

3 Putting responsible research and innovation into practice at a local level in South Africa

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Introduction

In a small volume entitled *Science and Survival*, published in 1966, Barry Commoner, then Professor of Botany at Washington University, begins his discourse with the question ‘Is science getting out of hand?’ Commoner explored many of the issues with which society is grappling in the second decade of the 21st century. Not least of these is a strident lack of trust between science and the society it purportedly serves. The concerns are not new: current issues resonate through chapter headings such as ‘Science versus society’, ‘The ultimate blunder’, ‘The scientist and the citizen’ and finally ‘To survive on earth’. Tellingly, he uses terminology such as ‘the erosion of science’s integrity’ (pp. 60–61), ‘agricultural devastation’ (p. 73), the ‘assault on the biosphere’ (p. 75). What is clear is that for at least the last 50 years, since the very obvious devastation and salutary lessons of the Second World War, people have been aware that the planet’s ‘thin life-supporting surface’ (Commoner, 1966: 110) is under siege. Yet, exponential population growth, industrial and technological development and rampant consumerism have continued without any real consideration of their effect on a finite and finely balanced biosphere.

As addressed by Cochrane, Sauer and Aswani (2019) working in the field of coastal and marine science in South Africa, the

world is facing social and environmental challenges such as ensuring sustainable use of resources and safeguarding biodiversity. They argue that to address modern-world challenges, changes in South African attitudes – and broader – are needed. Their study of presentations at the 2018 South African Marine Sciences Symposium (SAMSS) shows, however, that very few of the presentations from the coastal and marine sciences community could be assessed as actionable or directly relevant to societal needs (Cochrane et al., 2019: 4).

The recent White Paper on Science, Technology and Innovation (DST, 2019) published by the South African government also acknowledges this rapidly and fundamentally changing world. Drivers for these global changes are socio-economic and geopolitical, scientific and technological, and environmental. The White Paper sets the long-term policy direction for the South African government with the aim for a more prosperous and inclusive society via a growing role for science, technology and innovation. It suggests policy approaches which include developing ways to support the knowledge enterprise, and a role for science engagement and science communication. To make changes in South Africa possible, according to the White Paper (2019), society will need to value science, appreciate the impact of innovation on development, and anticipate and plan for change. Then, the potential of science, technology and innovation will be developed and advance South Africa.

Important in this policy, therefore, is that the needs of society will be taken into account. More specifically, to be able to develop a knowledge-based society and a healthy economy, South Africa should develop a responsible research and innovation (RRI) approach which includes, amongst others, a role for science engagement and communication (DST, 2019).

In this chapter, we explore how science engagement and communication can contribute to putting RRI into practice in South Africa and, consequently, assist in aiming for a more prosperous and inclusive society. We begin by providing a description of RRI and how it is embedded in South Africa. We

then discuss experiences of implementing RRI through science engagement and communication in a South African research institute. We base our findings and experiences on the results from a European-funded H2020 project – NUCLEUS – to gain insights from the achievements and challenges for science engagement and communication in developing South African society. The chapter ends with a discussion and conclusions.

Responsible research and innovation (RRI) in perspective

In examining responsible research and innovation (RRI), Rip (2014: 1) refers to it as ‘a social innovation’ which ‘catapulted from an obscure phrase to an issue in the European Commission’s Horizon 2020 Program’. In recent years, the concept of RRI has been increasingly addressed in academic literature (e.g. Rip, 2014; Shelley-Egan et al., 2018). Burget et al. (2017) argue that the concept is still in development. According to Rip (2014) and Shelley-Egan et al. (2018), ideas about responsible innovation – then not yet labelled as RRI – developed, amongst others, from a report by the British Royal Society and the Royal Academy of Engineering (RSRAE, 2004) which discussed nanotechnologies and possible strategies for dealing with them in the future. In this report, the promotion of a wider dialogue about emerging technologies was also proposed as well as ways of implementing such a dialogue in practice.

Rip (2014: 2) explored the position of RRI in what he terms ‘a historically evolving division of moral labour’ as the roles and responsibilities of ‘actors and stakeholders in research and innovation’ are articulated and developed. Accordingly, scientists can no longer leave it to others to consider social, ethical and political issues. It is clear that in an increasingly global context, scientists and citizens need to work together.

Definitions of RRI emphasise the inclusion of all societal actors in the process of aligning research and innovation outcomes to the needs and expectations of society. For example, Von Schomberg

(2013: 19) defines RRI as a ‘transparent and interactive process by which societal actors and innovators become mutually responsive to each other’. Meanwhile, the European Commission (EC) understands RRI as an inclusive approach to research and innovation which ensures that societal actors work together during the whole research and innovation process. In their view, RRI aims to better align both the process and the outcomes of research and innovation, with the values, needs and expectations of European society (European Commission, 2017). In practice that means, according to the European Commission, designing and implementing policy that will engage society in research and innovation developments; increase access to scientific results; ensure gender equality both in the research process and in the research content; include the ethical dimension and promote formal and informal science education. These aims have been translated by the EU into six key areas where RRI can be put into action: governance, public engagement, open access, gender equality, ethics and science education.¹

In the South African approach to RRI, articulated in the White Paper (DST, 2019), the influence of these six key areas is clearly visible, viz.: (i) engagement of all societal actors throughout the process of framing societal challenges and developing joint solutions; (ii) addressing racial and gender transformation to unlock the full potential of South African society; (iii) improving the educational and skills profile of South Africans; (iv) increasing open access to science, technology and innovation (STI); (v) maintaining a high level of ethics in terms of the relevance and acceptability of STI to society and environmental sustainability; and (vi) developing the required governance framework to drive the RRI agenda across the National System of Innovation (NSI).

In the next section, we will provide findings about South Africa from the NUCLEUS project, which aimed to bring RRI to life in universities and research institutes in various countries. The

1 <https://ec.europa.eu/programmes/horizon2020/en/h2020-section/responsible-research-innovation>

findings from the NUCLEUS project will serve as a case study of RRI in action. More specifically, in describing how the key areas are brought into practice, the role science communication and engagement play in fostering a responsible science–society relationship will be described.

Finding fertile ground for embedding RRI

NUCLEUS, a four-year project funded by the European Union through the Horizon 2020 programme, ran from 2015 to 2019. The acronym stands for New Understanding of Communication, Learning, and Engagement in Universities and Scientific Institutions. Basing its definition of RRI on the definition by Von Schomberg (2013) as described above, the project aimed to gather a broader cultural, international and enriched perspectives on what a responsible science–society relationship entails. Therefore, in the first phase of the project, the way RRI is shaped in various situations was analysed. In the second phase, based on the roadmap extracted from the recommendations from the first phase, elements of RRI, for example, regarding public engagement and science communication, were implemented at ten universities and scientific institutions. In addition, activities to foster RRI were organised in various other places and spaces. Below, we will present lessons learned from both phases.

First phase: Identifying a broader perspective on RRI

In the first phase of the project, RRI was explored by means of conducting various studies. This included field trips, each of which took one particular perspective to find out how RRI was embedded in diverse contexts. The field trip to South Africa took the perspective of civil society (Doran, 2016). The trip was facilitated by the South African Agency for Science and Technology Advancement² (SAASTA) which is the country partner on the

² <http://www.saasta.ac.za/>

NUCLEUS Consortium and the driver of the project in South Africa on behalf of the National Research Foundation. Visits were paid to SAASTA, the Osizweni Education and Development Centre and the National Zoological Gardens in Pretoria. At each location interviews were conducted with various members of civil society organisations such as science centres, community groups, education governance officials, teachers, business, zoos and others.

From these interviews the following observations were made (see Doran, 2016). The interviews revealed enthusiasm for engagement with civil society among museum staff and educators. Despite that enthusiasm, respondents indicated that engagement was mainly possible when tasks were within job roles and dedicated budgets were available. Interviews also showed that diversity and access to education is a challenge for various groups. Science centres in South Africa provide an outlet for informal learning and offer access to facilities for some schools further away from universities, but they are also in need of funding and equipment. Interviews with learners showed that they saw possibilities for their career paths via participation in activities offered by science centres. The question is how existing relationships between universities, science festivals, communities and organisations such as SAASTA can be taken to the next level to embrace RRI. A significant challenge that may prove to be a barrier to implementing RRI is funding.

On the other hand, there is also good opportunity to engage with civil society through citizen science projects, as is demonstrated with the Cradle of Humankind where communities and researchers connect with mutual learning benefits as outcomes. In this project, researchers, from South Africa and abroad, worked together with cavers and members of the local community on the discovery of a new species of a human relative, *Homo naledi*, in Maropeng. It included an open approach to social media and a coordinated communication effort that led to global coverage of the discovery and the research. The University of Witwatersrand played a role in convincing the collaborating parties that the story belonged to humanity as a whole and not to a single news network, and that the discovery should be shared globally. The

interviews highlighted how researchers can work together with the local and global community in a research project. To ensure a long-lasting relationship, those involvements should always be mutually beneficial (Doran, 2016).

Next, to include an intercultural context of RRI, a cultural adaptation study was conducted (Dijkstra et al., 2017) while for the European perspective interviews were conducted with European researchers (see Böger, 2017, not reported on here). The cultural adaptation study included the cases of China and South Africa. Research questions for the cultural adaptation study focused on how RRI and other related concepts are implemented in international contexts; what barriers and successes affect the future implementation of RRI; and what can be recommended for the future implementation of RRI in universities and research institutes (Dijkstra et al., 2017).

For data collection for the cultural adaptation study, a multi-methodological and qualitative approach was applied. The use of various qualitative methods allowed for more insightful understanding and a broader cultural perspective on RRI (cf. Patton, 2002). However, there are also limitations since qualitative research can never be statistically representative and the results should be seen from that perspective. Both a literature study and interviews were conducted. The literature review included multiple sources of information, such as academic literature, reports, news articles, but also policy documents, statistical reports and personal communication. Semi-structured interviews were conducted with the aim of gathering further insights into practices in both countries. The protocol for the interviews was based on the questions from the European interviews and adapted after testing. Questions probed for background information; challenges for research and society; engagement; impacts of research on society; governance of research; changes foreseen in current practices and policies; responsibilities; and support wanted or needed. As a final question, respondents were asked what they expected from Europe regarding RRI.

In total, for the South African study, 13 interviews were

conducted, either via Skype or face-to-face, and recorded. The recordings served as the basis for analysis which took place at the conceptual, governmental or political, institutional and individual level. Respondents, who were asked for informed consent, held various leading positions in universities and science centres as leading researchers, university or faculty management, management or senior officers. Of those interviewed, 12 were male, 1 was female, and their ages ranged from 38 to 75 years.

RRI in South Africa at the governmental, institutional and individual level

At the governmental level, innovation is seen by both the South African government as well as interviewees as a means to advance the economy and lives of people. Programmes for technology innovation and research support are in place both for basic sciences as well as for strategic areas. Promotion of public engagement is included in these programmes. The science system, according to the interviewees, although one of the best in the region, faces challenges, such as funding which influences research output. In addition, access to universities has become more difficult for those with fewer financial means due to higher tuition fees. Equal inclusion to research and innovation regarding both gender and those from different population groups has the attention of government. However, according to some interviewees, a difference is reported for equal access in practice due to poverty and affordability of university education. Policies stimulate collaboration between indigenous knowledge holders, practitioners and researchers and industry. Various collaborations exist, for example, where the San people are working with industry on the *kougoed* plant (*Sceletium tortuosum*), which may be seen as a form of engagement and an application of RRI in practice. In the research process, San people have a say in what research is conducted and how, which shows bottom-up engagement.³ Engagement efforts are also part of policy objectives of the Department of Science

3 <https://mg.co.za/article/2015-02-19-bushmen-cure-all-offers-locals-a-sustainable-income>

and Technology (DST). Through the agency of SAASTA the DST provides funds for science education and outreach which are allocated to foster awareness about science and technology. Effects, however, are difficult to measure (Dijkstra et al., 2017).

At the institutional level, SAASTA plays a major role in fostering efforts for science education and outreach, for example, by distributing materials, organising competitions or exhibitions and science festivals and providing training. Various science centres are funded by the DST. Rural areas are less developed than cities and are hard to reach for science education or outreach activities. Funding issues impact the ability of universities and other institutions to perform such tasks with limited means. South Africa is leading in open access policies (Unesco, n.d.) and these policies are taken up by several universities and institutes. The National Research Foundation, the main funding research agency in South Africa, considers impact and engagement to be important for the success of research projects. However, impact and engagement are not formalised in the key performance indicators applied to determine the success of research projects, so uptake by researchers is understandably limited as many feel that there is no tangible benefit for them. In addition, research proposals should adhere to ethical standards.

In practice, at the institutional level, the social impacts of research, as well as environmental impacts of research and innovation, appear to be considered as most important (Dijkstra et al., 2017). At the individual level, it was observed that researchers as well as science educators are performing many tasks with limited means. Engagement or outreach are not always considered part of their job but may be stimulated via role models. Inclusion, such as equal access to universities and research positions, are topics of concern for interviewees. Re-addressing existing differences will need careful strategies, they emphasised. Also, they considered equality to be an important aspect of the science–society relationship which may enhance trust and needs openness, transparency, respect and balance. Organising and participating in outreach and science education activities which may help development

and engagement was also seen as valuable. In addition, being considerate and respectful towards citizens and participants in research was an attitude shared by many interviewees (Dijkstra et al., 2017).

To conclude from the cultural adaptation study, at the conceptual level, in South Africa, the terminology of RRI is not yet well-known. However, this does not mean that the ideas behind it or the elements of RRI are unknown to South African researchers. On the contrary, there are many instances where efforts can be seen as RRI in action and that show that RRI is put into practice. Some elements were more prominent than others. Equality, science education, and outreach are most developed and present at the governmental, institutional and individual levels. Open access is less prominent and is seen primarily at the institutional and individual level. Stakeholder and public engagement, as well as attention to the potential broader impacts of research and technology – and being responsive to stakeholders, the public or potential impacts – are less prominent. Ethics are seen as important, but the main focus of researchers is on doing their job and not on ethical reflection. According to the findings from the study, the South African interpretation of RRI focuses mainly on equality and science education and outreach. Other elements are present, but to a lesser degree and, in the case of assessing the broader impacts of research, not perceived to be equally relevant for fundamental research as for community-oriented research projects (Dijkstra et al., 2017; Dijkstra & Schuijf, 2017).

Public and stakeholder engagement in South Africa is seen as science communication rather than a deliberative model in which stakeholders or the public have a say in the direction of research. The challenge is to find ways to assess and record the impacts of research and innovation on citizens, society or the environment. This could provide a constructive space for transdisciplinary research with social scientists.

Second phase: Implementing RRI in South Africa

In the second phase of the NUCLEUS project, the outcomes of the field trips, the European survey study and the cultural adaptation study were translated into recommendations which provided the basis for a roadmap to guide the implementation of RRI in practice. Ten research institutes and universities served as places where it was possible to experiment with the implementation of RRI. Alongside the sites based in Europe and China, one was situated in South Africa. In this section, experiences from the South African Institute for Aquatic Biodiversity (SAIAB) are described.

As the South African Nucleus Consortium partner, SAASTA was tasked with finding a suitable South African academic institution which could be one of the case studies for implementation of RRI. As a National Research Facility in the NRF, SAIAB was identified as a suitable test site for RRI. Dr Angus Paterson, managing director at SAIAB, and Penny Haworth, SAIAB's manager of communications and governance, were approached to champion the project at SAIAB. The Institute was brought into the project in August 2017. The immediate task was to conduct an RRI self-assessment and develop plans for implementation. For more context on SAIAB, see Box 1.

BOX 1 Setting the scene: SAIAB in South Africa's National System of Innovation

Situated in Grahamstown, recently renamed Makhanda, in the rural Eastern Cape province of South Africa, SAIAB has built on a legacy of ichthyological discovery that began with the ground-breaking discovery of the 'living' coelacanth in 1938. Established as a research institute in 1968, SAIAB is an internationally recognised centre for the study of aquatic biodiversity

and in 1999 became a Research Facility of the National Research Foundation. SAIAB is also an Associated Institute of Rhodes University.

Throughout its 50-year history, SAIAB has shown itself to be a consistently transformative space. The institute's origins lie in its long association with the story of the coelacanth through the discovery of this enigmatic prehistoric fish in the nets of a fishing trawler on 24 December 1938 by Marjorie Courtenay-Latimer and its subsequent identification by Rhodes University professor of chemistry, JLB Smith, in early 1939, thus debunking the long-held belief in scientific circles of its extinction.

This was a momentous discovery and the popular media followed the story from the first. Press clippings from 1939 show how the discovery of a 'living fossil' caught the world's imagination. The interest continued as Smith looked in vain for a second, complete, specimen. Finally, in 1952, it was through an advertisement circulated in the media and posters distributed by colleagues and acquaintances, that the elusive second specimen was discovered in the French Comoros islands and brought back to South Africa. This was a moment of special significance for Smith, but it was not his only contribution to aquatic biodiversity science. He and his research partner and wife, Margaret, made numerous expeditions across Africa working on both freshwater and marine fishes; the collections from these expeditions became the core of what is now the National Fish Collection housed at SAIAB.

Smith was a composite communicator and wrote for the popular media as well as scientific journals. His books about the coelacanth story have been translated into numerous languages and his efforts and those of his widow, Professor Margaret Smith, who after Smith's death, founded the JLB Smith Institute of Ichthyology in 1968 and became its first director, created the foundations of ichthyological research in South Africa.

That legacy continued. Scientists intent on tracking down live coelacanths off the coast of Africa received reports of coelacanths being caught by fishermen off the coast of Tanzania

and Professor Mike Bruton, who became second director of the JLB Smith Institute after Margaret Smith was instrumental in continuing the research and adding further study specimens to the institute's collection. Bruton has since devoted himself to keeping the story alive through popular publications such as *The Amazing Coelacanth* written for a younger audience and *The Annotated Old Four Legs* which brings the original text of Smith's book, *Old Four Legs* up to date.

When coelacanths were sighted by deep-water divers in Jesser Canyon, Sodwana Bay, off the coast of KwaZulu-Natal in 2000, popular interest in the coelacanth was reignited and the Institute was catapulted to the forefront of marine ecosystems research through the establishment by the DST of a national flagship marine research programme, the African Coelacanth Ecosystem Programme (ACEP). ACEP is managed by SAIAB and is the primary nationally-funded marine research infrastructure programme in South Africa. Under the management of SAIAB's current director, Dr Angus Paterson, it has played an increasingly significant role in the provision of marine research infrastructure to South African universities which otherwise would not have access to such equipment. ACEP has coastal research vessels and equipment based in Durban and Port Elizabeth, and will extend into the Western Cape during 2019.

Through these platforms, SAIAB runs an established marine science transformation programme which provides specialist equipment and training to equip the next generation of scientists and managers with tools to understand and manage environmental change. The ACEP Phuhlisa (Development) Programme is a focused transformation programme which wholly embraces the principles of RRI. Initiated in 2012, it has facilitated access to student bursaries, academic support and equipment to an increasing number of students and their supervisors from historically disadvantaged universities in South Africa. Currently 100 postgraduate students from honours through to PhD are supported at four South African universities – University of Fort Hare, Walter Sisulu University, the University of the Western

Cape, and the University of Zululand.

Research platform provision extends beyond the marine environment. Inland fisheries are highly relevant in southern Africa because they provide an opportunity for socio-economic benefits including jobs, rural livelihoods, food security and economic development based on the small-scale fishing and recreational fishing value chains. Built on significant foundations of taxonomy and systematics in freshwater fishes and freshwater ecology developed under Professor Paul Skelton, SAIAB's third director, SAIAB holds the DST/NRF South African Research Chair in Inland Fisheries and Freshwater Ecology, the overall goal of which is to develop regional capacity and research on inland fisheries to support their sustainable development.

A changing science paradigm

In 1999, the JLB Smith Institute of Ichthyology became a research facility of the National Research Foundation (NRF) which itself had been constituted through an Act of parliament. The science landscape in South Africa was rapidly evolving. The National System of Innovation, a concept promoted by the 1996 White Paper for Science, Engineering and Technology, was facing pressures, challenges and change.

In the following 10 years, the NRF developed rapidly and in 2009 adopted a new strategic plan. In this connection, all national facilities were under scrutiny in terms of their place and role in the National System of Innovation. The PhD epitomised the postgraduate training role that national facility researchers were to embrace. In this context, the facilitating and service-orientated role of national facilities and the importance of flagship programmes that embraced the research community became essential components to consider within the National System of Innovation. However, added to the mix in 2009 there were two overarching components of the research enterprise which applied to all research activities, namely, the need to use

research to educate and train students and researchers, and the imperative to link research activities and emerging knowledge to public awareness and information. How SAIAB addressed these components is discussed in more detail in the main body of this chapter.

In 2009, SAIAB was in its 10th year as a national facility. It had established a firm platform for scientific research in aquatic biodiversity in Africa. Furthermore, through various large multi- and inter-disciplinary projects and programmes it had become an effective 'hub' for aquatic biodiversity in southern Africa. Drivers influencing SAIAB's strategic planning over the next ten years included the Biodiversity Crisis - a global concern and obligation; the DST's and Technology Grand Challenges; NRF Vision 2015; SAEON and Long-Term Data sets; the National Environmental Management Act (1998) and its various sub-components such as the Biodiversity Act (NEM:BA 2004); and South African National Biodiversity Institute (SANBI).

Today, SAIAB serves as a major scientific resource for understanding globally significant aquatic ecosystems and has established multi-institutional, multidisciplinary stakeholder networks. SAIAB's research platforms have grown considerably and its scientific leadership and expertise in marine and freshwater aquatic biodiversity are vital to the national interest when dealing with issues arising from exponentially increasing pressures of human population growth and development, climate and global change.

Transformation and social justice at SAIAB

SAIAB had already been through a self-assessment process as part of an institutional review in 2015 and, in preparation for strategic planning towards 2025, had held a workshop with all staff to discuss the institute's vision and mission statement (last revised in 2010) and how this should change to better reflect the institute in 2018 and beyond. However, the RRI self-assessment

undertaken for the NUCLEUS project sharpened the focus. These initial steps were of immediate benefit in that they required critical assessment.

Although specific RRI terminology had not been part of the vocabulary of the institute, it was encouraging to find a reasonably well-established culture of RRI. However, the NRF had outlined a draft transformation framework in 2015 and initiated a process of examining diversity in the workplace through professionally facilitated workshops across the NRF in 2015. Workshops run at SAIAB in September of that year, showed that there were still long-standing under-currents of perceived inequity in SAIAB that had to be addressed and that a journey of self-discovery, involving everyone and taking a really good and honest look at the institute, needed to be maintained.

Amid controversial national conversations about transformation, the institute's leadership was not afraid to encourage robust conversations about transformation and diversity. SAIAB's executive showed its commitment to the transformation agenda. In October 2017, the process begun by the NRF continued and a leadership workshop was organised for identified leaders from all job levels at the institute. SAIAB leadership reiterated its determination to work with everyone to address meaningfully the transformation agenda and in April 2018 an all-day, externally facilitated workshop for all staff, interns and students followed. Facilitated by the Wits University Centre for Diversity Studies, which had facilitated the initial series of interactions, the workshop provided an open platform to explore and unpack received and assumed notions of diversity in the workplace. This and the two previous workshops provided stepping-stones for the implementation of transformation at the institute.

After the diversity workshop in April 2018, a workplace transformation committee comprising members identified from all levels of the institution was established to drive the process. The committee instituted some quick wins to appeal to the hearts and minds of those working there, and worked closely with SAIAB's Wellness Committee to offer staff and students access

to support mechanisms and activities designed to encourage a positive work-life balance. That said, it is recognised that SAIAB is on a continuous journey in relation to addressing remaining challenges around ethnicity and gender. With this in mind, SAIAB has developed a Transformation and Social Justice Strategy to be integrated into its broader institutional strategy and research agenda for 2019 to 2025.

Reaching out and finding common ground

As mentioned earlier, the intention of RRI is to involve all societal actors in the process of aligning research and innovation outcomes to the values, needs and expectations of society. One of the challenges in the dynamic socio-political context of South Africa that SAIAB had already acknowledged as requiring attention before it became involved in the NUCLEUS project was the need to recognise and optimise relevant science–society links, integrate these into the institute’s research strategy and better articulate them to policy-makers and the public. This was addressed, for example, in 2009 at the second Africa Science Communication Conference organised by SAASTA (Haworth, 2009).

As the example below describes, researchers from SAIAB have long recognised their responsibility to contribute to awareness and political action with regard to sustaining biological diversity. Healthy ecosystems and biodiversity are integral to human well-being and sustainable development. However, biological diversity is being lost at an alarming rate due to multiple human impacts, and freshwater fishes and amphibians are ranked among the groups with the highest proportion of species threatened with extinction. Responsibility for future generations requires that co-operative and innovative decisions must be taken now to halt this current trend. In South Africa, the rapid loss of biodiversity is compounded by our incomplete knowledge of species diversity and their geographical distributions.

The latest IUCN Red List assessment of all freshwater fishes of South Africa was done in 2016 by experts from multiple

research institutions and conservation agencies. The assessments are produced to communicate findings to policy-makers, environmental managers and the public. SAIAB's legacy of natural history collection management and curation is internationally recognised and provides the platform upon which the institute was brought into the NRF 20 years ago. In 2013, a national survey of natural history collections across South Africa found that SAIAB's National Fish Collection and the associated diversification of the SAIAB collections as a whole to include amphibians, cephalopods, diatoms, tunicates and aquatic invertebrates, were at the forefront of collection curation in South Africa. With this strong foundation in taxonomic research, SAIAB scientists have made significant contributions to IUCN Red List assessments, the most recent of which were published in 2017 and 2018. The data generated has contributed, and will continue to contribute, towards fulfilment of national policy on biodiversity conservation enshrined in the National Environmental Management and Biodiversity Act and fulfilment of the Convention for Biological Diversity's Global Taxonomic Initiative (Chakona et al., 2018).⁴

Box 2 describes a project in which SAIAB's researchers are addressing biodiversity issues through inter-agency collaboration.

BOX 2 Developing a participatory approach to addressing biodiversity issues for human well-being

Evidence from previous and ongoing molecular studies shows that a remarkable proportion of the diversity of freshwater fishes and frogs in South Africa remains scientifically undocumented (Chakona et al., 2015, 2018). The underestimation of taxonomic diversity has profound conservation implications for these threatened groups. In response to an urgent need for an innovative approach that can be used to assign specimens

4 https://www.saiab.ac.za/uploads/files/chakona_saiab_featured_research_november_2018_web_version.pdf

to known species as well as accelerate the pace of species discovery in order to identify priorities for taxonomic research and conservation actions, SAIAB initiated the Topotypes Project in 2014, led by SAIAB senior scientist, Dr Albert Chakona.

Working with regional and international partners, a trans-disciplinary research team comprising postgraduate students, DST-NRF interns and representatives from conservation authorities from the Western Cape (CapeNature), KwaZulu-Natal (Ezemvelo KZN Wildlife) and Mpumalanga (Mpumalanga Tourism and Parks Agency) conducted surveys throughout all 9 provinces in South Africa and collected comprehensive tissue samples and voucher specimens that have been deposited into the National Fish and Frog Collections at SAIAB. Peer-reviewed papers published since the inception of the project include the description of two new species (Chakona et al., 2014; Chakona & Skelton, 2017).

Future research projects will include regional conservation agencies from inception. This will increase appreciation by conservation authorities of the need to include all levels of diversity (species and genetic lineages) in conservation planning. This is integral to the Rio Convention on Biological Diversity and will contribute towards the achievement of the UN's Sustainable Development Goals linked to biodiversity sustainability and provision of ecosystem services to safe-guard human well-being, particularly for impoverished rural communities that are directly dependent on natural resources such as inland fisheries for their survival. Building on this, the challenge will be to ensure that in response to the results, management decisions and the implementation thereof include local communities who are affected by them. Conservation authorities such as CapeNature and Ezemvelo KZN Wildlife have well-developed public communication and environmental education programmes that could provide a vehicle for this.

Identifying and working to existing strengths

In response to the imperative to link research activities and emerging knowledge to public awareness and information as formulated in the NRF Strategy 2009–2014, SAIAB had begun looking for ways to develop a closer working relationship between scientists and communication. The most accessible model for SAIAB to work from in designing its science advancement activities were those it had developed historically and used prior to falling under the NRF. SAIAB was previously a declared cultural institution under Act 29 of 1969, and the engagement model it used was based on museum education and outreach.

For some time, SAIAB had run highly successful education outreach activities, mostly undertaken by dedicated education officers based in the communications division which was not effectively aligned with research activities. To be able to link the institute's research activities and emerging knowledge to public awareness and information, it was essential to find a platform for information transfer between the research division and the communications division. In 2009, the communications manager became included in regular research forum meetings, but the essential character of reported engagement activities remained the established museum education and outreach model. Nevertheless, this was a step in the right direction and the 2009 Africa Science Communication Conference provided an opportunity to share some of the challenges and successes that were experienced in integrating science communication efforts into the strategic imperatives (Haworth, 2009).

Staff changes and shifting priorities in staffing requirements at the institute in 2009 and 2010 resulted in the closure of the education unit at SAIAB. Effectively this put an end to schools outreach. The demise of SAIAB's first education unit and later, through shifting priorities and staff changes, its science communication capacity, meant that SAIAB had to find creative ways in which to try and fulfil its mandate in public engagement as a national facility. Targeted public engagement activities have

continued through national focus events such as the DST's National Science Week coordinated by SAASTA and Scifest Africa. Through this shift in available human capacity, researchers, support staff, interns and students have become more involved in formal public engagement activities, but engagement has yet to be fully embedded in the research agenda.

Through shifting priorities and staff changes, SAIAB has lost most of its dedicated science communication capacity. This function has been integrated into the support division and now includes governance as a major component of its focus. To some extent this supports putting RRI in action by finding ways to integrate RRI into the governance structures of academic organisations. However, it has also meant that SAIAB has had to find creative ways in which to try and fulfil its mandate in science communication and engagement.

The first self-evaluation exercise and SWOT analysis undertaken when SAIAB was brought into the NUCLEUS project was conducted from September to October 2017. It showed that SAIAB was implementing aspects of RRI through its management strategies and some of its research projects and related activities although these were not being articulated under that banner. One of the strengths identified in the analysis was SAIAB's position as a long-standing associated institute of Rhodes University. SAIAB's senior scientists are Rhodes University faculty members and SAIAB is represented on the Science Faculty Community Engagement Committee with which it collaborates on events such as faculty open days, Water World at Scifest Africa and National Science Week.

The university places strong emphasis on social innovation and community engagement.⁵ The principles underpinning the university's engagement with the Makhanda/Grahamstown community clearly resonate with the principles of RRI, through its stated mission to 'oversee the institutionalisation of community engagement at Rhodes University through the processes of making the

5 <https://www.ru.ac.za/communityengagement/about/>

university more responsive to its social context and making the university more accessible to the community'.⁶ The NUCLEUS project provided a platform through which to find common ground specific to RRI and collaboration began with the SA Research Chair in Biotechnology Innovation and Engagement held by Professor Janice Limson at the Rhodes University Biotechnology Innovation Centre (RUBIC).⁷

In exploring ways to catalyse ongoing debates about the role of science in society, a number of joint activities have been offered. These included a science engagement and dialogue workshop led by Dr Heather Rea from Edinburgh University (2018), combined workshops at Scifest Africa (2018 and 2019) and the National Arts Festival (2018). Experiences in implementing RRI have been presented at the SciComm100 Conference 2018 in Stellenbosch (Haworth, 2018; Limson, 2018). Visits to the Department of Chemistry and Forensics at the School of Science & Technology, Nottingham-Trent University⁸ and the steering committee of the Nottingham City Festival of Science and Curiosity,⁹ also provided opportunities to share experiences and exchange experiences about RRI within the NUCLEUS project.

Discussion and conclusion: Lessons learned and moving forward

In this chapter we have presented findings from the various studies and experiences conducted as part of the NUCLEUS project which aimed to bring RRI into practice, amongst others, in South Africa. The field trip to South Africa, at the start of the project, showed enthusiasm for engagement among interviewees, although at the same time budget challenges were real. Diversity

6 Rhodes University mission statement, <https://www.ru.ac.za/introducingrhodes/visionand-mission/>

7 <https://www.ru.ac.za/biotech/>

8 <http://www.nucleus-project.eu/2018/07/26/learn-how-nottingham-trent-university-implemented-rri-in-this-first-phase/>

9 <http://nottsfosac.co.uk/>

and access to education were seen as further challenges to effective engagement. A valid question in such a context is how it is possible to raise science–society relationships to a next level.

The cultural adaptation study provided more insights into RRI elements at the governmental level where innovation is seen as a means to advance the economy and lives of people. Engagement has a place in this. Equal access and inclusion are considered challenges to the science system while there are also examples, such as that of the *kougoed* plant, which show the benefits of collaboration between science and society. A consideration in this regard is that the effects of engagement are hard to measure.

Looking at RRI at the institutional level, it was shown that SAASTA plays an important role in fostering science education and outreach but, despite commendable efforts, rural areas are hard to reach. Institutes embrace open access policies and, according to the interviewees, impact and engagement are considered important, but they are not yet part of the key performance indicators for researchers and therefore their uptake is limited. According to the researchers interviewed, social and environmental impacts of their research should be valued.

Implementing RRI values at the individual level means that many tasks have to be conducted with limited means, which implies, for example, that despite being important, engagement is seen merely as part of the job. Interviewees suggest that role models may stimulate researchers to put effort into RRI-linked aspects. They also believe that careful strategies should be developed to foster inclusion and equality. Engagement is seen as valuable.

In all, elements of RRI were brought into practice at various levels. Although it was often not yet labelled as such, RRI was found in action in many places. While efforts to promote science education and equity are most developed, governance, open access, public engagement and ethics are aspects that needed work.

In the final phase of the NUCLEUS project, and with the findings from the first phase of the project in mind, elements of RRI were put into practice at the research institute SAIAB. Although SAIAB had a long history in engagement and science

education, RRI in action sharpened the focus for SAIAB. For example, the conversation about diversity and transformation in dealing with inequality, which had started before the NUCLEUS project, is seen as a continuous journey. Also, the need to optimise and recognise relevant science–society links is better acknowledged. At the same time, examples of specific projects show SAIAB’s willingness and ability to do this. In addition, budget constraints cut science education activities but, at the same time, the principles of RRI were incorporated into the governance of the institute. It is also recognised that winning hearts and minds, developing trust and stimulating co-responsibility among all actors at the institutional level is worthwhile. Moreover, at SAIAB, it is clear that RRI elements were already applied but not previously articulated as such. The NUCLEUS project, therefore, has served as a platform to stimulate and find common ground. This is visible, for example, in the newly established collaboration with Professor Janice Limson’s DST/NRF South African Research Chair in Biotechnology Innovation and Engagement at Rhodes University, and it is further explicated in various activities and workshops that have been organised, in presentations at conferences, and in sharing experiences.

In other words, at SAIAB there is now more emphasis on catalysing ongoing debates. Lessons for SAIAB, therefore, are that involvement in the NUCLEUS project enabled it to explore a broader context for RRI. It has also consolidated what has up to now been a somewhat fragmented communications and governance portfolio positioned within its support services unit. Furthermore, it has allowed SAIAB to recognise and build on strengths and, importantly, to share this journey with SAASTA which is the NUCLEUS consortium partner in South Africa, and with other (societal) stakeholders in South Africa and abroad.

SAIAB’s short-term goal for 2019–2021 is to further embed the principles of RRI within the culture and governance of the institution and the NRF. The immediate challenge is to sustain and continuously build on RRI in action.

Regarding RRI aspects in the broader South African context,

the past few years show an increasing awareness of developing a responsible science–society relationship, which can be further stimulated in the years to come, as pointed out in the White Paper (2019). Translating aspects of RRI aspects in the South African context may require looking at the local level where those aspects can be addressed. For example, our findings show that there is a willingness to engage societal actors in the development of science for meeting societal needs, despite the multiple challenges that exist. As addressed by Cochrane et al. (2019: 6), ‘ensuring societal relevance of science and research will bring about benefits but must be accompanied by an increase in expenditure on actionable research and development’.

Finally, some limitations have to be addressed. Findings presented in this chapter are only qualitative in nature and therefore cannot be considered conclusive. Further research and monitoring of RRI – and more specifically the role of engagement and science communication – will be valuable. To this end it is noted that as a follow-up to the NUCLEUS project, SAASTA has collaborated as the representative for Africa with 22 other partners on a three-year project (2018–2021) to form a network of all global RRI projects. The Responsible Research and Innovation Networked Globally (RRING) project takes a bottom-up approach, learning from best practices in RRI globally and from linkages, via the new RRING community, to develop the RRI linked-up world. Its objectives include creating the global RRING community; developing a global open access knowledge base of RRI; aligning RRI to the UN Sustainable Development Goals; determining qualitatively and quantitatively the competitive advantages of RRI; creating high-level RRI strategy recommendations; trialling RRI best practice learning and reviewing EU RRI benchmarking from a global perspective; promoting inclusive engagement of civil society and researchers with the RRING community and open access RRI knowledge base; and to gain social inclusion, co-creation, social innovation and entrepreneurship.¹⁰

¹⁰ <http://www.rring.eu/summary/#>

To conclude, findings from the NUCLEUS cultural adaptation study in South Africa and the subsequent site implementation at SAIAB proved to be insightful and provide more understanding of what a responsible science–society relationship in the South African context may entail. Further efforts to expand RRI across other NRF research institutes through adopting a similar way of working as described in this chapter, with an RRI mentor working closely with other institute staff to build local capacity, are being considered.

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