. *J Environ Manage*. 229:145–157. doi:10.1016/j.jenvman.2018.05.007.
- Shackleton CM, Mograbi P, Drimie S, Fay D, Hebinck P, Hoffman MT, Maciejewski K, Twine W. 2019b. Deactivation of field cultivation in communal areas of South Africa: patterns, drivers and socio-economic and ecological consequences. *Land Use Policy*. 82:686–699. doi:10.1016/j.landusepol.2019.01.009.
- Sitas N. 2014. *Opportunities and challenges for mainstreaming ecosystem services in decision making [PhD thesis]*. South Africa: Stellenbosch University.
- Sitas N, Nel J, and Reyers B. 2019. Lessons for mainstreaming ecosystem services into policy and practice from South Africa. In: Kumar P, editor. *Mainstreaming natural capital and ecosystem services into development policy*. Nairobi: Routledge; p. 40–59.
- Sitas N, Reyers B, Cundill G, Prozesky HE, Nel J, Esler KJ. 2016. Fostering collaboration for knowledge and action in disaster management in South Africa. *Curr Opin Environ Sustainability*. 19:94–102. doi:10.1016/j.cosust.2015.12.007.
- Smit IP, Roux DJ, Swemmer LK, Boshoff N, Novellie P. 2017. Protected areas as outdoor classrooms and global laboratories: intellectual ecosystem services flowing to-and-from a National Park. *Ecosyst Serv*. 28:238–250. doi:10.1016/j.ecoser.2017.05.003.
- Smith MKS, Smit IP, Swemmer LK, Mokhatla MM, Freitag S, Roux DJ, Dziba L. 2021. Sustainability of

- protected areas: vulnerabilities and opportunities as revealed by COVID-19 in a national park management agency. *Biol Conserv.* 255:108985. doi:[10.1016/j.biocon.2021.108985](https://doi.org/10.1016/j.biocon.2021.108985).
- Sobratee N, Davids R, Chinzi CB, Mabhaudhi T, Scheelbeek P, Modi AT, Dangour AD, Slotow R. 2022. Visioning a food system for an equitable transition towards sustainable diets - a South African perspective. *Sustainability.* 14(6):3280. doi:[10.3390/su14063280](https://doi.org/10.3390/su14063280).
- Sousa PM, Blamey RC, Reason CJC, Ramos AM, Trigo RM. 2018. The 'day zero' Cape Town drought and the poleward migration of moisture corridors. *Environ Res Lett.* 13(12):124025. doi:[10.1088/1748-9326/aaebc7](https://doi.org/10.1088/1748-9326/aaebc7).
- Sowman M, Sunde J, Raemaekers S, Schultz O. 2014. Fishing for equality: policy for poverty alleviation for South Africa's small-scale fisheries. *Mar Policy.* 46:31–42. doi:[10.1016/j.marpol.2013.12.005](https://doi.org/10.1016/j.marpol.2013.12.005).
- Sowman M, Sunde J. 2018. Social impacts of marine protected areas in South Africa on coastal fishing communities. *Ocean Coastal Manage.* 157:168–179. doi:[10.1016/j.ocecoaman.2018.02.013](https://doi.org/10.1016/j.ocecoaman.2018.02.013).
- Sowman M, Sunde J. 2021. A just transition? Navigating the process of policy implementation in small-scale fisheries in South Africa. *Mar Policy.* 132:104683. doi:[10.1016/j.marpol.2021.104683](https://doi.org/10.1016/j.marpol.2021.104683).
- Spierenburg M, Brooks S. 2014. Private game farming and its social consequences in post-apartheid South Africa: contestations over wildlife, property and agrarian futures. *J Contemp Afr Stud.* 32(2):151–172. doi:[10.1080/09637494.2014.937164](https://doi.org/10.1080/09637494.2014.937164).
- Steffen W, Richardson K, Rockström J, Cornell SE, Fetzer I, Bennett EM, Biggs R, Carpenter SR, De Vries W, De Wit CA, et al. 2015. Planetary boundaries: guiding human development on a changing planet. *Science.* 347(6223):1259855. doi:[10.1126/science.1259855](https://doi.org/10.1126/science.1259855).
- Stevens N, Erasmus BFN, Archibald S, Bond WJ. 2016. Woody encroachment over 70 years in South African savannahs: overgrazing, global change or extinction aftershock? *Philos Trans R Soc B.* 371(1703):20150437. doi:[10.1098/rstb.2015.0437](https://doi.org/10.1098/rstb.2015.0437).
- Swilling M, Anneck E. 2012. Just transitions: explorations of sustainability in an unfair world. United Nations University Press.
- Swilling M. 2020. The age of sustainability: just transitions in a complex world. London: Routledge.
- Taylor A, Pretorius L, McClure A, Iiping KN, Mwalukanga B, Mamombe R. 2021. Embedded researchers as transdisciplinary boundary spanners strengthening urban climate resilience. *Environ Sci Policy.* 126:204–212. doi:[10.1016/j.envsci.2021.10.002](https://doi.org/10.1016/j.envsci.2021.10.002).
- Temper L, Walter M, Rodriguez I, Kothari A, Turhan E. 2018. A perspective on radical transformations to sustainability: resistances, movements and alternatives. *Sustainability Sci.* 13(3):747–764. doi:[10.1007/s11625-018-0543-8](https://doi.org/10.1007/s11625-018-0543-8).
- Temper L, McGarry D, Weber L. 2019. From academic to political rigour: insights from the 'Tarot' of transgressive research. *Ecol Econ.* 164:106379. doi:[10.1016/j.ecolecon.2019.106379](https://doi.org/10.1016/j.ecolecon.2019.106379).
- Tengö M, Brondizio ES, 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. doi:[10.1007/s13280-014-0501-3](https://doi.org/10.1007/s13280-014-0501-3).
- Tengö M, Hill R, Malmer P, Raymond CM, Spierenburg M, Danielsen F, Elmqvist T, Folke C. 2017. Weaving knowledge systems in IPBES, CBD and beyond—lessons learned for sustainability. *Curr Opin Environ Sustainability.* 26–27:17–25. doi:[10.1016/j.cosust.2016.12.005](https://doi.org/10.1016/j.cosust.2016.12.005).
- Thondhlana G, Shackleton SE. 2015. Cultural values of natural resources among San people neighbouring Kgalagadi Transfrontier Park, South Africa. *Local Environ Int J Justice Sustainability.* 20(1):18–33. doi:[10.1080/13549839.2013.818950](https://doi.org/10.1080/13549839.2013.818950).
- Thondhlana G, Cundill G, Kepe T. 2016. Co-Management, land rights, and conflicts around South Africa's Silaka Nature Reserve. *Soc Nat Resour.* 29(4):403–417. doi:[10.1080/08941920.2015.1089609](https://doi.org/10.1080/08941920.2015.1089609).
- Thondhlana G, Cundill G. 2017. Local people and conservation officials' perceptions on relationships and conflicts in South African protected areas. *Int J Biodivers Sci Ecosyst Serv Manage.* 13(1):204–215. doi:[10.1080/21513732.2017.1315742](https://doi.org/10.1080/21513732.2017.1315742).
- Thondhlana G, Yose P, Cockburn J, Shackleton C. 2022. Livestock ecosystem services and disservices in a medium-sized South African town. *Ecosyst People.* 18(1):31–43. doi:[10.1080/26395916.2021.2019833](https://doi.org/10.1080/26395916.2021.2019833).
- Turner IB, Esler KJ, Bridgewater P, Tewksbury J, Sitas N, Abrahams B, Chapin FS, Chowdhury RR, Christie P, Diaz S, et al. 2016. Socio-Environmental systems (SES) research: what have we learned and how can we use this information in future research programs. *Curr Opin Environ Sustainability.* 19:160–168. doi:[10.1016/j.cosust.2016.04.001](https://doi.org/10.1016/j.cosust.2016.04.001).
- Turpie JK, Marais C, Blignaut JN. 2008. The working for water programme: evolution of a payments for ecosystem services mechanism that addresses both poverty and ecosystem service delivery in South Africa. *Ecol Econ.* 65(4):788–798. doi:[10.1016/j.ecolecon.2007.12.024](https://doi.org/10.1016/j.ecolecon.2007.12.024).
- UNDP (United Nations Development Program). 2020. Human Development Report 2020: the Next Frontier – Human Development in the Anthropocene. New York: UNDP.
- van Kerkhoff L. 2014. Developing integrative research for sustainability science through a complexity principles-based approach. *Sustainability Sci.* 9(2):143–155. doi:[10.1007/s11625-013-0203-y](https://doi.org/10.1007/s11625-013-0203-y).
- van Wilgen BW, Wannenburgh A. 2016. Co-Facilitating invasive species control, water conservation and poverty relief: Achievements and challenges in South Africa's working for water programme. *Curr Opin Environ Sustainability.* 19:7–17. doi:[10.1016/j.cosust.2015.08.012](https://doi.org/10.1016/j.cosust.2015.08.012).
- Venter ZS, Shackleton CM, Van Staden F, Selomane O, Masterson V. 2020. Green apartheid: urban green infrastructure remains unequally distributed across income and race geographies in South Africa. *Landsc Urban Plan.* 203:103889. doi:[10.1016/j.landurbplan.2020.103889](https://doi.org/10.1016/j.landurbplan.2020.103889).
- Wangai PW, Burkhard B, Müller F. 2016. A review of studies on ecosystem services in Africa. *Int J Sustainable Built Environ.* 5(2):225–245. doi:[10.1016/j.ijsbe.2016.08.005](https://doi.org/10.1016/j.ijsbe.2016.08.005).
- Ward CD, Cundill G, Midgley GF, Jarre A. 2021. Drawing on diverse knowledge systems to enhance local climate understanding in the southern Cape, South Africa. *Ecol Soc.* 26(4):10. doi:[10.5751/ES-12712-260410](https://doi.org/10.5751/ES-12712-260410).

- Weaver MJT, O'Keeffe J, Hamer N, Palmer CG. 2019. A civil society organisation response to water service delivery issues in South Africa drives transformative praxis. Part 1: emergence and practice. *Geoforum*. 107:1–13. doi:[10.1016/j.geoforum.2019.08.020](https://doi.org/10.1016/j.geoforum.2019.08.020).
- Wessels N, Sitas N, Esler K, O'Farrell P. 2021a. Understanding community perceptions of a natural open space system for urban conservation and stewardship in a metropolitan city in Africa. *Environ Conserv*. 48(4):244–254. doi:[10.1017/S0376892921000345](https://doi.org/10.1017/S0376892921000345).
- Wessels N, Sitas N, O'Farrell P, Esler KJ. 2021b. Assessing the outcomes of implementing natural open space plans in a global south city. *Landsc Urban Plan*. 216:104237. doi:[10.1016/j.landurbplan.2021.104237](https://doi.org/10.1016/j.landurbplan.2021.104237).
- West S, van Kerkhoff L, Wagenaar H. 2019. Beyond 'linking knowledge and action': towards a practice-based approach to transdisciplinary sustainability interventions. *Policy Stud*. 40(5):534–555. doi:[10.1080/01442872.2019.1618810](https://doi.org/10.1080/01442872.2019.1618810).
- Westley FR, Tjornbo O, Schultz L, Olsson P, Folke C, Crona B, Bodin O. 2013. A theory of transformative agency in linked social-ecological systems. *Ecol Soc*. 18(3):27. doi:[10.5751/ES-05072-180327](https://doi.org/10.5751/ES-05072-180327).
- Weyer D, Bezerra JC, de Vos A. 2019. Participatory mapping in a developing country context: lessons from South Africa. *Land*. 8(9):134. doi:[10.3390/land8090134](https://doi.org/10.3390/land8090134).
- Wilhelm-Rechmann A, Cowling RM. 2011. Framing biodiversity conservation for decision makers: insights from four South African municipalities. *Conserv Lett*. 4(1):73–80. doi:[10.1111/j.1755-263X.2010.00149.x](https://doi.org/10.1111/j.1755-263X.2010.00149.x).
- Wolff MG, Cockburn JJ, de Wet C, Carlos Bezerra J, Weaver MJT, Finca A, de Vos A, Ralekhetla MM, Libala N, Mkabile QB, et al. 2019. Exploring and expanding transdisciplinary research for sustainable and just natural resource management. *Ecol Soc*. 24(4):14. doi:[10.5751/ES-11077-240414](https://doi.org/10.5751/ES-11077-240414).
- World Bank. 2018. Poverty and shared prosperity 2018: piecing together the poverty puzzle. Washington (DC): World Bank.
- Wyborn C, Datta A, Montana J, Ryan M, Leith P, Chaffin B, Miller C, van Kerkhoff L. 2019. Co-Producing sustainability: reordering the governance of science, policy, and practice. *Ann Rev Environ Resour*. 44(1):319–346. doi:[10.1146/annurev-environ-101718-033103](https://doi.org/10.1146/annurev-environ-101718-033103).
- Young KD, van Aarde RJ. 2011. Science and elephant management decisions in South Africa. *Biol Conserv*. 144(2):876–885. doi:[10.1016/j.biocon.2010.11.023](https://doi.org/10.1016/j.biocon.2010.11.023).
- Zoeller KC, Gurney GG, Heydinger J, Cumming GS. 2020. Defining cultural functional groups based on perceived traits assigned to birds. *Ecosyst Serv*. 44:101138. doi:[10.1016/j.ecoser.2020.101138](https://doi.org/10.1016/j.ecoser.2020.101138).