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Paradigm shifts for a planetary emergency: Towards an anthropocenography for urban coastal research at False Bay, Cape Town, South Africa

Reflecting on a recent three-decade review of the social-ecological sciences of False Bay in Cape Town that was co-authored by 32 South African based scientists, this essay draws on current Anthropocene scholarship in the environmental humanities and social sciences to suggest four approaches to strengthening transdisciplinarity engagement between social and natural sciences. First, the material flows between the fields categorised as ‘nature’ and ‘society’ is suggested as an alternative empirical base for integrative transdisciplinary research, building on emergent transdisciplinary fields including industrial ecology, biogeochemical sciences, circular economics and critical zone scholarship. Second, a humanities-informed conversation in South African scholarship invites discussion as to whether and how the conceptual categories of nature and society remain empirically useful, given the evidence in Anthropocene stratigraphy that human living is terra-forming. Third, humanities scholarship is vital for the scholarly assessment of historical and contemporary data sets and scientific publications. Fourth, the theorisation of ‘social systems’, ‘the human’, ‘society’, and ‘ecosystem services’ in the social-ecological approaches represented in the review, create a barrier for social scientists to take up invitations to transdisciplinary research partnerships. The above concerns, taken together, frame an alternative approach to transdisciplinary research that is tentatively suggested as an ‘anthropocenography’: a research paradigm based on material flows in the Anthropocene.

Significance:

Innovations in transdisciplinary research that attend to material flows are evident in multiple emerging fields that address the Anthropocene, including biogeosciences, industrial ecology, urban metabolism, circular economies, and critical zone sciences. Responding to a 30-year review of the sciences of False Bay, I argue that these new research fields, which encompass earth sciences, biosciences and applied sciences, offer generative linkages to emerging scholarship in environmental social sciences and humanities that also attend to material flows. Linking social and natural sciences via material flows is therefore suggested as a generative approach to transdisciplinarity.

Introduction

‘What you see, blocks your sight’, veteran journalist Khaba Mkhize used to teach fellow journalists who were covering complex conflicts in South Africa in the 1990s.¹ In studying the scientific review paper titled ‘A synthesis of three decades of socio-ecological change in False Bay, South Africa: Setting the scene for multidisciplinary research and management’ by Pfaff et al.² (henceforth: ‘*Synthesis*’), Mkhize’s caution comes to mind. A chain of questions arises: What is being seen? What is not being seen? Has all that counts, been counted?

The *Synthesis* is a landmark in South African transdisciplinary efforts to address multi-decadal harms that have accrued in False Bay, in its particular expression of the planetary emergency comprising global heating, extinction risks, contamination, and extractivism. As does any work of scientific review, the *Synthesis* represents one of the most important forms of scholarly endeavour as it reflects back on prior research to take stock and reset research and funding agendas.

Published in the *Elementa: Sciences of the Anthropocene* in July 2019, the *Synthesis* was co-authored by 32 South Africa focused marine biologists, oceanographers, conservationists, geographers and geologists in collaboration with provincial and city officials. It cites 310 papers as well as 17 unpublished studies of False Bay in the three decades since white supremacy began to be undone. At the time of writing, the *Synthesis* had achieved a credible 25 citations in the three years since its publication.

As a social scientist, however, the dearth of social sciences and humanities in the article evidences an uncomfortably familiar fault line in South African scholarship between the social and natural sciences on environmental concepts and governance. Not a single social science journal article about Cape Town, or the Cape Flats, or the environmental challenges thrown up by apartheid’s urban planning, appears in the bibliography. Apartheid spatial planning set up the Cape Flats Wastewater Treatment Works on the sand dunes at the edge of False Bay, for example, and did not line its settlement ponds that are sited atop the major recharge zone of the Cape Flats Aquifer which in turn discharges vast quantities of water to the ocean.³ The siting of the Treatment Works in the area designated for people of colour, on the dunes close to False Bay’s northern edge, overlooks a crucial element of the urban-marine ecology under study. Thus, while institutionalised racism is congruent with many of the Anthropocene harms that the authors set out to describe, it receives no mention.

As for social theory, the sole social science theorist to be cited is Frances Fukuyama⁴, author of the ‘triumph of liberalism’ theory that supposes the present era to be at the end of social historical struggle. His argument, and its iteration in neoliberal concepts that inform the key social analytics of the framing narrative, has been the focus of heavy criticism from the social sciences. In the context of struggles against neoliberal governance in South Africa

in general and the Western Cape in particular, the concepts invoked do not offer a neutral or natural account of society or history.

This article offers a 'review of a review', in the hope that the fault line between social and natural sciences in environmental governance may be mediated, and chasms bridged. In developing this essay, I have four purposes. First, I hope to offer the wider bioscience community an insight as to where, how and why an engagement with contemporary environmental social sciences and humanities methods could offer generative re-framings of the paradigms currently directing environmental governance research in False Bay, and by implication, other contexts in South Africa too. A 'material humanities', I will argue, offers a viable and empirical research approach to the material flows between the physical spaces that are perceived to be separate because they are categorised as 'nature' and 'society'. The methods of that material humanities are those of 'muddy boots': walking and talking to observe and listen; track and trace – and both triangulate these findings with data sets and use them to frame new research questions based on local insights.

Second, I invite a humanities-informed conversation in South African scholarship about whether and how the categories of nature and society remain useful, given the evidence in Anthropocene stratigraphy that human living is terra-forming. Again the proposed method is empirical: follow the matter, regardless of whether it is in a space characterised as 'natural' or 'social'.

Third, I draw the attention of colleagues in the natural sciences to the importance of contemporary social sciences and humanities of reading data archives in the context of their production. Science studies, and histories of science, offer vitally important approaches to the evaluation of data and research.

Fourth, I draw the above together to point to the limitations attending the conceptualisation of nature as an ecosystem service, and society as a system. Both ideas are prominent in the *Synthesis*, and in my view, while these approaches may have rhetorical value in seeking buy-in from governing officials whose paradigm is neoliberal, they are not empirically useful in comprehending flows and processes on the ground. Earth processes do not function in dollar values. A paradigm shift in environmental governance sciences is therefore warranted.

The purpose of attending to the above concerns is not to attack environmental allies in the struggle to address the planetary emergency, but to try to identify ways to improve scholarly dialogue so that we may together address the immense challenges of the Anthropocene. The argument begins with an overview of the history of disciplinary divides; then moves to respond to the *Synthesis* from the perspective of contemporary environmental social science and humanities. I conclude with a summary of the proposal to shift transdisciplinary environmental governance sciences to focus on the material flows and processes that characterise the Anthropocene, and suggest that an integration of multiple emergent transdisciplinaries of material flows and exchanges may take form in a field that, following Eduardo Viveiros de Castro, could be usefully indexed as an 'Anthropocenography'.⁵

The challenge for science of a planetary emergency: Tackling disciplinary divides

The idea that humanity is separate from nature is a foundational one in modernist thought, stemming from Europe in the 1600s when Rene Descartes offered the Church his *Discourse on Method*.⁶ A peace treaty that attempted mitigation of the risks he and others faced to life and limb when accused by the Church of heresy, Descartes' *Discourse on Method* is a deeply theological text. It proposes a science of observable nature that would provide insight into the mind of God, while the Church should attend to the inobservables, that is, matters of theology and spirit. Long critiqued for separating body from mind, *Discourse on Method* did so to try to keep scientists' heads on their own shoulders. Its proposals were not enough to prevent Descartes from dying in exile, however, but it did provide the conceptual shift necessary to enable Descartes' successors to work in greater freedom as more and more researchers sought to persuade the powerful that what counts could be separated

from what was counted. What could be valued therefore came to be the concern of the Church, separated from what was to be considered as facts known by observational science. Following from this, culture came to be considered separately from nature; subject from object. That this bifurcation of scholarly attention was a political struggle for survival, not a fact of nature, is mostly forgotten now, and the separation of natural and social sciences is hard-wired into universities globally.

Now, amid the conditions described by earth scientists as 'the Anthropocene' geological era^{7,8}, which was suggested by Eugene F. Stoermer and Paul Crutzen⁹, universities and researchers alike are increasingly aware of the need to work across disciplinary divides, because clearly if human actions are affecting planetary processes, their separate study is neither intellectually tenable nor politically useful in the task of addressing the planetary crisis. While 'ecosystem services' has come to be a dominant approach in environmental governance sciences in recent decades as an attempt to link political values to scientific fact, its account of what counts, and its theorisation of nature, person, system and society is deeply problematic for many in the social sciences. Happily, it is not the only approach to transdisciplinarity, and a number of vital fields have emerged in the past decade that, in their focus on material flows, are more amenable to social science and humanities research partnerships.

Among these, the **biogeosciences**¹⁰ respond to the realisation that life processes themselves are terra-forming, and that the planetary conditions that support life are bolstered by life. A linkage of soils sciences, geohydrology and biogeosciences led to the supra-integrative field that has come to be known as **critical zone sciences**^{11,12} that offer a means to study the relations that make for habitability in the approximately 10-km-wide life-supporting zone at any point on the earth's surface between aquifer and cloud. In geohydrology, **hydrosocial sciences**¹³ emerged to rethink standard hydrological models in anthropogenic landscapes. The latter suggests the possibility for the biogeosciences to begin framing a biogeosocial science.

Anthrome studies¹⁴ offer a typology of human-altered landscapes. At the interface of engineering, planning and social sciences, the fields of **industrial ecology**¹⁵ and **urban metabolism**^{16,17} offer ways to conceptualise interlinked effects of urban planning decisions on **urban ecology**¹⁸.

In the social sciences and humanities, the notion of the '**technosphere**'¹⁹ offers a provocation for the integration of material and infrastructural worlds with earth sciences, and where geologists have begun framing typologies of **anthropogenic landscape transformations**⁷ (including the formation of anthropic rock), media scholars have begun to speak of **media geologies**²⁰ to account for the changing stratigraphy of rare earths and other heavy metals used in computers, cellphones, silicone chips, etc. That body of work integrates well with a social science approach to the Anthropocene that prefers the term **Capitalocene**²¹, although industry in general offers a more comprehensive diagnostic for the planetary emergency. Historians who attend to the landscape transformations associated with slavery and early capitalism offer the term '**Plantationocene**'.²²

Landscape histories have been taken forward in the environmental humanities and social sciences via a corpus of work that can broadly be characterised as 'the **new materialism**' in the humanities²³, spanning **environmental justice**²⁴ research on toxicity (see in particular Rob Nixon's *Slow Violence and the Environmentalism of the Poor*²⁵) and alternatives to the **militarisation of conservation**²⁶. In these bodies of work, Achille Mbembe's work on the concept of 'necropolitics'²⁷ – a politics of negation of the human subject – has been taken up by human geographers to describe '**necropolitical geologies**'²⁸. That work in turn links to a rich body of work in the field of **forensic architecture**²⁹ that tracks and traces toxins in urban design and zones of warfare. In the related body of work on **decolonial ecology**³⁰, the environmental struggles of our time are rooted in the objectifications of the world that underlie racism, sexism, and alienation from the earth³¹. Without engaging the legacies of objectified nature, decolonial ecologists argue, environmental governance scholarship will fail to achieve the goal of unmaking the Anthropocene.

For philosopher Bernard Stiegler, the goal of unmaking the Anthropocene requires scholarship on knowledge that speaks to the larger global struggles over science, in the age of for-hire consultancies and market-driven science.³² Stiegler calls for knowledge-producers to recognise that part of the crisis of the Anthropocene is in the production of anti-knowledge, such as climate denialism, or contaminant denialism. The negation of the Anthropocene, he argues, becomes possible when knowledge is fragmented and reduced to the enumerative, without a sense of purpose or goal. What counts, is not always what is counted. Stiegler's question is this: How can science be transformed to address what counts in the task of addressing the planetary emergency, amid the abuse of science and scientific authority to counter truths that discomfit the powerful?

In the spirit of a generative, urgent and transdisciplinary engagement that draws on these emergent transdisciplinaries, I offer a brief overview of the *Synthesis*, section by section, suggesting dialogues with the above literatures in ways that might foster the integrative approach needed to manage this vitally important Cape Town bay which is currently in crisis amid long-standing efforts by municipal coastal authorities to conceal the extent of its contamination. Knitted into this critique is an invitation to social sciences to engage with environmental governance scholarship in the spirit of generative disagreement between dissenting allies, and an invitation to colleagues in the applied and basic sciences, to take seriously the concerns of the social sciences and humanities, and the insights they bring to concepts, methods and approaches. My hope is that what follows offers the resources for transformative transdisciplinary research.

'A Synthesis of Three Decades of Socio-Ecological Change in False Bay': A critique

The goal of the *Synthesis* is set out in the opening lines of its abstract:

Over the past three decades, marine resource management has shifted conceptually from top-down sectoral approaches towards the more systems-oriented multi-stakeholder frameworks of integrated coastal management and ecosystem-based conservation. However, the successful implementation of such frameworks is commonly hindered by a lack of cross-disciplinary knowledge transfer, especially between natural and social sciences. This review represents a holistic synthesis of three decades of change in the oceanography, biology and human dimension of False Bay, South Africa.²

Notwithstanding the goal of providing an 'holistic synthesis' that includes the 'human dimension' of False Bay, absent is published research on the social struggles on the Cape Flats that materially affect False Bay, including ongoing sanitation struggles³³; the court battles to protect farmland and the aquifer on which food production depends³⁴; or the use of legal instruments by provincial government against the City Council (and private wastewater treatment plant operators) to curtail river pollution³⁵. Multiple unmentioned studies have been published on urban hunger in the Cape Flats³⁶ and the rise of corporate supermarkets that have displaced spazas and family-owned grocery stores in formerly black areas, aggravating plastic pollution and hunger and therefore also increasing pressure on marine protected areas³⁷. Apartheid shacklands and dormitories of Khayelitsha, Vrygrond, Lavender Hill, Lotus River and Capricorn that abut False Bay³⁸ fostered the gangs that now aggravate abalone extinctions risks³⁹. A slow violence of pollution²⁵ along these rivers from inadequate sewage treatment plants and failing sewer pump stations, affects the health of many, particularly when *E. coli* counts are artificially lowered by dosing sewage spills with chlorine, a volatile element that reacts with other compounds in polluted water, leading to complaints of chronic respiratory conditions for those who live along these rivers. Some of these struggles have received wide print, radio and television coverage including on a national investigative journalism television show that led to a subsequent battle at the Broadcasting Complaints Commission, which the City of Cape Town lodged, but lost.⁴⁰

The keywords that anchor the paper's engagement with the 'social' include 'population'; 'tourism'; 'development'; 'economy'; 'social goals' and 'social systems'. The words 'race' and 'racism' do not appear. 'Apartheid' appears once, as does 'inequality'. 'Poverty' appears three times, while 'water sport' appears four times and 'tourism' receives 18 in-text mentions including a dedicated table as a supplemental file. A crucial omission is an engagement with social science conceptual literature that critiques the theorisation of nature as 'ecosystem services'.^{41,42}

Where human population receives mention (nine times, in each case referring to 'over-population'), the argument invokes familiar *moralist* causal chains such as pollution, over-fishing and illegal fishing, or lack of care for the environment² without regard to the *structural* causal chains linked to extreme income inequalities, including extractive profit-taking in fisheries and the property sector, or the consequences of privatising services (such as the privatised management of the Zandvliet Wastewater Treatment Works on the Kuils River) in which profits to shareholders abroad increase the costs of basic services. So too, privatisation of treatment works upgrades have affected the environment: for over a decade, several major civil engineering companies fought court battles over who ought to have been awarded the tender for the upgrade of the sewage works at Zandvliet. This series of court battles affected the health and well-being of people, rivers and ocean, and, unchecked by authorities, it elevated companies' legal rights to contest a tender over citizens' constitutional rights to a clean environment.⁴⁰

It is noteworthy that the integrative field of 'biogeochemistry' is foregrounded throughout the paper. As the study of the metabolic and mutually transformative interactions of biosphere, atmosphere, hydrosphere and lithosphere⁴³, biogeochemistry offers a paradigm-shifting analytical framework, and its presence in the paper gestures towards possibilities for unifying the natural and applied sciences with the social sciences in the management of False Bay via the emerging transdisciplinaries listed above.

The discussion below follows the structure of the paper, in which the first three sections report on findings in the natural sciences under these headings: 'Geology and physical oceanography of False Bay'; 'Biogeochemical oceanography of False Bay'; 'Ecosystems and biota of False Bay'; and 'The human dimension of False Bay'.

Geology and physical oceanography of False Bay

The 'Geology and physical oceanography' section tells of the fascinating history and structure of the bay in geological time, but surprisingly does not bring into view its contemporary geological transformation: perhaps reflecting the assumption that geology occurred in the past. Emerging global transdisciplinary literatures on **neogeomorphology**⁴⁴ would assist in attention to this in four ways.

First, transport and residential infrastructure that are characterised by hard-surfacing using anthropogenic rocks such as concrete and tar that specifically introduce impermeability into geological landscapes, changing biogeochemical processes at the interfaces of solids and liquids (colloids⁴⁵) and airborne particles (dust, mist and smoke). These geological changes of the Bay are occurring in the present.

Second, extractivism such as the extensive sand dune mining on the Cape Flats at Macassar, on the northern edge of False Bay, is dramatically changing the geohydrology of the urban coastal edge. Dune mining is warned against by the authors of a report commissioned by the City⁴⁶ and is contrary to established international practice that seeks to work with natural landforms to protect cities against sea level rise⁴⁷.

Third, disposal in the coastal zone warrants scholarly attention and possible intervention. The wastewater treatment works near Strandfontein introduce biogeochemical changes to the False Bay coastal region, as does the two-decades-old waste dump known as Capricorn, both of which are situated one to two kilometres from the littoral zone on the primary recharge zone of the Cape Flats aquifer, which itself discharges water with dissolved chemicals and particulate matter to False Bay.⁴⁸ The municipal protocols at the Capricorn site do not compel the separation of e-waste



from any other waste, and the pollutants and heavy metals in technologies like millions of VHS tapes, NiCad batteries, CRT computer screens, low-energy CFL lightbulbs and various plastics, for example, degrade and leach into the wider environment along with many other toxins identified in the industrial ecology and environmental chemistry literature.²⁰

Fourth, histories of infrastructure invite conversations on the use of the sea as a disposal site by both the municipality and the state.^{49,50} The already-mentioned unlined sewage settlement ponds are a case in point, via which household, pharmaceutical and industrial toxins have leached into the aquifer since 1956. False Bay was used by the apartheid state for the disposal of military ordnance (notably at the site known by divers as 'Ammo Reef' near Boulders Beach), reflecting the Anthropocene-generating concept that the ocean constitutes an extra-terrestrial 'nowhere', outside of feedback loops to society. The knowledge that pollutants like toxins, microplastics and chemicals of emerging concern travel long-range with ocean evaporants, ocean circulation and migrating fish, is established consensus in the Stockholm Convention⁵¹, and therefore compels problem-focused, planetary-facing research questions from Cape Town that exceed the limits of any single established discipline in the natural or social sciences.

Biogeochemical oceanography of False Bay

The section on 'Biogeochemical oceanography' is assessed in four parts. First in focus are nutrients (offshore, nearshore and terrestrial inputs, and atmospheric inputs); second, water quality and pollution; third, chlorophyll; and fourth, algal blooms.

Given the intensity of struggles over clean water and sanitation in many areas bordering False Bay, it is surprising that the authors do not note their existence in their framing narrative. Pollutants are both microbial and chemical, with the former contributing to algal blooms in inland vleis (lakes) on Cape Town's Cape Flats, and in some cases even teenagers in various communities report the disappearance of frogs, toads, flamingoes, otters, crabs and fish that they remember from their childhood years. The pollution has become so severe, and municipal responses so poor, that on three occasions the political party in charge of the province, the centre-right Democratic Alliance, served its own party's City Council with orders by the Green Scorpions, its environmental investigations directorate, to clean up or face arrests of senior executives responsible for pollution.³⁵

The impression created, wilfully or otherwise, is that the authors are hesitant to criticise City officials who have been responsible for the quality of sea water for more than the past decade. In the section on water quality and pollution, a 2012 study is cited, which found that

approximately 30% of the City of Cape Town's 49 coastal sampling points ... did not comply with intestinal Enterococci-based human health criteria for intermediate-contact recreation... [T]he ... highest levels of contamination [were] along the northern shoreline between Muizenberg and Strand, with localized contamination hot spots, such as Kalk Bay Harbor. The main sources of contamination comprised leaking sewers and contaminated stormwater, often from poorly serviced areas. (§3.2).

Struggles for municipal sanitation are not mentioned in the 'governance' section later in *Synthesis*. Attributing the problem to 'poorly serviced areas' displaces responsibility from the municipality to local areas.

Also not mentioned is that the City had kept seawater quality data secret from the public for several years, only releasing local results on demand to Ratepayer Associations subject to an individual's signature on a non-disclosure agreement. This has effectively impeded independent scientific verification of the results, and put civic-minded volunteers at risk of a lawsuit for doing their neighbourly duty. It was fallacious for the authors to claim in this 2019 article, as they do in the conclusion (§6.1.1), that 'Routine, publicly available in-situ measurements are currently recorded for wind, coastal temperature, rainfall, evaporation, river flow

and water quality indicators' (emphasis added). Coastal pollution figures were released finally in 2021, but only in rolling 12-month averages that may be useful for the purpose of marketing Cape Town as a tourist destination, but have virtually zero scientific value.⁵² Predictive modelling of coastal pollution is not available to the Cape Town public, contrary to international best practice on beach management.

It is difficult to understand why the authors do not note questions about the availability, usability or veracity of the seawater quality results provided by the City, given that both False Bay desalination plants were having difficulty functioning in the period during which this article was being developed (2018–2019), as per the data sourced from the City of Cape Town's website for the period May to November 2018 and provided as supplementary material. Further, in a widely publicised dispute announced in April 2019 and its subsequent mediation, one of the private desalination contractors (in Table Bay) indicated that its case against the City rested on incorrect seawater quality data that had been supplied, as their results indicated that seawater quality was up to 400% more polluted than the maximum indicated by the City's coastal management division. While that occurred in Table Bay and not False Bay, the questions about the veracity and unavailability of seawater quality data from the City are as relevant to the failure of the two desalination plants in False Bay whose records demonstrate lengthy 'downtime' in warmer months, and whose early closures, before contract end dates, were also subject to non-disclosure agreements. Given the unavailability to scientists of coastal water quality data paid for by the public, it is problematic, if not unethical, for one of the co-authors who is employed by the City in its coastal management division and who therefore has access to both the undisclosed data and the discussions about keeping them secret, to not have declared a conflict of interest in the publication. Additional data that were available to the City coastal management scientists on this team would have been available from the desalination plants at Monwabisi and Strandfontein during the period of the research, which would have provided unprecedented access to seawater quality on a daily basis: the quality of which was responsible for inoperability of the plants for substantial periods of time, particularly when waters had warmed. It is difficult to understand why data accessible to City scientists on this team that was focused on critical questions regarding False Bay seawater quality was not disclosed to this scientific community, nor to the public, and that its secrecy was not discussed. The South African Constitution guarantees freedom of information and freedom of scientific research, yet these guarantees were being actively undermined by officials within City Coastal Management at the time of writing the *Synthesis*, who later elected to make data available only in meaningless annual rolling averages.

Disconcerting questions also arise in §3.1.2, titled 'Nearshore nutrient distributions and terrestrial inputs'. The *Synthesis* omits research in False Bay by environmental chemists Cecilia Ojemaye and Leslie Petrik whose studies of chemicals of emerging concern in fish caught in False Bay were heavily contested by City officials on the grounds that the findings would "damage fishers' livelihoods"⁵³. The Ojemaye-Petrik paper was published in May 2019, with extensive media coverage, two months before the date given by the journal on which the final version of *Synthesis* was accepted. As *Synthesis* includes reports from 17 unpublished studies, and two of the co-researchers on Petrik's funded research team are co-authors on this paper, the exclusion of this research is difficult to attribute to oversight rather than choice.

Another surprising omission is the presence of the Capricorn Waste Dump and the Cape Flats Wastewater Treatment Works, neither of which receive focused mention although they abut the False Bay coast. *Synthesis* notes that metal concentrations are most pronounced between Muizenberg and Strand, precisely where these infrastructures are located. Research on contaminants in rivers flowing into Table Bay is excluded.⁵⁴

'Metal concentrations in False Bay are influenced by the meteorology of the area, coastal topography, geomorphology, and hydrodynamics', the author of this section asserts, followed by a sentence that is at best obfuscatory: 'These environmental factors' – the language renders them natural, not culpable – 'also influence the extent' – the grammar occludes

governance responsibilities or policy problems – ‘of metal contamination caused by anthropogenic activities’ – the word choice evades municipal urban planning decisions.

Passive grammars are discouraged in the empirical social sciences precisely because they elide causality and slip into tautology – as in this circular argument which contends that anthropogenic contaminants are explained by their being anthropogenic. The section writer concludes: ‘Recent research has confirmed that concentrations of metals such as cadmium, lead, and manganese in Western Cape marine ecosystems have increased since 1985 and are influenced by localized sources’ and concedes, further, that there is also ‘evidence of bioaccumulation of metals such as arsenic, molybdenum, cadmium, copper and zinc in mussels (*M. galloprovincialis*) in False Bay’^{2(p.10)}. Yet, against this evidence, the writers simply note that ‘Further research needs to focus on determining the source of contaminants to False Bay’, making no mention of the waste dump that has not sorted e-waste from household waste; nor mentioning the sewage treatment works that sit directly on the primary recharge zone of the Cape Flats aquifer which the *Synthesis* notes contributes vast quantities of water into the Bay; nor mentioning the plumes of dust from the Capricorn Waste Dump that cover the Cape Flats in southerly summer winds, or the northerly winds that disperse waste dump dust directly into the Bay in winter, or the leachate from the aboveground waste dump into a river that flows into the ocean after travelling mere metres from the raised landfill site.

These omissions of on-the-ground relations speak to problems of concept, method and approach that would be remedied by engagement with a range of methodological and conceptual insights from the social sciences and humanities.

In regard to methods: qualitative social sciences conducted by walking, talking and observing, have the potential to frame research questions that are not available to studies of cartographies, policy documents and species. Second, work such as that conducted by Eyal Weizman and colleagues under the rubric of ‘forensic architecture’⁵⁵, would surface ways in which movements of toxins affect publics; thus pollution studies warrant on-the-ground community engagement to identify gaps in official knowledge, and struggles over habitability⁵⁶.

In regard to concepts, the conceptualisation of space in terms of categories has evidently hindered the capacity to see material flows, because urban infrastructure (‘society’) is not conceptualised as part of the marine environment (‘nature’). Second, in the absence of attention to flows of mud, dust, and mist, there is an evident confusion of states of matter – solids, liquid, and gas – with matters of state. Environmental governance is compromised when its research is overly focused on the categorisation of natural states of land and water (sea, river, land) without adequate regard to flows of the in-between states of matter, such as colloids, dust and mist that traverse boundaries established for the purpose of governance. The very ungovernability of mobile, in-between states of matter is the reason for environmental struggles over contaminants.⁵⁷ Property boundaries, legal categorisations, states of matter, and landform types have all hindered the researchers’ ability to see linkages that are in plain sight – and evident to those who live in the area. Muddy boots are necessities for regional Anthropocene studies.

Ecosystems and biota of False Bay

This section of the *Synthesis* focuses on ecosystem types: estuaries; sandy beaches; rocky shores; and invasive species; birds; and megafauna (sharks, seals, and cetaceans). The fall in the numbers of breeding populations reported in the studies that are reviewed, is the canary-in-the-coalmine for the conditions of habitability in the Cape Town region, reflecting the wider experience of ‘the sixth great extinction’⁵⁸ that characterises the Anthropocene as one of the most destructive to biodiversity in our planet’s history. The overview is comprehensive and of vital importance. The question, implicitly, is how to build environmental citizenship in a country where the vast majority of citizens, for over a hundred years, have been cut off from land and ecology.

Research on fishers’ care for the ocean and marine species, offers routes to fostering fishers’ care for species. This is important given

that the fisheries quota allocations reduce the relation of fishers and species to the extraction of biomass. The struggles of Cape Flats communities to protect wetlands, rivers and aquifers, in Princess Vlei, Sandvlei and the Phillippi Horticultural Area, offer insights into the kinds of environmentalism that is emerging in communities that were dispossessed of ecological lives by the apartheid state.

Contemporary social science extinctions literature⁵⁹ provides much discussion on relations of care for the material flows around circles of human activity, and their impact on water⁶⁰, and on soil⁶¹. Anna Tsing et al.’s *Arts of Living on a Damaged Planet*⁶² yields a rich vein of enquiry in relationships with species, building on Tsing’s earlier work on ‘multi-species relations’ as a sub-field of environmental anthropology⁶³. Literatures on loss of species engage the affective dimensions of living in the age of extinctions, exploration of which opens up possibilities for building public cultures of empathy and fellow-feeling for animals.⁶⁴ Feminist ecopolitics offers strategies for care that differ from the implied requirement for relations of command-and-control between sciences and publics; this thinking informs, for example, the ‘WaterStories’ website that offers publics strategies for living with care for the seas, rivers and vleis of Cape Town.⁶⁵

Shared by all these approaches is a refiguring of the theory of the human in which people constitute a class of beings that live *de facto* against nature. Building an ecological politics in Cape Town based on care for species, refigures the theory of the human and offers transformative and generative routes to reconnecting people with ecology – and planet.

The human dimension of False Bay

‘Human dimensions of False Bay’ is the focus of the fourth part of the *Synthesis*, and it reflects many years of work in the fisheries justice sector led by Merle Sowman⁶⁶ and, more recently, Serge Raemakers⁶⁷. The section offers an overview of policies and laws and protocols for fisheries governance, and appropriately points out the difficulties of environmental governance when the Bay is not under a single authority. It then notes various initiatives for enforcement, and lists actors in civil society. Nonetheless, while the focus of work in fisheries management has been on the issue of governance, the paradigm that holds there to be a ‘social system’ that constitutes a ‘human dimension’ of a ‘social-ecological system’ presents significant difficulties for social scientists to come aboard as a partner in environmental governance science projects. Environmental social science and humanities approaches do not work with ‘systems theory’ because ‘social systems’ are ideals rather than practices that are empirically observable. For that reason, research on ‘social systems’ is rarely a focus in qualitative social science journals. Social-ecological systems theory, with its focus on idealised governance and organisational systems, makes it difficult to bring into view the politics of dissent that affect False Bay such as the ongoing struggle of ratepayers against sewage malfunctions in Zandvliet and Kuils River, for example. Social-ecological systems approaches also fail to bring into view the role of engineering, design and infrastructure, or encompass their material flows – as is evidenced in the *Synthesis* where discussion on infrastructure in False Bay is missing in action.

The section on ‘Education and awareness’ focuses exclusively on the education of tourists via ecotourism and elite sports in formerly white areas where higher property prices are ‘generating income in the real estate and financial sectors’^{2(p.28)}. Excluded are environmental advocacy groups that are active in the areas that the apartheid state designated for ‘Blacks’ and ‘Coloureds’ on the Cape Flats. Scholarship on the lack of sanitation in Khayelitsha in critical social sciences and urban studies literature⁶³, and the well-publicised struggles of communities along the Kuils River downstream of the Zandvliet Wastewater Treatment Works, are also absent although they directly affect water quality in False Bay⁴⁰.

The section on ‘Human-wildlife conflicts’ identifies the entanglement of cetaceans in fishing gear, antagonism between fishers and seals over catches, and shark attacks. The advice offered here, viz ‘reducing the spatial overlap in time and space’^{2(p.30)} between animals and people is surprising given that this is an urban bay, and that encouraging care for species implies greater awareness – and therefore more exposure to

different species. The absence of critique of the human-wildlife conflicts paradigm is inexplicable given the presumption that the human-wildlife conflicts approach constructs as 'normal' a conflictual relationship between animals and people, and it relies on maintaining the paradigm of 'war' that it claims to identify and mediate.⁶⁸ This anthropocentric account of wildlife conflicts would benefit from engagement with equivalent work in the environmental humanities, in several respects. Non-behaviourist approaches attend to animal experience of their bodily presence in the world. The award-winning work of ethological philosopher Vinciane Despret, for example, discusses the importance of reframing animal studies via attention to animals' experiences and responses.⁶⁹ With that approach, questions arise as to whether contamination in False Bay may have contributed to the disappearance of several hundred great white sharks, particularly given that these apex predators evidenced high levels of bioaccumulated pollutants in a 2016 study in a nearby bay.⁷⁰

Finally: a theory of marine governance based on desire for habitability and safety undergirds the work led by *Synthesis* co-author Serge Raemakers in the Abalobi project.⁶⁷ The approach, co-developed with fishers, remains one of the most promising co-management initiatives in South Africa. An approach to environmental governance that is based on the work of Abalobi in respect of fishers' desire for habitability, is likely to be far more effective in building a people's environmentalism than a theory of environmental governance based on control that allies scientists with state violence, against the people, in the name of 'getting compliance with science' through one-way education and policing. That the latter approach to environmental sustainability is politically unsustainable, is amply demonstrated in the recent history of South African fisheries governance.

Conclusion: A paradigm refresh

What would a 'paradigm refresh' look like, that accounts for False Bay's Anthropocene? The aforementioned discussion has suggested a number of approaches that may yield a more generative discussion between the social and natural sciences on environmental governance research than the approaches represented in the *Synthesis*.

First, the material flows between the fields categorised as 'nature' and 'society' is suggested as an alternative empirical base for integrative transdisciplinary research, building on emergent transdisciplinary fields including industrial ecology, biogeochemical sciences, circular economics, urban ecology, and critical zone scholarship.

Second, a humanities-informed conversation in South African scholarship invites discussion as to where, whether and how the conceptual categories of nature and society remain empirically useful, given the evidence in Anthropocene stratigraphy that human living is terra-forming.

Third, humanities scholarship on reading evidence is necessary for scholarly reviews of data sets and published scientific literature, as it provides an approach that encompasses contexts of production of knowledge, and attends the question of how particular concerns – and lacunae – take form.

Fourth, the theorisation of the social via terms like 'social systems' and 'ecosystem services' in the social-ecological approaches represented in the review, constitutes a barrier for social scientists to take up invitations to research partnerships. So too, the theorisation of the human as inherently at war with nature, is a flawed diagnostic that derives from a specific ideological context, not from nature itself. To theorise South Africans' environmentalism or lack thereof, the place to begin is the history of land dispossession. Research and policy that is primarily oriented towards servicing elite sports and high-value tourism will never build the broad-based environmental public that will care for the waters, shorelines and species of False Bay. A research paradigm based on material flows at the marine urban edge, closely tied to environmental justice amid the ongoing harms of apartheid design and infrastructure, offers a viable basis for transdisciplinary research in the Anthropocene. Linking the multiple material-flows-based approaches to integrative scholarship that have emerged in the equivalent period that is under discussion in the 30-year *Synthesis*, would link current advances in biogeosciences to encompass material flows including those emanating from human activity. A 'bio-geo-social science' or 'material humanities'

or 'critical zone social science' could be names for a new field that spans these multiple transdisciplinaries; as too might the term proposed by Viveiros de Castro: 'Anthropocenography' – in which the noun is neither science nor humanities. Whatever its name, research endeavours that link emerging transdisciplinary attention to flows in and through geologies, bodies, infrastructures, water and atmosphere, would offer a gathering space for natural and social sciences, engineering, public health, law and economics, in dialogue with the humanities and its specialist skills in the production of knowledge, concepts and narrative.⁷¹

An integrative biogeosocial science of Anthropocene harms will be keenly attentive to the risks attending knowledge production in the era of market-driven science, including the kind of science communication that obscures coastal contamination data in order to market a city as a destination for tourism. Fearless science brings with it the willingness to see beyond that which is already agreed and within view, and does not balk at causing offence to the powerful, or to 'the market'. For this reason it is as crucial for the environmental governance sciences of our time to extricate their structures from tourism marketing concerns, as it was for the founders of the sciences to extricate their practices from the Church in the 1600s. To unmake the Anthropocene we need courageous sciences that address the harms that damage our planet: whether these harms come via infrastructures protected by powerful interests, or via market forces, or Constitution-violating foreclosures of access to information about contamination.

Bio-geo-social environmental governance scholarship will recognise that the building of an environmental public across all sectors of South African society requires acknowledgement that black South Africans have suffered generations of trauma from apartheid and colonial policies that cut off their access to land and ecology. This historical reality requires engagement from environmental sciences across the board if a broad-based environmental public is to be built. From a close research engagement with community organisations and the challenges that they face, a scholarly grounding in lived ecologies will emerge.

Finally: while this critique has focused on the review of research on a single bay offered by a cohort of 32 natural scientists, the invitation to contemporary social scientists in South Africa is implicit, and urgent. Both 'calling in' and 'calling out' are transformational tools. Our work warrants more than a default to the exposé, if we are to build generative engagements with allies in the natural sciences with whom we dissent. Simultaneously, the invitation to natural scientists is to engage deeply with emerging environmental social sciences and humanities literatures in pursuit of habitability amid the planetary challenges that are already with us – and those to come.

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Competing interests

I have no competing interests to declare.

References

1. Fordred L. Natal cockroaches fly: Khaba Mkhize and communitarian journalism in KwaZulu/Natal, South Africa. In: Marcus G, editor. Cultural producers in perilous states: Editing events, documenting change. Chicago, IL: Chicago University Press; 1997. p. 23–54.



2. Pfaff MC, Logston RC, Raemakers SJPN, Hermes JC, Blamey LK, Cawthra HC, et al. A synthesis of three decades of socio-ecological change in False Bay, South Africa: Setting the scene for multidisciplinary research and management. *Elementa*. 2019;32:1–49. <http://doi.org/10.1525/elementa.367>
3. Riemann K. World water quality alliance African use case study Cape Town aquifers deliverable 5: Summary report. Geneva: United Nations Environment Programme; 2022. Available from: <https://wedocs.unep.org/bitstream/handle/20.500.11822/36934/WWQA.pdf>
4. Fukuyama F. What is governance? *Governance*. 2013;26(3):347–368. <https://doi.org/10.1111/gove.12035>
5. Viveiros de Castro E. Anthropocenography: On the coming cosmopolitical war. Sawyer Seminar, Davis, CA: University of California, Davis; 2014. Available from: <http://www.geocritique.org/eduardo-viveiros-de-castro-ant>
6. Descartes R. Discourse on method, optics, geometry and meteorology. Indianapolis, IN: Hackett Classics; 2001.
7. Zalasiewicz J, Williams M, Haywood A, Ellis M. The Anthropocene: A new epoch of geological time? *Philos Trans R Soc Lond A*. 2011;369(1938):835–841.
8. Steffen W. The Anthropocene. In: Robin L, Sörlin S, Warde P, editors. *The future of nature: Documents of global change*. New Haven, CT: Yale University Press; 2013. p. 486. <https://doi.org/10.1558/jsrc.v10i4.31456>
9. Crutzen PJ, Stoermer EF. The 'Anthropocene'. *IGBP Newsletter*. 2000(May);41:17–18. Available from: <http://www.igbp.net/download/18.316f18321323470177580001401/1376383088452/NL41.pdf>
10. Schlesinger WH. Introduction to Volume 8. In: Holland HD, Turekian KK, editors. *Treatise on geochemistry*. Oxford: Pergamon; 2003. p. xv–xix. <https://doi.org/10.1016/B0-08-043751-6/08189-5>
11. Banwart SA, Chorover J, Gaillardet J, Sparks D, White T, Anderson S, et al. Sustaining earth's critical zone: Basic science and interdisciplinary solutions for global challenges. Sheffield: University of Sheffield; 2013.
12. Minor J, Pearl JK, Barnes ML, Colella TR, Murphy PC, Mann S, et al. Critical zone science in the Anthropocene: Opportunities for biogeographic and ecological theory and praxis to drive earth science integration. *Prog Phys Geogr*. 2019;44(1):50–69. <https://doi.org/10.1177/0309133319864268>
13. Ross A, Chang H. Socio-hydrology with hydrosocial theory: Two sides of the same coin? *J Hydrol Sci*. 2020;65(9):1443–1457. <https://doi.org/10.1080/02626667.2020.1761023>
14. Ellis EC. Anthromes. In: Goldstein MI, DellaSala DA, editors. *Encyclopedia of the world's biomes*. Amsterdam: Elsevier; 2020. p. 5–11.
15. Kapur A, Graedel TE. Industrial ecology. In: Cleveland CJ, editor. *Encyclopedia of energy*. Amsterdam: Elsevier; 2004. p. 373–382. <https://doi.org/10.1016/B0-12-176480-X/00533-7>
16. Kennedy C, Cuddihy J, Engel-Yan J. The changing metabolism of cities. *J Ind Ecol*. 2007;11(2):43–59. <https://doi.org/10.1162/jie.2007.1107>
17. Wachsmuth D. Three ecologies: Urban metabolism and the society-nature opposition. *Sociol Q*. 2012;53(4):506–523. <https://doi.org/10.1111/j.1533-8525.2012.01247.x>
18. Ernstson H, Sörlin S, editors. *Grounding urban natures: Histories and futures of urban ecologies*. Cambridge, MA: MIT Press; 2019.
19. Zalasiewicz J, Williams M, Waters CN, Barnosky AD, Palmesino J, Ronnskog A-S, et al. Scale and diversity of the physical technosphere: A geological perspective. *Anthr Rev*. 2016;4(1):22–29. <https://doi.org/10.1177/2053019616677743>
20. Parikka J. *A geology of media*. Minneapolis, MN: University of Minnesota Press; 2015.
21. Moore J, editor. *Anthropocene or Capitalocene?* Oakland, CA: Kairos Press; 2016.
22. Haraway D. Anthropocene, Capitalocene, Plantationocene, Chthulucene: Making kin. *Environ Humanities*. 2015;6(1):159–165. <https://doi.org/10.1215/22011919-3615934>
23. Gamble CN, Hanan JS, Nail T. What is New Materialism? *Angelaki*. 2019;24(6):111–134. <https://doi.org/10.1080/0969725X.2019.1684704>
24. Chakraborty J, Collins TW, Grineski SE. Environmental justice research: Contemporary issues and emerging topics. *Int J Environ Res Public Health*. 2016;13(11):1072. <https://doi.org/10.3390/ijerph13111072>
25. Nixon R. *Slow violence and the environmentalism of the poor*. Cambridge, MA: Harvard University Press; 2013.
26. Buscher B, Fletcher R. *The conservation revolution: Radical ideas for saving nature beyond the Anthropocene*. New York: Verso; 2021.
27. Mbembe A. *Necropolitics*. Durham, NC: Duke University Press; 2019.
28. Cavanagh CJ, Himmelfarb D. 'Much in blood and money': Necropolitical ecology on the margins of the Uganda protectorate. *Antipode*. 2015;47(1):55–73.
29. Weizman E. *Forensic architecture: Violence at the threshold of detectability*. Princeton, NJ: Princeton University Press; 2017.
30. Ferdinand M. *Decolonial ecology: Thinking from the Caribbean world*. Trans. Anthony Paul Smith. Cambridge, UK: Polity; 2022.
31. Yusoff K. *A billion black Anthropocenes or none*. Minneapolis, MN: Minnesota University Press; 2019.
32. Stiegler B. *The Neganthropocene*. Trans. Daniel Ross. London: Open Humanities Press; 2018.
33. Jackson S, Robins S. Making sense of the politics of sanitation in Cape Town. *Soc Dyn*. 2018;44(1):69–87. <https://doi.org/10.1080/02533952.2018.1437879>
34. Philippi Horticultural Area Food & Farming Campaign v MEC for Local Government, Environmental Affairs and Development Planning: Western Cape and others (16779/17). High Court of South Africa – Western Cape Division; 17 February 2020.
35. Kretzmann S. Province raps City's knuckles over state of rivers: Water quality results 'disturbing' says MEC. *GroundUp*. 20 February 2020. Available from: <https://www.groundup.org.za/article/province-raps-citys-knuckles-over-state-rivers/>
36. Battersby J. Urban food insecurity in Cape Town, South Africa: An alternative approach to food access. *Dev South Afr*. 2011;28(4):545–561. <https://doi.org/10.1080/0376835X.2011.605572>
37. Peyton S, Moseley W, Battersby J. Implications of supermarket expansion on urban food security in Cape Town, South Africa. *Afr Geogr Rev*. 2015;34(1):36–54. <https://doi.org/10.1080/19376812.2014.1003307>
38. Jensen S. The security and development nexus in Cape Town: War on gangs, counterinsurgency and citizenship. *Secur Dialogue*. 2010;41(1):77–97. <https://doi.org/10.1177/0967010609357038>
39. De Greef K, Abader S. *Poacher: Confessions from the abalone underworld*. Johannesburg: Kwela Books; 2018.
40. Green L, Solomon N, Barnes J, Petrik L. Environmental management needs to be democratised. *Daily Maverick*. 6 March 2019. Available from: <https://www.dailymaverick.co.za/article/2019-03-06-environmental-management-needs-to-be-democratised/>
41. Sullivan S. The natural capital myth; or, will accounting save the world? Preliminary thoughts on nature, finance and values. *Leverhulme Centre for the Study of Value Working Papers #3* [document on the Internet]. c2014 [cited . Available from: <http://thestudyofvalue.org/wp-content/uploads/2013/11/WP3-Sullivan-2014-Natural-Capital-Myth.pdf>
42. Sullivan S. Banking nature? The spectacular financialisation of environmental conservation. *Antipod*. 2013;45(1):198–217. <https://doi.org/10.1111/j.1467-8330.2012.00989.x>
43. Martin YE, Johnson EA. Biogeosciences survey: Studying interactions of the biosphere with the lithosphere, hydrosphere and atmosphere. *Prog Phys Geogr*. 2012;36(6):833–852. <https://doi.org/10.1177/0309133312457107>
44. Haff PK. Neogeomorphology, prediction, and the anthropic landscape. In: Wilcock PR, Iverson RM, editors. *Prediction in geomorphology*. Volume 135. Washington DC: American Geophysical Union; 2003. <https://doi.org/10.1029/135GM02>
45. Szerszynski B. Colloidal social theory: Thinking about material animacy and sociality beyond solids and fluids. *Theory Cult Soc*. 2021;39(2):131–151. <https://doi.org/10.1177/02632764211030989>
46. Cartwright A, Brundrit G, Fairhurst L. Final report: Sea-level rise adaptation and risk mitigation measures for the City of Cape Town. Proposal number: R030800032. Prepared for: The City of Cape Town Environmental Resource Management Department by Laqua Consultants. Unpublished report; July 2008.
47. Orff K. *Toward an urban ecology*. New York: Monacelli Press; 2016.



48. Swartz CD, Genthe B, Chamier J, Petrik LF, Tijani JO, Adeleye A, et al. Emerging contaminants in wastewater treated for direct potable re-use: The human health risk priorities in South Africa. Volume III: Occurrence, fate, removal and health risk assessment of chemicals of emerging concern in reclaimed water for potable reuse. WRC report TT 742/3/18. Pretoria: Water Research Commission; 2018.
49. Clark N, Szerszynski B. Planetary social thought: The Anthropocene challenge to the social sciences. Cambridge, UK: Polity Press; 2021.
50. Nail T. Theory of the earth. Redwood City, CA: Stanford University Press; 2021.
51. United Nations Environment Programme (UNEP). Stockholm Convention on persistent organic pollutants. Geneva: UNEP; 2019. Available from: <http://www.pops.int/TheConvention/Overview/TextoftheConvention/tabid/2232/Default.aspx>
52. City of Cape Town. Know your coast, 2020. City of Cape Town; 2020. Available from: https://resource.capetown.gov.za/documentcentre/Documents/City%20research%20reports%20and%20review/Know_Your_Coast_2020.pdf
53. Ojemaye CY, Petrik L. Occurrences, levels and risk assessment studies of emerging pollutants (pharmaceuticals, perfluoroalkyl and endocrine disrupting compounds) in fish samples from Kalk Bay harbour, South Africa. *Environ Pollut*. 2019;252A:562–572. <https://doi.org/10.1016/j.envpol.2019.05.091>
54. Daso AP, Fatoki OS, Odendaal JP. Polybrominated diphenyl ethers (PBDEs) and hexabromobiphenyl in sediments of the Diep and Kuils Rivers in South Africa. *Int J Sediment Res*. 2016;31(1):61–70. <https://doi.org/10.1016/j.ijsrc.2013.10.001>
55. Weizman E. Forensic architecture: Violence at the threshold of detectability. Princeton, NJ: Princeton University Press; 2017.
56. Agyeman J, Schlosberg D, Craven L, Matthews C. Trends and directions in environmental justice: From inequity to everyday life, community, and just sustainabilities. *Annu Rev Environ Resour*. 2016;41(1):321–340. <https://doi.org/10.1146/annurev-environ-110615-090052>
57. Bremner L. Sedimentary ways. *GeoHumanities*. 2021;7(1):24–43. <https://doi.org/10.1080/2373566X.2020.1799718>
58. Kolbert E. The sixth extinction: An unnatural history. New York: Henry Holt and Company; 2014.
59. Garlick B, Symons K. Geographies of extinction: Exploring the spatiotemporal relations of species death. *Environ Humanities*. 2020;12(1):296–320. <https://doi.org/10.1215/22011919-8142374>
60. Neimanis A. Bodies of water: Posthuman feminist phenomenology. London: Bloomsbury Academic; 2016.
61. Puig de la Bellacasa M. Matters of care: Speculative ethics in more than human worlds. Minneapolis, MN: University of Minnesota Press; 2017.
62. Tsing A, Swanson HA, Gan E, Bubandt N. Arts of living on a damaged planet. Ghosts of the Anthropocene; Monsters of the Anthropocene. Minneapolis, MN: University of Minnesota Press; 2017.
63. Tsing A. More-than-human sociality: A call for critical description. In: Hastrup K, editor. *Anthropology and nature*. London: Routledge; 2013. p. 27–42.
64. Van Dooren T, Rose DB. Storied-places in a multispecies city. *Humanimalia*. 2012;3(2):1–27.
65. Water Stories. Cape Town [homepage on the Internet]. No date [cited 2022 Oct 04]. Available from: www.waterstories.co.za
66. Sowman M, Raemaekers R, Sunde J. Shifting gear: A new governance framework for small-scale fisheries in South Africa. In: Sowman M, Wynberg R, editors. *Governance for justice and environmental sustainability: Lessons across natural resource sectors in sub-Saharan Africa*. London: Earthscan; 2014. <https://doi.org/10.4324/9780203120880-10>
67. Raemaekers S. 'Storied' seafood and community-led technology. TEDx Talks [video]. 23 January 2018. Available from: <https://www.youtube.com/watch?v=dArh0EfNbwY>
68. Green L. Rock water life. Durham, NC: Duke University Press; 2020.
69. Despret V. What would animals say if we asked them the right questions? Trans. Brett Buchanan. Minneapolis, MN: Minnesota University Press; 2016.
70. Marsili L, Coppola D, Giannetti M, Casini S, Fossi MC, Van Wyk JH, et al. Skin biopsies as a sensitive non-lethal technique for the ecotoxicological studies of great white shark (*Carcharodon carcharias*) sampled in South Africa. *Expert Opin Environ Biol*. 2016;4:1. <http://dx.doi.org/10.4172/2325-9655.1000126>
71. Latour B, Weibel P. Critical zones: The science and politics of landing on earth. Cambridge, MA: MIT Press; 2020.