



Decolonising engineering in South Africa – Experience to date and some emerging challenges

AUTHOR:
Mike Muller¹ 

AFFILIATION:
¹Visiting Adjunct Professor,
Wits School of Governance,
University of the Witwatersrand,
Johannesburg, South Africa

CORRESPONDENCE TO:
Mike Muller

EMAIL:
mike.muller@wits.ac.za

KEYWORDS:
decolonisation; developmental
state; water management

HOW TO CITE:
Muller M. Decolonising
engineering in South Africa –
Experience to date and some
emerging challenges. *S Afr
J Sci.* 2018;114(5/6), Art.
#a0270, 6 pages. [http://dx.doi.
org/10.17159/sajs.2018/a0270](http://dx.doi.org/10.17159/sajs.2018/a0270)

PUBLISHED:
30 May 2018

Decolonisation is poorly defined and contentious, particularly when applied in the domain of ‘pure’ sciences.¹ However, engineering involves the application of science in society and the political and cultural context has obvious relevance. Here, the implications of the decolonisation discourse for engineering are considered, using the lens of water – an archetypal focus of public policy and management.

This consideration arose from an invitation to present the *Annual Lecture of the South African Academy of Engineering (SAAE)* which seeks ‘To be a reliable and sought-after source of expert advice on matters pertaining to global competitiveness and quality of life for the nation’². The lecture was given on three university campuses, and was tailored to local issues to promote discussion. This discussion provided useful insights into the meaning and relevance of decolonisation in the engineering domain.

Two propositions informed the approach. First, was that engineering and the applied sciences are about translating knowledge into action to achieve practical goals. There is wide consensus on the societal goals of ‘water security’³ which avoids a debate about by whom and how goals are determined. The second proposition distinguishes between retrospective approaches which deconstruct colonial norms and values to understand their impact on the present and prospective approaches which consider what to do next. Should the priority be to break down the old or simply to recognise the flawed foundation and build a durable new future, perhaps through a developmental state tasked to achieve a new national vision?

The cases

In Cape Town, the focus was on the self-styled ‘water crisis’ whose origin and characterisation, it is suggested, is linked to the continued influence of European approaches inappropriate to African challenges.

The question in Port Elizabeth was whether a decolonised future will be characterised by new elites simply capturing the privileges of their predecessors? – the neo-colonialism described by writers such as Frantz Fanon⁵.

In Johannesburg, government has put the city at risk of a water crisis by delaying investments in water security to support ‘transformation’. Was it appropriate to undermine national development goals and allow a ‘recolonisation’ of knowledge?

The colonial history

To start, it was acknowledged that engineering was part of the colonial project. The British Institution of Civil Engineers was established as:

A Society for the general advancement of Mechanical Science, and more particularly for promoting the acquisition of that species of knowledge which constitutes the profession of a Civil Engineer; being the art of directing the great sources of power in Nature for the use and convenience of man as the means of production and of traffic in states, both for external and internal trade, as applied in the construction of roads, bridges, aqueducts, canals, river navigation, and docks, for internal intercourse and exchange; and in the construction of ports, harbours, moles, breakwaters, and lighthouses, and in the art of navigation by artificial power, for the purposes of commerce;[and] in the drainage of cities and towns.⁶

So civil engineering was about means of production, trade and commerce. It was the engineers who built the harbours and the roads along which the occupying forces advanced and who laid the tracks of the railways that enabled the metropolises to enlarge their wealth by extracting the raw materials of colonised countries.

The first civil engineering contract in South Africa was for a canal in Cape Town to supply fresh water to passing ships of the Dutch East India Company. The profession’s history is of the roads, mountain passes and railways, the dams, power stations and transmission lines that enabled settlement and made mining possible. Even water and sanitation was provided mainly for the colonisers, leaving a legacy of separate standards for white and black, rural and urban. Meanwhile, because black people were excluded, some stigma remains: can the profession be trusted to serve the interests of the majority?

Colonised engineering: The experience of Arthur Lewis

Colonialism was not just about economic infrastructure and colonial policy but had direct impacts on people. Arthur Lewis, a great academic from the African diaspora, won the Nobel Prize for economics in 1979 for his work on growth and employment in Africa. As he explained in his Nobel acceptance biography⁷, he originally wanted to be an engineer:

In 1932 I sat the examination and won the scholarship. At this point I did not know what to do with my life. The British government imposed a colour bar in its colonies, so young blacks went in only for law or medicine where they could make a living without government support. I did not want to be a lawyer or a doctor. I wanted to be an engineer, but this seemed pointless since neither the government nor the white firms would employ a black engineer.

© 2018. The Author(s).
Published under a Creative
Commons Attribution Licence.

Lewis's admirably concise description of his life choices illustrates simply how the wider discrimination in the European colonies at that time was reflected in engineering.

Cape Town's colonial approach

Cape Town's descent into water crisis, described elsewhere⁸, shows how colonial influence persists even after formal political change. At the least, the City's approach was excessively influenced by a Eurocentric paradigm, reflected in Europe's Water Framework Directive⁹, that seeks to avoid new infrastructure investments.

The City's leadership trusted this European paradigm rather than the tested systems approaches that have kept urban South Africa water secure.¹⁰ They delayed new water supply investment because they believed that their conservation programmes could sufficiently curtail demand. This had happened before around 2000, when Cape Town's environmental community opposed construction of the Berg River Dam. It was not needed they said – conservation and alien plant clearance would suffice.¹¹

On that occasion, a minor drought emphasised the need for action; without that dam, the City would have come much closer to its 'Day Zero' at the start of 2018. Yet, in 2013, city decision-makers once again stated that new infrastructure would not be needed before 2022/2024, despite recommendations of national government and the Planning Commission. They were convinced that it was their (excellent) conservation programmes rather than 3 years of good rains that had reduced consumption.

Two dry years and one year of drought later, supply restrictions were imposed. Post-hoc, this was blamed on severe drought (citing

rainfall records¹² not representative of the catchments concerned nor acknowledging more nuanced South African Weather Service accounts^{13,14}). Areal rainfall summary maps (Figure 1), while coarse grained, show rainfall at at least 75% of average in 2014/2015; between 50% and 150% in 2015/2016; and only reducing to 50–75% in 2016/2017.¹⁵ Streamflow records from the catchment areas of the major dams also present a less dramatic picture.¹⁶

European environmentalists in countries with temperate climates, a substantial endowment of old infrastructure, stable populations and rich economies question the need for new infrastructure. But codified conservation is grossly inappropriate in African countries with much higher population, economic and urban growth all driving increased water use.^{17,18}

Nelson Mandela Bay Metro and the post-colonial predatory state

In analyses of post-colonial development in Africa, concepts of the 'predatory state' and 'neopatrimonialism' figure large, suggesting that new power elites capture the resources of their societies for their own benefit. Replacing one set of exploitative elites by another does not constitute decolonisation but the danger is that it gives rise to a 'deterministically pessimistic view of development in Africa'¹⁹.

Water shortages in Nelson Mandela Bay Metropolitan Municipality in 2017 and 2018 did not occur because of water resource constraints. Apartheid's hydraulic empire building phase in the 1960s saw the Orange River Scheme built, principally to benefit the farming constituency but also to provide water to Port Elizabeth,²⁰ which still has an unused allocation. Yields from Port Elizabeth's old dams were inadequate and

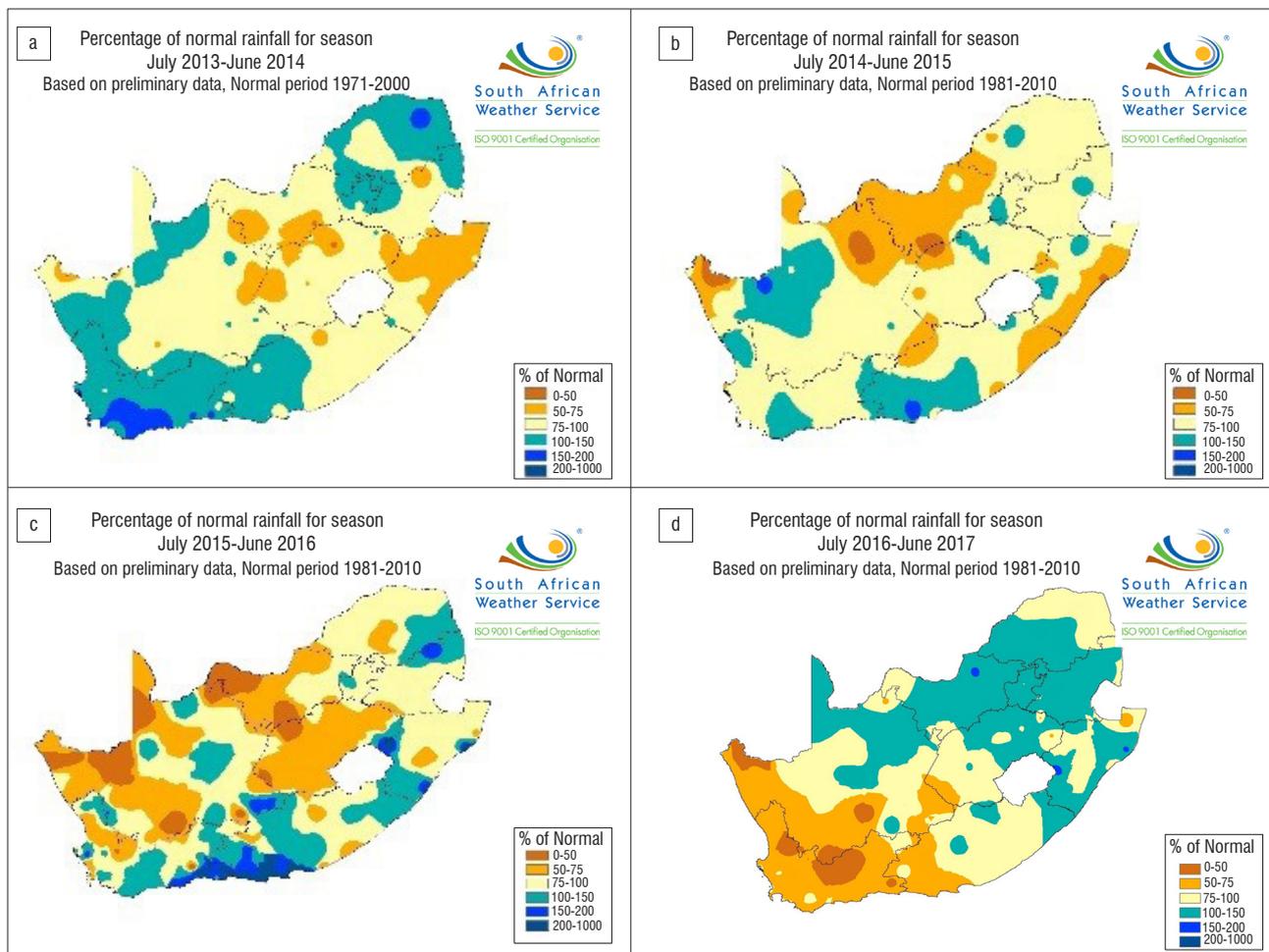


Figure 1: Areal rainfall summary maps: (a) 2013/2014, (b) 2014/2015, (c) 2015/2016 and (d) 2016/2017.

the Nooitgedacht works, long identified as the next supplementation for the city, were incomplete although the City's 2006 water plan stated that they would be needed by 2015, confirmed by the Algoa Supply System analysis in 2011.

The project was repeatedly delayed because a very expensive desalination option was preferred. Around 2004, there were appeals to national government to fund a project as a drought emergency. A new company would produce salt, chemicals and desalinated water; in 2010 progress appeared 'imminent' but in 2015, the company was deregistered. The Municipality is infamous for mismanagement and the fact that public investments only proceed if local political elites benefit.²¹ The Nooitgedacht scheme was finally started, although it is not yet complete and further investments within the City will be needed. It has taken over 10 years to build a project that should have been completed in 3 years.

This raises sharp questions about the role of engineers in a 'post-colonial' South Africa. Should they simply serve new leaderships and build whatever they are told, regardless of better options? This lived reality of many government technicians surely does not represent decolonisation.

Planning the Vaal System – shallow transformation invites recolonisation

South Africa is correctly committed to transforming the demographics of its institutions – a process often treated as synonymous with decolonisation. This transformation faced challenges in technical institutions, given the limited pool of expertise initially available. The impact of this challenge on water security in the Gauteng economic heartland offers another perspective on decolonisation.

The transformation of the national water department included efforts to increase participation of black-owned companies in its business. But is transformation or decolonisation achieved merely by changing demographics? Or is the objective to ensure substantive participation by black professionals as both clients and service providers?

Water security for South Africa's cities is planned using complex systems modelling, developed in the 1970/1980s when the computing power needed first became available.²² Models estimate the yield of interconnected systems as a whole, not just the sum of individual sources. Reliability levels are determined by stochastic methods, using rainfall and run-off variability data to generate flow and storage sequences. This approach has successfully informed operations, users and decision-makers.¹⁰

Recommendations derived from the models are not always followed, as Cape Town and Nelson Mandela Bay Metro Municipalities have demonstrated. But they have underpinned three decades of water security in the more complex Vaal River System, despite serious drought challenges.

This is specialised work, undertaken by a handful of consultants who have developed the necessary expertise. However, in 2014, the new Minister of Water explicitly sought to change this approach. She refused to appoint 'the same old companies', saying that 'she would decide which projects to build and who would build them'²³. She introduced a 'panel system' (often excluding qualified companies) and awarded tenders only to preferred panel members.

This procurement system created lucrative (and sometimes corrupt) consulting opportunities on large projects but also applied to the systems modelling firms. When the Department's financial management collapsed, amidst allegations of systemic corruption and mismanagement,^{24,25} funds for planning and associated modelling were slashed; when work restarted, experienced firms found that they were now expected to work as sub-contractors to 'panel' members. The new firms had limited capabilities but the old firms now had limited funds to train new staff. Meanwhile, with just a handful of skilled staff left, the Department no longer offers new graduates supervised technical experience – its historical training function.

This process has not only weakened oversight of water security in the big cities but has also blocked the reproduction of skills in a field in which South Africa had been a global leader. Local firms are being taken over by foreign companies that often use external resources for specialised technical work. Breaking down old institutions rather than building new ones is effectively ceding South Africa's capacities to foreign interests. Rather than decolonising, South Africa is inviting recolonisation: a process aggravated by weak strategic management and sometimes motivated by corruption.

Discussion

Short-term view and other problems of politicians

In the public presentations, the divide drawn between engineers and politicians raised some discomfort. Yet it was acknowledged that, in the cases presented, politicians' actions were not in the public interest. Damage was done when technical recommendations were not implemented or deliberately ignored in pursuit of private interests.

There is a wider debate over the roles that politicians and technocrats should play in public administration. Few politicians have the skills to make technical judgements about the work they oversee. Yet, since 1994, they have taken on increasingly operational roles rather than concentrating on oversight. This trend has led to problems when their priorities have deviated from formal goals. The situation has been aggravated by the appointment of malleable, rather than technically competent, officials, which weakens institutional capacity and the quality of advice.

Engineers and politicians work to different time scales. Engineers often plan decades ahead. Meanwhile, for politicians, short term means this week, and long term is until the next election. This short horizon inevitably shifts priorities. Politicians also need to mobilise political support and build constituencies. The obvious temptation is to use patronage, allocating resources in return for political and financial support. While public administrators have similar temptations, a well-functioning system ensures oversight; political heads appoint competent people to ensure that procedures are followed and goals are achieved. When politicians *take* management decisions, this oversight is lost, demonstrating that, as Fanon said, 'an engineer is a thousand times more indispensable to his country than an officer'²⁵.

While some dramatic cases of the resultant water sector corruption have been chronicled, more important issues are often ignored. Expensive projects – poorly conceived, implemented and operated – are failing to meet their objectives; the reliability of water supplies is decreasing.^{26,27} The water users who suffer most are those living furthest from the cities. Even when it works, over-priced infrastructure is a liability not an asset, which increases costs of living and doing business and contributes to the financial crisis of many municipalities.

The role of the engineers is also challenged

But what are the expectations of technical professionals such as engineers? They must deal with the contradictions in their role evident in dictionary definitions of professionals as either²⁸:

1: engaged in one of the learned professions, characterized by or conforming to the technical or ethical standards of a profession, exhibiting a courteous, conscientious, and generally business-like manner in the workplace; or

2: participating for gain or livelihood in an activity or field of endeavour often engaged in by amateurs; engaged in by persons receiving financial return.

Engineers might like the first definition, but trust in experts has declined, with some justification. Accountants present information that is false or misleading; doctors manipulate research results to promote dubious medicines. These are just hired hands, promoting commercial interests, not ethical 'professionals'. But healthy scepticism is being nurtured, a

syndrome of which Donald Trump is just a symptom. When, in Cape Town, academics and activists assert that water conservation will meet new water demands, they can easily reject contrary views from hydrologists and engineers as just another group promoting its own interests. With new factors like climate change, technical predictions of how much water is reliably available can be challenged, simply by saying that, surely, 'this time it's different!'

The role of professionals in a developmental state

A 'developmental state' approach is often promoted as the way to address the country's structural challenges. In traditional models, technocrats enjoy a status of 'embedded autonomy'. While part of the administration, they are insulated from politicians who seek political or personal gain rather than technical goals.²⁹

In what is characterised as South Africa's apartheid 'developmental state'³⁰, the core cadre of engineers and scientists were produced by the state. This followed recognition of excessive investment in the Orange River Scheme and the need for professional water management to avoid water becoming a brake on national development. A Commission of Enquiry analysed water management policies and priorities, and produced a comprehensive guide to the future.³¹

A key recommendation was to professionalise water management. Investment in water research and student bursaries created a community of professionals who could cooperate around common goals. They enjoyed a degree of trust that gave them considerable scope to implement and innovate – an environment in which it was possible to develop new approaches and undertake complex and challenging projects.^{10,32} It is this 'production line' that has been lost as the state's capacity to absorb and train new graduates has weakened and most practical work is outsourced. This situation has also broken the mechanisms that integrated these professionals into society as 'trusted experts'. That breakdown has been aggravated by suggestion that professional organisations are closed clubs, seeking to maintain privileges and control entry. This global challenge is particularly acute in South Africa where a white old guard apparently controls the entry of the new cadre of young black engineers.

Society decides what tasks to delegate to their 'technicians' to protect the public. Whatever the approach, the concern for engineers is that their advice should be accepted and trusted. The challenge for technical professionals in 21st-century South Africa is to recognise that trust in 'experts' derives as much from their embeddedness in their society as from their technical ability.

This statement reinforces a general finding on water management: water problems are primarily people problems or, more precisely, socio-political rather than technical. Technical pathways to water security are often complex and long term. Professionals such as engineers in a developmental state must help politicians, administrations and the communities they serve to make and implement decisions when they are needed. To do that, they need to be trusted.

Conclusions: Decolonisation means asserting new roles

While the past obviously influences the future, it is useful to maintain separate perspectives, to avoid the trap of path dependence. Otherwise, if future strategies are primarily a response to the past, the past will continue to determine the future.

So, yes, engineering has undoubtedly been coloured by colonial objectives and attitudes that determined who came into the profession and what they could do; and equally important, who was excluded, with what consequences. Its purpose was, to a greater or lesser extent, to advance the colonial mission. Indeed, from the vantage point of economics, Lewis insisted that resource colonialism, the beginning of the new international economic order, began as '... an off-shoot of the transport revolutions. The railway was a major element here'³³.

Because of this history, many engineering institutions are perceived as old fashioned and conservative. This perception is not helpful because

engineers work in a world in which the role of technical expertise is increasingly challenged even as it becomes more vital. Engineers are vulnerable in this situation because their solutions to apparently simple challenges – like ensuring reliable water supplies – are often long term, complex and not understood or effectively communicated. This makes their recommendations easier to reject or just ignore.

Cape Town's plight reflects this situation. Its decision-makers were not telling lies when they claimed that they had permanently reduced water consumption. Their mistake was to claim an easy victory for a focus on demand management, ignoring more obvious drivers such as weather and population growth, and options such as increasing supply. But engineers failed too. They were not heard promoting an alternative, cautionary view because they were not adequately 'embedded' in that society, distrustful as it is of national politicians and solutions that might damage 'nature'.

The failure to date to articulate a clear vision of a decolonised future is unfortunate because it leaves many negative tendencies unchallenged. One example is the undermining of local capacity to model water resource systems; such capacity is critical to support both planning and operations. Undermining local capacity is opening the way for a recolonisation of a technical domain in which South Africa until recently had sovereign leadership.

While South African society will not be well served if it simply ignores engineers and their institutions, the responsibility also lies with the profession itself. Continued introspection is needed, to acknowledge and address its problematic history and legacy. But priority must be given to the new forces that are shaping the future.

The composition of the profession is changing radically, with a growing cadre of young black participants, including many women (Figure 2),³⁴ Over the next decade, the well-recognised gap of experienced 'middle professionals' will be filled. Many of today's young engineers who have worked with little support will turn out to have absorbed a great deal of wisdom as they navigated difficult circumstances.

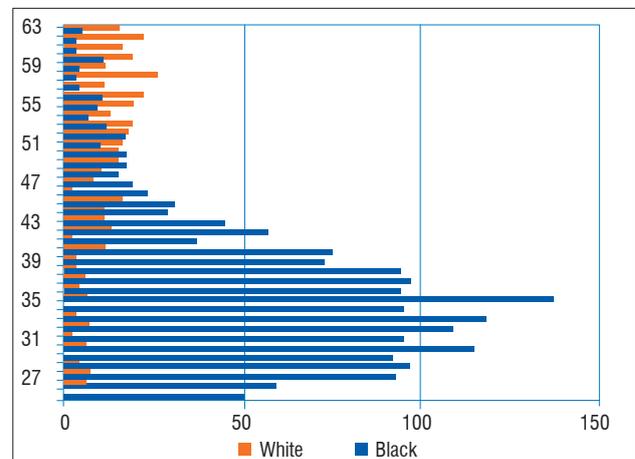


Figure 2: Engineering staff in (local) government, by race in 2015.

This change will not automatically transform other dimensions of the profession. Engineers will still be expected to exhibit those qualities of objectivity, ethical behaviour as well as technical competence inherent in the word 'professional'. They will need fortitude – and appropriate mechanisms – to manage the risks encountered in a competitive and acquisitive economy and polity. But the task will become easier as the complexion of the profession changes.

Buoyed by Fanon's estimate of their value, engineers should be more assertive in promoting the vital role that technical professionals must play if South Africa is to move towards the vision of a developmental state. Rather than being heard as voices from the past, they will be seen as pathfinders of the future, explaining what needs to be done. That is, in large measure, what decolonisation should be about.

The new generation of engineers will still need to fight for the space to do its work. In the water sector, they will have to be vocal in proclaiming the goal of water security, providing a sustainable and reliable water supply and sanitation services for people and economic activity. That will help them when they challenge politicians on the governance of technically focused public institutions. They must demand a clear distinction between what technical planners and managers do and what political heads *should* do. Engineers can engage, analyse, prioritise, and make and implement recommendations efficiently and effectively. Politicians should ensure that this is done competently, within clear policy frameworks, and following procedures that protect the public from attempts to make personal gains.

A further challenge will be to engineer effective institutions and systems. Cape Town's tribulations have helpfully shown that a failure to use technical expertise effectively is not the province of just one political party. All politicians should beware the arrogance of ignorance and learn to nurture and harvest sound advice, not ignore it. The difficulties emerging in Vaal System planning show that transforming institutions and decolonising knowledge is not just about demographics.

These challenges are most obvious for engineers in the public sector, because they are responsible for basic structures and services that are the foundations of society. But similar challenges face practitioners in other fields of engineering – mining, chemical, electrical and mechanical. Their work can transform conditions in the larger society for better or worse. They too must do more to make the voices of professional engineers heard, as critical contributors to public debate who inform the decisions of public and private policymakers.

This process will continue, and be contested, as long as society develops and evolves. Meanwhile, in the wider community, people will continue to measure society's progress by turning on the taps in their homes to see whether they can take at least this one of life's basic needs for granted. For its part, water will continue to teach that the reliability of its flows is determined by people, not hydrology. It will flow when and where needed as a result of the right decisions taken at the right time, informed by the best possible advice. This will often come in large measure from a truly decolonised cadre of engineers that is respected and nurtured by the communities in which it works.

References

1. Nordling L. How decolonization could reshape South African science. *Nature*. 2018;554:159–162. <https://doi.org/10.1038/d41586-018-01696-w>
2. South African Academy of Engineering (SAAE). Mission and vision [webpage on the Internet]. No date [cited 2018 May 07]. Available from: <http://saae.co.za/about-us/>
3. Grey D, Sadoff C. Sink or swim – Water security for growth and development. *Water Pol.* 2007;9(6):545–571. <https://doi.org/10.2166/wp.2007.021>
4. National Planning Commission (NPC). National development plan. Pretoria: Presidency; 2012.
5. Fanon F. *The wretched of the earth* [translated]. London: MacGibbon and Kee; 1965.
6. Institution of Civil Engineers. Royal charter, by-laws, regulations and rules. London: Institution of Civil Engineers; 2015. Available from: <https://www.ice.org.uk/ICEDevelopmentWebPortal/media/Documents/About%20Us/Royal-Charter-By-laws-Regulations-and-Rules-2015.pdf>
7. Lewis WA. Sir Arthur Lewis – Biographical [webpage on the Internet]. c2014 [cited 2018 May 07]. Available from: https://www.nobelprize.org/nobel_prizes/economic-sciences/laureates/1979/lewis-bio.html
8. Muller M. Understanding the origins of Cape Town's water crisis. *Civil Engineering*. 2017;25(5):11–16.
9. European Commission. Water framework directive 2000 [webpage on the Internet]. c2000 [cited 2018 May 07]. Available from: <http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32000L0060>
10. Basson MS, Van Rooyen JA. Practical application of probabilistic approaches to the management of water resource systems. *J Hydrol.* 2001;241(1–2):53–61. [https://doi.org/10.1016/S0022-1694\(00\)00367-X](https://doi.org/10.1016/S0022-1694(00)00367-X)
11. Thompson L. Managing mobilisation? Participatory processes and dam building in South Africa, the Berg River Project. Working Paper Series 254. Brighton: IDS; 2005. Available from: <http://opendocs.ids.ac.uk/opendocs/handle/123456789/4047>
12. Wolski P. Facts are few, opinions plenty... on drought severity again (blog post on the Internet). c2018 [cited 2018 May 07]. Available from: <http://www.csag.uct.ac.za/2018/01/22/facts-are-few-opinions-plenty-on-drought-severity-again/>
13. Kruger AC, Nxumalo MP. Historical rainfall trends in South Africa: 1921–2015. *Water SA.* 2017;43(2):285–297. <https://doi.org/10.4314/wsa.v43i2.12>
14. South African Weather Service (SAWS). Media releases of 26 January [webpage on the Internet]. c2018 [cited 2018 May 07]. Available from: <http://www.weathersa.co.za/news-events/media-release>
15. South African Weather Service (SAWS). Historical rain maps [webpage on the Internet]. No date [cited 2018 May 07]. Available from: <http://www.weathersa.co.za/climate/historical-rain-maps>
16. South African Department of Water and Sanitation (DWS). Hydrology: drainage regions G & H [webpage on the Internet]. No date [cited 2018 May 07]. Available from: <https://www.dwa.gov.za/Hydrology/Verified/hymain.aspx>
17. United Nations Department of Economic and Social Affairs (UNDESA). World urbanization prospects: The 2014 Revision: Highlights. Report ST/ESA/SER.A/352. New York: Population Division, UNDESA; 2014.
18. European Commission. Nature-based solutions [webpage on the Internet]. No date [cited 2018 May 07]. Available from: <https://ec.europa.eu/research/environment/index.cfm?pg=nbs>
19. Mkwandire T. Neopatrimonialism and the political economy of economic performance in Africa: Critical reflections. *World Politics.* 2015;67(3):563–612. <https://doi.org/10.1017/S004388711500009X>
20. South African Department of Water Affairs and Forestry (DWAf). History of the Orange River Project [webpage on the Internet]. No date [cited 2018 May 07]. Available from: http://www.dwaf.gov.za/orange/Mid_Orange/overview.htm
21. Olver C. *How to steal a city: The Battle for Nelson Mandela Bay*. Johannesburg: Jonathan Ball; 2017.
22. Basson MS, Allen RB, Pegram GGS, Van Rooyen JA. Probabilistic management of water resource and hydropower systems. Highlands Ranch, CO: Water Resources Publications; 1994.
23. Blom N. Statist ideology bars water crisis solution. *Business Day*. 2017 December 12; National/Science & Environment [cited 2018 May 07]. Available from: <https://www.businesslive.co.za/bd/national/science-and-environment/2017-12-12-statist-ideology-bars-water-crisis-solution/>
24. Auditor General South Africa (AGSA). Report of the Auditor-General to the Joint Committee of Inquiry into the functioning of the Department of Water and Sanitation: Challenges facing the water and sanitation portfolio. Pretoria: AGSA; 2018.
25. Davis R, Payne S. Gugile Nkwinti inherits a Water Department that may tip SA into chaos. *Daily Maverick*. 2018 February 27. Available from: <https://www.dailymaverick.co.za/article/2018-02-27-cabinet-reshuffle-gugile-nkwinti-inherits-a-water-department-that-may-tip-sa-into-chaos/#.WvLw6oiFOUI>
26. Statistics South Africa (StatsSA). Community survey 2016 data. Pretoria: StatsSA; 2016.
27. Statistics South Africa (StatsSA). GHS series report volume VIII. Water and sanitation: In-depth analysis of the General Household Survey 2002–2015. Pretoria: StatsSA; 2016.
28. Merriam-Webster Dictionary [online]. Professional [updated 2018 Apr 30; cited 2018 May 07]. Available from: <https://www.merriam-webster.com/dictionary/professional>
29. Evans P. Government action, social capital and development: Reviewing the evidence on synergy. *World Develop.* 1996;24(6):1119–1132. [https://doi.org/10.1016/0305-750X\(96\)00021-6](https://doi.org/10.1016/0305-750X(96)00021-6)
30. Freund B. A ghost from the past: The South African developmental state of the 1940s. *Transformation.* 2013;81(1):86–114. <https://doi.org/10.1353/trn.2013.0007>

31. South Africa. Report of the Commission of Enquiry into Water Matters. R.P:34/1970. Pretoria: Government Printing Works; 1970.
32. Muller M. Greater security with less water: Sterkfontein Dam's contribution to systemic resilience. In: Increasing resilience to climate variability and change. Singapore: Springer; 2016. p. 251–278. https://doi.org/10.1007/978-981-10-1914-2_12
33. Lewis WA. The evolution of the international economic order. Discussion paper number 74. Princeton, NJ: Research Programme in Development Studies, Woodrow Wilson School, Princeton University; 1977.
34. Lawless A. Numbers and needs in local government – update 2015. Paper presented at: The Annual Conference of the Institute of Municipal Engineering of Southern Africa; 2016 October 26–28; East London; South Africa.

