JANUARY 2023 - SCIENCE BRIEF
The WRC operates in terms of the Water Research Act (Act 34 of 1971) and its mandate is to support water research and development as well as the building of a sustainable water research capacity in South Africa.

SOUTH AFRICAN ESTUARIES IN THE DECADE OF ECOSYSTEM RESTORATION: UN 2021-2030

Estuarine ecosystems are the most threatened of all other ecosystems (such as rivers, terrestrial, marine etc.) in South Africa, by types and by area. About 86% of the 22 estuary types are threatened. Deteriorating water quality is driving most of the changes. There are six main drivers of degradation: freshwater flow modification, organic/inorganic pollution, overexploitation of fish and invertebrates, land-use and development, sedimentation, plastics, and biological invasions (alien /or invasive species, plant and animals). The impact of climate change is exacerbating the situation, with severe and frequent cycles of drought and storms. Unplanned urbanisation, including formal/informal housing developments, food production on floodplains and sand dunes, make the already vulnerable systems far less resilient.

South Africa has no lack of resources, legislative mechanisms, scientific tools, however, their cooperative operationalisation appears to be lacking. Several research-based products have been produced through support from the Water Research Commission (WRC). Besides the restoration calls outlined in certain SDG:2030 goals, especially 6 and 15, the UN further placed strong emphasis (2021), calling on all nations of the world to prioritise restoration for good of humanity and livelihood in the light of extensive and continuous ecosystem degradations. This degradation is accelerated through anthropogenic activities. The survival of the economy and people depend entirely on healthy ecosystems the opposite is grinding poverty and conflicts. It is for that reason that the countries are called to act and act swiftly bearing in mind the impacts of climate change. This science brief is biased towards the St Lucia estuary, even though the situation applies broadly to all South African estuaries, especially those close to large urban centres.

Introduction

South Africa's National Biodiversity Assessment of 2018 defines an estuary as "a partially enclosed permanent water body, either continuously or periodically open to the sea on decadal time scales, extending as far as the upper limit of tidal action, salinity penetration or back-flooding under closed mouth conditions". South Africa is endowed with a roughly 3 000 km stretch of estuaries from Namibia on the cold Atlantic to Mozambique's warm Indian ocean.

Figure 1. The spatial distribution of South African estuaries, where green is used to indicate a "low" pressure, while red is used to indicate a "high" pressure from a water quality perspective. (Source: WRC Report No. TT 748/18)

St Lucia is a hugely diverse ecosystem with biodiversity services that support, for example, ecotourism, fisheries, businesses, carbon sequestration or climate mitigation and many more. Estuaries and marine ecosystems contribute between R4.2 and R10 billion per annum to the South African GDP (WRC Report no. TT 805/19). This emphasises the need for strategic interventions across multiple sectors to restore estuarine health and protect benefits to people (WRC Report no. TT 748/18). Estuaries are under-protected in South Africa, with only 1% of estuarine areas being well protected. The development of estuaries and their catchments has come at a cost of about R700 million per annum in terms of lost fishery benefits as well as unknown costs to society from the overexploitation of natural resources, including biodiversity (WRC report no. TT 805/19). Beaches retain their blue flag status as long as their waters are clean and healthy for use in recreation. Concern has been expressed over estuaries and beaches' ability to withstand escalating levels of pollution (Sunday Times article, November 2022). Clean water of acceptable quantity must reach these estuaries and beaches via the inflows from river catchments, something that is fast declining (DFFE, St Lucia Panel Report, March 2022). This balance is critical and required by estuaries as nurseries for many of the marine fish species that local communities and fishermen rely upon. This represents a huge ocean economy that is under threat from ecosystem degradation. Despite the role of the coast in the livelihood of many citizens, these ecosystems are particularly vulnerable. South Africa has one of the highest unemployment rates (currently above 35% and growing), poverty stricken and unequal societies. The matter has been made worse by the COVID-19 pandemic.

It is abundantly clear that the deteriorating water quality is driving most of the changes. Literature shows that there are six main drivers of degradation: freshwater flow modification, pollution, overexploitation of fish and invertebrates, land-use and development; manipulation of inlets; and biological invasions (Lara van Niekerk, et al, 2022). There has been a significant increase in pollution pressures from wastewater treatment works (WWTW) discharges, amplified by a decreasing ability to treat effluent to required standards (about 840 million litres of wastewater flow daily into South African estuaries). This is further exacerbated by rapid urbanisation, leading to increased stormwater discharges. Increased nutrient loading is causing severe eutrophication, resulting in low oxygen levels and decreasing estuary productivity and important ecosystem services they provide, such as nursery function. In extreme cases it causes noxious algal blooms and fish kills. In the long run, it affects recreation value and property values and reduces business opportunities. Poor water quality is also affecting resilience and creating opportunities for invasive species. The national state of invasive species and their management (SANBI, 2017) indicates an increasing spread of invasive species on our coastlines. It is not only sewage that leads the pollution of the coastline, but also plastics. Plastic pollution is a significant concern as plastic material entangles marine animals and, when ingested, untimely leads to death through starvation. In fact, with limited recycling, Net et al (2015) estimated that 630 000 metric tons of mismanaged plastic waste finds its way to South Africa's coastal areas, placing the country at number eleventh in the world as a contributor to plastic marine pollution. It is further projected that at this rate of pollution, by 2050 (only 30 years away), if the circular economy is not operationalised, there will be more tons of plastics in the oceans than fish. Much more work needs to be done to establish long-term impacts of the microplastics on the aquatic life, besides the obvious, such as entanglement mentioned above. Some countries have already moved far ahead on banning single use plastics, a route South Africa is likely to follow based on the current review of the solid waste management strategy (DFFE, January, 2021, Gazette No. 44116). Another serious water quality challenge is the sedimentation of estuaries due to poor upstream land use and inadequate freshwater reaching these lower end systems.

According to the World Economic Forum: Future of Nature and Business, the global population escalated from 2.5 billion in 1950 to almost 8 billion people today (July 2020). In fact, the latest global census confirmed that the population hit 8 billion at 15 November 2022. The livelihood demands for the population have to be met through amongst others, generation of food, extensive land use, exploitation of oceans and many more activities. In the process of growing the economy, developments have led to an estimated 80% of biodiversity loss, globally. GEO BON and FWBON (2022) provides the estimated decline in biodiversity since 1970 to 2020 at 83%, see Figure 2, below. The WWF summarising the Living Planet Index shows that the freshwater biodiversity associated with inland water ecosystems has declined more steeply than that on land or in the sea, although significant reductions are apparent in all realms.

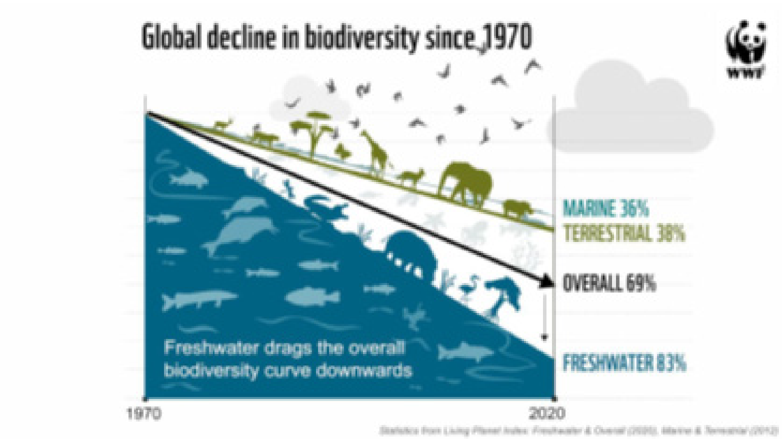

Figure 2. The estimated global decline in biodiversity from 1970 – 2020. (Source: GEO BON and FWBON, 2022)

In South Africa this degradation is confirmed through research, where wetlands and estuaries are the worst threatened ecosystems, way above 65% (NBA, 2018). This situation has triggered the world debate focused on green economy recovery strategies. This is in recognition of the environment as the foundation for sustainable development. In fact, the realization that no economy can be sustained on a sick planet has caught up with every nation. The situation is made more desperate when one overlays the pollution extent with the severe impacts and disasters driven by climate change where in many cases there is lack of preparedness, mitigation, adaptation and resilience (TT/871).

With the increasing demand for coastal space and resources on one hand, and the increased commitment to biodiversity conservation on the other hand, serious multi-user conflicts have emerged. In South Africa, estuarine resource management still has a strong single sector focus (e.g. fisheries, conservation, water and waste, marine aquaculture). These are outlined in several pieces of legislation, most prominent being the National Environmental Management: Waste Act, National Water Act, Agricultural Acts, estuarine management plans, marine protected areas, and many more. The SDG2030:Goal14 calls specifically for the protection of life under water, mainly focused on estuarine, coastal and marine ecosystems. As if that is not enough, the UN declared 2021-2030 a decade of ecosystem restoration (UN, 2021).

Transformation of sediment depository or sink estuaries, from brackish to freshwater is a likely trajectory unless urgent steps in rehabilitation of the catchments are undertaken. South Africa has no lack of natural resources legislative mechanisms and scientific research in policy support, rather their cooperative operationalization. In this brief a specific case of St Lucia estuary is explored, though applicable as well elsewhere.

Methodologies and Results: Biophysical and Social Estuarine restoration and management tools

As highlighted earlier, the estuarine ecosystems are the most threatened of all other ecosystems (such as rivers, terrestrial, marine etc.) in South Africa, by types and by area. About 86% of the 22 estuary types are threatened (NBA, 2018). The drivers of estuarine ecosystem degradation were listed. The picture is that of the entire list of affected estuaries, including some within the protected areas such as Greater St Lucia Lake system, an iconic Ramsar and a UNESCO site within the protected iSimangaliso Wetland Park is no safer from degradation. This shows that being inside a protected area alone is inadequate as the fenced area depends on the connectivity with its river feeder catchment. St Lucia Lake system provides a typical example of a system that can either transform into a freshwater system (from brackish) or be resilient in the light of rainfall and flows available to sustain it. St Lucia estuarine system relies heavily on the surrounding feeder rivers (Table 1). Hydrologically, any land use in the broader catchments has direct consequences on volume and quality of water.

Table 1: *St Lucia Estuary- Summary of Ecological Water Requirements (EWR) for rivers feeding the estuary (DWS 2016). This table does not include the minor feeder rivers and groundwater.*

Name	Natural MAR (Mm^3/a)	Present MAR (Mm^3/a)	EWR	% Natural
Mkuze	271.8	248.7	264 7	97.4%
Hluhluwe	61.5	48.1	48.1	78.2%
Mzinene	26.4	20.3	20.3	76.9%
Nyalazi	123.8	102.6	102 6	82.9%
uMfolozi	1054.4	952.2	978.8	92.8%

It is therefore critical that the water balance and water allocations in the catchment, especially those licensed, should consider the water requirements of the St Lucia system to sustain its ecological functioning, including the natural breaching of the mouth (DFFE, Panel report 2022). In short, this calls for an integrated catchment management where all stakeholder views are taken into consideration and trade-off decisions are informed as such.

One of the methods under development is the socio-ecological systems restoration framework for estuaries. The study developed and tested framework using the Swartkops Estuary as a case study which is adaptable and can be used for other estuaries as well. The details of this WRC-funded study will be available in April 2023. What is key about the study focus is the recognition of the citizen scientists in the estuary catchment finding of solutions and centralising them in the restoration vision, hence ownership. The focus so far has been on biophysical aspects of restoration. Figure 3 below is an illustration of the various drivers of estuarine ecosystem degradations and extent in South African estuaries per category. By majority, the most work is required on water security, such as restoration of flows, water quality, riparian areas/buffer zones as well as eradication of alien and invasive species.

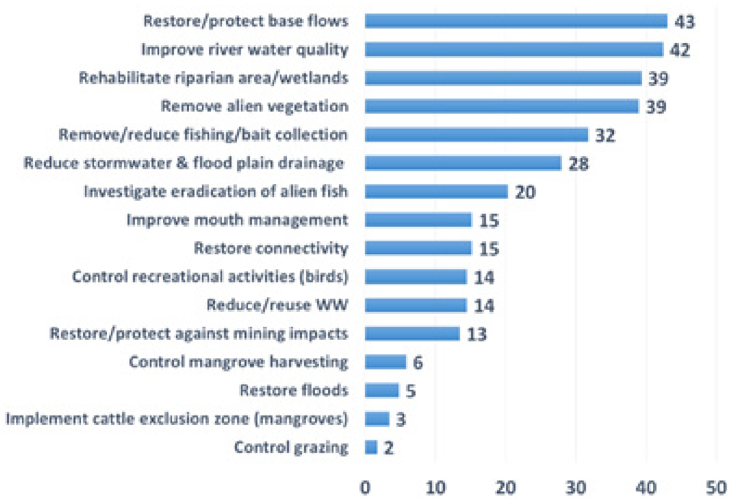

Figure 3. A summary of major restoration interventions required in estuaries to address decline in health condition, (Lara van Niekerk and Janine Adams, personal comm. 2022)

In another method development, Lara ***et al*** (2017, WRC report No. TT 748/18) suggests that the increasing demand for coastal and estuarine space and resources, and the increased commitment to biodiversity conservation, serious multi-user conflicts have emerged within these environments. In South Africa estuarine resource management still has a strong single sector focus (e.g., fisheries, conservation, water and waste, marine aquaculture). As a result, the use of natural resources (i.e., water, land and estuarine biodiversity) are planned and managed by different authorities through sector-specific statutory legislations. However, single sector management approaches, e.g., focusing just on fisheries, conservation, or water and waste management, are most likely to be successful when these are integrated in a broader, multi-sector strategic resource planning processes. This is because resource use within one sector may impact on those of another. Also improved coordination of sector-based resource management plans will enhance optimal use of limited natural resources, and address potential conflicts. The spatial planning process has proven to be a practical, rational tool to facilitate multi-sector resource planning (as has been applied for decades in terrestrial land-use planning). This process requires the physical demarcation of multiple uses in environmental spaces, and in doing so provides a platform to acknowledge potential conflicts and, to negotiate biophysical, social and economic objectives across sectors. In the light of the this, a study was designed to develop and test a multi-sector strategic resource planning online platform in South African estuaries. The estuary spatial planning platform was developed using a geodatabase and spatial software that is ArcGIS Geodatabase and ArcGIS Pro because one of its key features is that it can be shared online and is thus available and accessible to large audiences. To access the online platform, users must visit this site, it has the stepwise guide on application.

Estuary Spatial Planning Platform weblink available at: *https://csir.maps.arcgis.com/apps/MapSeries/index.html?appid=a58ab2075a954549b9b1f8b5e063380e*

Because the focus is on strategic resources planning, it was important to include relevant, general information that is typically required for estuarine resource planning. Thus two general information modules were included, namely one on important administrative information and another that presents general biophysical information on all South Africa's estuaries. A combination of administrative measures and potential conflicts as an example of planning tool is spatially illustrated and is live. The overlay of different data sets in a sector and/or across sectors, provides the user with an oversight of important sector-relevant information and potential conflicts.

Green/Blue economy model

Following from the World Economic Forum list of top risks to humanity today, it is inevitable that innovative approaches be devised that saves the natural capital while drawing benefits from it for an ever-expanding population. Though the UN (2022) census believes the rate of population increase has slowed down, the projections to 2050 (+9billion) are a reason for great concern as Mother Nature (limited planet) continued to lose capability to support productive agriculture, and other human needs.

One of the methods to sustainable develop the oceans (or Operation Phakisa, as it was called in South Africa) funded through the WRC, was the exploration of the Blue Economy Model (WRC report no. TT 805/19). The United Nations Environment Programme (UNEP) refers to a sustainable Blue Economy as a "Green Economy in a Blue World" (UNEP, 2012). Initially, the concept of the 'Green Economy' was largely promoted through UNEP's Green Economy Initiative (GEI) which, together with other organisations, ensured that it was placed on the Rio +20 Agenda. However maritime nations, especially the small island states, argued that the 'Green Economy' was too focused on land-based processes, and did not adequately address their fundamental dependence on the sea. Thus, they introduced a parallel concept of the Blue Economy. In essence, a **Blue Economy** is a **Green Economy** applied to coastal- and ocean-based economies. Of course, there are several other forms of economic concepts explored elsewhere, including at the WRC, such as circular economy, doughnut economy, etc. All are focused at limiting or not developing at the expense of externalizing the risks to society, still the old sustainable development concept presented in different fashions.

Using Knysna estuary as a study site, the blue economy model was developed (WRC report no. TT 805/19) and tested with the local municipality managers. The idea being to demonstrate that wetlands (ecological infrastructure) in Knysna, rehabilitated and used to complement built infrastructure (such as WWTW) can yield far more profitable and sustainable purification of water releasing cleaner water into the estuary/ocean, attract tourism and create viable jobs. The team therefore developed a bespoke cost benefit analysis (CBA) tool to facilitate comparisons of monetary, social and ecological costs and benefits, ensuring that more informed decisions can be made regarding the choices associated with Blue Economy development. The Scores-based Excel Decision Support Tool serves as a framework for structured systematic conversation around different potential development scenarios. It must be used at the conceptualisation/planning, start and throughout project lifespan and never brought in as an after-thought, which may be far down the road of development. The model is used for understanding the trade-offs between scenarios. The purpose is to inform decision makers of the implications and consequences of the different development choices.

The role of policy/private sector/citizen scientists in restoration

South Africa is well-known for producing democratically accommodative and environmentally friendly legislation which allows development without compromising the environment for the beneficial use of the next generations (from constitution to Acts, strategies and plans). Various pieces of legislation are managed and implemented through different departments (Policy) occasionally resulting in a silo approach to managing complex landscape dynamics which require an integrated approach. As already alluded to by Lara ***et al*** (WRC report no. TT 748/18), ecosystems are connected and that calls for multisectoral approaches to management at catchment scale. To allow for management and development that meets societal needs while aligning with all relevant legislation, management plans are an opportunity for a trans- departmental and transdisciplinary approach to efficiently deal with growing socio-ecological systems complex challenges that require complex approaches, but produce simply solutions, implementable. Below is Figure 4 summarising the socio-ecological systems approach to multitudes of landscape challenges.

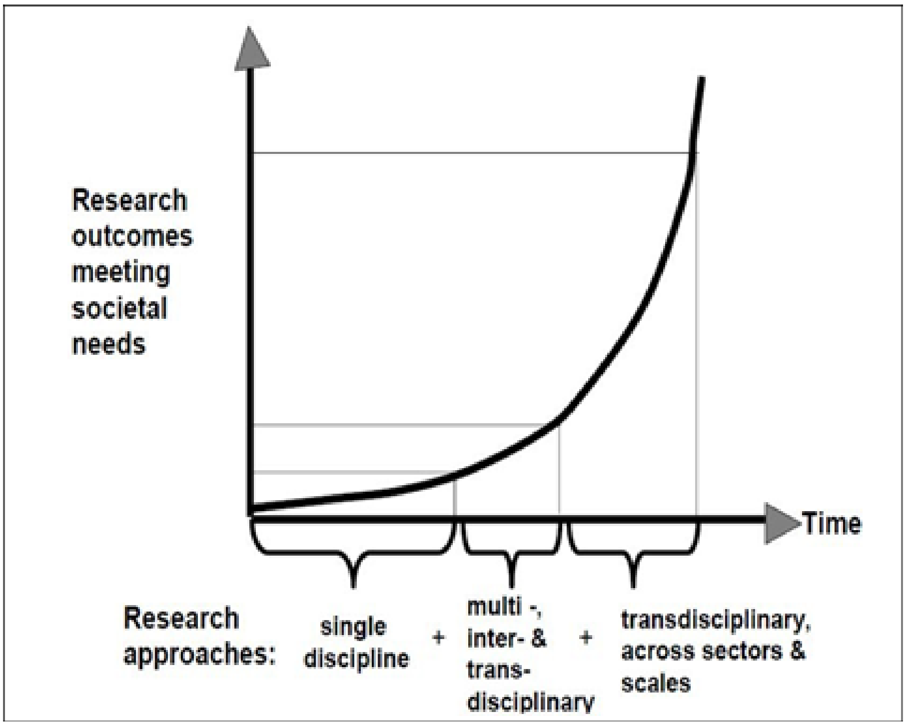

Figure 4. A conceptual model suggesting that single discipline research can build towards and include transdisciplinary research and be multisectoral over time. Source: Breen et al. (2013).

The economy depends on healthy ecosystems able to deliver the services it is naturally expected to do. However, the truth is that the natural capital (stock of natural assets) is in the state of fast decline all over the world, including South Africa despite all excellent legislation, compliance and enforcement laws being in place, (UNEP, 2020). The business needs natural resources (water and biodiversity) to prosper, but most businesses externalizes this risk to neighbouring societies who then have to cope with polluted ecosystems that cannot benefit them as downstream inhabitants. In the report by McKinsey & Co. (2022), it is made clear that companies that make meaningful returns have a role to restore nature and work towards the balance. They estimate that the world economy currently emits 2.6 times more plastic into water sources each year than it did in 2010 — negatively affecting species, ecosystems, and food webs, and reducing the ability of oceans to sequester carbon. This is a clear challenge to the Plastic Industry and indeed the legislation, both should be acting faster than waste generation through adopting circular economy principles. Some companies are starting to acknowledge dimensions of nature such as biodiversity loss, but very few have set quantified targets and commitments, financially. It is critical that companies realize their footprints on nature degradation, costs transferred, impacts and risk(s) of not investing in restoration or better still proactively be preventative. As would be expected, businesses should look at how investing in restoration will enhance company performance, return on investments, and other positive spinoffs. Companies can do a lot to support the return to a safe operating space for humanity, but they cannot do it on their own. Other stakeholders in both the public and social sectors will have a critical role to play in tackling issues such as evolving regulatory and policy guidance (McKinsey & Co, 2022).

Effective monitoring conservation, and ecological restoration of the biodiversity of inland waters must include the variety of observation and knowledge systems that exist, and find a way to build stronger collaborations by bridging knowledge systems to enhance our understanding of biological diversity (Tengö et al**.** 2017). Citizen science initiatives have the potential to fill spatial and temporal monitoring gaps and contribute to more robust estimates of inland water biodiversity. Globally, citizen scientists have contributed to monitoring of water quality, freshwater biodiversity, endangered and invasive species, and ecosystem change. While GEO BON and FWBON, (2022) focus is on inland water resources, the facts are equally true for estuarine monitoring (WRC report no. TT 763/18). The challenges remain the same, such as the total acceptance and trust of citizen science collected data by the policy. However, this is most likely to change soon due to serious data gaps observed, especially in developing countries (UNEP SDG:2030 report, 2021). Based on increasing popularity and efforts globally to bring citizen science groups into action, in fact UN decade of ecosystem restoration centralizes citizens in efforts to reverse degradation. South Africa started to produce monitoring tools specifically for use by the citizen scientists in 2002 (Dickens et al, 2002), revised and embedded into the school curriculum (WRC report no. TT 763/18), currently a process is underway (led by WRC and partners) to establish a citizen scientists society for SADC in order to have litigatory impacts where necessary, otherwise aimed at public awareness and empowerment for pollution reduction and liveable catchments. A citizen science first ever state of water resources report is expected early 2024. WRC/UNICEF signed an MoU in order to operationalise citizen science through further research funding, focusing on water and hygiene, youth, early warnings, especially on climate change, chemical water and air quality monitoring. Restoration success depends on common vision where western concepts and intertwined and complement indigenous/ or local knowledge. Monitoring to support national and international policy on biodiversity cannot be conducted without the involvement and leadership of Indigenous Peoples, including through Indigenous-led efforts and the use of Indigenous methodologies. Furthermore, Indigenous-led programs and programs that integrate Indigenous methodologies have been shown to offer holistic and transdisciplinary approaches to addressing research questions (Moewaka Barnes ***et al.*** 2021 in GEO BON and FWBON, 2022), and to act as a tool to support Indigenous governance and facilitate engagement in decision-making

Conclusion

Based on the brief exploration of estuarine science of degradation, it is clear that restoration of these highly productive systems is a joint and multisectoral responsibility and actions are overdue. There are all reasons to act now, choosing from several tools already in place, supported by the extensive legislation.

Experts in the estuarine field believe that there is a pressing need for a national estuary restoration programme or even a strategy, then a costed implementation plan where multisectoral and institutional framework is integrated with multidisciplinary science. Due to constraints imposed by the macroeconomic current realities, the plans that focus on degraded and novel systems, with an emphasis on the larger systems of high biodiversity importance and the socially important urban systems should be prioritised, such as the urgent restoration of the St Lucia estuary system. Here an opportunity exists for flagship programmes that could be developed in a collaborative manner between government agencies, private sector and civil society. Unlike the inland wetlands, with estuaries restoration of degraded or novel ecosystems (highly transformed estuaries) have not been systematically dealt with in South Africa (Lara van Niekerk, personal communication). There are numerous disjointed or independent estuarine management plans and studies that are locally focused, an adaptable framework is required, including mouth breaching guidelines.

Although hydrological and ecological data provide useful insight into the environmental reality of managing estuarine systems, social actors are important ecosystem components and to exclude social or economic realities from management plans will only further exacerbate conflict between management and related stakeholders. Transdisciplinary approaches to aquatic ecosystem restoration are important, i.e. a socio-ecological systems approach to restoration through action research should be adopted.

References

- Breen C, Crafford J, Mitchell S, and Roux D. 2013. The review, re-conceptualization and re- design of the shared rivers initiative programme. Water Research ommission Research Report No. KV 314/13, Pretoria.
- Claire Janisch, Myles Mander, Prof. Janine Adams,Shannon Royden-Turner and Mao Amis (2019). Sustainable Blue economy growth models. (WRC TT 805/19)
- Dickens, CWS, Graham, et al (2002). The South African Scoring System (SASS) Version 5 Rapid Bioassessment
- Method for Rivers. African Journal of Aquatic Scientists.
- DWS (Department of Water and Sanitation). 2016. Chief Directorate – Water Ecosystems: Reserve determination study of selected surface water and groundwater resources in the Usuthu/Mhlathuze Water Management Area. Lake St Lucia Intermediate EWR Assessment Report – Volume 1: Ecoclassification and EWR Assessment. Prepared by Tlou Consulting (Pty) Ltd and Anchor Environmental Consultants (Pty) Ltd. Report no: RDM/ WMA6/CON/COMP/2213.
- FAO, IUCN CEM & SER. (2021). Principles for Ecosystem Restoration to Guide the United Nations Decade 2021–2030. Rome, FAO.
- GEO BON and FWBON, 2022. Inland Waters in the Post-2020 Global Biodiversity Framework. Available from https://geobon.org/science-briefs/.
- McKinsey and Company, 2022. https://www.mckinsey.com/capabilities/sustainability/our-insights/nature-in-the-balance-what-companies-can-do-to-restore-natural-capital

- Independent Panel of Experts (DFFE, 2022). Review of the Scientific Basis for Breaching the Mouth of Lake St Lucia Estuary. Department of Forestry, Fisheries and Environment.
- L van Niekerk, S Taljaard, C-L Ramjukadh, JB Adams, SJ Lamberth, S Weerts, C Petersen, M Audouin, A Maherry (2017). A multi-sectoral resource planning platform for South Africa's estuaries (WRC TT 748/17)
- L van Niekerk, and J B Adams (2022). Restoration case studies towards the development of a National Estuarine Restoration Programme (Discussion Document).
- L Van Niekerk, S Taljaard, JB Adams, SJ Lamberth, SP Weerts, D Lotter, D Lemley, and T Riddin (2022). DEVELOPMENT OF CLIMATE CHANGE MITIGATION AND ADAPTATION STRATEGIES
- FOR SOUTH AFRICA'S ESTUARINE LAKES. Volume II: Climate Change Vulnerability. TT/871
- Assessment and recommended Mitigation and Adaptation Strategies
- Mark Graham & Jim Taylor (2018). Development of Citizen Science Water Resource Monitoring Tools and Communities of Practice for South Africa, Africa and the World. TT 763
- National Waste Management Strategy (2020). National Environmental Management: Waste Act, 2008 (Act No. 59 of 2008). Vol:667 (Gazette No.44116)-January, 2021.
- Nel, H. and Froneman, P.W. (2015). A quantitative analysis of microplastic pollution along the south-eastern coastline of South Africa. Marine Pollution Bulletin 101(1):274-279.
- SANBI and C•I•B, 2018. The status of biological invasions and their management in South Africa in 2017. South African National Biodiversity Institute, Kirstenbosch and DST-NRF Centre of Excellence for Invasion Biology, Stellenbosch.
- Skowno, A.L., Poole, C.J., Raimondo, D.C., Sink, K.J., Van Deventer, H., Van Niekerk, L., Harris, L.R., Smith-Adao, L.B.,Tolley, K.A., Zengeya, T.A., Foden, W.B., Midgley, G.F. & Driver, A. 2019. National Biodiversity Assessment 2018: The status of South Africa's ecosystems and biodiversity. Synthesis Report. South African National Biodiversity Institute, an entity of the Department of Environment, Forestry and Fisheries, Pretoria. (NBA,2019)
- United Nations Environment Programme (2021). Progress on ambient water quality. Tracking SDG 6 series: global indicator 6.3.2 updates and acceleration needs. Nairobi.
- World Economic Forum, (2020). Global Risks Report, 16th edition