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# Sustainability science engagement and engaged sustainability science

## Introduction

The South African *Science, Technology and Innovation Decadal Plan (2022–2032)*<sup>1</sup> shows a strong commitment to *science engagement*, with most references referring to the communication of science. This plan builds on the 2015 Department of Science and Innovation (DSI)'s *Engaged Science Strategy*<sup>2</sup>, which notes that engaged science approaches are as yet underdeveloped in South Africa. The Decadal Plan<sup>1</sup> explicitly relates science engagement to the need for more inter- and transdisciplinary approaches to science, with mention of greater inclusion of stakeholders in defining the needs and objectives for research, but without clear insight into how this is to be done or supported. More in-depth approaches and understanding may be needed to adequately bridge the science-society gap, including in and through the educational sphere. This special issue of the *South African Journal of Science* addresses this through joining the DSI conversation on science engagement<sup>1,2</sup>, by juxtaposing science engagement with engaged science.

Science engagement typically draws attention to public engagement with science<sup>2</sup>, and may easily be misunderstood as a simple activity of communicating scientific findings to publics once the scientific process is complete. This is most visible in the dominance of the concepts of 'science communication' and 'dissemination' in the science arena. However, as can be seen from the discourse in the Decadal Plan<sup>1</sup>, and across contributions and deliberations in this special issue, *science engagement* takes different forms, reaching far beyond one-way communication approaches between scientists and publics, and encompassing a range of concepts such as inter- and transdisciplinary science, knowledge co-production, place-based research and learning, citizen science and responsible research and innovation, amongst others. These concepts bring processes of *engaged science* into focus, and raise questions on how the sciences are promoting active involvement of publics in scientific knowledge (co)production, how this may influence science, communication, action and practices, and, in the process, challenge and reframe narrow views of science engagement. This conversation is not insignificant given calls to decolonise scientific practice in South Africa, to re-think human-nature relations in and through research, and to demonstrate a more visible impact of research in policy and practice arenas. Through such a conversation, we may potentially also contribute to rethinking, or at least broadening, the notion of science impact itself.

Viewed in relation to the complex, wicked problems<sup>3</sup> that are typically dealt with by the sustainability sciences (e.g. climate change, water insecurity, landscape change and governance), Grove and Pickett<sup>4(p.7)</sup> argue that inter- and transdisciplinary sciences require more durable science platforms that can address the spatial-temporal and ethical challenges of the social-ecological crisis, which simultaneously manifest as "immediate crises and emergencies over days and weeks; to sudden events over months and years; to extensive, pervasive, and subtle changes occurring over decades" at different levels and scales of society with differing impacts. However, we do not only need more durable science platforms. The process of scientific knowledge production itself needs to be revised in relation to affected publics and the more-than-human world, challenging the often taken-for-granted established role of higher education and research in society. This is beautifully pointed out in the book review by Du Preez, which opens the special issue.

Contributions in this issue draw on a range of disciplines and publics generating co-engaged knowledge that advances understanding of '*Sustainability science engagement and engaged sustainability science*', with emphasis on the relationship between these. In particular, the research articles in this special issue bring together selected contributions from a National Research Foundation (NRF) / Department of Science and Innovation (DSI) Community of Practice (CoP) involving 11 Research Chairs working in the sustainability sciences in and across natural and social science disciplines. The core interest of the CoP was to develop theory and practice at the interface of sustainability science, policy and practice. Each Chair worked with a network of partners (academia, state, civil society, private sector), with other chairs, and with a vibrant network of early career researchers, the configurations of which are reflected in the co-authorships in the special issue. The issue also includes invited commentaries and book reviews which complement and expand the focus and content of the special issue. As such, the special issue joins the broader conversation emerging in the South African science community on science engagement introduced above.

## Wicked sustainability problems, engaged science and science engagement

All the contributions (articles, commentaries and book reviews) in this special issue demonstrate that the sustainability sciences are embracing the in-between space that exists between the concepts of 'science engagement' and 'engaged science', thereby clarifying both. The research papers show that sustainability scientists from a variety of disciplines are explicitly engaged with development of citizen sciences, and inter- and transdisciplinary approaches to knowledge (co)production, as they engage the complexity of 'wicked problems'<sup>3</sup> that characterise human-environment crises, such as climate change, water insecurity and pollution, landscape change and biodiversity loss, or the condition of 'hot messes' referred to by McGarry et al. As said by McGarry et al. and Du Preez, these can be traced back to the privileged irresponsibility that contributed to coloniality and ecological damage.

In response, papers by Mickelsson et al., Odume et al. and Nqowana et al. consider the potential of citizen engagement in addressing the ubiquitous challenges of water pollution and quality in South Africa. The paper by Nqowana et al. and the commentary by Graham et al. argue that citizen science tool innovations, if socially



conceptualised in collaboration with communities, and if combined with transformative learning approaches, can expand capabilities for engaged science and more inclusive water governance. Odume et al. argue for giving attention to competing interests and motives in such initiatives. Providing a wider perspective on this, Mickelsson et al. say that, “Life in river systems is increasingly dependent on human actions that bring river health into being”, pointing out that citizen science, practised as engaged sustainability science, is a form of sustainability practice that can heal damaged human-environment relations.

With a wider landscape lens on engaged science, the paper by Shackleton et al. focuses on landscape and catchment management. It reports on development of approaches to collaborative management in complex catchments, while the paper by Ivey et al. focuses on collaboration in bioremediation of invasive plants in complex landscapes. The authors of both papers argue for giving detailed attention to how communities of practice are formed and how they work together in landscapes, offering guidance to researchers seeking to engage in similar forms of collaboration. The commentaries by Palmer and Tanner, and Kuse et al. add impetus to their arguments for investing time and resources in transformative social learning and adaptive systemic approaches for advancing both science engagement and engaged science in catchments and landscapes. The paper by Rosenberg et al., located in a biosphere reserve context, argues that explicit evaluative reflections on such processes can ensure that transformative concepts translate into transformative practices.

As shown in these contributions, dealing with ‘wicked problems’ in the contexts of pollution, degradation and sustainability landscapes in co-engaged ways, demands new methods for scientific practice and science engagement. All of the papers in the issue show that more complex configurations of participatory methods are emerging as scientists seek to engage societal actors in the investigation and resolution of complex problems. The papers show that the development of methods such as forming transdisciplinary communities of practice (Shackleton et al., Ivey et al., Mickelsson et al.), place-based transgressive learning as open-ended inquiry (Lotz-Sisitka et al.), co-defining theories of change (Rosenberg et al.), emic ways of approaching complex systems analysis (Mbatha), adaptive systemic approaches to catchment management (Palmer et al.), and place-based co-management and livelihoods co-construction (Kuse et al., Mubangizi), are offering some ways forward for engaging such wicked problems through inter- and transdisciplinary science practised as engaged science.<sup>5</sup> In their commentary, Van Breda and Treffry-Goatley talk of ‘methodological agility’ which “helps researchers to switch between disciplinary approaches, avoid instrumentalism, and address the ‘legitimation crisis’... – the erosion of confidence in scientific processes”. They argue that such ‘methodological agility’ is “crucial in building legitimacy through co-constructing just and sustainable pathways” – a point emphasised also in the book review by Vogel, who reflects on methodological approaches that are ‘quantum informed’ in the sense that they require “beliefs, relationships, metaphors, entanglement consciousness and agency”. The book review of *Agency and Transformation* by Hammond draws attention to the detailed research being undertaken internationally to both conceptualise and analyse the emergence of transformative agency, while the book review by Ncube draws attention to wider global justice concerns and the politics of achieving climate justice. The care taken to elaborate these methods, and their theoretical and practical dimensions in this special issue, helps to further develop the academic, political and contextual rigour associated with science engagement and engaged science.

## Conceptual, philosophical and contextual dynamics

Contributions in this special issue address the relationship between inter- and transdisciplinary research and potentially transformative science and education, which at present is under-developed as science engagement and engaged science praxis. Pennington et al.<sup>6(p.564)</sup> note that,

... potentially transformative research depends on the existence of an interesting and worthwhile problem to which participants can contribute in

salient ways, human and material foundations within disciplines, collaborative mutualism across disciplines, and a transformative learning process that enables knowledge integration across diverse perspectives.

As such, the papers in the special issue bring *relational approaches* into focus as a philosophical dynamic of sustainability science engagement and engaged sustainability science. Not only are new methods needed, but there is a need to engage with conceptual, philosophical and contextual dynamics, particularly a shift from dualism between ‘objectivity’ and ‘subjectivity’ towards intersubjective and interspecies relations.

All the papers focus on human-environment relations as a foundational premise of sustainability sciences, but there are some nuances associated with these relations. The paper by Mickelsson et al. and the Nqowana et al. paper show clearly that microorganisms in rainwater tanks and rivers affect the health and well-being of communities and other life forms – a relationship that can be detected through citizen science technology innovations. Both papers give attention to the microbial world and its relations to the human world – not as separate entities, but as interrelated. The book review by Du Preez and commentary by McGarry et al. take this line of thinking further to embrace the post-human concept of human-environment relational assemblages.<sup>7</sup> McGarry et al. provocatively point to the need for new “organs of perception” if we are to fully embrace interspecies relations and reduce the dominance of humans as the central figure in sustainability science.

The papers by Shackleton et al. and Ivey et al. both point to the work needed to establish collaborative relations in dealing with complex sustainability concerns in landscapes, with emphasis on the formation of communities of practice constituted by multi-actor groups, not all of whom share the same experience or background. Odume et al. point out that, in the context of the Upper Vaal catchment, water regulation and management has become a contested space between resource users and regulators. Odume et al.’s research points to scientific credibility in the methods for deriving water quality standards as an important mediator of such contestation, along with the need to build trust within the regulatory system. In the place-based learning contexts referred to in the Lotz-Sisitka et al. paper, which gives credence to local and Indigenous knowledge practices, people’s cultural histories and regenerative place-based relations, and epistemic justice were found to be equally important to sustainability transformations. Mbatha’s commentary points to finding new language and metaphors for perceiving relationality in African human-environment contexts – a point also made by Mubangizi in her argument for place-based approaches to engaged science. McGarry et al. point to a radical transformation of metaphors and frames of reference, charting instead a slow relational ecology of science praxis.

## An emphasis on learning, education and skills development

As can be seen from the above, in the NRF/DSI CoP, researchers focused on three complex or ‘wicked’ problems in South Africa, broadly framed as clean water, climate action, and landscape management and governance. Additionally, we sought to develop an understanding of transdisciplinary science approaches which includes an explicit focus on decolonial, place-based approaches to developing transdisciplinary science in South Africa. To cement the longevity impact of such innovations, the importance of *learning and education system* transformations surfaced.

The relationship between engaged science, learning and sustainability is highlighted in all the papers in this special issue, but is substantively engaged in the papers by Olvitt et al., Shackleton et al., Lotz-Sisitka et al., and Rosenberg et al. As indicated above, this requires conceptualising and advancing forms of engaged science that can be co-developed by and with a diversity of publics, and that advance mutual learning, as evidenced by Nqowana et al.

A focus on learning itself would have limited value in the longer term, if not conceptualised and practised as education system transformations that can strengthen science engagement and engaged science in sustainability transitions. Education system practices can be catalytic of

wider forms of learning for sustainability if also transformed.<sup>8</sup> Papers by Olvitt et al., Ramsarup et al., and Rosenberg et al. all explicitly discuss changes necessary in curriculum and skills system development to strengthen sustainability science engagement in practice. Olvitt et al. articulate principles guiding transdisciplinary curriculum design, while Ramsarup et al. indicate that dominant market-led logics of supply and demand are contradictory in framing skills research for just transitioning to sustainability. Additionally, the book review by Mandikonza urges scientists to give careful attention to ways of engaging with teachers on sustainability concerns that can advance transformative learning and pedagogy in the schooling sector.

## Institutional support and development

A final thread running across the papers in the special issue is a call for stronger institutional support for transdisciplinary science advancement, engaged science and science engagement. Such support is needed, not only for funding the co-engaged forms of inter- and transdisciplinary science presented in the special issue, but also for the education, training and research practice shifts that are needed.

In this special issue, Hackmann and Van Jaarsveld comment on efforts to create a more sustainable funding landscape for transdisciplinary sciences, while Rosenberg et al. draw attention to the evaluation of science engagement interventions as learning processes, and Van Breda and Treffry-Goatley and McGarry et al., amongst others, comment on the ethics of research. While transdisciplinary sciences are making progress with advancing the intensity of practitioner involvement in science, they may fall short in realising empowerment – a point addressed in the papers by Shackleton et al., Nqowana et al. and Lotz-Sisitka et al., amongst others. Furthermore, researchers in this special issue draw attention to the shifts in institutional approaches needed to embrace decolonial, place-based approaches that fully engage local epistemologies, languages and ontologies, calling for a deeper commitment to the ontological and epistemological foundations of transdisciplinary forms of engaged science (e.g. Lotz-Sisitka et al., Mbatha, Mubangizi, McGarry et al., Van Breda and Treffry-Goatley, Vogel). Those working in education draw attention to institutional support required for curriculum and skills system innovation – an issue addressed in the contributions by Rosenberg et al., Ramsarup et al., Olvitt et al., Allais and Mandikonza.

Overall, the special issue shows that the role of transdisciplinary and decolonial sciences, transformative learning approaches, and sustainability transitioning through engaged science needs improved articulation in relation to calls for university education and the education system more broadly to better serve the public and common good. However, as said by Allais in her commentary, the education system cannot make the transition on its own. For this, wider policy, societal, and economic transformations are needed, as also pointed out in the book reviews by Du Preez and Ncube.

## Conclusion

As shown across the papers, commentaries and book reviews, this special issue gives attention to science engagement and engaged science processes and their clarification, and also to the specific methods and methodological, conceptual and contextual premises necessary to advance sustainability science and society relations.

The special issue demonstrates a growing experience among South African sustainability scientists and practitioners of science engagement and engaged science approaches. It surfaces temporality questions related to the tensions experienced around short-term projects and an expressed need for longer-term, more durable science platforms for sustainability sciences to address diverse types of complex, wicked problems. It also surfaces spatial questions in relation to place-based concerns, and bounded landscape-level relational science engagements. It furthermore deepens methodological, epistemological and ontological deliberations on science engagement and engaged science.

Overall, the special issue contributions, with their diversity of perspectives, help to more substantively elaborate the full meaning of ‘transformative science for and with society’, including in and through educational interventions that can advance engaged science, and science engagement.

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