MAPPING WATER AND SANITATION INTERLINKAGES ACROSS THE SUSTAINABLE DEVELOPMENT GOALS

Report

to the Water Research Commission

by

Notiswa Libala, Amanda Nyingwa and Neil Griffin

Unilever Centre for Environmental Water Quality
Institute for Water Research
Rhodes University

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Water Research Commission

Private Bag X03

Gezina, 0031

South Africa

orders@wrc.org.za or download from www.wrc.org.za

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EXECUTIVE SUMMARY

Following the conclusion of the Millennium Development Goals (MDGs) in 2015, the United Nations (UN) adopted the 2030 Agenda for Sustainable Development, consisting of 17 sustainable development goals (SDGs), as well as a monitoring framework of 69 targets and 230 indicators to track achievement of the SDGs. Since the adoption of the SDGs, South Africa has made great strides in unlocking opportunities and devising mechanisms that support the effective implementation of the SDGs. Despite the commendable efforts that have been made, the 2019 reporting period revealed that significant work is still required for South Africa to achieve the 2030 Agenda within the allotted time. A particular gap was recognised in the country's knowledge and understanding of interlinkages across the goals, and how the interactions can be mapped out to provide evidence of possible trade-offs between goals, and opportunities among goals that can accelerate progress and support improved programmatic planning, implementation and monitoring. This knowledge gap is acutely noted in relation to SDG 6, which focuses on water and sanitation.

This study aims to address the existing knowledge gaps by identifying interlinkages between the indicators of SDG 6 and the indicators of other SDGs across the 2030 Agenda. The study examines the key dimensions within which interactions occur, and assesses vertical coherence and horizontal integration in the implementation of interlinked indicators. The project also identifies research needs for interlinked indicators, and undertakes a tabling of recommended means of implementing interlinked indicators that have been identified to have strong network connections.

The data was collected from literature and through stakeholder interviews with key informants – focal points of the other SDGs. However, it should be noted that not all focal points were available for interviews. In addition to the interviews, a workshop was conducted to harvest additional data, as well as present preliminary findings. Data gained from the interviews and workshop engagements was analysed for linkages and patterns through a network analysis.

The results of the linkages of SDG 6 (water and sanitation) with the social goals – SDG 1 (no poverty), SDG 2 (zero hunger), SDG 3 (good health and wellbeing), SDG 4 (quality education) and SDG 5 (gender equality) – indicated that positive interlinkages (synergies) between SDG 6 and the social SDGs clearly outweigh the negative interlinkages (trade-offs). The pattern of goals with greater collections of interlinkages with SDG 3 (good health and wellbeing) and SDG 2 (zero hunger) contains the most synergies, while interlinkages with SDG 1 (no poverty) and SDG 2 (zero hunger) contain the most trade-offs. This suggests that achieving SDG 3 (good health and wellbeing) will rely on the build-up of much stronger linkages between communities and agencies in water areas to enable a more holistic approach to health and water governance, and on strengthening capacity to enhance the synergies between the two SDGs. In order to address critical areas where more trade-offs were identified – SDG 1 (no poverty) and SDG 2 (zero hunger) – there is an urgent need for scientists or researchers in the agriculture and water resources disciplines to share knowledge and collaborate more.

The economic SDGs that were assessed include SDG 8 (decent work and economic growth), SDG 9 (industry, innovation and infrastructure), SDG 10 (reduced inequalities), SDG 11 (sustainable cities) and SDG 12 (responsible consumption and production). The identified links from the analysis based on the literature found synergies and trade-offs between the indicators; the number of synergies clearly outweighed trade-offs, indicating that the progress towards the indicators of SDG 6 should support progress in economic indicators and vice versa. In the analysis based on stakeholder interviews, all links bar two were synergies. The most common SDG 6 indicators in links relate to water quality, water-use efficiency and ecosystem functioning. Common economic indicators in links

were links to tourism, followed by commitment to research. Other economic links were perceived to be less common.

With regard to interlinkages shared between the indicators of SDG 6 and the goals of the environmental cluster – SDG 7 (affordable and clean energy), SDG 13 (climate action), SDG 14 (life below water) and SDG15 (life on land) – the connections illustrated that, firstly, the synergies between SDG 6 and the goals of the environmental cluster are concentrated around indicators that support action on reversing ecosystem degradation, and restoring and enhancing ecological integrity, including increasing the protection of water-related ecosystems. The second cluster, within which synergies between indicators of SDG 6 and those of the goals of the environmental dimension are concentrated, relates to action that supports risk mitigation, improving decision and response capability, and minimising the adverse effects of climate change on ecosystems and water, sanitation and hygiene (WASH) infrastructure. Trade-offs that are observed between the environmental dimension and SDG 6 were identified in the indicators that monitored actions that had the potential to disturb ecosystem health and biodiversity, despite fulfilment of the action having a positive social and livelihood improvement aspect.

Linkages shared between the indicators of SDG 6 and those of SDG 16 (peace, justice and strong institutions) and SDG 17 (partnership for the goals) were all synergistic. The synergies are clustered around indicators that aid action, aimed at supporting good governance, integrity, access to finance, peace and cooperation, as well as research development and innovation. It is within these areas that custodians of SDG 6, SDG 16 and SDG 17 are to concentrate their efforts to amplify the effects of the identified synergies. These are the critical areas on which to focus to inspire change in South Africa's water sector.

Overall, the results showed that the indicators of SDG 3 (good health and wellbeing), SDG 8 (economic growth), SDG 9 (industry, innovation and infrastructure), SDG 12 (responsible consumption and production), SDG 13 (climate action) and SDG 16 (peace, justice and strong institutions) contain the most synergies, and indicators of SDG 1 (no poverty), SDG 2 (zero hunger) and SDG 9 (industry, innovation and infrastructure) contain the most trade-offs. These results suggest that sectors covered by these goals could be the most important for coordinated partnership, and interdisciplinary planning and decision-making in the work towards the SDGs. Significant work is required to enhance policy coherence and increase institutional capacity to effectively respond to the interlinkages.

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Reference Group	**Affiliation**
Mr J Dini	Water Research Commission (Research Manager)
Ms N Algera	Academy of Science of South Africa
Ms H Dayal	Department of Planning, Monitoring and Evaluation
Ms J Jay	Department of Water and Sanitation
Mr M Bannister	Department of Water and Sanitation
Mr D Behrmann	Department of Water and Sanitation
Ms R Pillay	Department of Water and Sanitation
Ms L Matlala	Department of Water and Sanitation
Dr C Dickens	International Water Management Institute
Dr ST Karuaihe	University of Pretoria – SDG Hub
Dr M Weaver	Rhodes University

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ACRONYMS AND ABBREVIATIONS

AUDA-NEPAD	African Union Development Agency
CMA	Catchment Management Agency
DALRRD	Department of Agriculture, Land Reform and Rural Development
DBE	Department of Basic Education
DEA	Department of Environmental Affairs
DEFF	Department of Environment, Forestry and Fisheries
DFI	Development Finance Institutions
DPME	Department of Planning, Monitoring and Evaluation
DRR	Disaster risk reduction
DWS	Department of Water and Sanitation
EEZ	Exclusive economic zone
FOSAD	Forum of South African Directors-General
GDP	Gross domestic product
HLPF	High-level Political Forum on Sustainable Development
ICSU	International Council for Science
IDP	Integrated Development Plan
IGES	Institute for Global Environmental Studies
IRP	Integrated Resource Plan
IWRM	Integrated Water Resources Management
MDGs	Millennium Development Goals
NCM	National Coordination Mechanism
NDP	National Development Plan
NGO	Non-governmental organisation
NWRS	National Water Resource Strategy
NWSMP	National Water and Sanitation Master Plan
ODA	Official donor assistance
OECD	Organisation for Economic Cooperation and Development

R&D	Research and Development
REIPP	Renewable Energy Independent Power Producer
SADC RISDP	Southern African Development Community Regional Indicative Strategic Development Programme
SDGs	Sustainable Development Goals
SDGWG	SDG 6 Working Group
Stats SA	Statistics South Africa
UN	United Nations
WASH	Water, Sanitation and Hygiene
WEF	Water-Energy-Food
WHO	World Health Organization
WSSLG	Water and Sanitation Sector Leadership Group
WRC	Water Research Commission

CHAPTER 1: INTRODUCTION

1.1 BACKGROUND

Following the conclusion of the Millennium Development Goals (MDGs) in 2015, the United Nations (UN) adopted the 2030 Agenda for Sustainable Development. The 2030 Agenda consists of 17 sustainable development goals (SDGs) (see Figure 1.1), as well as a monitoring framework of 69 targets and 230 indicators to track achievement of the SDGs. The SDGs build on the MDGs and present a significantly broader context for tackling universal developmental challenges.

The SDGs provide a unique opportunity for multilateral stakeholders to triangulate and confront pressing challenges in a coordinated and integrated manner. This is because the SDGs are indivisible in the sense that they must be implemented as a whole, in an integrated rather than a fragmented manner, recognising that the different goals and targets are closely interlinked (European Commission, 2019). As a result, the SDGs offer a platform for the effective and deliberate positioning of leaving no one behind, eradicating poverty, increasing access to education, combating climate change and reducing inequality.

Figure 1.1: SDG diagram (Anastácio, 2017)

The SDGs emphasise the significance of a strengthened enabling environment for pursuing the 2030 Agenda. To this end, the SDGs address issues concerned with creating effective institutions, good governance, the rule of law and peaceful societies. Moreover, the SDGs actively rally stakeholders from diverse groups to unlock and devise mechanisms that will enable the pooling of resources and streamlining of efforts to advance the achievement of the SDGs in a concerted manner.

Although the SDGs present a significant departure from the MDGs in that they are holistic in approach and integrated in nature, there are concerns about whether the cumulative SDGs' ambition can be turned into reality (Pando, 2017). The anxiety originates from the evidence presented in the Sustainable Development Goals Report: 2019 (UN, 2019). The report outlines the world's progress over the last three years of SDG implementation and indicates that, despite the enormous leaps that have been made, there has been slow progress and even regression on some fronts. For example, inequality has deepened, and climate change impacts and biodiversity loss are approaching tipping points (UN, 2019). Notwithstanding this, the Sustainable Development Goals Report: 2019 calls for a much deeper, faster and more ambitious response to achieving the SDGs. Part of this process

includes examining interlinkages across the goals and leveraging opportunities to accelerate progress.

The SDG interlinkages are crucial for breaking silos and facilitating greater integration among various stakeholders operating in diverse contexts. The SDG's interlinkages promote networks and foster connections between the goals, targets and indicators of the 2030 Agenda. As a result, understanding the interlinkages between the goals, targets and indicators is crucial for the integrated governance and policy coherence that is necessary to implement the SDGs (Moinuddin and Zhou, 2017). Knowledge of the linkages enables countries to effectively implement the goals and targets by harnessing synergies between them, while managing any potential conflicts (UN-Water, 2016). This information is key to unlocking the full potential of the SDGs at any scale, as well as ensuring that progress made in some areas is not at the expense of progress in others (ICSU, 2017).

While there is great significance and opportunity in mapping SDG interlinkages, existing knowledge about these connections remains limited. Kraak et al. (2018) explain that mapping SDG interlinkages has been hampered, in part, by inappropriate data handling, coupled with inefficient and incorrect information design. Kraak et al. (2018) further argue that the selection of distracting base maps or inappropriate map design elements also affects the effective mapping and visualisation of SDG interactions.

On the other hand, Nilsson et al. (2018) argue that mapping SDG interactions is constrained by the lack of a universally adopted framework and tools that support the aggregation and systemisation of SDG interactions. Nilsson et al. (2018) also explain that the lack of a global knowledge base of interactions presents a glaring gap in understanding SDG interconnections. To this end, there is an opportunity to identify, characterise and address interactions between SDGs and to develop a globally approved framework to map SDG interactions.

Owing to the magnitude of the SDGs, several studies (ICSU, 2017; Nilsson et al., 2018; Moinuddin and Zhou, 2017; Karnib, 2019) have opted to map the SDG interactions by singling out one goal and understanding the positive and negative interactions such a goal has with other SDGs. This has enabled a more manageable and concise way of understanding SDG interactions. Additionally, it has enabled the piloting of various frameworks and tools that can be used for mapping SDG interactions. However, this mapping approach has resulted in other goals and their interactions not being mapped, and it has created differing scales for mapping SDG interactions. For example, much of the mapping of SDG interactions has been undertaken at a global scale, and less of it on the national front. To this end, a gap exists in mapping goal interactions at a national level. One such gap exists for SDG 6 (ensure availability and sustainable management of water and sanitation for all).

SDG 6 is regarded as central to the achievement of all the other SDGs, and vice versa, because social development and economic prosperity depend on the sustainable management of freshwater resources and ecosystems. Freshwater in sufficient quantity and of sufficient quality is essential for all aspects of life and sustainable development. Given the interconnected nature of SDG 6 with the other SDGs, it is critical to understand the full extent of the relationships and interactions in order to assume more integrated decision making and coherent policy approaches. However, only a few studies have captured the extent of SDG 6 interactions with other SDGs (UN-Water, 2016; UN ESCAP, 2017). These studies have glaring gaps, and as a result, a comprehensive view of SDG 6 interactions with other SDGs is still lacking. For example, the majority of the studies assess only SDG 6 interactions with other SDGs until the target level. These studies do not drill down to the indicator level where the UN tracks SDGs' progression or regression. Importantly, it is at the indicator level where data, finances and policy considerations, as well as other means of implementation, are considered. Secondly, some studies only map SDG 6 interactions with certain goals. Lastly, the studies do not

demonstrate the local basis for interactions, choosing to highlight only the global rationale for SDG 6 interactions with other SDGs.

Given the centrality of SDG 6 in realising the 2030 Agenda for Sustainable Development and the growing recognition to be more systematic regarding the deployment of resources to achieve the SDGs, it is imperative that the linkages that SDG 6 shares with other SDGs are understood, particularly at an indicator level.

Demystifying such interactions is crucial for unlocking the means of implementation, as well as advocating for the equitable distribution of resources. Moreover, such understanding is critical for facilitating an environment where pressure points for investment are transparent and easily inspire collective action to safeguard the mutual achievement of linked indicators.

1.2 ABOUT THE RESEARCH STUDY

The Water Research Commission (WRC) is cognisant of the limited body of knowledge that examines SDG 6 interactions with other SDGs. The scarcity of information is even more severe at a national scale. To this end, the WRC, together with the Department of Water and Sanitation (DWS), has commissioned a study to analyse the extent to which SDG 6 indicators demonstrate interactions or interlinkages with other SDG indicators in a South African context.

The purpose of the study is to address the existing knowledge gaps by identifying interlinkages between indicators of SDG 6 and other SDG indicators across the 2030 Agenda. Consequently, this study examines the key dimensions within which interactions occur, and assesses vertical coherence and horizontal integration in the implementation of interlinked indicators. The project also identifies research needs for interlinked indicators and tables that recommend means of implementation for interlinked indicators, which have been identified as having strong network connections.

1.2.1 Project aims

The specific aims of the research study are as follows:

- To critically assess interlinkages between the SDG 6 indicators and other SDG indicators in order to determine dependencies, trade-offs and implications for implementation
- To present research needs and recommendations on how to improve the institutionalisation, localisation and implementation of interlinked water-related SDGs
- To provide recommendations on developing appropriate systems and platforms to monitor and evaluate progress on SDG 6-linked indicators

The research study achieves the above through this document: “Mapping water and sanitation interlinkages across the SDGs”.

1.2.2 Limitations

The main limitation of the study was lack of participation in and attendance at both the interviews and the workshop by custodians of goals within the social and economic cluster; the study also only engaged stakeholders from national departments. The impact of this resulted in a lack of a defined picture for understanding how the custodians and implementers of the SDGs within the two clusters view interlinkages between their respective goals and SDG 6. Additionally, a nuanced insight of on-the-ground dynamics that shape the interlinkage is minimal; as a result, where possible, the researchers have supplemented this information with information gained from literature. Therefore, most of the linkages identified between SDG 6 and goals within the social and economic cluster were informed by literature research, and the interlinkages identified may differ from on-the-ground reality

due to lack of information. However, the researchers have undertaken rigorous literature research to ensure that this limitation is mitigated.

The interlinkages between SDG 6 and the other goals are shaped by information gained from literature and less by insights gained from individuals who work with the respective SDGs. As a result, a greater network of connections has been identified through literature than through stakeholder engagements. There is a need to look at the factors that contributed to lack of participation by other SDG roleplayers and discover what can be done to raise the profile.

1.3 REPORT STRUCTURE

The structure of this document is as follows:

Chapter 1: Introduction
The introduction provides context on SDGs, interactions and explains the purpose of the research study.

Chapter 2: SDG interaction in South Africa
This chapter provides a high-level overview of SDG 6 in South Africa. It expands on the progress and challenges, including priority areas and recommendations recognised during the 2019 reporting period.

Chapter 3: Enabling environment for the implementation of interlinked SDGs
This chapter presents the policy and institutional structures that support and can be leveraged to advance decision making and strengthen discourse regarding interlinked SDGs.

Chapter 4: Methodology
This chapter describes the approach and analysis used in the study.

Chapter 4: Research results and discussion
This chapter presents the linkages identified between SDG 6 and the other SDGs, using insights from literature and stakeholder engagements (stakeholder interviews and stakeholder workshop) analysed by network analysis.

Chapter 6: Recommendations
This chapter presents the recommendations for advancing the implementation of SDG 6 indicators, interlinked with indicators of goals from the social, economic and environmental cluster, including indicators from SDG 16 and SDG 17.

Chapter 7: Conclusion
This chapter provides the closing remarks for the report.

1.4 TARGET AUDIENCE

The report contains information that is useful to a diverse group of stakeholders, those in the public and private sectors, as well as academia, research bodies and civil society. The immediate stakeholders are outlined below, although this is by no means an exhaustive list.

- The Department of Water and Sanitation is the custodian of SDG 6 and a key player in shaping and providing the strategic direction regarding goal implementation. The DWS is also instrumental in mobilising government-driven opportunities that support the realisation of interlinked SDGs.
- The Water Research Commission has a critical role to play in identifying and researching avenues for, as well as driving innovation that supports, the full implementation of the water-linked

SDGs. The institution occupies an essential role, aimed at bridging the gap between research, academia and public policy makers.

- Statistics South Africa, as the national SDG Secretariat, has an interest in understanding new advancements regarding the improved implementation of the SDGs.
- The Department of Planning, Monitoring and Evaluation (DPME) is the chair of the National Coordination Mechanism, a newly developed structure that aims to strengthen implementation of development policies and to review progress on the SDGs and other agendas, including continental and regional agendas. The DPME is key in supporting the endorsement of the report in high-level committees such as the Inter-Ministerial Committee on Sustainable Development Agendas, the National Development Stakeholders Forum and the Director-Generals' National Steering Committee.
- Various high-level interdepartmental committees and working groups: Government departments converge across a number of platforms to ensure coordinated decision making and streamlined planning. It is imperative that these platforms are leveraged to establish concerted action regarding the advancement of SDG indicators that are interlinked with SDG 6 indicators.
- The organs of state that are custodians or support the achievement of those SDG indicators linked with the indicators of SDG 6 are vital for supporting improved decision making and planning, as well as integrated tracking of the SDGs.
- Non-governmental organisations (NGOs) and private sector affiliates have a critical role to play in partnering with the water and sanitation sector organs of state, as well as with other public entities to support the advancement of interlinkages between the indicators of SDG 6 and other SDG indicators.
- Development finance institutions (DFIs) have a crucial role to play in reshaping the discourse and advocating for deepened exploration of the means of implementation for advancing interlinked SDG indicators. Additionally, DFIs are critical in unlocking, as well as funding, initiatives aimed at supporting the integrated implementation of indicators that have interlinkages with the indicators of SDG 6.
- A concerted and collaborative effort between these players, each owning their role and playing their part, for example, policy implementation and regulation, research and advocacy, is critical for the integrated advancement of the 2030 Agenda.

CHAPTER 2: SDG INTERACTION IN SOUTH AFRICA

2.1 BACKGROUND

In 2015, South Africa joined the 193 countries that ratified the 2030 Agenda on Sustainable Development. In 2019, like most of its counterparts, South Africa provided its first progress report on the implementation of the SDGs. The reporting process was achieved through the development of 17 goal reports, four thematic reports and one country report, which reported on 128 out of 199 Tier I, II and domesticated indicators. The reporting process provided a clear window on how South Africa had interacted with the SDGs since adopting the 2030 Agenda in 2015. This chapter aims to provide a high-level analysis of the relationship South Africa has maintained with the SDGs thus far. To this end, the chapter does not recount the results of the reporting period; for that in-depth knowledge, the reader is encouraged to consult the SDG 2019 Country Report (Statistics, South Africa, 2019).

Definitions

- **Tier I indicators:** The indicator is conceptually clear, has an internationally established methodology, and standards are available. Data is regularly produced by countries for at least 50% of countries and of the population in every region where the indicator is relevant.
- **Tier II indicators:** The indicator is conceptually clear, has an internationally established methodology and standards are available, but data is not regularly produced by countries.
- **Domesticated indicators:** Indicators are country specific, they represent a modified UN global indicator and can be viewed as a country's version of the UN global indicator.

South Africa's relationship with the 2030 Agenda is one characterised by hits and misses. At the strategic level, the country has made laudable headway in mainstreaming the SDGs into long-term strategic planning instruments at a national, provincial or local level. This strategic level embrace of the SDGs indicates a clear understanding of the importance of linking the SDGs to the country's long-term strategic planning instruments in order to elevate the implementation priority of the SDGs and increase the rate of implementation, given that they are not isolated from the country's long-term objectives. Additionally, the strategy-level prioritisation ensures that most of the SDG implementation is prioritised and achieved through the national budget, thus securing resources. This innovative approach of mainstreaming the SDGs is commendable. However, shifting national budgeting to deliberately integrate the SDGs and ensure that the SDGs informed budgeting is still required to elevate the implementation of all the SDGs and not just the ones that happen to coincide with national, provincial or local priorities.

South Africa's SDG engagement at an institutional level is one that is marked by considerable room for improvement. The 2019 reporting period revealed that, in the office of Statistics South Africa (Stats SA), South Africa has a strong central institution that can help coordinate the country's SDG journey. However, considerable improvements are required, with the establishment of capable and well-resourced institutional structures that will drive the effective reporting and monitoring of SDG implementation by the respective institutions. The newly developed National Coordination Mechanism (NCM) is set to fill this gap. However, the terms of reference of this structure are yet to be made public, and as a result, ambiguity exists as to the functions of the structure. Additionally, there is no clear indication of who the stakeholders are that will be part of the structure. Presently, the structure seems to prioritise government representatives, but what about civil society and the private sector? How will their views and – more importantly – their contribution to the SDGs be coordinated? A rethinking of how South Africa is to institutionalise the SDGs is important and must be done swiftly, given that only 10 years remain until 2030.

At the implementation level, the 2019 reporting period revealed that the execution capacity of the country requires bolstering at a number of levels if the nation is to meet the 2030 deadline and leave no one behind.

The strengthening is urgently required at a human resource, financial, technological, monitoring and infrastructure level, among others. The country report reflects that data paucity and access to reliable data pose a challenge to both consistent reporting and the development of targeted action in order realise the SDG goals in South Africa (Stats SA, 2019). This admission by Stats SA reveals deeper underlying challenges regarding the implementation of the SDGs in South Africa. For the data paucity and unreliable data phenomenon to occur entails South Africa having challenges in ensuring that institutions implementing the SDGs are resourced with sufficient well-trained personnel, who have the resources, technology and infrastructure to undertake consistent monitoring and who are able to interpret the results and report on them through approved structures, instruments and methods. For South Africa to improve its implementation capacity, a thorough evaluation is required to assess gaps and available resources in order to develop a structured suite of corrective measures to overcome implementation challenges.

The need to localise the SDGs is highlighted as a critical milestone in ensuring that everyone in the country assumes a common understanding and responsibility to achieve the SDGs. Everyone has a role to play in the implementation of the SDGs, either directly or indirectly. So how has South Africa localised SDG implementation? Within the upper echelons of government, a clear understanding exists for implementing the SDGs, and contribution is well articulated; yet, at the lower levels of government, a disconnect exists as the arena within which local government operates is focused on implementing local plans without clear ties to the bigger picture. This is particularly worrying, given that most local government authorities are aware of the SDGs, since they are reflected in their long-term strategic planning instruments; yet, the translation of these plans into results that raise the SDG implementation profile of the country is lacking. Greater work is required to ensure that local government is able to link their role and contribution back to the national SDG contribution. Creating this line of continuity is essential for closing implementation gaps and generating impact from the sphere that is directly in contact with the people, and is the most critical for leaving no one behind.

Outside the government and public sphere, are civil society, the private sector, and research and academia actor groups. Most of the stakeholders associated with these groups support South Africa in localising the SDGs. Yet, they execute their contribution in silos and often without government collaboration. As a result, despite these actor groups owning the SDGs, their contribution does not feed into and cannot be traced back to the national SDG profile. Structures are needed to ensure that the concerted efforts of stakeholders that do not fall within the public sphere, but who own and contribute to the SDGs, can be linked to the national implementation profile. Additionally, these groups need to be meaningfully engaged by government, and these groups themselves need to partner with government to ensure alignment in implementation and to foster the pooling of resources.

As mentioned earlier, the country's relationship regarding SDG implementation between 2015 and 2019 has been characterised by both gains and missed opportunities. In relation to understanding interlinkages between the SDGs, a question exists regarding which of the quadrants South Africa lies in, the former or the latter? The SDG 2019 reporting period revealed the lack of a defined national picture regarding interactions shared between the SDG indicators. As a result, a critical gap exists in understanding the extent to which SDG indicators are linked, either positively or negatively. Secondly, there is a lack of information regarding the implementation implications of linked indicators, particularly those where progress in one indicator negatively affects progress in another, despite each indicator aiming to illustrate positive action. Thirdly, a thorough investigation has not been conducted regarding how each SDG links with other SDGs. Lack of this information, as outlined in Chapter 1.1, can fortify siloed planning and reduce innovative, integrated and efficient approaches to resource allocation and planning that result from understanding indicator interactions. South Africa is often critiqued for operating in silos (The Presidency, 2019). Given the indivisible nature of the SDGs, shedding this reputation and focusing on efforts that work towards understanding indicator linkages in order to broker solutions that support the integrated

implementation of linked SDG indicators is paramount for maximising positive impact and managing trade-offs.

This section has illustrated that South Africa's relationship with the SDGs since their adoption in 2015 is one that is dissimilar. As a result, a number of supporting mechanisms are required to bring it in balance and ensure that the country leaves no one behind by 2030. As the country enters the decade of action in 2021, it needs to lay itself bare in order to aptly navigate and diagnose pressure points and so systematically respond to individual problems, thus achieving the much-needed multiplier effect, given the short timeframe. To do this, the country should start at the bottom, focusing on the locus on which all social, economic and environmental prosperity for the country depends: SDG 6 (ensure availability and sustainable management of water and sanitation for all). As a first step, the country needs to take stock of its progress in delivering SDG 6 and thereafter understand the linkages between SDG 6 and all the other SDGs.

2.2 UNDERSTANDING SDG 6: WATER AND SANITATION IN SOUTH AFRICA

SDG 6 is aimed at ensuring the availability and sustainable management of water and sanitation for all. During the 2019 reporting cycle, South Africa reported progress on the delivery of SDG 6 using 12 indicators (see Table 2.1). Of these indicators, eight are the UN indicators, two are domesticated indicators and two are disaggregated domesticated indicators. The purpose of this section is to present an analysis of the progress made by the country in delivering SDG 6 between 2015 and 2019, to highlight the implementation priorities, but also to build a case as to why it is particularly important to understand the linkages between the indicators of SDG 6 and the other SDG indicators. This section does not recount the quantitative results of SDG 6; for that in-depth knowledge, the reader is encouraged to consult the SDG 2019 Country Report (Stats SA, 2019).

Definitions

- **UN indicators:** These are indicators that have not been domesticated or modified, and appear as represented in the UN framework for SDG indicators (e.g. 6.1.1).
- **Domesticated indicators:** These are country specific. They represent a modified UN global indicator and can be viewed as a country's version of the UN global indicator (e.g. 6.3.1D).
- **Disaggregated domesticated indicator:** This is a domesticated indicator that has been separated into two or more components.

Reflecting the national situation, the 2019 progress report for SDG 6 revealed that South Africa has made commendable progress in certain areas, while improvements are urgently required in other areas. The country has made progress in increasing access to safe water and sanitation services. However, the continued success of this win is threatened by declining infrastructure conditions due to poor infrastructure asset management, which affects the reliability of these services, thus compromising access. Other areas where South Africa has been successful regarding the delivery of SDG 6 is in implementing integrated water resources management (IWRM), the establishment of transboundary institutions for shared water courses, and in establishing structural mechanisms for facilitating local community participation in water and sanitation management. The country has met the IWRM quota by having a strong policy that advocates for IWRM. It has prioritised IWRM in budgeting, even though – at times – insufficiently. Additionally, the country has a strong central institution with the DWS to undertake IWRM-related tasks. However, the establishment of catchment management agencies (CMAs) is still critical for further success. To realise success in managing transboundary waters, the country enshrined – in its policy – the promotion of the sustainable management of shared watercourses, and it facilitated the establishment of basin commissions and authorities. Regarding local community participation, the country ensured that local water and sanitation planning instruments – the water services development plan, which forms part of the Integrated Development Plan (IDP) – are formally adopted with the endorsement of local communities.

As mentioned earlier, South Africa's delivery of SDG 6 is one that is also marked by challenges. The reporting cycle revealed that the country is struggling to protect its freshwater ecosystems. Water quality levels are declining due to increased pollution and the poor management of wastewater infrastructure, coupled with poor regulation. Additionally, the country's water-related ecosystems are chronically under-protected, and the effects of climate change are increasing water stress. Despite this, water-use efficiency levels by the various water-use sectors remain very low.

Given the above-mentioned challenges, there is a high risk that South Africa will not realise SDG 6 if it does not change its trajectory. It is paramount for the country to translate its strong policy into action. Secondly, the country needs to improve the allocation of human and financial resources in the water and sanitation sector in order to boost its capacity for implementation and to address the pressing challenges the country has in delivering SDG 6. Thirdly, the country needs to improve its capacity to regulate, monitor, collect and generate reliable data for decision-making, as well as reporting on SDG progress. Lastly, as reflected in Chapter 2.1, it must understand the linkages between SDG 6 and all the other SDGs.

Table 2.1: Targets and indicators used by South Africa in its reporting against SDG 6

Target	SDG indicator	Reported indicator	Indicator type	Tier classification
6.1 By 2030, achieve universal and equitable access to safe and affordable drinking water for all.	6.1.1 Proportion of population using safely managed drinking water services	SDG indicator		Tier II
6.2 By 2030, achieve access to adequate and equitable sanitation and hygiene for all, and end open defecation, paying special attention to the needs of women and girls, and those in vulnerable situations.	6.2.1 Proportion of population using (a) safely managed sanitation services; and (b) a handwashing facility with soap and water	SDG indicator		Tier II
6.3 By 2030, improve water quality by reducing pollution, eliminating dumping and minimising the release of hazardous chemicals and materials, halving the proportion of untreated wastewater and substantially increasing recycling and safe reuse globally.	6.3.1 Proportion of wastewater safely treated	6.3.1D: Proportion of water containing waste safely treated and lawfully discharged	Domesticated	Tier II
	6.3.2 Proportion of bodies of water with good ambient water quality	6.3.2D: Proportion of bodies of water that comply with South African water quality objectives	Domesticated	Tier II
6.4 By 2030, substantially increase water-use efficiency across all sectors and ensure the sustainable withdrawal and supply of freshwater to address water scarcity and substantially reduce the number of people suffering from water scarcity.	6.4.1 Change in water-use efficiency over time	SDG indicator		Tier II
	6.4.2 Level of water stress: freshwater withdrawal as a proportion of available freshwater resources	SDG indicator		Tier I
6.5 By 2030, implement integrated water resources management at all levels, including through transboundary cooperation as appropriate.	6.5.1 Degree of integrated water resources management implementation (0-100)	SDG indicator		Tier I
	6.5.2 Proportion of transboundary basin area with an operational arrangement for water cooperation	SDG indicator		Tier I

Target	SDG indicator	Reported indicator	Indicator type	Tier classification
6.6 By 2020, protect and restore water-related ecosystems, including mountains, forests, wetlands, rivers, aquifers and lakes.	6.6.1 Change in the extent of water-related ecosystems over time .	6.6.1D(1): Change in the spatial extent of water-related ecosystems over time, including wetlands, reservoirs, lakes and estuaries as a percentage of total land area	Disaggregated and domesticated	Tier I
		6.6.1D(2): Change in the national discharge of rivers and estuaries over time	Disaggregated and domesticated	Tier 1
6a By 2030, expand international cooperation and capacity-building support to developing countries in water- and sanitation-related activities and programmes, including water harvesting, desalination, water efficiency, wastewater treatment, recycling and reuse technologies.	6a.1 Amount of water- and sanitation-related official development assistance that is part of a government-coordinated spending plan	SDG indicator		Tier I
6b Support and strengthen the participation of local communities in improving water and sanitation management.	6b.1 Proportion of local administrative units with established and operational policies and procedures for the participation of local communities in water and sanitation management	SDG indicator		Tier I

2.3 SIGNIFICANCE OF UNDERSTANDING THE SDG 6 INDICATOR LINKAGES WITH THOSE OF OTHER SDG INDICATORS FOR SOUTH AFRICA

South Africa is a water-scarce country, with high variability and unpredictability. Compounding this reality is uneven rainfall and the common experience of extreme weather (drought and floods) due to climate change (Creamer Media, 2012). Water is central to South Africa's developmental agenda. The country has committed to ending poverty, reducing inequalities and clamping down on unemployment rates, while growing an inclusive economy by 2030 (National Planning Commission, 2013). The effective management of water resources and the services derived from them are essential for achieving this commitment (National Planning Commission, 2011).

However, the country's water mix is highly linear, with the majority of the water resources derived from surface water sources, closely followed by groundwater. As a result of this profile, it is paramount that the country protects water sources and expedites water-use efficiency measures in order to safeguard the availability of water and sanitation services, even during times of crisis. The National Water and Sanitation Master Plan (NWSMP) has shown that protecting water resources and ensuring water-use efficiency measures to control demand is not engrained in South Africa's culture. Testament to this is the warning that if demand continues to grow at current levels, the deficit between water supply and demand could be between 2,7 and 3,8 billion m^3/a by 2030, amounting to a gap of about 17% of available surface and ground water (DWS, 2018a).

In reality, this reveals that the availability of water to realise national objectives, as detailed in the National Development Plan (NDP) and other instruments, will be highly constrained. As a result, the country will struggle to attract investment to grow the much-contracted economy without water and, thus, suffer chronic economic losses. During the Cape Town drought, the agricultural sector alone incurred approximately R14 billion (USD $1.17 billion) in losses due to water shortage (Toale and Molfetas, 2019). Secondly, water insecurity, coupled with unreliable water and sanitation infrastructure, can compromise the country's ability to ensure that communities are healthy, given the prevalence of waterborne diseases and infections without water and sanitation services. The COVID-19 pandemic has illustrated the fragilities within the current water and sanitation services; more importantly, the pandemic has highlighted the extremely detrimental and – at times – fatal impact of poor access to water and sanitation services.

Thirdly, a limited supply of water threatens efforts to address hunger and achieve food security; it threatens the sustainability of the agricultural sector (commercial and subsistence). Water insecurity also affects peace in communities. Unreliable water and sanitation services can incite social unrest, leading to all forms of violence and disturbance of the peace. The number of water- and sanitation-related service delivery strikes continues to rise throughout the country.

From the above, it is clear that South Africa is highly dependent on water, as it affects all activities in every corner of society. Therefore, South Africa needs to realise SDG 6 to avoid compromising the achievement of the goals of the other SDGs. Understanding interlinkages between SDG 6 and other SDGs is critical for ensuring that all actions related to SDG 6 are executed with the recognition that it extends to the other SDGs. Given that South Africa has a looming 17% water gap, understanding the deep connections that exist between SDG 6 and the other SDGs is vital for streamlining decision making, improving efficiencies in the allocation of resources, and minimising duplications. Additionally, such understanding is important for improving intergovernmental collaborations, given that SDG 6 is the locus through which all social and economic development initiatives are enabled.

CHAPTER 3: REVIEW OF THE ENABLING ENVIRONMENT FOR IMPLEMENTING LINKED SDGS

South Africa has good ecosystem of laws, strategies and institutions; so much so that some of the instruments in the country's enabling ecosystem are regarded as international best practice. A case in point is the National Water Act, which has been adapted by several countries across the globe, including China and Zambia (Schreiner, 2013). Yet, it is unknown how this enabling ecosystem fares and supports the delivery of interlinked SDGs. In view of this, the purpose of this chapter is to discuss the efficacy of the existing national frameworks and structures to support the collective implementation of the SDGs that share linkages with SDG 6.

3.1 FRAMEWORKS (POLICY, LEGISLATION AND LONG-TERM STRATEGIC FRAMEWORKS)

3.1.1 Constitution of the Republic of South Africa

The Constitution of the Republic of South Africa sets the precedent for cooperative governance. Chapter 3 of the Constitution calls on all government departments and spheres to (section 41(1)h):

> (iii) inform one another of, and consult one another on, matters of common interest;
>
> (iv) coordinate actions and legislation with one another.

The stipulations set out in Chapter 3 of the Constitution encourage collaboration and communication between government agencies or departments (horizontally and vertically). Chapter 3 paves the way for integrated planning and decision making to support water-linked SDG indicators. However, the concerted implementation of water-linked indicators could fall victim to the pre-existing challenges that hinder cooperative governance in South Africa. Edwards (2008) explains that the lack of cooperative governance in the different spheres can be attributed to the fact that the three spheres have to deal with issues such as bureaucracy, and a lack of the following:

- Properly coordinated and structured information systems to facilitate provincial monitoring
- Effective communication between different role players
- The capacity to implement policies and programmes
- Trained personnel
- Financial resources
- Commitment to cooperate (the mandates of the different government departments in legislation contradict one another)
- Efficiency and effectiveness in decision making
- The alignment of policies between local and provincial government

Therefore, despite the constitution being clear on principles for facilitating cooperative governance, as well as fiscal arrangements, without a systemic strategy to overcome the challenges mentioned above, administering cooperative governance will be difficult.

For the SDGs, the above shortfall in cooperation indicates that, despite the support of the Constitution, the implementation of interlinked SDG indicators will also fall victim to the current fragmentation that exists between the three spheres of government and, as a result, implementation will be difficult to realise.

3.1.2 Intergovernmental Regulations Framework Act (Act No. 13 of 2005)

The Intergovernmental Regulations Framework Act (Act No. 13 of 2005) builds on Chapter 3 of the Constitution to establish or provide for structures and institutions to promote and facilitate intergovernmental relations. It is within these structures that deliberations regarding the concerted implementation of interlinked SDGs can take place. However, the mere existence of an Act and its impact is no guarantee that it will be translated into action, with the intended results. The national developmental agenda promotes decentralisation, but practises centralisation. There are certain challenges facing the capacity to implement and promote intergovernmental relations that will have to be addressed as a matter of urgency.

The Act defines intergovernmental relations as “relationships that arise between different governments or between organs of state from different governments in the conduct of their affairs”. Woolman (2009) states that the Act is silent with regard to the problem of how cooperation between provincial departments within any given province should be regulated. Neither the Constitution’s provisions on cooperative government in Section 40, nor the Act itself speak directly to these provincial interdepartmental relations. The Constitution’s muteness and the Act’s silence with regard to provincial interdepartmental relations are important for two primary reasons. First, departments within the same sphere of government are often required to cooperate with respect to the discharge of their functions. Secondly, and most critically for our purposes, SDG interlinkages require a cooperative and coordinated effort, even within the various provincial departments.

Woolman (2009) suggests two solutions to the problem of provincial interdepartmental relations. Firstly, he suggests the development of protocols that regulate provincial interdepartmental cooperation and are enforced by the Premier or the executive of the province. The Act can be used as a guide in developing such protocols to promote provincial interdepartmental cooperation. Secondly, the response is to develop performance-based contracts of employment with senior officials within the province, which incorporate compliance with memoranda of cooperation or interdepartmental implementation protocols as a key performance area.

Interlinkages between the various SDGs demonstrate the need for a coordinated and cooperative response from the government and organs of state. While the Constitution and the Act provide mechanisms for intergovernmental cooperation, i.e. cooperation between the three spheres of government, there is no provision for the promotion and regulation of provincial interdepartmental cooperation. This cooperation, which is necessary for the progress towards and the achievement of interlinked SDG indicators, can be achieved by the conclusion of provincial interdepartmental cooperation protocols.

3.1.3 National Development Plan Vision 2030: Our future – make it work

The National Development Plan is clear that if the country is to meet the national objectives, as well as global commitments, there needs to be increased integration between government, civil society and the private sector. This call for increased integration provides a bedrock for interlinked indicators.

Fourie (2018) states that aligning South Africa’s NDP and the SDGs will have its fair share of complications. He notes two obstacles. Firstly, the NDP was adopted before the 2030 Agenda, and superimposing the global agenda onto the local plan may be politically problematic because the NDP cannot be changed without seriously damaging its legitimacy. Secondly, the 2030 Agenda expresses global commitments reached by the United Nations’s 193 members states, and thus there might be little space in the core text of such an agenda for national development challenges. To overcome these obstacles, and in order to exploit the interlinkages, Fourie (2018) suggests reliance on the Organisation for Economic Cooperation and Development (OECD)’s Recommendation on Policy

Coherence for Sustainable Development, an industry standard for creating policy coherence. Policy coherence is indispensable in exploiting synergies and minimising trade-off interlinkages.

3.1.4 Agenda 2063

Although not at a national level, Agenda 2063 – The Africa we want, engenders an integrated continent. This aspiration enables inter-country collaboration. Key structures within the African continent that can facilitate inter-country collaboration include the African Union platforms such as the African Union Development Agency (AUDA-NEPAD) the regional economic committees and the continent's centres of excellence located within five subregions: eastern, western, central, northern and southern Africa.

3.2 INSTITUTIONAL STRUCTURES AND PLATFORMS

3.2.1 National Coordination Mechanism

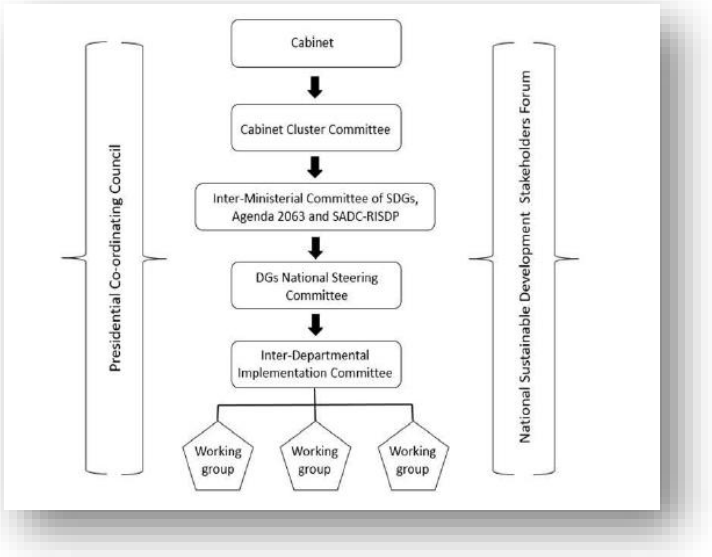
The National Coordination Mechanism, led by the DPME, is tasked with strengthening the implementation of development policies and reviewing progress on the SDGs and other agendas, such as the African Union's Agenda 2063 and the Southern African Development Community Regional Indicative Strategic Development Programme (SADC RISDP) (The Presidency, 2019).

The NCM is designed to obtain high-level guidance from the top political leaders, to strengthen administration through committees that bring together political authorities and civil service managers, and to integrate the views of government and social partners (The Presidency, 2019).

The NCM relies on current government structures and processes to avoid duplication. Owing to the expanded role of the NCM, new structures, such as the Inter-Ministerial Committee on Sustainable Development Agendas and the National Development Stakeholders, have been created consistent with the mandate of the NCM (The Presidency, 2019). Figure 3.1 provides a simplified structure of the NCM.

Despite the existence of the NCM, the terms of reference for the Inter-Ministerial Committee on Sustainable Development Agendas and that of the NCM have not been made available to the public. As a result, it is not easy to conclude how the NCM will prioritise the implementation of interlinked SDG indicators. Additionally, no clear indication exists regarding the capability and resources of the structure to coordinate, monitor, collect and disclose data of interlinked SDGs. It is clear that there are significant gaps of knowledge regarding this structure, perhaps because it was officially formalised relatively recently, on 27 March 2019. The gaps in knowledge regarding this structure make it difficult to assess its efficacy in planning, delivering and monitoring interlinked SDG indicators.

Figure 3.1: Structure of the National Coordinating Mechanism (The Presidency, 2019)



3.2.2 Government clusters

Government clusters are groupings of government departments with cross-cutting programmes. Clusters foster an integrated approach to governance that is aimed at improving government planning, decision making and service delivery. The objective is to ensure proper coordination of all government programmes at national and provincial level. The main functions of the clusters are to ensure the alignment of government-wide priorities, to facilitate and monitor the implementation of priority programmes and to provide a consultative platform on cross-cutting priorities and matters being taken to Cabinet. The clusters of the Forum of South African Directors-General (FOSAD) mirror the ministerial clusters. The FOSAD clusters provide technical support to the ministerial clusters. The Director-General in The Presidency is the Chairperson of FOSAD. The clusters are as follows:

- Economic Sectors, Investment, Employment and Infrastructure Development
- Social Protection, Community and Human Development
- Governance, State Capacity and Institutional Development
- Justice, Crime Prevention and Security
- International Cooperation, Trade and Security

Given the mandate of the government clusters mentioned above, it follows that the clusters are critical structures for facilitating the implementation of interlinked SDGs since they do this for cross-cutting government programmes. Yet, a question remains regarding how successful these clusters have been in supporting government's implementation of cross-cutting programmes, given that the tagline of siloed governance is still attached to the legacy and present circumstances. Unfortunately, no evidence exists showing how the clusters have supported integrated planning. To implement interlinkage, the SDGs and the capacity of FOSAD would have to be examined in executing this action. Secondly, measures and mechanisms would have to be made available to support the delivery of the interlinked SDGs through government clusters.

3.2.3 DWS's SDG Working Group

The DWS's SDG 6 Working Group (SDGWG) was established within the Planning and Information Branch of DWS. Under the SDGWG (see Figure 3.2), 11 task teams were initiated, each reporting to the SDG Working Group. Each task team relates to one of the specific eight sub-goals or targets of

SDG 6. Each task team comprises a leader and five to eight experts in their field of responsibility to support the delivery of progress. Three additional task teams make up the 11 task teams:

- Task Team Sector Support and Coordination – designed to communicate progress and notices to all sector stakeholders besides providing guidance support and capacity-building initiatives to the sector
- Task Team Research and Innovation – led by the WRC to assist other task teams to provide appropriate solutions to challenges in the sector
- Task Team Water and Sanitation Sector Leadership Group (WSSLG) – to oversee the SDG 6 programme from a sector perspective, analyse the gaps identified within the eight targets and strategise, mobilise or influence how best the sector can turn around shortfalls to meet the targets

The SDGWG also works on increasing collaboration with other government departments and agencies responsible for other goals to improve the implementation of SDG 6, as well as offer support on goals that have links to SDG 6. For the SDGWG to realise this, it is important that a comprehensive mapping of interlinkages between indicators of SDG 6 and those of other SDGs is undertaken. The results of this mapping will be critical in understanding areas of support to maximise synergies and reduce the impact of trade-offs.

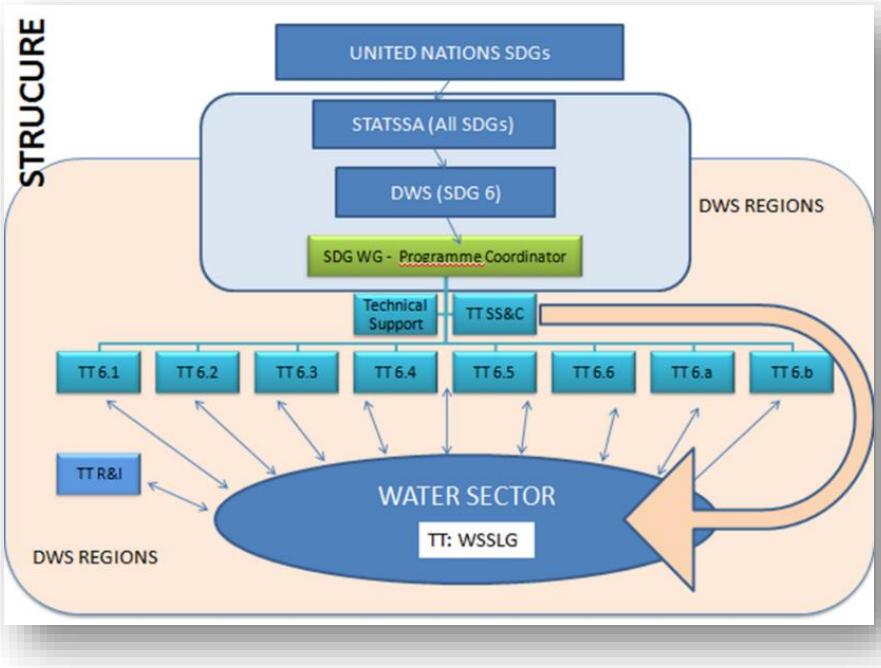


Figure 3.2: DWS SDG 6 Working Group structure

CHAPTER 4: METHODOLOGY

4.1 DATA COLLECTION

4.1.1 Literature review and search

A literature search is defined as “a systematic and thorough search of all types of published literature in order to identify as many items as possible that are relevant to a particular topic” (Ridley, 2008). Because the literature forms the basis of the writing and often also of the definition of research questions, a thorough and well-conducted literature search is a crucial part of one’s research.

As a first step, a two-part literature review was conducted to inform the study on SDG 6 interlinkages. A comprehensive literature review on international findings of SDG 6 interlinkages with other SDGs was compiled to provide context to internationally recognised interactions between SDG 6 indicators with other SDGs. The review provided information on the synergies and trade-offs between SDG 6 indicators and other SDGs. It also explored the vertical and horizontal coherence required for implementing actions aimed at supporting the achievement of interlinked indicators. A literature review of internationally recognised methodologies was also undertaken to assess interlinkages between the SDGs at indicator level, and whether they were based on expert input or indicator performance, or a combination, or other approaches (e.g. ICSU, 2017; IGES, 2017; Pradhan et al., 2017; Nilsson et al., 2018; Allen et al., 2019).

Furthermore, a literature review of the South African context was undertaken to investigate progress that has been made in mapping interlinkages between SDG 6 interlinkages and other interlinkages. The South African literature review was also conducted to examine the extent to which the linkages identified internationally are reflected in the national context. The literature review analysed the relationship that exists between indicators of SDG 6 and indicators of other SDGs based on whether there are synergies (improving one will improve the other) or trade-offs (improving one makes the other worse) between interactions, or if the interactions are bidirectional (improving one improves the other and vice versa) or unidirectional (improving the first improves the second, but not the other way around).

The literature review was mainly conducted via an online search using a database such as Google Scholar in order to get an overview of the scope and quality of the literature. Subsequently, the search was expanded via library catalogues and books. More than 50 international papers and reports were reviewed. These include United Nations, Institute for Global Environmental Studies (IGES), High-level Political Forum on Sustainable Development (HLPF) and International Council for Science (ICSU) reports, while more than 30 papers and reports from South Africa were reviewed, including South Africa’s country report, South Africa’s voluntary national review report, and reports of the DWS.

4.1.2 Stakeholder engagement

Semi-structured interviews

Apart from conducting a literature review of published and other reports, semi-structured interviews were used to obtain information on the synergies or trade-offs between indicators of SDG 6 and indicators of other SDGs, and to generate new results. The semi-structured interviews were also used to acquire information on whether the interactions are bidirectional or unidirectional.

Interviews were chosen as a tool for this study because they obtain in-depth descriptions on a topic and gather information about an individual’s personal experience that is not otherwise available in the literature. Semi-structured interviews include open-ended questions and allow the researcher to ask probing or clarifying questions. This helps to generate a rich discussion about the interview topic,

which is important since few studies in South Africa have investigated knowledge and data on the SDGs' indicator interlinkages.

Sampling strategy

Participants were purposively chosen from various organisations to provide information on the link their focal SDG indicators have with the indicators of SDG 6, as well as to identify the nature of the interactions. Purposive sampling is a non-probability strategy in which the investigator intentionally selects certain people in a study based on defined characteristics, and who may be exposed to a particular phenomenon. In the context of this study, the project team identified a minimum of 17 key informant stakeholders (at least one per SDG) with which to engage. The project team approached Stats SA, the national coordinator for the SDG reporting process, to provide the names and contact details of a focal point person for each of the 17 SDGs. Project reference group members were also asked if they knew people working on SDGs. Subsequently, a list of possible interview partners was developed.

Seventeen stakeholders were contacted via email and were invited to be interviewed; 13 did not respond to the email at all; only four responded. After several follow-up emails elicited no response, the research team visited the offices of the key informant stakeholders to conduct face-to-face interviews. Six stakeholders were interviewed face-to-face, plus the four who had responded to the emails. Finally, ten interviews could be used for the analysis. Participants used an interview guide that was created by the team. Online or email interviews were conducted in October and November 2019, while face-to-face interviews were conducted in January 2020. Each interview lasted between 20 and 30 minutes. Face-to-face interviews were based on individual permission, recorded on a voice recorder and later transcribed.

Workshop

A workshop was also used as a method to collect data. The main purpose of the workshop was to present the draft Framework on Mapping Interactions between indicators of SDG 6 with indicators of other SDGs, and examine interlinkages that exist between the indicators of SDG 6 and those of the social, economic and environmental goals in the South African context (Table 4.1) and to identify practical means of implementation to support the improved planning and implementation of SDG 6-linked indicators, including answering the following questions:

- What implications do these interlinkages have for the way in which we monitor and report on the SDGs (and SDG 6 specifically) in South Africa?
- How best can DWS support other SDG custodians in their implementation, monitoring and reporting of targets that have linkages to SDG 6?
- Which are the priority indicators for attention, based on the interlinkages?

Table 4.1: Participating SDG custodians

Social goals	Economic goals	Environmental goals	Governance goals
SDG 1	SDG 8	SDG 13	SDG 16
SDG 2	SDG 9	SDG 14	
SDG 4		SDG 15	
SDG 5			

Workshops provide the stakeholders of different organisations the opportunity to collaborate with one another (Ørngreen and Levinsen, 2017) to learn about a particular topic. This helps a researcher to

gather data through the collaboratively shared experience. In workshops, researchers may be able to elicit rich information from the participants who are selected via the purposive sampling technique. In this study, workshop participants included various departments, NGOs, private companies and researchers working on SDGs.

The workshop was also used as a platform to involve stakeholders who were unable to participate in face-to-face or online interviews. Although the workshop attendance was great, few SDG custodians attended the workshop, especially from the economic and social dimensions. The workshop facilitated numerous levels of stakeholders to share knowledge and perspectives on SDG interlinkages.

Ethical clearance

Ethical clearance was obtained from the Rhodes University Ethics Committee, and consent details are curated in the Institute for Water Research, Rhodes University. A consent form requesting authorisation was provided to interviewees who signed the form before the researcher proceeded with the interview. The consent form served as proof that the participant had agreed to be interviewed and that they had the right to withdraw their participation at any time if they were not comfortable with it.

4.2 DATA ANALYSIS

4.2.1 Information analysis and synthesis

Information collected from the literature review of the South African context and the stakeholder engagements was analysed to identify the extent to which interactions occur from a South African perspective. The researchers assessed whether synergies, trade-offs or constraints exist between the SDG 6 indicators and other SDG indicators, and whether interlinkages between the SDG 6 indicators and other indicators are at a data level or a strategic level.

4.2.2 Analysis of interlinkages

An analysis was undertaken of interlinkages and patterns of links between the SDG 6 indicators and other SDG indicators. Interlinkages were identified from appropriate literature, or from the feedback of stakeholders who were interviewed. This produced two lists of linked indicators. Each of these was analysed separately. Linked SDG indicators were classified as social (SDG 1 to SDG 5), economic (SDG 8 to SDG 12), environmental (SDG 7, SDG 13 and SDG 15) and governance-related (SDG 16 and SDG 17). These thematic classifications informed the presentation of the results. A simple network analysis was then undertaken. As the analysis only assessed links from other indicators to SDG 6, and not all the interlinkages between indicators, a full suite of network metrics was not available to assess the importance of particular indicators. However, each indicator could be ranked using its degree, which is a count of the number of other indicators linked to it.

Links between indicators are classed as synergies or trade-offs. In this context, a synergy refers to the case when progress in the score of one indicator towards its target is likely to cause another indicator's score to move towards its target. Synergies are a positive change in one indicator that causes another to improve. Trade-offs are the reverse: when progress in one indicator towards its target leads another indicator to move away from its target. It is important to remember that progress of an indicator towards its target can involve an increasing or a decreasing indicator score, depending on the target, and synergies do not always imply a positive correlation between indicator scores, nor a negative correlation for trade-offs.

Network analysis derives from social network analysis and is a method for analysing links between entities using network and graph theory (Otte and Rousseau, 2002). Network analysis has received much attention in a number of fields where relations between entities are important (Borgatti et al.,

2009). This approach has commonly been used to explore and illustrate networks between SDGs, SDG targets and SDG indicators (e.g. Allen et al., 2019; Miola et al., 2019; IGES, 2017; ICSU, 2017; Le Blanc, 2015; Mantlana and Maoela, 2019).

Network analysis, as indicated above, can be used to analyse any data where nodes are linked by defined relations. As such, a network analysis can be undertaken regardless of the approach adopted to define relationships. Several approaches have been used in applying network analysis to assessments of SDG interlinkages, and these have been defined by the methods of identifying and quantifying interlinkages. For example, Le Blanc (2015) used a linguistic method to produce a network, ICSU (2017) used relationships defined by expert opinion using the scale developed by Nilsson et al. (2016), and Miola et al. (2019) defined relationships based on the correlation of the time series of indicator data. These approaches are often combined, for example, where researchers use one method to identify links, and another to quantify them.

Network analysis was used to assess and analyse relationships between nodes (in this context, indicators). The relationships in this context are commonly referred to as edges (or ties or links). Each edge can have several properties, such as direction and strength. Once all edges between the nodes are in place, the nodes are held in a network. Once a network analysis has been undertaken, one can use several measures to devise the importance of any node within the network, as well as other descriptors of the network strength. This enables, for example, the assessment of the importance of a node, or a cluster of nodes, within the network, using centrality analyses. In the current context, this would highlight particular indicators for prioritisation based on their links to other indicators. These links could be synergies, as well as trade-offs. Network degree was used to assess how interlinked particular SDG indicators were, to indicate how many other nodes an indicator may be linked to, or, in the current context, how many interlinkages might exist with any particular node.

Network analysis was used to assess the interlinkages between SDG 6 and all the other SDGs based on data from the literature. It was then repeated using data from the stakeholder interviews. Once the full analyses had been completed, they were repeated using subsets of the same datasets to clarify linkages with SDG 6 indicators within the social, economic, environmental and governance sectors.

CHAPTER 5: RESEARCH RESULTS AND DISCUSSION

5.1 OVERVIEW

The SDG interactions are diverse and extremely complex. They can also be infinite, becoming a vortex of linkages and connections without categoric conclusions to help decision makers establish solid departure points to move SDG implementation in an integrated manner. This chapter presents and discusses the results of the analysis of the literature review and stakeholder engagement using network analysis, following an effort to understand the linkages between the indicators of SDG 6 and the indicators of the other SDGs. The aim of this chapter is to provide the extent that linkages between the indicators of SDG 6 have with the indicators of the other SDGs so as to formulate clear recommendations and conclusions for the concerted implementation of the SDG indicators that are interlinked with indicators of SDG 6.

The results presented in this chapter highlight the identified synergies, trade-offs and implications for implementation between the indicators of SDG 6 and the indicators of the other SDGs. Below are the definitions of the key words that have shaped the analysis:

- **Synergies** are interlinkages that are positive and may be mutually reinforcing and, when combined, produce a greater impact.
- **Constraints or trade-offs** are interlinkages that still have positive aspects when executed individually, but have negative effects when implementation is conducted in tandem with another SDG that conflicts with or lessens the other goal's effect to deliver sustainable development. Trade-offs are evident when two goals conflict with each other in order to deliver their respective intentions.
- **Implications for implementation** denote the factors that implementers of SDGs need to be aware of in realising interlinked SDGs**.** For the purpose of this study, the factors for the implications of implementation have been restricted to policy and institutional implications, technological considerations and data considerations.
  - **Policy and institutional implications** are factors that need to be considered for the integrated implementation of interlinked indicators in relation to the policy and institutional landscape.
  - **Technological implications** are the technological shifts that are required to support the implementation of interlinked indicators.
  - **Data considerations**, at a first level, refer to indicators that are connected based on the fact that the same data is used to report on either indicator. At a second level, they refer to interlinked indicators that would benefit from being reported on using the same data. At a third level, they refer to the impact a shortage of data in one indicator would have on the other indicators, ultimately achieving the concerted implementation of interlinked indicators.

5.1.1 Links from literature

The output of a social network analysis on indicator interlinkages is shown in Figure 5.1. In assessing the results of this analysis, it is important to bear in mind that this is not a full analysis of the indicators shown, but is one that only focuses on interlinkages with SDG 6 and ignores other interactions between indicators. The SDGs are colour coded to indicate into which broad group they fall: interlinkages are coded blue and maroon to indicate whether they represent synergies or trade-offs, respectively. Raw data is presented in Appendix A:

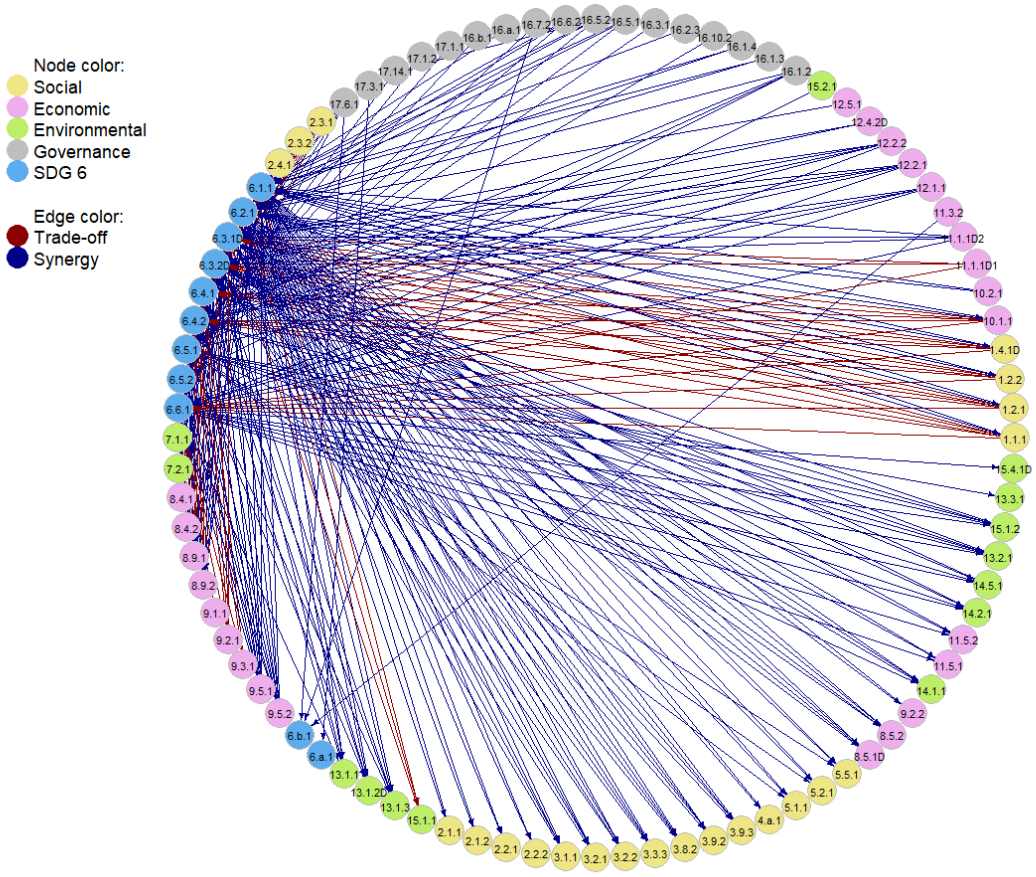


Figure 5.1: Output of a social network analysis of interlinkages between indicators of SDG 6 and other SDG indicators as identified in literature from South Africa

The degree of any node is a basic measure of connectedness, as it assesses how many other nodes are directly linked to it. An assessment of the interlinkages presented in Figure 5.1 reveals that indicators 6.1.1 (drinking water), 6.2.1 (sanitation and hygiene), 6.3.2D (water quality goals), 6.3.1D (wastewater safely treated), 6.6.1 (water-related ecosystems), 6.5.1 (IWRM), 6.4.1 (water-use efficiency) and 6.4.2 (water stress) are the most interlinked of the SDG 6 indicators (Table 5.1). This group has between 24 and 44 interlinkages at each indicator. These interlinkages include synergies and trade-offs, as is evident from inspection of Figure 5.1.

In the case of indicator 6.2.1 (sanitation and hygiene), interlinkages are largely synergies, and it is apparent that achieving indicator 6.2.1 will aid in achieving a number of other indicators. Achieving the goals indicated by indicator 6.6.1 (water-related ecosystems) would likewise support a number of other indicators, but achieving these indicators is constrained by progress towards a number of indicators. Progress towards indicators 6.4.1 (water-use efficiency) and 6.4.2 (reduced water stress) is also constrained by trade-offs with other indicators. Connectedness, as a degree, of all nodes is presented in Table 5.1.

All other indicators of SDG 6 were revealed to be much less connected, with indicator 6.5.2 (transboundary basins), having five interlinkages, ranging down to 6a.1 (development assistance), which was connected to only one other indicator. As these other indicators of SDG 6 are less interlinked with other SDG indicators, they have relatively few synergies and trade-offs. As such, progress toward these indicators is not affected much by progress towards other indicators, and they, in turn, have little effect on other indicators.

Given that this report assessed interlinkages with SDG 6 indicators, it is not surprising that the most interlinked indicators assessed were from SDG 6. Other indicators that were highly interlinked with SDG 6 are indicators 8.9.1 (tourism-directed GDP), 8.9.2 (sustainable tourism jobs), 9.5.1 (business R&D spend) and 9.5.2 (proportion of researchers), all of which had nine identified links with indicators of SDG 6. These SDG 9 indicator links were all synergies, whereas the SDG 8 indicator links were a mix of synergies and trade-offs. Beyond this, other indicators have a decreasing number of links to SDG 6, as shown in Table 5.1.

Table 5.1: Count of direct links (degree) to indicators of SDG 6 when assessing links identified from the relevant literature between indicators of SDG 6 and all other SDG indicators

Degree shows the total number of links associated with an indicator; outdegree is the number of links from that indicator; indegree is the number of links to that indicator; and all degrees is the indegree and outdegree combined. Links are identified as synergies and trade-offs throughout.

			Outdegree		Indegree		All degrees	
Indicator no.	**Indicator description**	**Degree**	**Synergies**	**Trade-offs**	**Synergies**	**Trade-offs**	**Synergies**	**Trade-offs**
6.1.1	Proportion of population with safe drinking water	44	31	1	12	0	43	1
6.2.1	Proportion of population with safe sanitation, and water, sanitation and hygiene (WASH)	44	32	1	11	0	43	1
6.3.2D	Proportion of water bodies achieving water quality goals	42	21	0	10	11	31	11
6.3.1D	Proportion of wastewater safely treated and discharged	35	16	1	8	10	24	11
6.6.1	Change in the extent of water-related ecosystems over time	32	8	0	10	14	18	14
6.5.1	Implementation of IWRM	28	13	0	15	0	28	0
6.4.1	Changed water-use efficiency	27	5	0	9	13	14	13
6.4.2	Level of water stress	24	2	0	9	13	11	13
8.9.1	Tourism-directed gross domestic product (GDP)	9	0	3	6	0	6	3
8.9.2	Proportion of sustainable tourism jobs	9	0	3	6	0	6	3
9.5.1	Business expense on research and development (R&D)	9	9	0	0	0	9	0
9.5.2	Proportion of researchers	9	9	0	0	0	9	0
1.1.1	Proportion of population below the international poverty line	7	0	5	2	0	2	5
1.2.1	Proportion of population below the national poverty line	7	0	5	2	0	2	5
1.2.2	Proportion of population in poverty	7	0	5	2	0	2	5
1.4.1D	Proportion of population in households with basic services	7	0	5	2	0	2	5
2.3.1	Production per labour unit at enterprise size	7	0	5	2	0	2	5
2.3.2	Income of small-scale farmers	7	0	5	2	0	2	5
2.4.1	Proportion of agricultural area that is productive and sustainable	7	0	5	2	0	2	5
10.1.1	Increasing household expenditure in poorest 40%	7	0	5	2	0	2	5
17.6.1	Number of science or technology programmes between countries	7	7	0	0	0	7	0
6.5.2	Transboundary basins with cooperative management	5	2	0	3	0	5	0

			Outdegree		Indegree		All degrees	
Indicator no.	**Indicator description**	**Degree**	**Synergies**	**Trade-offs**	**Synergies**	**Trade-offs**	**Synergies**	**Trade-offs**
8.4.1	Material footprint	5	5	0	0	0	5	0
8.4.2	Domestic material consumption	5	5	0	0	0	5	0
9.2.1	Manufacturing value-add	5	0	5	0	0	0	5
12.2.1	Material footprint per GDP	5	5	0	0	0	5	0
12.2.2	Domestic consumption per GDP	5	5	0	0	0	5	0
13.1.1	Proportion of disaster-related death	5	0	0	5	0	5	0
13.1.2D	Number of disaster risk reduction strategies	5	0	0	5	0	5	0
13.1.3	Proportion of local governments with disaster risk reduction strategies	5	0	0	5	0	5	0
13.2.1	Nationally determined contributions, strategies, plans, etc. for climate change	5	0	0	5	0	5	0
15.1.2	Proportion of terrestrial and freshwater biodiversity sites that are protected	5	0	0	5	0	5	0
3.1.1	Maternal mortality ratio	4	0	0	4	0	4	0
3.2.1	Proportion of births with health professionals	4	0	0	4	0	4	0
3.2.2	Neonatal mortality rate	4	0	0	4	0	4	0
3.3.3	Malaria incidence	4	0	0	4	0	4	0
3.8.2	Proportion of population with large health expenditure	4	0	0	4	0	4	0
3.9.2	Mortality rate owing to unsafe water, sanitation or WASH	4	0	0	4	0	4	0
3.9.3	Mortality owing to unintentional poisoning	4	0	0	4	0	4	0
8.5.1D	Average monthly earnings	4	0	0	4	0	4	0
8.5.2	Unemployment rate	4	0	0	4	0	4	0
11.1.1D2	Proportion of informal households with basic services	4	4	0	0	0	4	0
12.1.1	Countries with sustainable consumption and production action plans	4	4	0	0	0	4	0
14.1.1	Coastal eutrophication and plastic debris index	4	0	0	4	0	4	0
14.2.1	Proportion of exclusive economic zone (EEZ) managed using ecosystem-based approaches	4	0	0	4	0	4	0
14.5.1	Coverage of protected areas in relation to marine areas	4	0	0	4	0	4	0
16.1.2	Proportion of conflict-related death	4	4	0	0	0	4	0
16.5.2	Proportion of businesses bribed (or asked) in last year	4	3	0	1	0	4	0

			Outdegree		Indegree		All degrees	
Indicator no.	**Indicator description**	**Degree**	**Synergies**	**Trade-offs**	**Synergies**	**Trade-offs**	**Synergies**	**Trade-offs**
5.1.1	Promote, enforce and monitor equality on the basis of sex	3	0	0	3	0	3	0
5.2.1	Proportion of women and girls 15 years and older subjected to violence by partner	3	0	0	3	0	3	0
5.5.1	Proportion of seats held by women in national and local government	3	0	0	3	0	3	0
6b.1	Proportion of local water administration with community input	3	0	0	3	0	3	0
7.1.1	Proportion of population with electricity	3	0	3	0	0	0	3
7.2.1	Renewable energy share	3	3	0	0	0	3	0
9.3.1	Proportion of small-scale industry value-add	3	0	3	0	0	0	3
11.1.1D1	Proportion of urban population in informal settlements	3	0	3	0	0	0	3
11.5.1	Proportion of people directly affected by disasters	3	0	0	3	0	3	0
11.5.2	Direct economic loss owing to disasters	3	0	0	3	0	3	0
15.1.1	Forest area as a proportion of total land area	3	0	0	0	3	0	3
16.5.1	Proportion of people bribed (or asked) in last year	3	3	0	0	0	3	0
16.6.2	Proportion of population satisfied with last experience of public services	3	3	0	0	0	3	0
2.1.1	Prevalence of undernourishment	2	0	0	2	0	2	0
2.1.2	Prevalence of moderate or severe food insecurity	2	0	0	2	0	2	0
2.2.1	Prevalence of stunting among children under five years of age	2	0	0	2	0	2	0
2.2.2	Prevalence of malnutrition among children under five years of age	2	0	0	2	0	2	0
4a.1	Proportion of schools with services	2	0	0	2	0	2	0
9.2.2	Proportional of employment as manufacturing	2	0	0	2	0	2	0
10.2.1	Proportional of population below median income with disabilities	2	2	0	0	0	2	0
12.4.2D	Hazardous waste per capita	2	2	0	0	0	2	0
16.1.3	Proportion of population subjected to violence in last year	2	2	0	0	0	2	0
16.1.4	Proportion of population feeling safe walking alone near home	2	2	0	0	0	2	0
16.7.2	Proportion of population believing decision making is inclusive and responsive	2	2	0	0	0	2	0
17.14.1	Mechanisms to enhance policy coherence of sustainable development	2	2	0	0	0	2	0

			Outdegree		Indegree		All degrees	
Indicator no.	**Indicator description**	**Degree**	**Synergies**	**Trade-offs**	**Synergies**	**Trade-offs**	**Synergies**	**Trade-offs**
6a.1	Amount of water- and sanitation-related official development assistance	1	0	0	1	0	1	0
9.1.1	Proportion of rural population near all-season road	1	0	1	0	0	0	1
11.3.2	Proportion of cities with direct participation of civil society	1	1	0	0	0	1	0
12.5.1	National recycling rate	1	1	0	0	0	1	0
13.3.1	Integrated mitigation, adaptation, impact reduction, etc. into educational curricula	1	0	0	1	0	1	0
15.2.1	Progress towards sustainable forest management	1	1	0	0	0	1	0
15.4.1D	Percentage of mountain ecosystem types represented in protected areas	1	0	0	1	0	1	0
16.10.2	Countries with guarantees for public access to information	1	1	0	0	0	1	0
16.2.3	Proportion of people aged 18-29 years who experienced sexual violence by age 18	1	1	0	0	0	1	0
16.3.1	Proportion of victims of violence reporting crime in last year	1	1	0	0	0	1	0
16a.1	Independent national human rights institutions complying with Paris Principles	1	1	0	0	0	1	0
16b.1	Proportion of population reporting having personally felt discriminated against	1	1	0	0	0	1	0
17.1.1	Total government revenue as a proportion of GDP	1	1	0	0	0	1	0
17.1.2	Proportion of domestic budget funded by domestic taxes	1	1	0	0	0	1	0
17.3.1	Foreign investment and assistance as a proportion of total domestic budget	1	1	0	0	0	1	0

An inspection of Figure 5.1 reveals the complexity of links between indicators, even when only indicators linked to SDG 6 are considered. In many cases, one particular indicator might be linked to a number of others through links that include synergies, as well as trade-offs. Nevertheless, as Figure 5.1 shows, some generalities can be made about the interlinkages that were identified. Firstly, it is important to note that the great majority of links to indicators of SDG 6 are synergies. This has two major implications. The first is that improving indicator scores for SDG 6 should improve the indicator scores of most linked SDG indicators. The other is that improvements in most SDG indicator scores should benefit the SDG 6 indicator scores. However, there are some exceptions. For example, indicators of SDG 1 (no poverty) often had trade-offs with indicators of SDG 6, and the implication is that progress towards reduced poverty may have negative implications for achieving the targets of SDG 6. In Figure 5.1, the indicators 1.1.1, 1.2.1 and 1.2.1 (all indicators of poverty in the population) and 1.4.1D (basic services in households) constrain improvements in water, suggesting that steps to reduce poverty may have a negative impact on indicators of SDG 6. Most of the remaining trade-offs were linked to indicators in SDG 8 (decent work and economic growth) and SDG 9 (industry, innovation and infrastructure), where growth in economy and infrastructure might challenge water resource integrity and supply.

5.1.2 Links from stakeholder interviews

The output of a social network analysis of interlinkages between SDG indicators identified by key respondents is presented in Figure 5.2, and can be compared to the results of the literature review presented in Figure 5.1. The respondents were identified from groups responsible for realising progress towards SDG targets in South Africa, and other officials exposed to this process. It is important to bear in mind that this is not a full analysis of the indicators shown, but only focuses on interlinkages with SDG 6 and ignores other interactions between indicators. Raw data is presented in Appendix A.

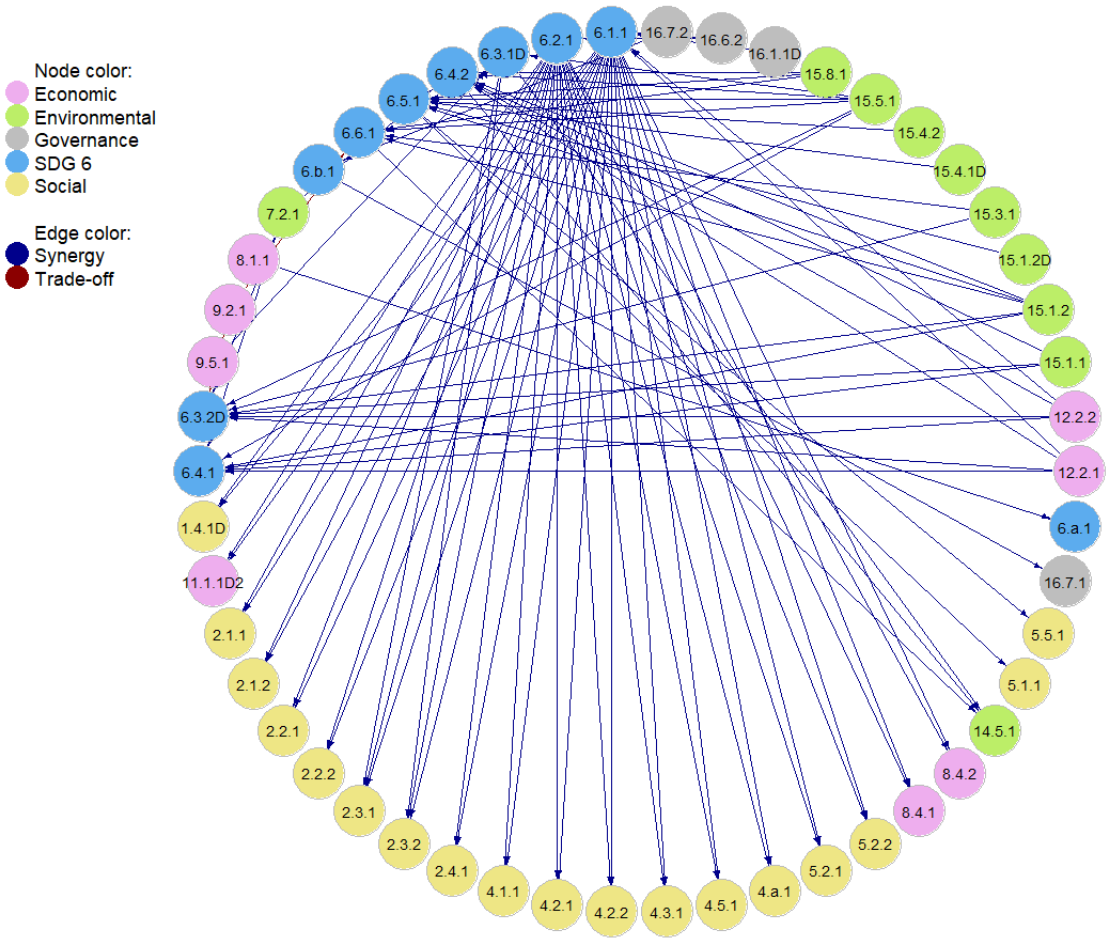


Figure 5.2: Output of a social network analysis of interlinkages between indicators of SDG 6 and other SDG indicators as identified by respondents with responsibility for or exposure to programmes for achieving SDGs in South Africa

The degree of any node is a basic measure of connectedness, as it assesses how many other nodes are directly linked to it. As such, a higher degree for any node indicates how many other nodes influence it or are influenced by it. A higher degree therefore assists in showing which indicators might be prioritised on the basis that these might have knock-on effects, or which nodes might have trade-offs with other indicators. Connectedness of the indicators in Figure 5.2 is given in Table 5.2.

Table 5.2: Count of direct links (degree) between indicators when assessing links identified by respondents between indicators of SDG 6 and all other SDG indicators

Degree shows the total number of links associated with an indicator; outdegree is the number of links from that indicator; indegree is the number of links to that indicator; and all degrees is the indegree and outdegree combined. Links are identified as synergies and trade-offs throughout.

			Outdegree		Indegree		All degrees	
Indicator no.	**Indicator description**	**Degree**	**Synergies**	**Trade-offs**	**Synergies**	**Trade-offs**	**Synergies**	**Trade-offs**
6.1.1	Proportion of population with safe drinking water	23	19	0	4	0	23	0
6.2.1	Proportion of population with safe sanitation and WASH	20	19	0	1	0	20	0
6.3.2D	Proportion of water bodies achieving water quality goals	8	0	0	7	1	7	1
6.4.2	Level of water stress	8	1	0	7	0	8	0
6.5.1	Implementation of IWRM	8	2	0	6	0	8	0
15.5.1	Red List Index	6	6	0	0	0	6	0
6.4.1	Changed water use efficiency	6	0	0	6	0	6	0
6.6.1	Change in the extent of water-related ecosystems over time	6	1	0	4	1	5	1
6.3.1D	Proportion of wastewater safely treated and discharged	5	3	0	2	0	5	0
15.1.2	Proportion of terrestrial and freshwater biodiversity site that are protected	5	5	0	0	0	5	0
12.2.1	Material footprint per GDP	4	4	0	0	0	4	0
12.2.2	Domestic consumption per GDP	4	4	0	0	0	4	0
2.3.1	Production per labour unit at enterprise size	3	0	0	3	0	3	0
2.3.2	Income of small-scale farmers	3	0	0	3	0	3	0
7.2.1	Renewable energy share	3	3	0	0	0	3	0
14.5.1	Coverage of protected areas in relation to marine areas	3	0	0	3	0	3	0
15.1.1	Forest area as a proportion of total land area	3	3	0	0	0	3	0
15.8.1	Legislation and resources for the prevention or control of invasive alien species	3	3	0	0	0	3	0
1.4.1D	Proportion of population in households with basic services	2	0	0	2	0	2	0
2.1.1	Prevalence of undernourishment	2	0	0	2	0	2	0
2.1.2	Prevalence of moderate or severe food insecurity	2	0	0	2	0	2	0

			Outdegree		Indegree		All degrees	
Indicator no.	**Indicator description**	**Degree**	**Synergies**	**Trade-offs**	**Synergies**	**Trade-offs**	**Synergies**	**Trade-offs**
2.2.1	Prevalence of stunting among children under five years of age	2	0	0	2	0	2	0
2.2.2	Prevalence of malnutrition among children under five years of age	2	0	0	2	0	2	0
2.4.1	Proportion of agricultural area that is productive and sustainable	2	0	0	2	0	2	0
4.1.1	Proportion of children and young people proficient in reading and mathematics	2	0	0	2	0	2	0
4.2.1	Proportion of children under five years on track in health, learning, etc.	2	0	0	2	0	2	0
4.2.2	Participation rate in organised preprimary learning	2	0	0	2	0	2	0
4.3.1	Participation of youth or adults in formal or non-formal education	2	0	0	2	0	2	0
4.5.1	Parity indices for all education indicators	2	0	0	2	0	2	0
4a.1	Proportion of schools with services	2	0	0	2	0	2	0
5.2.1	Proportion of women and girls 15 years and older subjected to violence by partner	2	0	0	2	0	2	0
5.2.2	Proportion of women and girls 15 years and older subjected to violence by non-partner	2	0	0	2	0	2	0
6b.1	Proportion of local water administration with community input	2	1	0	1	0	2	0
8.4.1	Material footprint	2	0	0	2	0	2	0
8.4.2	Domestic material consumption	2	0	0	2	0	2	0
9.2.1	Manufacturing value-add	2	0	2	0	0	0	2
11.1.1D2	Proportion of informal households with basic services	2	0	0	2	0	2	0
15.3.1	Proportion of land that is degraded over total land area	2	2	0	0	0	2	0
16.6.2	Proportion of population satisfied with last experience of public services	2	2	0	0	0	2	0
5.1.1	Promote, enforce and monitor equality on the basis of sex	1	0	0	1	0	1	0
5.5.1	Proportion of seats held by women in national and local governments	1	0	0	1	0	1	0
6.a.1	Amount of water- and sanitation-related official development assistance	1	0	0	1	0	1	0
8.1.1	Annual growth rate of real GDP per capita	1	1	0	0	0	1	0
9.5.1	Business expense on R&D	1	1	0	0	0	1	0

			Outdegree		Indegree		All degrees	
Indicator no.	**Indicator description**	**Degree**	**Synergies**	**Trade-offs**	**Synergies**	**Trade-offs**	**Synergies**	**Trade-offs**
15.1.2D	Percentage of terrestrial or freshwater ecosystems that are well protected	1	1	0	0	0	1	0
15.4.1D	Percentage of mountain ecosystem types represented in protected areas	1	1	0	0	0	1	0
15.4.2	Mountain Green Cover Index	1	1	0	0	0	1	0
16.1.1D	Number of murder victims per 100 000 of the population	1	1	0	0	0	1	0
16.7.1	Proportions of positions in public institutions compared to national distributions	1	0	0	1	0	1	0
16.7.2	Proportion of population believing decision making is inclusive and responsive	1	1	0	0	0	1	0

Stakeholders identified nearly all links as synergies, with only two trade-offs identified between indicators 9.2.1 (manufacturing value add) and 6.3.2D (water quality goals achieved), and between indicators 9.2.1 (manufacturing value add) and 6.6.1 (water-related ecosystems).

Of the indicators presented in Figure 5.2, the most connected is indicator 6.1.1 (drinking water), followed closely by indicator 6.2.1 (sanitation and hygiene), with 23 and 20 links respectively. These are linked to indicators from a range of other SDGs and, given the dominance of synergies, progress in these indicators should have beneficial effects on the many linked indicators.

The next most connected indicators are indicators 6.3.2D (water quality goals achieved), 6.4.2 (water stress) and 6.5.1 (IWRM). All have eight links; far less than those identified for indicators 6.1.1 and 6.2.1 above. No stakeholders proposed that a better score in indicator 6.3.2D (water quality goals achieved) would lead to improvements in other indicators, which may be an oversight. However, improvements in seven other indicators were proposed as leading to an improvement in indicator 6.3.2D. Almost the same applied for indicator 6.4.2 (water stress), where improved scores in seven indicators should lead to an improved score for indicator 6.4.2. Indicator 6.5.1 (IWRM) was similar in that improvements in six linked indicators might support improvement in indicator 6.5.1.

The indicators listed so far are all from SDG 6. This is not surprising, as indicators of SDG 6 might be linked to all other SDG indicators, while other indicators can only be linked to indicators of SDG 6. According to stakeholders, indicator 15.5.1 (Red List index), which tracks the overall risk of extinction, was linked to six indicators of SDG 6. As a result, this indicator was highlighted as the indicator most likely to have a positive effect on indicator scores for SDG 6.

Three further SDG 6 indicators follow the above trend. Indicator 6.4.1 (water-use efficiency) can be affected by positive changes in six other SDG 6 indicators. Indicator 6.6.1 (water-related ecosystems) can be positively affected by improvements in four other indicators, but has a trade-off with indicator 9.2.1 (manufacturing value add). Indicator 6.6.1, in turn, has a positive effect on indicator 14.5.1 (protected area coverage). Finally, indicator 6.3.1D (amount of wastewater treated) is positively affected by improvements in two other SDG indicators, and itself can have a positive effect on indicators 14.5.1 (protected area coverage), 2.3.1 (production by labour) and 2.3.2 (small-scale farmer income).

Other SDG indicators follow the indicators of SDG 6 above in terms of their centrality score. Indicators 15.1.2 (biodiversity site protection), 12.2.1 (material footprint), 12.2.2 (domestic consumption), 2.3.1 (production by labour), 2.3.2 (small-scale farmer income), 7.2.1 (renewable energy), 14.5.1 (protected area coverage), 15.1.1 (forest area) and 15.8.1 (invasive alien control) are all linked with three or more indicators of SDG 6. All of these are synergies. Indicators 15.1.2 (biodiversity site protection), 12.2.1 (material footprint), 12.2.2 (domestic consumption), 7.2.1 (renewable energy), 15.1.1 (forest area) and 15.8.1 (invasive alien control) all have positive effects on several SDG 6 indicators when they improve, but they are not affected by changes in any SDG 6 indicator. On the other hand, indicators 2.3.1 (production by labour), 2.3.2 (small-scale farmer income) and 14.5.1 (protected area coverage) are all affected by changes in several SDG 6 indicators, but changes to the scores of these indicators were not predicted to have any effect on SDG 6 indicator scores.

The general trends identified by stakeholders in links between SDG 6 and other indicators include a great dominance of synergies, and only two trade-offs. According to stakeholder understanding, therefore, SDG 6 in South Africa is likely to support and be supported by progress in other SDGs, with very few constraints. Another clear generality is the identified importance of indicators 6.1.1 (drinking water) and 6.2.1 (sanitation and hygiene). The links between these indicators and other SDG indicators are all synergies, and they indicate the perceived importance of drinking water and safe sanitation in achieving other SDG indicators.

The importance of indicators 6.1.1 (drinking water) and 6.2.1 (sanitation and hygiene) in achieving other indicators makes these indicators something of an anomaly among other SDG 6 indicators as, in this analysis, other SDG 6 indicators are more commonly affected by changes in other indicators rather than leading to changes in linked indicators.

5.1.3 Comparison of network analyses

One broad area of difference between the two analyses presented in Figure 5.1 and Figure 5.2 lies in the different assessment of the importance of trade-offs between indicators. In Figure 5.1, although the majority of links are synergies, trade-offs are still clearly present. Figure 5.2, on the other hand, shows a great majority of synergies, with only two trade-offs between indicators 9.2.1 (manufacturing value-add) and 6.3.2D (water quality goals achieved), and between indicators 9.2.1 (manufacturing value-add) and 6.6.1 (water-related ecosystems).

Another broad difference between the analysis based on literature and the analysis based on stakeholder interviews is the number of links identified. Inspection of Figure 5.1 reveals that far more links were found than in Figure 5.2, and that the increased number of links involved a greater number of indicators. The reason for this is not clear, although it is possible that, during the interviews, stakeholders listed a few more obvious links, without considering the more tentative links that were found in the literature. It is also possible that, if a greater number of stakeholders had been approached, the number of identified links might increase.

Both analyses were in agreement that the most strongly interlinked indicators were indicators 6.1.1 (drinking water) and 6.2.1 (sanitation and hygiene). However, these had more in common than simply the number of links. In both cases, the links identified were overwhelming synergies, and the nature of the links indicate that, in a large majority of cases, improvements in the scores of indicators 6.1.1 and 6.2.1 are likely to lead to improved scores in other linked indicators. It is far less common that improvements in other indicators would lead to changes in indicators 6.1.1 and 6.2.1. The extensive number of links, and the fact that they are synergies, where changes in the identified indicators should have beneficial effects on other indicators, means that progress in these indicators may lead to progress in other indicators from a range of SDGs.

In Figure 5.2, the number of links to indicators 6.1.1 (drinking water) and 6.2.1 (sanitation and hygiene) clearly outweighed other indicators in the analysis. However, in Figure 5.1, indicators 6.3.2D (water quality goals achieved), 6.3.1D (wastewater treatment), 6.6.1 (water-related ecosystems), 6.5.1 (IWRM), 6.4.1 (water-use efficiency) and 6.4.2 (water stress) all had clearly more links than other SDG 6 indicators. In addition, these SDG 6 indicators all had more links than indicators of any other SDG. In the analysis of the literature, all of these, except indicator 6.5.1 (IWRM), had significant constraints from other indicators via trade-offs. In contrast, the analysis from stakeholder interviews had only two trade-offs, with indicators 9.2.1 (manufacturing value-add) and 6.36.2D (water quality goals achieved), and with indicators 9.2.1 (manufacturing value-add) and 6.6.1 (water-related ecosystems). The remainder of the links involving this set of SDG 6 indicators involved only synergies. However, as in the literature analysis, there was less emphasis on how changes to the indicators might impact others, but rather that these indicators respond to changes in other indicators.

In the literature analysis, the other SDGs most often linked were, in order of frequency, SDG 8 (as indicators 8.9.1 (tourism-directed GDP) and 8.9.2 (sustainable tourism jobs)), SDG 9 (as indicators 9.5.1 (business R&D spend) and 9.5.2 (proportion of researchers)), SDG 1 (as indicators 1.1.1 (population below the international poverty line), 1.2.1 (population below the national poverty line), 1.2.2 (population in poverty) and 1.4.1D (households with basic services)) and SDG 2 (as indicators 2.3.1 (labour production), 2.3.2 (small-scale farmers income) and 2.4.1 (productive agricultural area)).

These SDG 8 indicators were supported by progress with SDG 6 indicators, but could constrain some SDG 6 progress. The SDG 9 indicators, both related to commitment to research, strongly support SDG 6. Indicators of SDG 1, largely indicators of poverty, were found to constrain progress in SDG 6, although, in some cases, progress in SDG 6 supported indicators of SDG 1. A similar situation was found with the indicators of SDG 2, which deal with production by labour and agriculture. Progress towards identified SDG 2 indicators constrained progress towards the SDG 6 indicators, while progress in some SDG 6 indicators supported SDG 2 indicators.

The results of the analysis of stakeholder interviews identified different SDGs as being strongly linked to SDG 6. SDG 15 (as indicators 15.5.1 (Red List Index) and 15.1.2 (biodiversity site protection)) was the most linked, followed by SDG 12 (as indicators 12.2.1 (material footprint) and 12.2.2 (domestic consumption)), and SDG 2 (as indicators 2.3.1 (labour production) and 2.3.2 (small-scale farmer production)). Here, indicators of SDG 15 strongly supported indicators for SDG 6. SDG 12 was also found to strongly support indicators of SDG 6. Progress towards the identified SDG 2 indicators was not reported here to impact on indicators of SDG 6 (despite the constraints found in the literature analysis), but progress in SDG 2 was supported by progress in SDG 6.

Both analyses were in agreement that indicators 6a.1 (development assistance in water and sanitation) and 6b.1 (community water administration) were not significantly interlinked. As a result, changes in these indicators are not likely to impact on other indicators and vice versa. This is in contrast with other SDG 6 indicators.

5.2 WATER AND SANITATION LINKAGES WITH THE DIMENSIONS OF THE 2030 AGENDA

This section presents interlinkages between SDG 6 and other SDGs. Interlinkages have been categorised using the three pillars of sustainable development: social, economic and environmental. To that end, 15 goals have been grouped according to social, economic and environmental goals. The groupings allow for simplified reading and intimate engagement with each of the goals. The remaining goals, SDG 16 and SDG 17, have been grouped under the categories peace, justice and strong institutions, and partnerships for the goals.

As noted in section 5.1, two sources of information inform the results of the analysis: literature and stakeholders. To reflect these two sources of information in the sections below, the following safeguards have been used, not only to provide credibility to the sources of information, but also to indicate areas of divergence between the two sources of information, as well as areas of concert:

- Where an interlinkage has been identified through both sources, reference is made that the interaction is informed by both streams of sources.
- Where one of the sources of information identifies the linkage, the source of information is referenced individually.
- Where the interlinkage is identified by the two streams, yet they diverge with regard to whether the linkage is a trade-off or a synergy, the divergence is noted as reflected from the two streams of information.

5.2.1 Social goals

Results from the network analysis

This section presents the results of linkages between SDG 6 and the social goals. The social goals include the following:

- SDG 1: No poverty
- SDG 2: Zero hunger
- SDG 3: Good health and wellbeing

- SDG 4: Quality education
- SDG 5: Gender equality

The interlinkages of indicators of SDG 6 with indicators of social goals were identified from both the literature and stakeholder engagement. The visual links of how indicators of SDG 6 inherently interlink with social goals indicators are shown in Figure 5.3 and Figure 5.4.

The results showed that 96 interlinkages were identified from the literature. Of those, 61 were synergies and 35 were trade-offs (Figure 5.3). Stakeholder analysis showed that 36 synergies were identified with no trade-offs (Figure 5.4). The literature analysis showed that the highest positive interlinkages (synergies) were found between SDG 3 (good health and wellbeing) and SDG 6 (water and sanitation) indicators, while SDG 1 (no poverty) and SDG 2 (zero hunger) had the highest negative interaction (trade-offs) with SDG 6 (water and sanitation) indicators (Figure 5.3). On the other hand, the results from stakeholder engagement analysis showed that respondents only identified synergies. The reason behind the differences between the literature and stakeholder results was the lack of stakeholder participation from SDG 3 focal persons.

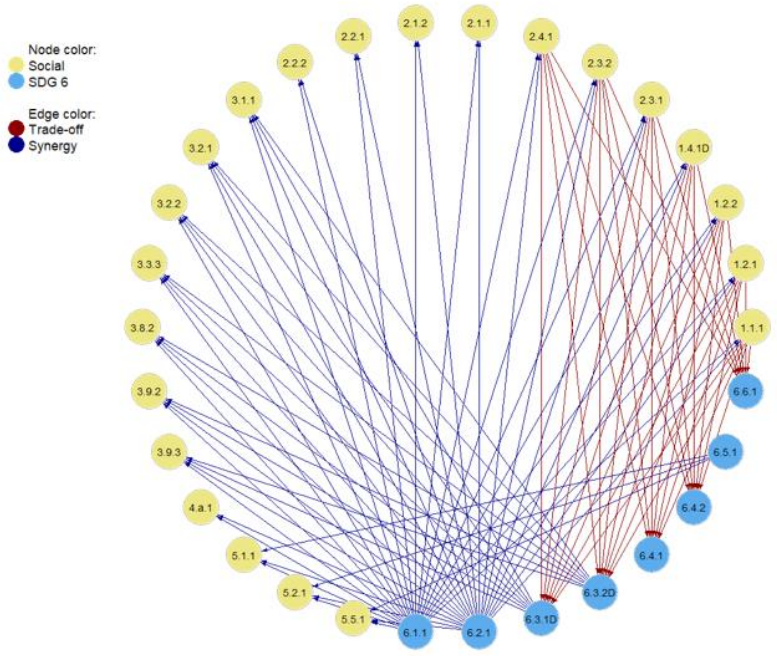


Figure 5.3: Output of a social network analysis of interlinkages between indicators of SDG 6 and social SDG indicators as identified in literature from South Africa

SDG 1 calls for measures to end poverty in all forms. SDG 6, as a catalyst for social wellbeing and an enabler for economic activities, has a critical role to play in supporting the full realisation of indicators of SDG 1. From the literature, four synergies were identified. These interlinkages were between access to safe drinking water (indicator 6.1.1) and eradicating extreme poverty for all people (indicator 1.1.1), reducing poverty in all its dimensions (indicators 1.2.1 and 1.2.2) and ensuring access to basic services (indicator 1.4.1). Findings from the stakeholder survey revealed only one direct synergy, which was evident between access to basic services (indicator 1.4.1), and access to safe drinking water (indicator 6.1.1). These results showed that SDG 6 presents vital opportunities for helping households and individuals break out of the scourge of poverty. It is clear that ensuring adequate and reliable water supplies for agricultural activities (including livestock, horticulture and other types of production) is a key to poverty reduction, especially in rural areas where poor people depend on freshwater ecosystems for their livelihoods.

The other four synergies identified from the literature were between access to sanitation and hygiene services (indicator 6.2.1) and eradicating extreme poverty for all people (indicator 1.1.1), reducing poverty in all its dimensions (indicators 1.2.1 and 1.2.2) and ensuring access to basic services (indicator 1.4.1). The reasoning for these synergies is that better health and nutrition through sanitation and hygiene services enables people to work more productively at home, at school and in the workplace, thus maximising their earning potential and reducing poverty. The stakeholder survey had one synergy, which was evident between access to basic services (indicator 1.4.1) and sanitation services (indicator 6.2.1).

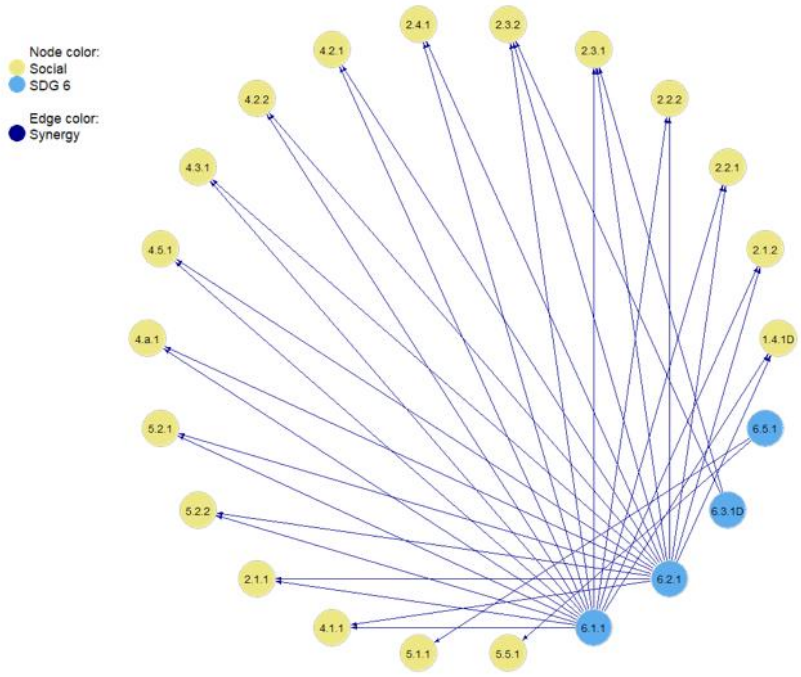


Figure 5.4: Output of a social network analysis of interlinkages between indicators of SDG 6 and social SDG indicators as identified by respondents with responsibility for or exposure to programmes for achieving SDGs in South Africa

Twenty trade-offs were also identified between indicators of SDG 1 and SDG 6, where increasing access to basic services such as food (indicator 1.4.1) and development in eradicating poverty (indicator 1.1.1) and reducing poverty (indicators 1.2.1 and 1.2.2) can have negative impacts on ambient water quality (indicators 6.3.1 and 6.3.2), water availability (indicators 6.4.1 and 6.4.2) and ecosystems (indicator 6.6.1) if care is not taken to reduce pollution, use water sustainably and protect ecosystems (UN-Water, 2016). As mentioned above, all these trade-offs emerged from the literature analysis since respondents identified no trade-offs.

For SDG 2, which targets hunger, food security, nutrition and agriculture, SDG 6 has a key role to play in anchoring the growth, production and preparation of food and reducing undernutrition through access to safe and adequate WASH services. Both the literature and stakeholder analysis found the same 14 synergies between SDG 2 and SDG 6. The strong interlinkages between SDG 2 (zero hunger) and SDG 6 (water and sanitation) are based on the argument that food production and sustainable agriculture are strongly dependent on water availability. The results showed that increasing access to sufficient food for the poor (indicators 2.1.1 and 2.1.2), ending malnutrition (indicators 2.2.1 and 2.2.2) improving agricultural productivity (indicators 2.3.1 and 2.3.2) and ensuring sustainable food production (indicator 2.4.1) can only be achieved through access to clean water and sanitation (indicators 6.1.1 and 6.2.1).

On the other hand, 15 trade-offs were also identified from the literature where action towards poverty alleviation, such as increasing access to basic services like food, double agricultural productivity (indicator 2.3.1), the incomes of small-scale producers (indicator 2.3.2) and increased sustainable food production (indicator 2.4.1), can have negative impacts on ambient water quality (indicators 6.3.1 and 6.3.2), water availability (indicators 6.4.1 and 6.4.2) and ecosystems (indicator 6.6.1), if care is not taken to reduce pollution, use water sustainably and protect ecosystems. Thus, a negative inter-relation exists between these indicators (UN-Water, 2016).

SDG 3 aims to ensure healthy lives and promote wellbeing of all ages. One of the key determinants of health and wellbeing is access to safe water and the use of or access to services that prevent diseases. Safe drinking water, and adequate sanitation and hygiene are fundamental to protecting health, and contribute directly to achieving good health and wellbeing. Twenty-eight positive interlinkages were identified between SDG 3 (good health and wellbeing) and six indicators, while no trade-offs were identified.

The foundation for the interlinkages is based on the argument that the provision of safe, equitable water (indicator 6.1.1) and sanitation services (indicator 6.2.1), coupled with the commitment to improve water quality (indicator 6.3.1D) and reduce the pollution of water resources (indicator 6.3.2D), contributes to reducing maternal mortality (indicator 3.1.1), the under-five mortality rate (indicator 3.2.1), neonatal mortality (indicator 3.2.2), exposure to waterborne diseases such as malaria (indicator 3.3.3) and access to quality and affordable essential healthcare services for all (indicator 3.8.2). The World Health Organisation (WHO) (2020) also suggested that access to safe water, sanitation and hygiene services is essential for human health protection during COVID-19. Ensuring evidence-based and consistently applied WASH practices in communities and healthcare facilities will help prevent the transmission of the virus and reduce the number of deaths caused by COVID-19.

Access to safe water, sanitation services and improved water quality result in a reduction of deaths due to unintentional poisoning, unsafe sanitation and lack of hygiene. In South Africa, unintentional poisoning accounted for 0.2 deaths per 100 000 of the population in 2011, which reached a high of 0.4 deaths per 100 000 of the population in 2013. By 2015, the rate had declined to the 2011 level (Stats SA, 2019). This demonstrates positive interlinkages between WASH indicators (indicators 6.1.1 and 6.2.1) and reducing the number of deaths due to ambient air pollution (indicator 3.9.2) and deaths from chemicals, water and soil pollution (indicator 3.9.3).

SDG 4 aims to ensure inclusive and equitable quality education and promote lifelong learning opportunities for all. The learning process is severely affected by a lack of access to basic services, such as electricity, basic drinking water, basic sanitation services and handwashing facilities. Therefore, achieving access to safe drinking water and sanitation services must include achieving such access at schools. In the literature, two synergies were identified between access to safe drinking water (indicator 6.11), sanitation services (indicator 6.2.1) and schools with access to basic services (indicator 4a.1). Results from the stakeholder interviews showed 12 synergies between access to safe drinking water (indicator 6.11), sanitation services (indicator 6.2.1) and improving education, such as ensuring that all complete education (indicator 4.1.1), have access to quality early childhood development (indicator 4.2.1), youth and adults in formal and non-formal education (indicator 4.3.1), eliminate gender disparities in education (indicator 4.5.1) and schools with access to basic services (indicator 4a.1).

These interlinkages are related to cases where adequate sanitation facilities are lacking, for example concerns over safety and menstrual hygiene management may keep girls away from school or compromise their learning. It was also indicated that, in response to the urgent need for running water at schools in the time of COVID-19, provinces have directly submitted the numbers of schools requiring the provision of emergency water. It is clear that water and sanitation services are essential

in improving education for all in schools. There were no trade-offs identified between SDG 4 and SDG 6.

SDG 5 aims to achieve gender equality and empower all women and girls. The interaction between SDG 6 and SDG 5 stems from the fact that, through IWRM dimensions, there is room to implement gender-responsive policies that address women's specific needs and strengthen or establish water sector institutions or platforms that promote women's involvement in the water sector.

Nine synergies were identified from the literature. These interlinkages relate to the commitment to end all forms of discrimination (indicator 5.1.1), eliminate violence against all women and girls (indicator 5.2.1) and ensure women's full and effective participation and equal opportunities (indicator 5.5.1), intertwined with access to safe drinking water (indicator 6.1.1), sanitation services (indicator 6.2.1) and the implementation of IWRM (indicator 6.5.1).

From stakeholder results, six synergies were identified. These were the same as the literature, except for synergies between eliminating sexual violence (indicator 5.2.2) and access to safe water (indicator 6.1.1) and sanitation services (indicator 6.2.1). One participant from the stakeholder interviews indicated the risks of violence against women in communities where poor WASH access is a well-known problem, for example, "the well-known case of a woman who was sexually assaulted and killed in Cape Town because she had to go to the loo at night". This shows a synergy between sexual violence (indicator 5.2.2) and access to safe drinking water (indicator 6.1.1) and sanitation services (indicator 6.2.1). No trade-offs were identified in either the literature or the stakeholder interviews.

Synthesis

From both the literature and stakeholder analysis, the results indicate that positive interlinkages (synergies) between SDG 6 (water and sanitation) and the other social SDGs clearly outweigh the negative interlinkages (trade-offs). Similarly, a study conducted by Pradhan et al. (2017) around synergies and trade-offs, based on correlations of indicator values for all SDGs, found that synergies outweigh trade-offs. The results showed that, from the social dimension, a pattern of goals with greater collections of interlinkages was from SDG 3 (good health and wellbeing) and SDG 2 (zero hunger), which contained the most synergies, while SDG 1 (no poverty), and SDG 2 (zero hunger) contained the most trade-offs. Achieving SDG 3 (good health and wellbeing) will rely on the build-up of much stronger linkages between communities and agencies in water areas to enable a more holistic approach to health and water governance, including in terms of strengthening the capacity to manage the synergies between the two SDGs. This entails clustering the synergies between the indicators of SDG 6 and the social goals indicators around areas that support livelihood improvement and reduce deaths, which may result due to poor access to water and sanitation services.

Trade-offs between indicators of SDG 6 and the social goals indicators were concentrated among indicators whose efforts to alleviate poverty and hunger constrained the integrity of water resources, and also affected water supply. In order to address critical areas where more trade-offs were identified – SDG 1 (no poverty) and SDG 2 (zero hunger) – there is an urgent need for scientists or researchers in agriculture and water resources disciplines to share knowledge and collaborate more. Research institutions and universities should develop research and science infrastructure facilities, and Big Data platforms, and direct resources and funds towards SDG fields. Government stakeholders from the national, provincial and municipal spheres also need to collaborate and partner more with the private sector, farmers' associations and local people. The results suggest that improving agriculture to address food insecurity might negatively affect water resources, therefore smart approaches to water use in agriculture are needed. The increase in food production in a sustainable manner will require coherent water-food policies. The Water-Energy-Food (WEF) nexus approach is intended to address this problem, specifically by encouraging more communication,

coordinated partnerships and interdisciplinary planning between the three sectors to avoid these resource-use conflicts.

Key dimensions and implications for implementation

SDG 1 (no poverty) and SDG 6 (water and sanitation

Policy and institutional implications: Good governance and careful planning are critical for managing the trade-offs between SDG 6 and SDG 1. Furthermore, mitigation measures and effective policy practice will be necessary. The National Water Act exists as South Africa's principal regulation for decoupling social development and poverty eradication from environmental degradation.

Technological considerations: Technological advancements that support poverty alleviation, as well as environmental integrity, should be fully explored.

Data considerations: SDG 1 and SDG 6 share data connections in the sense that there are SDG 1 indicators that rely on data from SDG 6 indicators in order to track progress. The SDG 1 indicator is indicator 1.4.1, which relies on the SDG 6 indicators 6.1.1 and 6.2.1.

SDG 2 (zero hunger) and SDG 6 (water and sanitation)

Policy and institutional implications: South Africa has strong institutions and policies to support water resources management. However perpetual challenges, such as capacity constraints and the lack of resources, have made for relatively weak governance and regulation over water resources, particularly in terms of water quality, which affects food and nutrition security in many ways**.** The WEF nexus approach has also been explored to address these challenges.

Technological considerations: South Africa has made technological and scientific advances to help support water-use efficiency in agriculture and to reduce pollution from agricultural runoff. However, translating scientific knowledge into policy and practice has been slow. The technological and scientific advances that have been made should be revisited as a means to manage the trade-offs that exist between SDG 2 and SDG 6. Advanced irrigation technologies need to be used to reduce water use in agriculture. These include low-cost technologies, such as rainwater harvesting and planting drought-tolerant crops.

Data considerations: There are no data connections between SDG 2 and SDG 6. However, food production depends on water quality and quantity. Therefore, water and food indicators could benefit from having standardised, shared data, given their interlinked nature.

SDG 3 (good health and wellbeing) and SDG 6 (water and sanitation)

Policy and institutional implications: Access to WASH services is hampered more by institutional challenges, resources and capacity constraints than by governance or policy-related matters. As a result, solutions, including policy solutions, should be explored to overcome these challenges.

Technological considerations: South Africa has made advances in WASH technologies that fit the national landscape. However, most of the technologies struggle to move beyond the pilot phase to full-scale implementation. Some blockages include policy blockages, limited uptake and ownership from government, as well as the lack of political will to embrace new WASH technologies. For universal WASH to occur, it is vital to embrace emerging WASH technologies.

Data considerations: SDG 6 and SDG 3 do not have data connections. Given the enabling role that WASH services have on the achievement of SDG 3, a recommendation would be to track the number of WASH facilities in hospitals and local clinics. At present, there is a gap, as no indicator tracks access to basic services, particularly access to WASH facilities, in local clinics and hospitals.

SDG 4 (quality education) and SDG 6 (water and sanitation)

Policy and institutional implications: The Department of Basic Education (DBE) has adopted norms and standards for school infrastructure. Minimum norms and standards are regulations that define the infrastructural conditions that make a school a school. They stipulate the basic level of infrastructure that every school must meet in order to function properly. These legally binding standards set a standard for provincial education departments to work towards, and against which to be held accountable, enabling communities to hold government officials accountable. Norms and standards are therefore a mechanism for top-down and bottom-up accountability.

Technological considerations: Technological innovations, such as waterless toilets, present possibilities to increase access to safe sanitation services. These innovations can be used in schools to replace dangerous pit latrines.

Data considerations: SDG 6 and SDG 4 share a data connection. South Africa has shown a gradual improvement in school infrastructure over time. According to the DBE's 2011 School Monitoring Survey (DBE, 2013), only 55% of schools met the nationally determined minimum infrastructure needs in all respects. This figure increased marginally to 59% in the 2017/18 survey (DBE, 2018). Levels of compliance in the 2017/18 survey to the minimum physical infrastructure requirements were the highest in Gauteng (92%) and the Western Cape (91%) and the lowest in the Eastern Cape and KwaZulu-Natal (both at 42%). Although there is progress in WASH facilities, access to WASH is still a challenge in the poor rural areas of South Africa.

Table 5.3 summarises the main synergies and trade-off linkages between the indicators of SDG 6 and the social indicators. The symbols used in the table follow two main categories of linkages described below:

Synergies		These are interlinkages that are positive and may be mutually reinforcing. When combined, they produce a greater impact.
Constraints/trade-offs		These are interlinkages that still have positive aspects when executed individually, but have negative effects when implementation is conducted in tandem with another SDG that conflicts with or reduces the other goal's effect to deliver sustainable development.

Table 5.3: Summary of interlinkages between social indicators related to the indicators of SDG 6 (modified from UN-Water, 2016)

Indicators	Water services (6.1.1)	Sanitation services (6.2.1)	Wastewater safely treated (6.3.1D)	Good ambient water quality (6.3.2D)	Water-use efficiency (6.4.1)	Levels of water stress (6.4.2)	IWRM implementation (6.5.1)	Water-related ecosystems (6.6.1D1)
(1.1.1, 1.2.1 and 1.2.2) Development for poverty reduction (1.4.1) Access to basic services (food)								
(2.1.1, 2.1.2, 2.2.1 and 2.2.2.) Food security and nutrition								
(2.3.1, 2.3.2 and 2.4.1) Double agricultural productivity and small-scale income, sustainable agriculture								
(3.1.1,3.2.1, 3.2.2, 3.3.3, 3.8.2, 3.9.2 and 3.9.3) Control diseases, reduce death and illnesses, access to health care								
(4.1.1, 4.2.1, 4.3.1, 4.5.1 and 4a.1) All complete education, quality childhood development, informal and formal education, gender disparities and access to basic services								
(5.1.1, 5.2.1, 5.2.2 and 5.5.1) End discrimination, domestic violence, sexual violence, women in government positions								

SDG 5 (gender equality) and SDG 6 (water and sanitation)

Policy and institutional implications: In harmony with indicator 5.5.1 (ensuring women's full and effective participation and equal opportunities), it is critical that, when policies are adopted and decisions made, women are equitably represented and are full participants in the process. Strengthening interactions with gender equality can be pursued through several different types of institutional arrangements. One of these platforms is through the implementation of IWRM.

Technological considerations: Gender-sensitive technological advancement in the provision of water and sanitation facilities will help to support women's inclusion.

Data considerations: There are no data connections.

5.2.2 Economic goals

Results from the network analysis

This section presents the results of linkages between SDG 6 and the economic goals. The economic goals include the following:

- SDG 8: Decent work and economic growth
- SDG 9: Industry, innovation and infrastructure
- SDG 10: Reduced inequality
- SDG 11: Sustainable cities and communities
- SDG 12: Responsible consumption and production

The results of network analyses of interlinkages identified between the economic indicators and indicators of SDG 6, as revealed in the literature, are presented in Figure . In a similar way, the results from an analysis of links between the economic SDG indicators and the indicators of SDG 6, as revealed in the stakeholder interviews, are presented in Figure . The results showed that 105 interlinkages were identified from the literature. Of those, 82 were synergies and 23 were trade-offs (Figure 5.5). Stakeholder analysis showed that 16 synergies were identified with only two trade-offs (Figure 5.6).

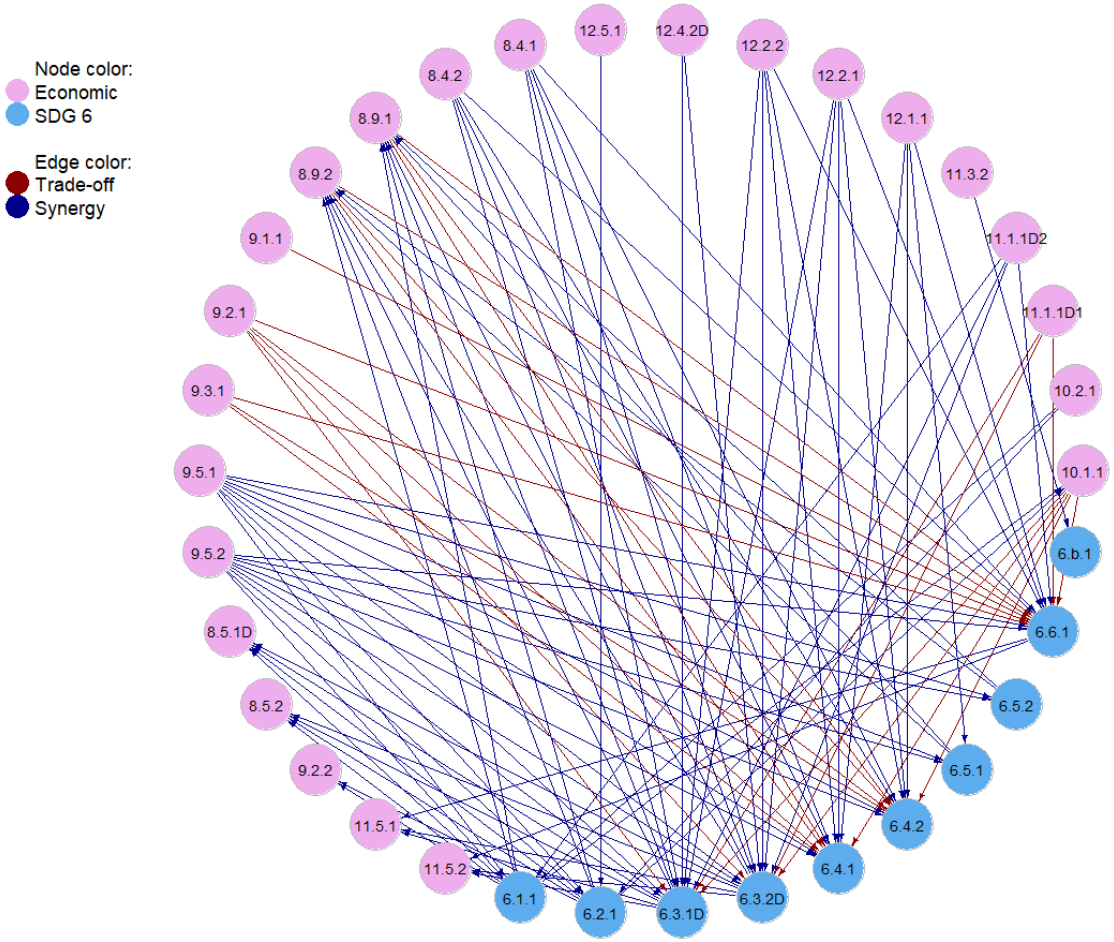


Figure 5.5: Output of a social network analysis of interlinkages between indicators of SDG 6 and economic SDG indicators as identified in literature from South Africa

SDG 8, the SDG for decent work and economic growth, has indicators linked to SDG 6 in the literature (Figure 5.5) and the responses of stakeholders (Figure 5.6). Using either analysis, the links between SDG 6 and SDG 8 are largely synergies, although trade-offs are present in Figure 5.5. From the literature, 30 synergies were identified, with six trade-offs, while stakeholder engagements identified five synergies with no trade-offs. In Figure , although not in Figure , improvements in indicators 8.9.1 (tourism-directed GDP) and 8.9.2 (sustainable tourism jobs) have negative effects on indicators 6.4.1 (water-use efficiency), 6.4.2 (water stress) and 6.6.1 (water-related ecosystems), despite being generally positively influenced by the SDG 6 indicators. All other links between these SDGs are synergies. In Figure only, indicators 8.5.1D (monthly earnings) and 8.5.2 (unemployment rate) were positively affected by SDG 6 indicators 6.1.1 (drinking water), 6.2.1 (sanitation and hygiene), 6.3.1D (wastewater treated) and 6.3.2D (water quality goals). In Figure , indicators 8.4.1 (material footprint) and 8.4.2 (domestic material consumption) were positively influenced by indicators 6.3.1D (wastewater treated), 6.3.2D (water quality goals), 6.4.1 (water-use efficiency), 6.4.2 (water stress) and 6.6.1 (water-related ecosystems). Figure shows links with the SDG 6 indicators and indicators 8.4.1 (material footprint) and 8.4.2 (domestic material consumption), but here these SDG 8 indicators are positively affected by indicators 6.1.1 (drinking water) and 6.2.1 (sanitation).

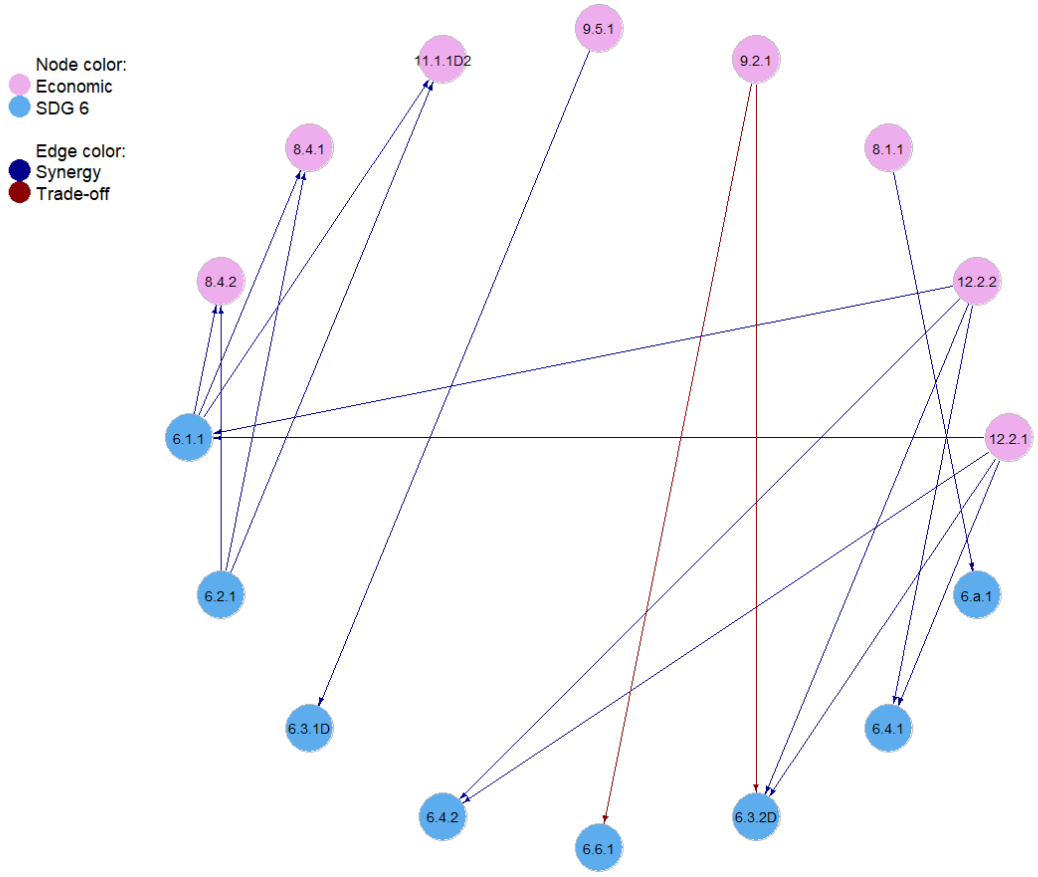


Figure 5.6: Output of a social network analysis of interlinkages between indicators of SDG 6 and economic SDG indicators as identified by respondents with responsibility for or exposure to programmes for achieving the SDGs in South Africa

SDG 9, the goal for industry, innovation and infrastructure, was found to be linked to SDG 6 in analyses based on the literature and stakeholder responses. From the literature, 20 synergies were identified, with nine trade-offs, while stakeholder engagements identified only one synergy with two trade-offs. Both analyses agree that the links from indicator 9.2.1 (manufacturing value-add) to the indicators of SDG 6 indicate trade-offs, although the analyses differ as to which SDG 6 indicators are involved. In Figure , the indicators are 6.3.1D (wastewater treated), 6.3.2D (water quality goals), 6.4.1 (water-use efficiency), 6.4.2 (water stress) and 6.6.1 (water-related ecosystems), while in Figure only indicators 6.3.2D (water quality goals) and 6.6.1 (water-related ecosystems) are linked in this way. Indicator 9.2.1 is the only indicator associated with trade-offs in Figure .

However, in Figure , other trade-offs are present: indicator 9.1.1 (rural population near road) negatively affects indicator 6.6.1 (water-related ecosystems), and indicator 9.3.1 (small industry value-add) negatively impacts on indicators 6.4.1 (water-use efficiency), 6.4.2 (water stress) and 6.6.1 (water-related ecosystems). Synergies were also found. In Figure , indicators 9.5.1 (business R&D spend) and 9.5.2 (proportion of researchers) had a positive effect on all the SDG 6 indicators except for indicators 6a.1 (development assistance in water and sanitation) and 6b.1 (community water administration). Figure only has indicator 9.5.1 (business R&D spend) positively influencing indicator 6.3.1D (wastewater treated). In Figure , again, indicator 9.2.2 (manufacturing employment) responds positively to improvements in indicators 6.1.1 (drinking water) and 6.2.1 (sanitation and hygiene).

SDG 10 aims to reduce inequality. This goal was not found to have many predicted interlinkages with indicators of SDG 6. From the literature, four synergies were identified, with five trade-offs, while stakeholders who were interviewed did not predict a single link between indicators of SDG 10 and SDG 6. All results presented here are therefore drawn from Figure . Indicator 10.1.1 (poorest household expenditure) was found to have negative effects on the SDG 6 indicators 6.3.1D (wastewater treated), 6.3.2D (water quality goals), 6.4.1 (water-use efficiency), 6.4.2 (water stress) and 6.6.1 (water-related ecosystems). Simultaneously, indicator 10.1.1 is positively affected by improvements in indicators 6.1.1 (drinking water) and 6.2.1 (sanitation and hygiene). The only other indicator involved in SDG 6 interactions in Figure was indicator 10.2.1 (disabilities among the poor), which was positively affected by improvements in indicators 6.1.1 (drinking water) and 6.2.1 (sanitation and hygiene).

SDG 11 is the SDG for sustainable cities and communities, one that would seem, at first glance, to have many interlinkages with SDG 6 as a result of the importance of water and wastewater management in communities. From the literature, 11 synergies were identified, with three trade-offs, while stakeholders who were interviewed identified only two synergies and no trade-offs between the indicators of SDG 11 and those of SDG 6. The synergies were indicator 11.1.1D2 (service provision in informal settlements), which was positively influenced by improvements in indicators 6.1.1 (drinking water) and 6.2.1 (sanitation and hygiene) (Figure). In Figure , improvements in indicator 11.1.1D2 should have a positive impact on indicators 6.1.1 (drinking water), 6.3.1D (wastewater treated), 6.3.2D (water quality goals) and 6.6.1 (water-related ecosystems). In contrast, indicator 11.1.1D1 (urban population in informal settlements) had a negative effect on indicators 6.3.1D (wastewater treated), 6.3.2D (water quality goals) and 6.6.1 (water-related ecosystems). Indicators 11.5.1 (disaster-affected people) and 11.5.2 (economic cost of disasters) were both positively affected by indicators 6.3.1D (wastewater treated), 6.3.2D (water quality goals) and 6.6.1 (water-related ecosystems). Finally, indicator 11.3.2 (participation of civil society) has a positive impact on indicator 6b.1 (community water administration), making this one of the few indicators to interact with indicator 6b.1.

SDG 12 deals with responsible consumption and production, and can therefore also be expected to have links to SDG 6. Both stakeholders and the literature identify links and, as is common elsewhere, more links are found in Figure than in Figure . From the literature, all 17 links between the indicators of SDG 6 and SDG 12 were synergies, while stakeholders who were interviewed identified eight synergies with two trade-offs. Improvements in indicators 12.2.1 (material footprint) and 12.2.2 (domestic consumption) were found to be likely to lead to improvements in indicators 6.3.1D (wastewater treated), 6.3.2D (water quality goals), 6.4.1 (water-use efficiency), 6.4.2 (water stress) and 6.6.1 (water-related ecosystems) in Figure . In Figure , indicator 12.2.1 (material footprint) and indicator 12.2.2 (domestic consumption) should lead to an improvement in indicators 6.1.1 (drinking water), 6.3.2D (water quality goals) 6.4.1 (water-use efficiency) and 6.4.2 (water stress). Here the two analyses mostly agree. Figure does not show any other SDG 12 interactions, but Figure has several more. In Figure , indicator 12.1.1 (sustainable consumption or production plans) improvements should lead to improvements in indicators 6.4.1 (water-use efficiency), 6.4.2 (water stress), 9.5.1 (business R&D spend) and 6.6.1 (water-related ecosystems). Indicator 12.4.2D (hazardous waste) improvements should support indicators 6.3.1D (wastewater treated) and 6.3.2D (water quality goals). Finally, according to the literature, indicator 12.5.1 (recycling rate) improvements should improve indicator 6.2.1 (sanitation and hygiene) scores.

Synthesis

Indicators from the economic SDGs that were identified as being interlinked with the SDG 6 indicators included a mix of trade-offs and synergies, indicating that progress towards the economic SDGs is predicted to further or hinder progress towards SDG 6 indicators, depending on the indicator selected. As

such, some economic SDG indicators might seem suitable for prioritisation from an SDG 6 perspective, but others may need to be managed more carefully, ideally in collaboration with economic and water managers.

On the basis of the number of interlinkages with indicators of SDG 6, SDG 9 indicators 9.5.1 (business R&D spend) and 9.5.2 (proportion of researchers) are potential candidates for prioritisation using data collected from the literature. These indicators show the amount of scientific research and development in a country, both in terms of monies spent and researchers employed. This link is a synergy, indicating that increased R&D should have a positive impact on all SDG 6 indicators, except for indicators 6a.1 (development assistance in water and sanitation) and 6b.1 (community water administration). Stakeholders noted a link to indicator 9.5.1, although other links were more common in having links to the SDG 6 indicators.

Stakeholders who were interviewed indicated that the most common synergy between the economic SDG indicators and the SDG 6 indicators was with indicators 12.2.1 (material footprint) and 12.2.2 (domestic consumption). These are linked by synergies with indicators 6.3.1D (wastewater treated), 6.3.2D (water quality goals), 6.4.1 (water-use efficiency), 6.4.2 (water stress) and 6.6.1 (water-related ecosystems), and should have knock-on effects in improving these SDG 6 indicator scores. The literature was in agreement, and linked improvements in sustainable resource use and management to improvements in most of the SDG 6 indicators.

The links above highlight several economic indicators, which, if improved, might have positive spin-offs for SDG 6 indicators. However, this is not true of all the economic indicators. For example, indicators 8.9.1 (tourism-directed GDP) and 8.9.2 (sustainable tourism jobs) lead to trade-offs and negative responses in SDG 6 indicators 6.4.1 (water-use efficiency), 6.4.2 (water stress) and 6.6.1 (water-related ecosystems), despite being generally positively influenced by the SDG 6 indicators. SDG 10 indicator 10.1.1 (poorest household expenditure) has a worse knock-on effect, and may lead to reduced scores in indicators 6.3.1D (wastewater treated), 6.3.2D (water quality goals), 6.4.1 (water-use efficiency), 6.4.2 (water stress) and 6.6.1 (water-related ecosystems). Stakeholders who were interviewed identified no trade-offs in the economic SDG indicators. From the perspective of SDG 6, the prioritisation of these indicators should be undertaken with due care. The effect of direct trade-offs from these economic indicators might lead to reduced scores in the SDG 6 indicators, making these areas where water managers and economic managers would need to work together to avoid negative effects.

Key dimensions and implications for implementation

SDG 8 (decent work and economic growth) and SDG 6 (water and sanitation)

Policy and institutional implications: South Africa has major challenges with regard to unemployment and economic growth, and these have been exacerbated by the challenges posed by the COVID-19 pandemic. Simultaneously, recent droughts have challenged and continue to challenge the capacity to meet SDG 6. Improved capacity and strengthening policy to address economic challenges is needed for these SDGs to be met.

Data considerations: SDG 6 and SDG 8 do not share data connections.

SDG 9 (industry, innovation and infrastructure) and SDG 6 (water and sanitation)

Policy and institutional implications: Industry is a significant and, at times, major consumer of water and needs to have appropriate water quantity and quality. Simultaneously, industry may have the potential to pollute water resources. Collaboration between departments is required so that planning,

management and the ongoing monitoring of systems can be successfully undertaken. Sufficient capacity is required to do this.

Technological considerations: A functioning system for planning and monitoring water quantity and quality is required, together with the capacity to undertake these tasks. A second technological consideration relates to the development of industrial procedures that do not require water to operate.

Data considerations: Industry that uses water requires real-time access to water quantity and quality data and to projections of future supply.

SDG 10 (reduced inequalities) and SDG 6 (water and sanitation)

Policy and institutional implications: As access to basic services is one aspect of inequality in South Africa, planning and the delivery of safe drinking water and sanitation acts to reduce some aspects of inequality. Planning and the delivery of these services where they are required is a large and challenging task, and resources and capacity need to be maintained to achieve this.

Technological considerations: As noted above, the successful delivery of safe drinking water, and the removal and treatment of wastewater requires resources and capacity that need to be maintained. Issues around capacity have been a problem in maintaining these services around the country, particularly at municipal level. The upkeep of facilities, and maintenance and training are crucial for these systems and services to be maintained.

Data considerations: SDG 6 and SDG 10 do not share data connections.

SDG 11 (sustainable cities) and SDG 6 (water and sanitation)

Policy and institutional implications: South Africa is a semi-arid country, and an adequate and sustainable supply of water is a requirement for a city. Recent droughts have threatened several cities in South Africa, and have highlighted the importance of water for human life. Having policies in place to timeously plan for water in extreme circumstances is therefore important, particularly as the effects of climate change become more apparent. Another aspect of the sustainability of cities relates to sanitation, which, in turn, has the potential to reduce the quality of the resource. Resources and capacity for water and sanitation management and planning are a key part of managing cities in a sustainable manner.

Technological considerations: The resources and capacity for the management of both water and waste treatment systems must be in place to ensure that they are not interrupted. It would be of great benefit to ensure that treatment methods are sustainable, and that leaks in systems are properly dealt with.

Data considerations: Like industry, municipalities and water user associations require real-time access to water quantity and quality data and to projections of future supply.

SDG 12 (responsible consumption and production)

Policy and institutional implications: Areas where sustainable consumption and water need concurrent consideration relate to the consumption of water, and the production of waste, particularly waste that is waterborne. Ensuring policies to support the management, planning and upkeep of water and waste management systems is crucial.

Technological considerations: The sustainable consumption of water relies heavily on controlling loss of water, so capacity for the maintenance of the distribution network is crucial. Waste treatment requires the upkeep of plant equipment and ongoing training to ensure capacity.

Data considerations: Adequate planning will require an understanding of the quantity of water removed from a system, as well as the quality and quantity of waste discharged into the system.

Table 5.4 summarises the main synergies and trade-off linkages between the indicators of SDG 6 and the economic indicators. The symbols used in the table follow two main categories of linkages described below:

Synergies		These are interlinkages that are positive and may be mutually reinforcing. When combined, they produce a greater impact.
Constraints/trade-offs		These are interlinkages that still have positive aspects when executed individually, but have negative effects when implementation is conducted in tandem with another SDG that conflicts with or reduces the other goal's effect to deliver sustainable development.

Table 5.4: Summary of interlinkages between economic indicators related to indicators of SDG 6 (modified from UN-Water, 2016)

Indicators	Water services (6.1.1)	Sanitation services (6.2.1)	Wastewater safely treated (6.3.1D)	Good ambient water quality (6.3.2D)	Water-use efficiency (6.4.1)	Levels of water stress (6.4.2)	IWRM implementation (6.5.1)	Trans-boundary catchment management (6.5.2)	Water-related ecosystems (6.6.1)
(8.4.1 and 8.4.2) Material footprint and consumption (8.5.1D and 8.5.2) Disabled earnings and unemployment (8.9.1 and 8.9.2) Tourism GDP and jobs									
(9.1.1) Rural road access (9.2.1 and 9.2.2) Manufacturing and employment (9.3.1) Small-scale industry (9.5.1 and 9.5.2) Research funds and researchers									
(10.1.1) Income growth (10.2.1) Disability proportion									
(11.1.1D1 and 11.1.1D2) Inadequate housing (11.3.2) Civic participation in cities (11.5.1 and 11.5.2) Disaster-related death and economic loss									

Indicators	Water services (6.1.1)	Sanitation services (6.2.1)	Wastewater safely treated (6.3.1D)	Good ambient water quality (6.3.2D)	Water-use efficiency (6.4.1)	Levels of water stress (6.4.2)	IWRM implementation (6.5.1)	Trans-boundary catchment management (6.5.2)	Water-related ecosystems (6.6.1)
(12.1.1) Sustainable consumption and production plans (12.2.1 and 12.2.2) Material footprint and consumption (12.4.2D) Hazardous waste (12.5.1) Recycling rate									

5.2.3 Environmental goals

Results from the network analysis

This section presents the results of linkages between SDG 6 and the environmental goals. The environmental goals cover the following:

- SDG 7: Affordable and clean energy
- SDG 13: Climate action
- SDG 14: Life below water
- SDG 15: Life on land

The results of the linkages between the indicators of SDG 6 and the indicators for the environmental goals are presented in Figure 5.7 and Figure 5.8 through a network analysis. Figure 5.7 presents results obtained from information gained through literature research, while Figure 5.8 presents the results from information gained through stakeholder engagements (interviews and workshop). The two figures show that a cumulative total of 77 linkages was identified, of which 71 were synergetic and positively reinforcing, while six were contrasting, denoting trade-offs. The literature analysis showed that the highest positive interlinkages (synergies) between SDG 6 and the goals of the environmental dimension were found with SDG 13 and SDG 15, while SDG 7 had the highest negative interactions (trade-offs) with SDG 6 (water and sanitation) indicators. In relation to the stakeholder analysis, SDG 15, followed by SDG 14 and SDG 7, had the most positive interactions with indicators of SDG 6. The respondents did not identify trade-offs.

SDG 7 aims to ensure access to affordable, sustainable, reliable and modern energy for all. The cumulative total of linkages (literature review and stakeholder engagement) between SDG 7 and SDG 6 is nine, of which six are synergies and mutually reinforcing, while three are conflicting, indicating the need to manage trade-offs. Information from both stakeholder engagements and the literature identified that increasing the share of renewable energy consumption (indicator 7.2.1) mutually reinforces efforts to improve ambient water-quality levels (indicator 6.3.2D) to reduce water stress (indicator 6.4.1) and to increase water-use efficiency (indicator 6.4.2). This phenomenon is rationalised on the basis that renewable energy sources inherently contain low pollution levels and result in low water consumption rates, ensuring a net positive water impact (Castillo et al., 2018). The footing for the conflicting indicators between SDG 7 and SDG 6 is based on the understanding that realising universal access to electricity (indicator 7.1.1) will negatively affect intentions to improve ambient water-quality levels (indicator 6.3.2D), reduce water stress (indicator 6.4.1) and increase water-use efficiency (indicator 6.4.2), particularly if it is achieved through coal-generated electricity. Fossil fuel-generated electricity can destabilise the health of freshwater sources, increase demand for water and undermine water-use efficiency targets as large amounts of water are required upstream during the extraction and processing of raw products, as well as downstream during the cooling phases (Sparks et al., 2014).

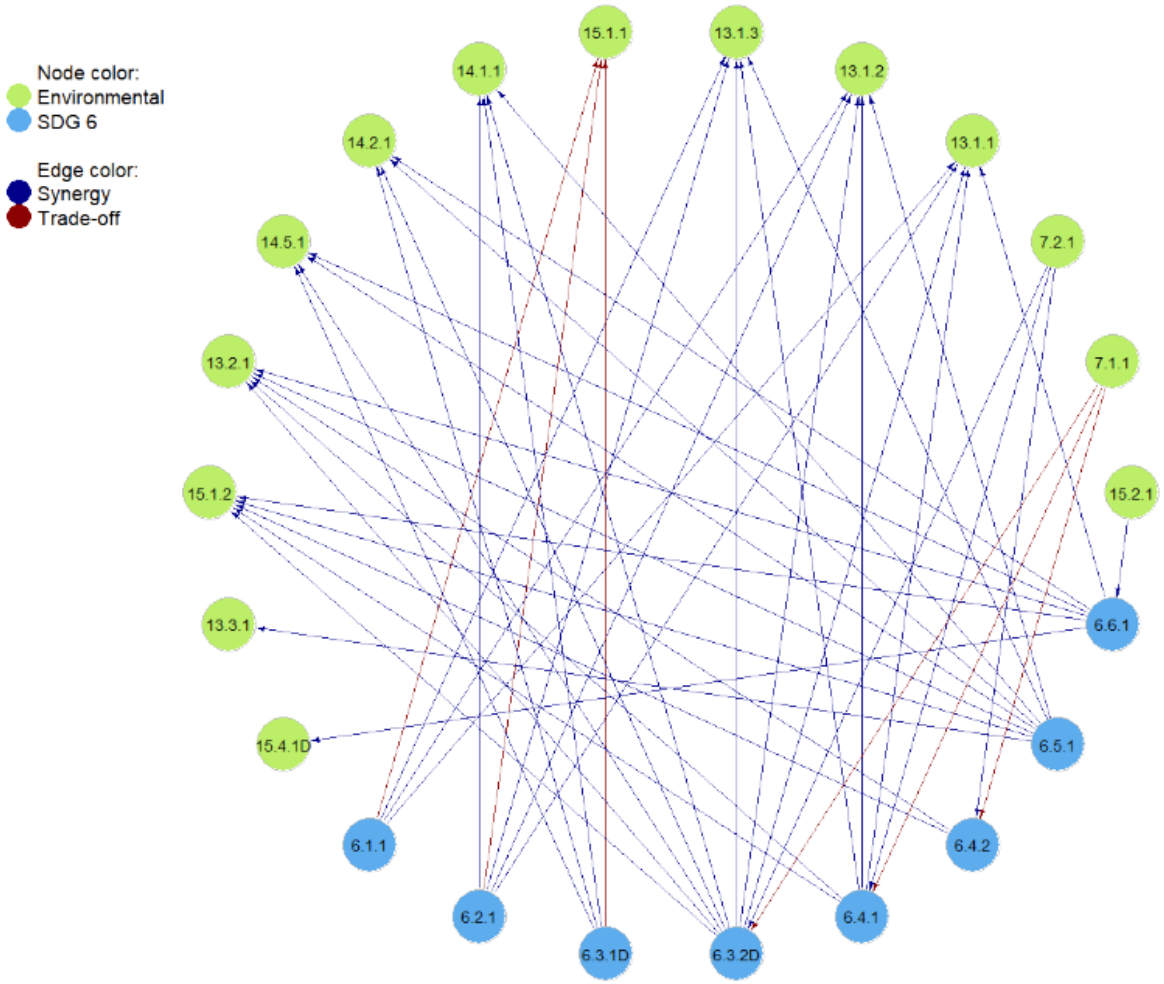


Figure 5.7: Output of a social network analysis of interlinkages between indicators of SDG 6 and the environmental SDG indicators as identified in literature from South Africa

SDG 13, which encourages stakeholders to take urgent action to combat climate change, demonstrated 21 linkages with indicators of SDG 6, all which were positively reinforcing and informed by data from literature sources only. At a first level, the linkages are founded on the basis that, in the frontline of climate change disasters, the presence of water and sanitation infrastructure (indicators 6.1.1 and 6.2.1), coupled with advances in freshwater quality and water-use efficiency (indicators 6.3.2D and 6.4.2) and the buffers derived from increased expansion of water-related ecosystems (indicator 6.6.1) work collectively to decrease the direct impact of disasters on the population (indicator 13.1.1) (Karnib, 2019). Secondly the linkages are established on the conclusion that national and local disaster risk reduction strategies (indicators 13.2.1 and 13.3.3), which have mainstreamed action to promote resilience in water and sanitation services (indicators 6.1.1 and 6.2.1), foster advances in freshwater quality, water-use efficiency and reduction in water stress (indicators 6.3.2D and 6.4.2). Implementing IWRM (indicator 6.5.1) mutually reinforces targets on raising awareness of climate change (indicator 13.3.1), integrates climate change and ecosystem values into national development processes (indicator 13.2.1) and encourages the protection of freshwater ecosystems (indicator 6.5.1). The rationale is based on the argument that IWRM (indicator 6.5.1) offers effective instruments to reduce climate change vulnerability and negative impacts (UN-Water, 2016).

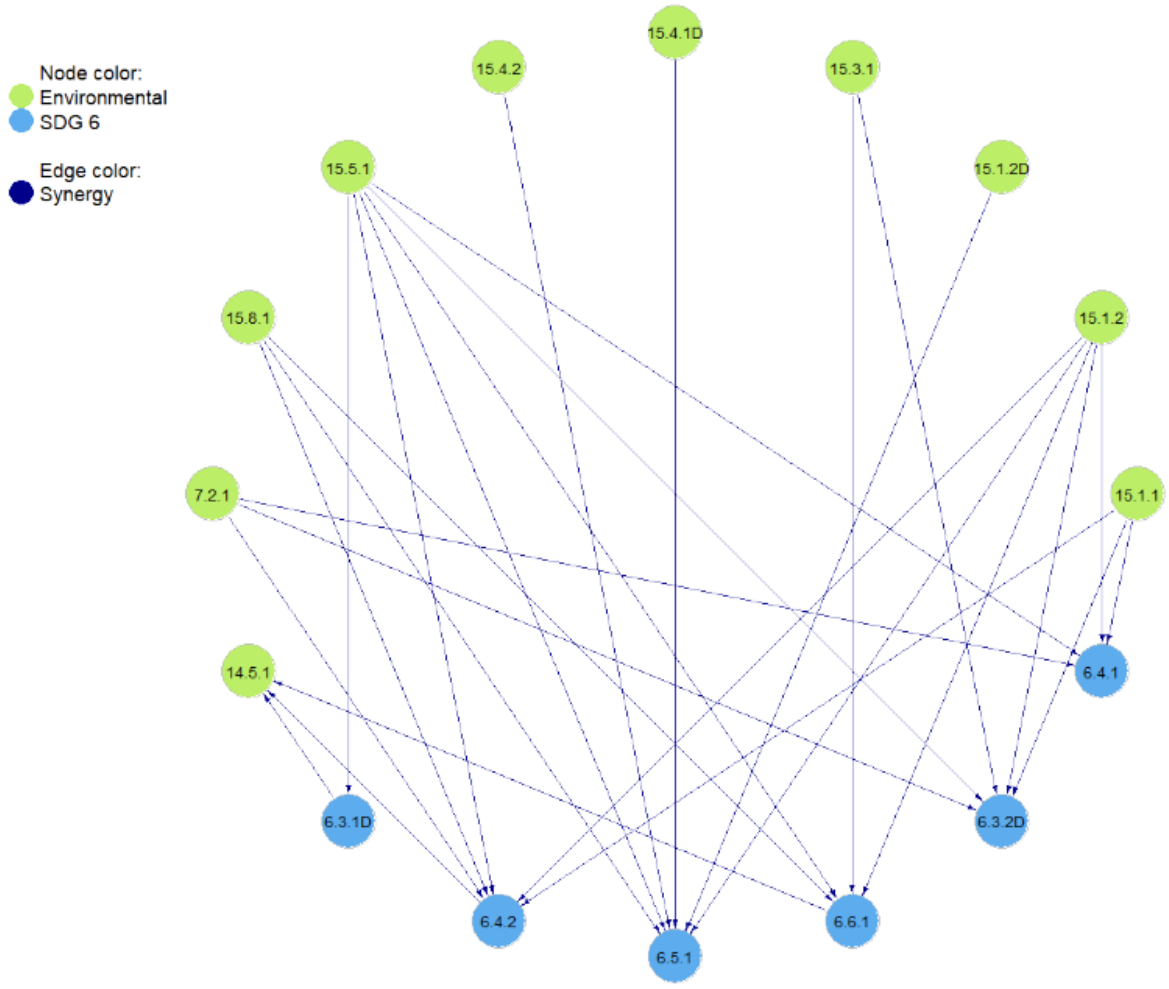


Figure 5.8: Output of a social network analysis of interlinkages between indicators of SDG 6 and the environmental SDG indicators as identified by respondents with responsibility for or exposure to programmes for achieving SDGs in South Africa

SDG 14 seeks to conserve and sustainably use the oceans' resources for sustainable development. The goal has strong positive linkages with SDG 6. Testament to this relationship are the 15 mutually reinforcing linkages found between the two goals. The linkages were determined using views from literature comprising 12 positive links, while stakeholder engagement identified three linkages. It must be noted that, although stakeholder engagement identified fewer links, the few links that were identified were identical to respective links identified through literature, and create a commonality of views. SDG 6 is vital for protecting the integrity of marine waters and ecosystems against land-based pollution. The foundation of this link is maintained in the relationship that the implementation of IWRM measures (indicator 6.5.1), coupled with increasing access to safe sanitation services (indicator 6.2.1) and action aimed at reducing effluent pollution on freshwater courses, helps to improve ambient water quality (indicators 6.3.2D and 6.3.1D). In turn, such action underscores efforts aimed at reducing coastal eutrophication and debris as a result of land-based activities (indicator 14.1.1). Activities geared towards protecting water-related ecosystems (indicator 6.6.1), driving the implementation of the IWRM framework (indicator 6.5.1), work towards reducing pollution in freshwater courses (indicator 6.3.1D), as well as maintaining water-quality levels (indicator 6.3.2D, all positively reinforce efforts that reduce the adverse impacts on marine and coastal ecosystems, and enable the realisation of ecosystem-based approaches to managing marine areas (indicator 14.2.1).

Increasing the coverage of protected marine areas (indicator 14.5.1) is linked to wastewater treatment, reduction in water stress and ecosystem expansion (indicators 6.3.1D, 6.4.2 and 6.6.1D). The link emanates from the rationale that some marine and coastal ecosystem types require freshwater and terrestrial sediments in order to function (e.g. estuaries, estuarine shore types, ecosystems within the sediment or freshwater discharge “plumes” of larger rivers). As a result, the protection of those terrestrial ecosystems extends to the preservation of marine areas.

SDG 15 is realised through action that protects, restores and promotes the sustainable use of terrestrial ecosystems, fosters the sustainable management of forests, combats desertification, and halts and reverses land degradation and biodiversity loss. The goal is inextricably linked to SDG 6, owing to the land and water interface: healthy landscapes equal healthy water-related ecosystems. The cumulative (stakeholder- and literature-informed) number of linkages determined between the two goals was 32. Of the 32 linkages, three are trade-offs, 22 were identified through stakeholder engagement, while 10 were informed by literature sources. Although fewer links were identified through literature sources, the 10 links that were identified were identical to the respective links identified through stakeholder engagement, so validating a convergence or commonality of views between the two sources of information. The construction and clearance of land required to provide water and sanitation infrastructure (indicators 6.1.1 and 6.2.1), including wastewater treatment infrastructure to support the safe disposal of treated effluent (indicator 6.3.1) may undermine and therefore constrain efforts to conserve and restore terrestrial and inland freshwater ecosystems (indicator 15.1.1). SDG 6 action, which promotes the protection of water-related ecosystem (indicator 6.6.1), ensures the implementation of IWRM (indicator 6.5.1), strives towards water-use efficiency and a reduction in water stress (indicators 6.4.1 and 6.4.2), promotes the treatment of effluent and good water-quality levels (indicators 6.3.1 and 6.3.2), and presents positive correlations with SDG 15 action, which is aimed at protecting and restoring freshwater sources (indicator 15.1.2), maintaining biodiversity (indicator 15.4.1D), restoring forests (indicator 15.2.1) and restoring land (indicator 15.3.1). SDG 15 action aimed at reducing threats to Red List Index species (indicator 15.5.1), induced by the degradation of natural habitats, and SDG 15 action aimed at reducing the impact of invasive alien species on land and water ecosystems (indicator 15.8) are supported by SDG 6 efforts that promote the protection of water-related ecosystems (indicator 6.6.1), ensure the implementation of IWRM (indicator 6.5.1), strive towards water-use efficiency and a reduction in water stress (indicators 6.4.1 and 6.4.2), and promote the treatment of effluent and the maintenance of good water-quality levels (indicators 6.3.1 and 6.3.2).

Synthesis

The results tabled above illustrate that SDG 6 and the goals of the environmental dimension share more synergies than trade-offs. The synergies between SDG 6 and the indicators of the environmental dimension are concentrated around two clusters. In the first cluster, the synergies between SDG 6 and the goals in the environmental dimension are concentrated around indicators that support action on reversing ecosystem degradation (indicators 14.1.1, 14.2.1 and 15.1.2), restoring and enhancing ecological integrity (indicators 15.2.1, 15.3.1 and 15.4.1) and increasing the protection of water-related ecosystems (indicators 15.1.2, 15.5.1 and 14.5.1). The second cluster within which synergies between SDG 6 indicators and indicators of the goals of the environmental dimension are concentrated is on action that supports risk mitigation (indicators 13.1.2 and 13.1.3), improving decision and response capability, and minimising adverse effects on climate change (indicator 13.2.1) to ecosystems and WASH infrastructure.

The synergetic interactions entail significant opportunities for streamlining the allocation of resources to avoid duplication and wasteful expenditure. Additionally, opportunity exists to align and optimise institutional actions to harvest co-benefits, foster policy coherence and standardise procedures to facilitate improved data collection, monitoring and reporting. Although these opportunities exist, exploiting

them may prove to be far more complex and may require several modalities and delivery mechanisms to be in place.

For example, enhancing the synergies observed between the indicators of SDG 6 and SDG 7 requires deliberate investments in clean energy technologies, a detailed understanding of the social and economic implications of a clean energy transition, as well as an analysis of what South Africa stands to compromise with water and its link to the economy by a slow uptake of clean energy. Amplifying the synergies identified between SDG 14 and SDG 6 requires an increase in the regulation and monitoring of domestic and industrial effluent at discharge points. In tandem, the upgrading of wastewater treatment is required. This action needs to be followed by consistent infrastructure asset management. The NWSMP noted that 56% of wastewater treatment works in South Africa do not work properly (DWS, 2018a).

Trade-offs observed between the environmental dimension and SDG 6 were identified on indicators that monitored actions that had the potential to disturb ecosystem health and biodiversity (indicators 6.2.1, 6.1.1 and 6.3.1D), despite fulfilment of the action having a positive social and livelihood improvement aspect. Where trade-offs are present, a careful balancing act needs to be embraced to minimise the impact of the negative relationship. This can be facilitated by adopting innovative technological and strategic solutions to harmonise actions as far as possible. To minimise the trade-offs observed between SDG 6 and SDG 7, embracing clean energy options is critical; programmes such as the renewable energy independent power producer (REIPP) programme have been instrumental in elevating renewable energy use in South Africa, yet for a full roll-out of renewable energy, programmes need to move to national norm and will. To manage the trade-offs identified between SDG 15 and SDG 6, improved planning in the construction of water and sanitation infrastructure is necessary. The planning should be informed by insight into the biodiversity and freshwater ecosystem of the location.

Key dimensions and implications for implementation

SDG 7 (affordable and clean energy) and SDG 6 (water and sanitation)

Policy and institutional implications: South Africa is a water-scarce country and continuing to support the water demands of coal-generated electricity at the same pace needs to be re-examined. Part of the reassessment process includes implementing the policy decisions on accelerating renewable energy from the newly developed Integrated Resource Plan (IRP) of 2019, and in developing guidelines to support Eskom, as the coal-generating electricity entity, to reduce water demand.

Technological considerations: To mitigate the impacts of coal-generated electricity on water sources, some technological advancements are required. The IRP promotes the development of high efficiency, low-emission technologies and other cleaner coal technologies in order to support cleaner coal production for power generation (Department of Energy, 2019). Fast-tracking the adoption and use of these technologies will help improve the ecological health and integrity of freshwater ecosystems. Electricity is often noted as one of the biggest expenses in water and sanitation supply, as well as in the operation of wastewater treatment works. To that end, a technological shift in the installation and use of renewable energy sources to power wastewater treatment and pump water is required to improve the uptake of renewable use.

Data considerations: SDG 6 and SDG 7 do not have any data connections.

SDG 13 (climate action) and SDG 6 (water and sanitation)

Policy and institutional implications: The mainstreaming of climate change in water and sanitation policies, as well as the integration of water and sanitation in national and local disaster risk reduction

(DRR) plans requires the bolstering of institutional and individual capacity. In the eventuality of disasters, such capacity building will be critical in reducing the impact of the hazard.

Technological considerations: Investments in DRR technologies are necessary. Technologies such as early-warning systems and gauging stations are key for reducing the climate vulnerability of water and sanitation infrastructure, both built and ecological, against climate disasters. Investments in WASH infrastructure that respond to both drought- and flood-related disasters should also be considered.

Data considerations: Currently, SDG 6 and SDG 13 do not share data considerations. However, once a universally adopted methodology has been developed for indicator 13.2.1, data might be shared for reporting purposes.

SDG 14 (life below water) and SDG 6 (water and sanitation)

Policy and institutional implications: South Africa has a well-established policy and legal environment to help support the regulation of land-based activities. However, institutional capacity is lacking. As a result, strengthening capacity in institutions is essential to improve monitoring at discharge points and effectively regulate effluent discharge into watercourses. Additionally, collaboration between DWS and the Department of Environment, Forestry and Fisheries (DEFF) in monitoring effluent discharge will help foster a more integrated framework.

Technological considerations: Unrolling technology to support monitoring is necessary to improve coverage, the frequency of monitoring and to replace outdated or dysfunctional technologies.

Data considerations: At present, there are no data connections between the two SDGs. However, to improve the monitoring of coastal water quality, collaboration between DWS and DEFF is essential. Such partnerships may also facilitate the sharing of data for improved decision making, planning and regulation.

SDG 15 (life on land) and SDG 6 (water and sanitation)

Policy and institutional implications: The protection of freshwater ecosystems is enshrined in a number of legislations, including the National Biodiversity Act, the Protected Areas Act and the National Water Act. Despite this robust framework, freshwater ecosystems are still under-protected and highly threatened. Policy implementation has been fraught with challenges. Insufficient resources and capacity has meant that wetland sites are not designated and, as a result, do not receive the necessary protection. Additionally, weaknesses in the structures and lack of cooperative governance have resulted in fragmented policy implementation and the increased vulnerability of freshwater ecosystems. In moving forward, more attention has to be paid to improving cooperative governance and strengthening institutional capacity to capitalise on the synergies between the goals, as well as to reduce duplications and maximise available resources. Improving the legislative ease with which freshwater ecosystems can be proclaimed is a critical way of safeguarding the health of water-related ecosystems, as well as improving their expansion.

Technological considerations: Technological advancements that help accelerate the delineation of freshwater ecosystems to designate protected water-related ecosystems will be instrumental in advancing the protection of freshwater ecosystems.

Data considerations: Direct linkages, where estimates of the extent of the freshwater ecosystem (indicator 6.6.1D) and estimates of the extent of the protection of priority freshwater biodiversity sites (indicator 15.1.2D) utilise the same foundational input data (freshwater ecosystem extent as captured

in the National Wetland Map – curated by the South African National Biodiversity Institute, on behalf of DWS).

Table 5.5 summarises the main synergy and trade-off linkages between indicators of SDG 6 and the environmental indicators. The symbols used in the table follow two main categories of linkages described below:

Synergies		These are interlinkages that are positive and may be mutually reinforcing. When combined, they produce a greater impact
Constraints/trade-offs		These are interlinkages that still have positive aspects when executed individually, but have negative effects when implementation is conducted in tandem with another SDG that conflicts or lessens the effectiveness of the other goal to deliver sustainable development.

Table 5.5: Summary of interlinkages between the environmental indicators related to the SDG 6 indicators (modified from UN-Water, 2016)

SDG 6-linked environmental indicators	Water services (6.1.1)	Sanitation services (6.2.1)	Wastewater safely treated (6.3.1D)	Good ambient water quality (6.3.2D)	Water-use efficiency (6.4.1)	Levels of water stress (6.4.2)	IWRM implementation (6.5.1)	Trans-boundary basin area (6.5.2)	Water-related ecosystems (6.6.1)
(7.1.1) Increase access to universal electricity									
(7.2.1) Increase renewable energy share in the total final energy consumption									
(13.1.1) Reduce persons affected by disasters									
(13.1.2 and 13.1.3) Develop DRR national and local plans									
(13.2.1 and 13.3.1) Climate measures mainstreamed in national planning or climate awareness									
(14.1.1) Reduce pollution and the eutrophication of marine environments from land-based activities									
(14.2.1 and 14.5.2) Manage national EEZs using ecosystem-based approaches or protected marine areas									

SDG 6-linked environmental indicators	Water services (6.1.1)	Sanitation services (6.2.1)	Wastewater safely treated (6.3.1D)	Good ambient water quality (6.3.2D)	Water-use efficiency (6.4.1)	Levels of water stress (6.4.2)	IWRM implementation (6.5.1)	Trans-boundary basin area (6.5.2)	Water-related ecosystems (6.6.1)
(15.1.1 and 15.1.2) Disturbance to forest land cover and protection of freshwater sites	↙↗	↙↗	↙↗	⇄	⇄	⇄	⇄		⇄
(15.2.1, 15.3.1, 15.4.1 and 15.4.2) Sustainable forest management, combating land degradation, protecting mountain catchments and cover				⇄			⇄		⇄
(15.5.1) Red List Index – aquatic ecosystem-dependant species			⇄	⇄	⇄	⇄			⇄
(15.8.1) Control of alien invasive species						⇄	⇄		⇄

5.2.4 Peace, justice and strong institutions and partnerships for goals (governance)

Results from the network analysis

This section presents the results of the linkages between SDG 6 and both SDG 16 (peace, justice and strong institutions) and SDG 17 (partnerships for the goals). The two goals have been combined under peace, justice, strong institutions and partnerships for goals (governance). The outputs of the linkages between the indicators of SDG 6 and the indicators of goals represented under peace, justice and strong institutions, and partnerships for the goals are presented in Figure 5.9 and Figure 5.10. Figure 5.9 presents results obtained from information gained through literature research, while Figure 5.10 presents the results gathered from information through stakeholder engagements (interviews and the workshop). From the figures, a cumulative total (stakeholder engagement and literature) of 42 linkages was identified, all of which were synergetic and positively reinforcing. Below is a disaggregated presentation of the results in response to the linkages the indicators of SDG 6 share with the indicators of goals represented under the SDG dimension of peace, justice and strong institutions, and of partnerships for the goals.

SDG 16 endeavours to promote peaceful and inclusive societies for sustainable development, to provide access to justice for all, and to build effective, accountable and inclusive institutions at all levels. The tenets of SDG 16 and SDG 6 are complementary and mutually reinforcing. This relationship is corroborated by the 17 positive indicator linkages observed between SDG 6 and SDG 16, of which 13 were identified through literature sources and four through a stakeholder engagement process, which featured both interviews and a stakeholder workshop.

The synergetic relationship between SDG 6 and SDG 16 is founded on the basis that access to water and sanitation services (indicators 6.1.1 and 6.2.1), reduction in water stress (indicator 6.4.2), and the implementation of IWRM, including the establishment of transboundary institutions, can support efforts aimed at reducing conflict (indicator 16.1.2). Similarly, the provision of water and sanitation services can act to reduce the number of people who are victim to intentional homicide (indicator 16.1.1), sexual violence (indicators 16.1.3 and 16.2.3), and those who do not feel safe walking alone where they live (indicator 16.1.4). These linkages indicate that SDG 6 is central to promoting safe and peaceful societies.

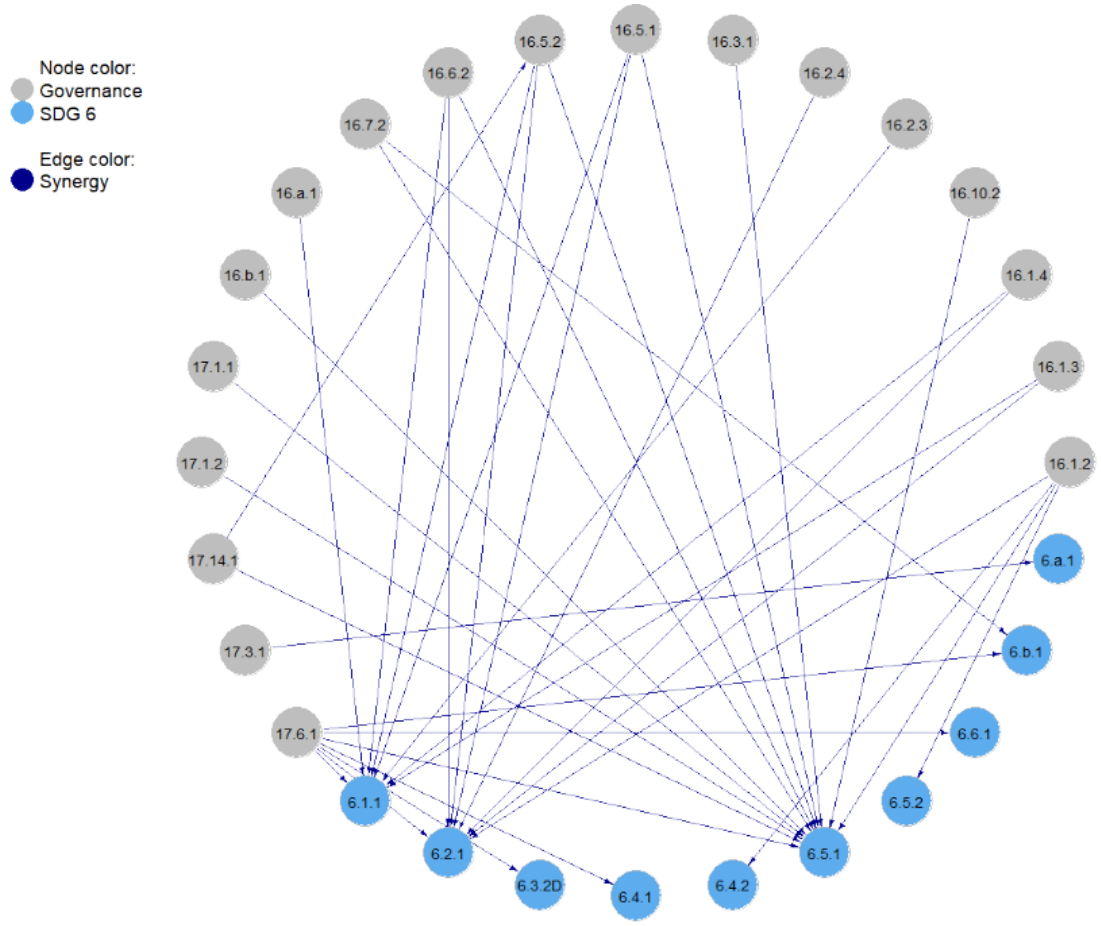


Figure 5.9: Output of a social network analysis of interlinkages between the indicators of SDG 6 and the governance SDG indicators as identified in literature from South Africa

The full implementation of IWRM (indicator 6.5.1) supports the reduction of bribery and corruption in all forms (indicators 16.5.1 and 16.5.2) and translates to effective delivery of water and sanitation services (indicators 6.1.1 and 6.2.1). The spinoff of the effective delivery of water and sanitation services is increased population satisfaction from public services (indicator 16.6.2). The turn towards IWRM (indicator 6.5.1) offers an opportunity to integrate the principles of equity, transparency, efficiency, participation and accountability into the administration of water and sanitation (Karnib, 2019). The IWRM framework can support the development of institutional capacity and participatory processes, and provide tools for effective, accountable and transparent institutions.

The implementation of the IWRM framework (indicator 6.5.1) supports stakeholder participation (indicator 6b.1). When these two indictors are combined, they contribute towards the realisation of inclusive participation and decision making (indicator 16.7.2). The IWRM framework (indicator 6.5.1) espouses transparency and promotes access to reliable information to this end, and contributes to the implementation of constitutional, statutory and/or policy guarantees for public access to information (indicator 16.10.2). Preserved within the IWRM framework (indicator 6.5.1) is the intention to ensure that water resources are equitably distributed without discrimination. This commitment to non-discrimination supports the enforcement of non-discriminatory laws and policies for sustainable development (indicator 16b.1).

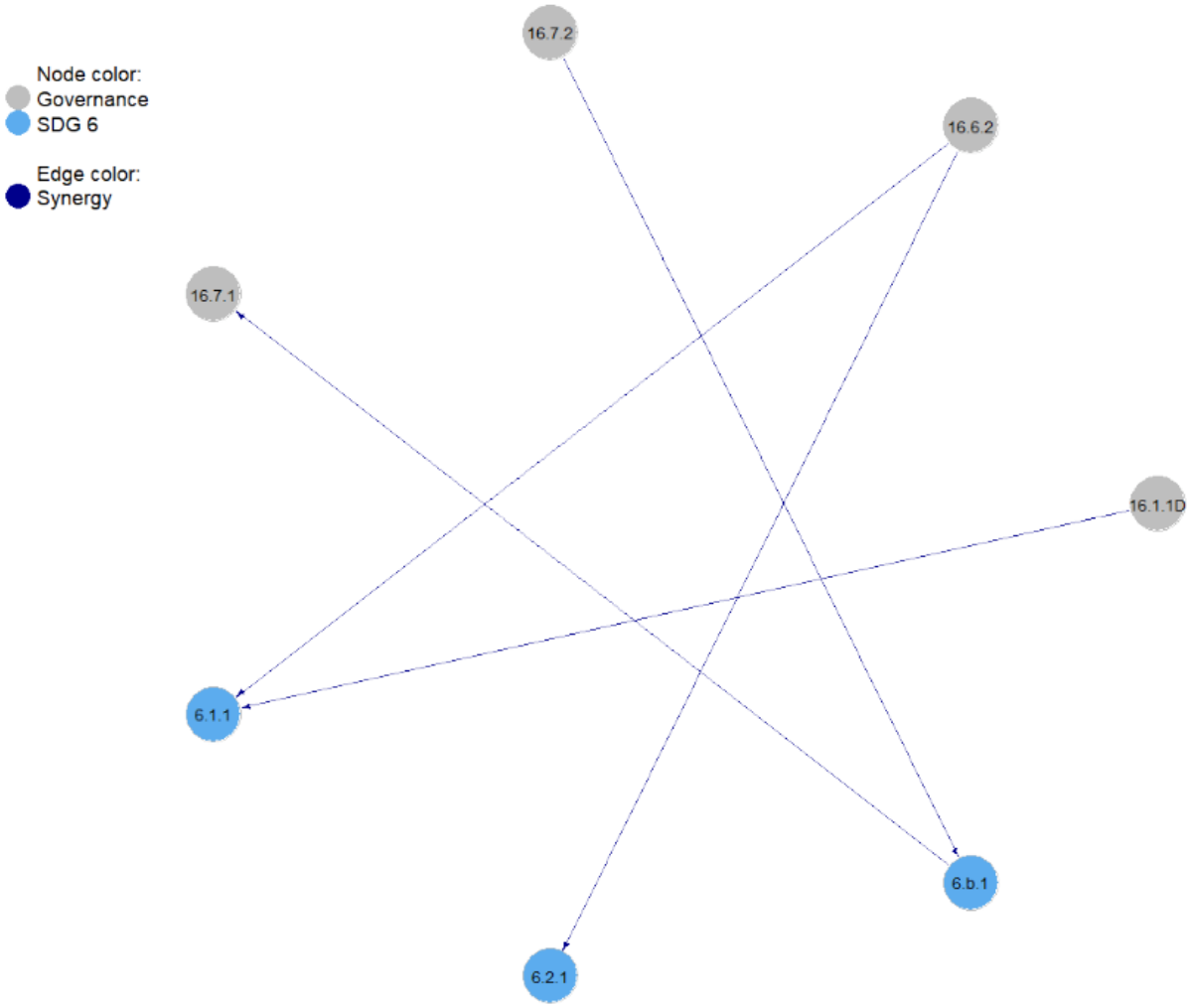


Figure 5.10: Output of a social network analysis of interlinkages between indicators of SDG 6 and the governance SDG indicators as identified by respondents with responsibility for or exposure to programmes for achieving SDGs in South Africa

SDG 17 aims to strengthen the means of implementation and revitalise the global partnership for sustainable development. SDG 17 exhibited 11 mutually reinforcing interlinkages with SDG 6. The links were observed based on information obtained through literature. The effective collection of water and sanitation taxes, as well as wastewater tariffs, including the introduction of subsidies (indicator 6.5.1) can help pump revenue (indicators 17.1.1 and 17.1.2) into the sector, while improving levels of service delivery. This action will, to a large extent, contribute towards strengthening domestic resource mobilisation, particularly if the subsidies and tariff structures are applied with the aim of achieving an appropriate level of service within the principles of equity and affordability. The implementation of tariffs and subsidies is critical. Likewise, IWRM measures the establishment of institutions (or improving the capacity of institutions) to collect revenue through appropriate systems.

Synergies were identified between national official donor assistance (ODA) (indicator 17.3.1) and water and sanitation ODA (indicator 6a.1) on the observation that an increase in the ODA disbursed to water and sanitation could result in an increase in national ODA. Of late, ODA disbursements in the water sector have been waning, largely due to the classification of South Africa as an upper-middle income country. Nonetheless, some ODA has been received by the country and there is hope that

more will come in. As a result, creative ways are required to channel ODA for the achievement of SDG 6.

The pursuit of partnerships that aim to improve science, innovation and technology in the water sector (indicator 17.6.1) mutually reinforce efforts to improve the provision of water and sanitation services (indicators 6.1.1 and 6.2.1) to underserved areas, and similarly support improvements in water quality (indicator 6.3.2D), water use efficiency (indicator 6.4.1), reduction in water stress (indicator 6.4.2) and to encourage community participation (indicator 6b.1), particularly if the advancements are positioned to improve IWRM implementation (indicator 6.5.1). The linkages demonstrate the inseparable and central role that science or research, technology, and innovation will have in SDG 6 decision-making. The link between indicators 17.14.1, 6.5.1 and 6.5.2 is based on the observation that IWRM (indicator 6.5.1), in essence, strives towards sustainable development. Subsequently, the establishment of basin transboundary cooperation (indicator 6.5.2) helps to improve water cooperation and, in turn, policy coherence and sustainable development (indicator 17.14.1) among countries.

Synthesis

Linkages between SDG 6 and the goals represented under the category peace, justice, strong institutions and partnerships for goals are all mutually reinforcing. The synergies are clustered around indicators that underpin action aimed at supporting good governance (indicators 16.6.2, 16.7.1 and 16.7.2), integrity (indicators 16.5.1 and 16.5.2), access to finance (indicator 17.3.1), peace and cooperation (indicators 16.1.2 and 16.3.1), as well as research development and innovation (indicator 17.6.1). This entails that, within these areas, custodians of SDG 6, SDG 16 and SDG 17 are to concentrate their efforts on amplifying the effects of the identified synergies. These are the critical areas that are to be focused on to inspire change in South Africa's water sector. The report entitled "Money down the drain: Corruption in South Africa's water sector" illustrated that corruption in the country's water sector has weakened governance and facilitated illicit flows of finance. These actions have compromised peaceful societies, evidenced by the increase in service delivery protest in the country (Muller, 2020). It is therefore vital that good governance is promoted in the water sector in order to deliver water and sanitation services, as well as to improve the country's profile with regard to good governance.

Key dimensions and implications for implementation

SDG 16 (peace, justice and strong institutions) and SDG 6 (water and sanitation)

Policy and institutional implications: Institutionally, there is room to improve the provision of reliable water and sanitation services. The number of underserved households continues to increase, as does the number of riots linked with disservice regarding the provision of water and sanitation services. Secondly, corruption in the water sector institutions has reached unprecedented levels, but this does not mean that it cannot be clamped down on and eliminated, especially if a culture of consequences is cultivated and procurement systems and practices are strengthened (Khaas, 2020).

Technological considerations: Improving the deployment of technology that will enable the deployment of water and sanitation services to currently underserved areas is critical. For example, in densely populated townships, technologies that are different to those used in sparsely populated, water-scarce rural areas need to be employed. However, all technologies need to unequivocally uphold the rights and dignity of citizens.

Data considerations: SDG 6 and SDG 16 do not currently have data connections. A recommendation made during stakeholder engagements was for DWS to start keeping a record of the occurrence of water- and sanitation-related service delivery protests.

SDG 17 (partnership for the goals) and SDG 6 (water and sanitation)

Policy and institutional implications: A number of policy and institutional advancements needs to be made to achieve SDG 6. Full implementation of IWRM will be critical in supporting the required advancement.

Technological considerations: Sufficient financial resources are required to improve the roll-out of existing water and sanitation technological advancements.

Data considerations: SDG 6 and SDG 17 have a data connection on indicator 6a.1, which measures the amount of water- and sanitation-related official development assistance that is part of a government-coordinated spending plan.

Table 5.6 summarises the main synergy and trade-off linkages between indicators of SDG 6 and the governance indicators. The symbols used in the table follow two main categories of linkages described below:

Synergies		These are interlinkages that are positive and may be mutually reinforcing. When combined, they produce a greater impact
Constraints/trade-offs		These are interlinkages that still have positive aspects when executed individually, but have negative effects when implementation is conducted in tandem with another SDG that conflicts or lessens the other goal's effectiveness to deliver sustainable development.

Table 5.6: Summary of interlinkages between the governance indicators related to SDG 6 indicators (modified from UN-Water, 2016)

SDG 6-linked governance indicators	Water services (6.1.1)	Sanitation services (6.2.1)	Wastewater safely treated (6.3.1D)	Good ambient water quality (6.3.2D)	Water-use efficiency (6.4.1)	Levels of water stress (6.4.2)	IWRM implementation (6.5.1)	Trans-boundary basin area (6.5.2)	Water-related ecosystems (6.6.1)	Water and sanitation related official donor assistance (6a.1)
(16.1.1, 16.1.2, 16.1.3, 16.1.4 and 16.2.3) Intentional homicide, conflict-related deaths, physical violence, safety at night, violence against children										
(16.5.1, 16.5.2, 16.6.2 and 16.7.2) Corruption, bribery, public services, inclusive decision making										
(16.10.2, 16a.1 and 16b.1) Access to information and non-discriminatory laws										
(17.1.1 and 17.1.2) Domestic revenue collection										
(17.3.1, 17.6.1 and 17.14.1) National donor assistance, science, innovation and technology, policy coherence and sustainable development										

CHAPTER 6: RECOMMENDATIONS

The following priority areas and recommendations have been identified from the information and insights gained from the literature review and stakeholder engagements. The priority areas are identified in an effort to move the SDG implementation process forward in an integrated manner, as well as to demonstrate critical areas that require urgent action. To that end, the areas of recommendations have been grouped according to social, economic, environmental and research goals.

6.1 RECOMMENDATIONS FROM SOCIAL GOALS

Poverty alleviation and water

One of the aims of social development in South Africa is to reduce poverty through integrated sustainable development and the provision of basic services such as food and water to people (SDG 1). The National Water and Sanitation Master Plan also seeks to address water and sanitation issues, including the provision of basic services (SDG 6). Water plays a key role in catalysing and supporting economic growth through the effects of investments in large-scale infrastructure and the stimulation of small, local entrepreneurs in providing water services. Agricultural production, including crop and livestock, agro-processing and ecosystems, is influenced by the quality and quantity of available water. Although South Africa has made progress in reducing poverty since 1994, the rate of poverty is still high, especially in rural areas where many people still do not have access to enough water for productive and consumptive use. These people are poor because they do not have water for agricultural activities. Because South Africa experiences both water and poverty issues, it is important that the range of departments responsible for societal issues and the DWS work together on new approaches that are more structured and effectively link water management to poverty reduction in order to achieve the 2030 Agenda.

Food security and water

SDG 2 addresses food insecurity and malnutrition, while promoting sustainable agriculture to achieve zero hunger and sustainable development. Access to clean, safe water and sanitation services (SDG 6) is a key enabler in achieving food security and better nutrition. South Africa is experiencing water management challenges. Target 6.4 of SDG 6 aims to “increase water-use efficiency across all sectors to address water scarcity and substantially reduce the number of people suffering from water scarcity”, while Target 2.4 of SDG 2 aims “to ensure sustainable food production systems and implement resilient agricultural practices that increase productivity and production, and strengthen capacity for adaptation to climate change, and drought”. It is clear that proper planning and commitment is required between the Department of Agriculture, Land Reform and Rural Development (DALRRD) (the Food Security Directorate) and DWS to improve water for drinking, sanitation and agriculture purposes to achieve the 2030 Agenda. Managing the trade-offs that exist between SDG 2 and SDG 6 could help ensure that agricultural productivity is increased through sustainable agricultural and water practices.

Health and water

The Department of Health aims to improve health status by preventing illnesses and promoting healthy lifestyles and improving the healthcare delivery system by focusing on access, equity and sustainability. Adequate water, sanitation and hygiene are essential components of providing basic health services, and the DWS and the Water Services Act address both water supply and sanitation. The provision of WASH in healthcare facilities serves to prevent infections and the spread of disease. The current COVID-19

pandemic has shown that investment in the provision of basic water, sanitation and hygiene services must be a key priority for all communities and healthcare facilities. In South Africa, many healthcare facilities in rural areas have no WASH services, a situation that presents a serious health risk to poor, vulnerable people.

It is evident that health issues cannot be achieved without safe water and sanitation. Therefore, improvements of WASH in healthcare facilities will require commitment from both the Department of Health and DWS's partners at local and national level. The DWS invests in water tanks to be located in communities without basic water services.

Education and water

SDG 4 (indicator 4a.1) aims to upgrade school facilities such as electricity, basic drinking water, sanitation and handwashing facilities. SDG 6 (indicators 6.1.1 and 6.2.1) also looks at WASH services. Providing drinking water and promoting sanitation and hygiene in schools is a crucial component of ensuring that children can attend school regularly, remain healthy and improve their education. In South Africa, the majority of schools without safe WASH services are in rural areas, and it is important to ensure that these services reach rural areas to improve education. The current COVID-19 pandemic has highlighted the need for safe water and sanitation in schools to reduce the spread of the virus. Therefore, commitment is necessary from both DBE and DWS to plan together to achieve access to WASH in all schools.

6.2 RECOMMENDATIONS FROM ECONOMIC GOALS

Water quality

The most commonly linked indicators in the economic sector were the water-quality related indicators 6.3.1D (wastewater treated) and 6.3.2D (water quality goals). These indicators also ranked highly in the other sectors, serving to highlight the importance of water quality. Water quality in South Africa is degrading (CSIR, 2010; DWA, 2011), leading to states where water is not easily accessible and quality-related issues such as toxic algal blooms (Harding, 2015; van Ginkel, 2011), acid mine drainage (McCarthy, 2011) or unacceptably high levels of bacteria or heavy metals (CSIR, 2010; DWA, 2011) are evident. Water quality is a concern both because of the direct threat to water users, but also because water of low quality cannot be used directly, which reduces the amount of water available for use. The economic sector is very much a part of this issue, both as a source of many contaminants, but also as a water user. For water quality to be controlled, existing monitoring programmes need to be used in compliance assessment, and compliance with water-use licences and other instruments must be strictly enforced.

Water-use efficiency

The linked indicators 6.4.1 (water-use efficiency) and 6.4.2 (water stress) are also strongly linked to results from the economic sector, and this helps to highlight the importance of water availability for life in South Africa. South Africa is a semi-arid country and has faced threats from several droughts recently. Drought (and flood) frequency is liable to increase in the future as climate change takes hold (DEA, 2017). The recent drought that threatened Cape Town, the ongoing Eastern Cape drought and others highlight the importance of access to water, and of the frugal use of water if life is to continue under future droughts. Frugal or sustainable use of water would entail developing or applying methods to limit water loss, both as leakage from pipes delivering water, or as water-efficient irrigation systems that ensure that water is used by plants, with little being lost to evaporation.

6.3 RECOMMENDATIONS FROM ENVIRONMENTAL GOALS

Improving planning for climate-related disasters

South Africa is vulnerable to climate change-induced weather extremes, such as droughts and floods. These extremes compromise the reliable delivery of water and sanitation services for both domestic and commercial services. Severe droughts and floods reduce water availability, increase water stress and affect the health of water-related ecosystems. In the past, porous planning against climate change-related disasters led to economic losses, threatened livelihoods and increased poverty. Given the social, economic and environmental knock-on effects of climate change-related disasters, it is paramount to bolster planning for the eventuality of the disaster. In doing so, clear mitigation and adaptation mechanisms, which are aimed at lessening the devasting impact of disasters, as well as building the resilience of the community against climate hazards, can be developed. Part of the process of bolstering planning for climate change disasters includes mainstreaming water- and sanitation-related mitigation measures into the disaster risk response plans of local municipalities. Secondly, such planning includes increasing the capacity of local municipalities to develop effective and implementable risk response reports. Lastly, improving planning for climate-related disasters may require the integration of climate change in water and sanitation planning. In view of the above, it is clear that SDG 13 (climate action) and SDG 6 are strongly linked at a planning level. To this end, focus area indicators between the two goals are indicators 6.5.1 (IWRM implementation) and 13.2.1 (national adaptation plans), as well as national and local disaster risk reduction plans (indicators 3.1.2 and 13.1.3).

Enhance co-governance and collaboration on the protection of freshwater ecosystems

Indicators of SDG 6 and SDG 15 on freshwater ecosystems (indicators 6.6.1D(1) and 15.1.2) share common reporting and, as a result, are presented as a focus area to deepen relations between the focal institutions, as well as to streamline resources (financial and human resources). The mandate for the protection and management of freshwater ecosystems is shared between DWS and DEFF and its entities (the South African National Biodiversity Institute and South African National Parks). Therefore, cooperative governance between the water and environment actors is essential for achieving the shared mandate of freshwater ecosystem conservation, which straddles SDG 6 and SDG 15. One way of fostering co-governance and collaboration between the respective institutions is to re-ignite and expand the mandate of existing interdepartmental structures and platforms (i.e. the Interdepartmental Committee on Inland Water Ecosystems, chaired by DWS) to include the SDGs. This will allow for a concerted strategic direction regarding the tracking and implementation of linked SDG 6 and SDG 15 indicators, as well as addressing the existing business planning fragmentations that may hamper integrated freshwater ecosystem management by the two departments. The platforms will also play a role in strengthening communication and sharing information between the respective actors regarding SDG implementation. Additionally, interdepartmental platforms will ensure that freshwater ecosystems remain an explicit focus in both SDG 6 and SDG 15. There is a risk that efforts to achieve SDG 15 (life on land) will neglect freshwater ecosystems, and that efforts to achieve SDG 6 will focus primarily on water as a resource for human and economic consumption, and neglect the underlying freshwater ecosystems on which the provision of this resource depends.

Increasing citizen participation in water resource management

Active citizenry in water resources is paramount for improving the health of ambient water sources and for safeguarding the integrity of marine and coastal waters. As a result, DWS and DEFF, including their respective entities, should establish closer working ties to devise platforms where citizens can participate in addressing areas related to SDG 6, SDG 14 and SDG 15. One of the platforms that can be re-ignited from the DWS's corner is the Adopt-a-River Campaign, which encouraged communities to

clean and look after a specific river by removing debris, as well as reporting any activities that may compromise river health. The programme yielded positive results in encouraging public participation to preserve freshwater ecosystems. The downstream benefits of the programme were less debris entering the marine and coastal waters through rivers. Citizen science tools such as miniSASS play an instrumental role in monitoring and understanding the water quality of ambient water sources. Results received from citizen science monitoring tools provide a high-level overview of the quality of water in rivers. As a result, ensuring increased uptake and the adoption of citizen science-inspired monitoring mechanisms will be instrumental in gaining a first-level understanding of the effect domestic and industrial wastewater effluent that is discharged into water sources can have on the ocean eutrophication levels downstream.

6.4 RESEARCH RECOMMENDATIONS

In order to fill knowledge gaps in critical areas where more trade-offs were identified, there is an urgent need for scientists from different disciplines to share knowledge, as well as to collaborate and partner more. Universities and research institutions also need to develop more research and funding around the SDG indicators.

- South African monitoring and evaluation has received relatively little attention, which may be problematic as this is key to measuring progress over time, to understanding policy impacts, and to ensure accountability. Policy makers need to implement new laws, planning and evaluation methodologies around this arena.
- More studies have assessed SDG-to-SDG, or target-to-target interlinkages. Very few studies have assessed indicator-to-indicator interlinkages, and there is a need for studies that focus on indicators as they are an important measure of progress.
- There is limited involvement of civil society and local communities in the arena of SDGs. Coordination and partnership between government officials and local communities are therefore required.
- It needs to be recognised that interlinked SDG budgeting needs to be reorganised to support the SDGs' mutual purpose. As a result, a research gap exists in understanding budgeting for interlinked indicators and in understanding what the facets and determinants are for the budgeting of intertwined SDGs. Understanding the budgeting mechanisms for intertwined SDGs is critical for ensuring that the interlinked SDGs identified in this document are implemented in a concerted manner.
- The results of this analysis indicate the importance of research capacity and of undertaking research into indicators of SDG 6. The results suggest that the benefit of monies spent on research will be regained through new processes and more efficient methods, and that supporting an active research community benefits the country.

CHAPTER 7: CONCLUSION

Overall, 223 synergies and 64 trade-offs were identified between the indicators of SDG 6 and the related SDG indicators from the literature, while 85 synergies and two trade-offs were identified from stakeholder engagement. The result shows the complexity of water systems, and the impact they have on society, the economy and the environment. Synergies and trade-offs were found in all four clusters of SDGs (social, economic, environmental and governance), demonstrating the extent to which water underpins all aspects of sustainable development. The results showed that a pattern of goals with greater collections of interlinkages from SDG 3 (good health and wellbeing), SDG 8 (economic growth), SDG 12 (responsible consumption and production), SDG 13 (climate action) and SDG 16 (peace, justice and strong institutions) contain the most synergies, and SDG 1 (no poverty), SDG 2 (zero hunger) and SDG 9 (industry, innovation and infrastructure) contain the most trade-offs. These results suggest that sectors covered by these goals could be the most important for coordinated partnership and interdisciplinary planning and decision making. In the work towards the SDGs, significant work is required to enhance policy coherence and increase institutional capacity to respond effectively to the interlinkages. In view of this, the following high-level conclusions are drawn:

Good water governance is essential. Bold political choices will be needed to ensure that resources are equitably allocated and to ensure the provision of water and sanitation for all. Good governance, intersectoral coordination and policy development via engaging stakeholders in an accountable and transparent manner can then be expressed as national legislation, sector regulation and/or institutional arrangements that identify clear roles and responsibilities for institutions. There was a lack of participation and attendance in both the interviews and the workshop. More participants in the workshop were from environmentally related SDGs than from other SDGs. There is a need to look at the factors that contribute to the lack of participation by other SDGs and what can be done to raise the profile.

Leveraging on multi-stakeholder platforms and partnerships can unlock potential. Sharing, accessing and adapting solutions takes cooperation. Utilising the existing platforms and fostering new partnerships at the national, regional and global levels can bring actors together from the public and private sectors, civil society and academia to align work, optimise resources and unlock the potential of collaboration through ownership and interdependence.

Capacity must be strengthened. South Africa has capacity constraints in certain areas that affect the manner in which the country undertakes progress on the SDGs. As a result, capacity development is needed to fast-track the implementation of the interlinked indicators. Capacity development is a cross-cutting issue that is essential for improving service levels, operating and maintaining technology, and monitoring performance. Capacity development is required in engineering, scientific and technical disciplines, and across all areas of the water sector, including policy, law, governance, finance, information technology and management. Investment in capacity development requires a long-term view, as its benefits may not be felt immediately.

Technology must be integrated into fast-tracking interlinkages. Technological advancements are central to the achievement of interlinked SDGs as they help mitigate trade-offs. Additionally, technological advancements accelerate the positive spinoffs from interlinked SDGs.

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APPENDIX A: RAW DATA

This appendix contains raw data on interlinkages between indicators of SDG 6 and other SDG indicators as indicated by a survey of appropriate literature, as well as a questionnaire survey of stakeholders. In all cases, the links are classified as directional, and they act from the source indicator to the target indicator. For each link, its classification as a synergy or constraint (or trade-off) is given.

Table A1: Interlinkages between indicators of SDG 6 and other SDGs taken from a review of appropriate literature

Source	Target	Link type
1.1.1	6.3.1D	Constraint
1.1.1	6.3.2D	Constraint
1.1.1	6.4.1	Constraint
1.1.1	6.4.2	Constraint
1.1.1	6.6.1	Constraint
1.2.1	6.3.1D	Constraint
1.2.1	6.3.2D	Constraint
1.2.1	6.4.1	Constraint
1.2.1	6.4.2	Constraint
1.2.1	6.6.1	Constraint
1.2.2	6.3.1D	Constraint
1.2.2	6.3.2D	Constraint
1.2.2	6.4.1	Constraint
1.2.2	6.4.2	Constraint
1.2.2	6.6.1	Constraint
1.4.1D	6.3.1D	Constraint
1.4.1D	6.3.2D	Constraint
1.4.1D	6.4.1	Constraint
1.4.1D	6.4.2	Constraint
1.4.1D	6.6.1	Constraint
10.1.1	6.3.1D	Constraint
10.1.1	6.3.2D	Constraint
10.1.1	6.4.1	Constraint
10.1.1	6.4.2	Constraint
10.1.1	6.6.1	Constraint
10.2.1	6.1.1	Synergy
10.2.1	6.2.1	Synergy
11.1.1D1	6.3.1D	Constraint
11.1.1D1	6.3.2D	Constraint
11.1.1D1	6.6.1	Constraint
11.1.1D2	6.1.1	Synergy
11.1.1D2	6.3.1D	Synergy
11.1.1D2	6.3.2D	Synergy

Source	Target	Link type
11.1.1D2	6.6.1	Synergy
11.3.2	6.b.1	Synergy
12.1.1	6.4.1	Synergy
12.1.1	6.4.2	Synergy
12.1.1	6.5.1	Synergy
12.1.1	6.6.1	Synergy
12.2.1	6.3.1D	Synergy
12.2.1	6.3.2D	Synergy
12.2.1	6.4.1	Synergy
12.2.1	6.4.2	Synergy
12.2.1	6.6.1	Synergy
12.2.2	6.3.1D	Synergy
12.2.2	6.3.2D	Synergy
12.2.2	6.4.1	Synergy
12.2.2	6.4.2	Synergy
12.2.2	6.6.1	Synergy
12.4.2D	6.3.1D	Synergy
12.4.2D	6.3.2D	Synergy
12.5.1	6.2.1	Synergy
15.2.1	6.6.1	Synergy
16.1.2	6.2.1	Synergy
16.1.2	6.4.2	Synergy
16.1.2	6.5.1	Synergy
16.1.2	6.5.2	Synergy
16.1.3	6.1.1	Synergy
16.1.3	6.2.1	Synergy
16.1.4	6.1.1	Synergy
16.1.4	6.2.1	Synergy
16.10.2	6.5.1	Synergy
16.2.3	6.1.1	Synergy
16.3.1	6.5.1	Synergy
16.5.1	6.1.1	Synergy
16.5.1	6.2.1	Synergy
16.5.1	6.5.1	Synergy
16.5.2	6.1.1	Synergy
16.5.2	6.2.1	Synergy
16.5.2	6.5.1	Synergy
16.6.2	6.1.1	Synergy
16.6.2	6.2.1	Synergy
16.6.2	6.5.1	Synergy
16.7.2	6.5.1	Synergy
16.7.2	6.b.1	Synergy
16.a.1	6.1.1	Synergy

Source	Target	Link type
16.b.1	6.5.1	Synergy
17.1.1	6.5.1	Synergy
17.1.2	6.5.1	Synergy
17.14.1	16.5.2	Synergy
17.14.1	6.5.1	Synergy
17.3.1	6.a.1	Synergy
17.6.1	6.1.1	Synergy
17.6.1	6.2.1	Synergy
17.6.1	6.3.2D	Synergy
17.6.1	6.4.1	Synergy
17.6.1	6.5.1	Synergy
17.6.1	6.6.1	Synergy
17.6.1	6.b.1	Synergy
2.3.1	6.3.1D	Constraint
2.3.1	6.3.2D	Constraint
2.3.1	6.4.1	Constraint
2.3.1	6.4.2	Constraint
2.3.1	6.6.1	Constraint
2.3.2	6.3.1D	Constraint
2.3.2	6.3.2D	Constraint
2.3.2	6.4.1	Constraint
2.3.2	6.4.2	Constraint
2.3.2	6.6.1	Constraint
2.4.1	6.3.1D	Constraint
2.4.1	6.3.2D	Constraint
2.4.1	6.4.1	Constraint
2.4.1	6.4.2	Constraint
2.4.1	6.6.1	Constraint
6.1.1	1.1.1	Synergy
6.1.1	1.2.1	Synergy
6.1.1	1.2.2	Synergy
6.1.1	1.4.1D	Synergy
6.1.1	10.1.1	Synergy
6.1.1	13.1.1	Synergy
6.1.1	13.1.2D	Synergy
6.1.1	13.1.3	Synergy
6.1.1	15.1.1	Constraint
6.1.1	2.1.1	Synergy
6.1.1	2.1.2	Synergy
6.1.1	2.2.1	Synergy
6.1.1	2.2.2	Synergy
6.1.1	2.3.1	Synergy
6.1.1	2.3.2	Synergy

Source	Target	Link type
6.1.1	2.4.1	Synergy
6.1.1	3.1.1	Synergy
6.1.1	3.2.1	Synergy
6.1.1	3.2.2	Synergy
6.1.1	3.3.3	Synergy
6.1.1	3.8.2	Synergy
6.1.1	3.9.2	Synergy
6.1.1	3.9.3	Synergy
6.1.1	4.a.1	Synergy
6.1.1	5.1.1	Synergy
6.1.1	5.2.1	Synergy
6.1.1	5.5.1	Synergy
6.1.1	8.5.1D	Synergy
6.1.1	8.5.2	Synergy
6.1.1	8.9.1	Synergy
6.1.1	8.9.2	Synergy
6.1.1	9.2.2	Synergy
6.2.1	1.1.1	Synergy
6.2.1	1.2.1	Synergy
6.2.1	1.2.2	Synergy
6.2.1	1.4.1D	Synergy
6.2.1	10.1.1	Synergy
6.2.1	13.1.1	Synergy
6.2.1	13.1.2D	Synergy
6.2.1	13.1.3	Synergy
6.2.1	14.1.1	Synergy
6.2.1	15.1.1	Constraint
6.2.1	2.1.1	Synergy
6.2.1	2.1.2	Synergy
6.2.1	2.2.1	Synergy
6.2.1	2.2.2	Synergy
6.2.1	2.3.1	Synergy
6.2.1	2.3.2	Synergy
6.2.1	2.4.1	Synergy
6.2.1	3.1.1	Synergy
6.2.1	3.2.1	Synergy
6.2.1	3.2.2	Synergy
6.2.1	3.3.3	Synergy
6.2.1	3.8.2	Synergy
6.2.1	3.9.2	Synergy
6.2.1	3.9.3	Synergy
6.2.1	4.a.1	Synergy
6.2.1	5.1.1	Synergy

Source	Target	Link type
6.2.1	5.2.1	Synergy
6.2.1	5.5.1	Synergy
6.2.1	8.5.1D	Synergy
6.2.1	8.5.2	Synergy
6.2.1	8.9.1	Synergy
6.2.1	8.9.2	Synergy
6.2.1	9.2.2	Synergy
6.3.1D	11.5.1	Synergy
6.3.1D	11.5.2	Synergy
6.3.1D	14.1.1	Synergy
6.3.1D	14.2.1	Synergy
6.3.1D	14.5.1	Synergy
6.3.1D	15.1.1	Constraint
6.3.1D	3.1.1	Synergy
6.3.1D	3.2.1	Synergy
6.3.1D	3.2.2	Synergy
6.3.1D	3.3.3	Synergy
6.3.1D	3.8.2	Synergy
6.3.1D	3.9.2	Synergy
6.3.1D	3.9.3	Synergy
6.3.1D	8.5.1D	Synergy
6.3.1D	8.5.2	Synergy
6.3.1D	8.9.1	Synergy
6.3.1D	8.9.2	Synergy
6.3.2D	11.5.1	Synergy
6.3.2D	11.5.2	Synergy
6.3.2D	13.1.1	Synergy
6.3.2D	13.1.2D	Synergy
6.3.2D	13.1.3	Synergy
6.3.2D	13.2.1	Synergy
6.3.2D	14.1.1	Synergy
6.3.2D	14.2.1	Synergy
6.3.2D	14.5.1	Synergy
6.3.2D	15.1.2	Synergy
6.3.2D	3.1.1	Synergy
6.3.2D	3.2.1	Synergy
6.3.2D	3.2.2	Synergy
6.3.2D	3.3.3	Synergy
6.3.2D	3.8.2	Synergy
6.3.2D	3.9.2	Synergy
6.3.2D	3.9.3	Synergy
6.3.2D	8.5.1D	Synergy
6.3.2D	8.5.2	Synergy

Source	Target	Link type
6.3.2D	8.9.1	Synergy
6.3.2D	8.9.2	Synergy
6.4.1	13.1.1	Synergy
6.4.1	13.1.2D	Synergy
6.4.1	13.1.3	Synergy
6.4.1	13.2.1	Synergy
6.4.1	15.1.2	Synergy
6.4.2	13.2.1	Synergy
6.4.2	15.1.2	Synergy
6.5.1	13.1.2D	Synergy
6.5.1	13.1.3	Synergy
6.5.1	13.2.1	Synergy
6.5.1	13.3.1	Synergy
6.5.1	14.1.1	Synergy
6.5.1	14.2.1	Synergy
6.5.1	14.5.1	Synergy
6.5.1	15.1.2	Synergy
6.5.1	5.1.1	Synergy
6.5.1	5.2.1	Synergy
6.5.1	5.5.1	Synergy
6.5.1	8.9.1	Synergy
6.5.1	8.9.2	Synergy
6.5.2	8.9.1	Synergy
6.5.2	8.9.2	Synergy
6.6.1	11.5.1	Synergy
6.6.1	11.5.2	Synergy
6.6.1	13.1.1	Synergy
6.6.1	13.2.1	Synergy
6.6.1	14.2.1	Synergy
6.6.1	14.5.1	Synergy
6.6.1	15.1.2	Synergy
6.6.1	15.4.1D	Synergy
7.1.1	6.3.2D	Constraint
7.1.1	6.4.1	Constraint
7.1.1	6.4.2	Constraint
7.2.1	6.3.2D	Synergy
7.2.1	6.4.1	Synergy
7.2.1	6.4.2	Synergy
8.4.1	6.3.1D	Synergy
8.4.1	6.3.2D	Synergy
8.4.1	6.4.1	Synergy
8.4.1	6.4.2	Synergy
8.4.1	6.6.1	Synergy

Source	Target	Link type
8.4.2	6.3.1D	Synergy
8.4.2	6.3.2D	Synergy
8.4.2	6.4.1	Synergy
8.4.2	6.4.2	Synergy
8.4.2	6.6.1	Synergy
8.9.1	6.4.1	Constraint
8.9.1	6.4.2	Constraint
8.9.1	6.6.1	Constraint
8.9.2	6.4.1	Constraint
8.9.2	6.4.2	Constraint
8.9.2	6.6.1	Constraint
9.1.1	6.6.1	Constraint
9.2.1	6.3.1D	Constraint
9.2.1	6.3.2D	Constraint
9.2.1	6.4.1	Constraint
9.2.1	6.4.2	Constraint
9.2.1	6.6.1	Constraint
9.3.1	6.4.1	Constraint
9.3.1	6.4.2	Constraint
9.3.1	6.6.1	Constraint
9.5.1	6.1.1	Synergy
9.5.1	6.2.1	Synergy
9.5.1	6.3.1D	Synergy
9.5.1	6.3.2D	Synergy
9.5.1	6.4.1	Synergy
9.5.1	6.4.2	Synergy
9.5.1	6.5.1	Synergy
9.5.1	6.5.2	Synergy
9.5.1	6.6.1	Synergy
9.5.2	6.1.1	Synergy
9.5.2	6.2.1	Synergy
9.5.2	6.3.1D	Synergy
9.5.2	6.3.2D	Synergy
9.5.2	6.4.1	Synergy
9.5.2	6.4.2	Synergy
9.5.2	6.5.1	Synergy
9.5.2	6.5.2	Synergy
9.5.2	6.6.1	Synergy

Table A2: Interlinkages between indicators of SDG 6 and other SDGs taken from semi-structured interviews and other interactions with qualified stakeholders

Source	Target	Link type
12.2.1	6.1.1	Synergy
12.2.1	6.3.2D	Synergy
12.2.1	6.4.1	Synergy
12.2.1	6.4.2	Synergy
12.2.2	6.1.1	Synergy
12.2.2	6.3.2D	Synergy
12.2.2	6.4.1	Synergy
12.2.2	6.4.2	Synergy
15.1.1	6.3.2D	Synergy
15.1.1	6.4.1	Synergy
15.1.1	6.4.2	Synergy
15.1.2	6.3.2D	Synergy
15.1.2	6.4.1	Synergy
15.1.2	6.4.2	Synergy
15.1.2	6.5.1	Synergy
15.1.2	6.6.1	Synergy
15.1.2D	6.5.1	Synergy
15.3.1	6.3.2D	Synergy
15.3.1	6.6.1	Synergy
15.4.1D	6.5.1	Synergy
15.4.2	6.5.1	Synergy
15.5.1	6.3.1D	Synergy
15.5.1	6.3.2D	Synergy
15.5.1	6.4.1	Synergy
15.5.1	6.4.2	Synergy
15.5.1	6.5.1	Synergy

Source	Target	Link type
15.5.1	6.6.1	Synergy
15.8.1	6.4.2	Synergy
15.8.1	6.5.1	Synergy
15.8.1	6.6.1	Synergy
16.1.1D	6.1.1	Synergy
16.6.2	6.1.1	Synergy
16.6.2	6.2.1	Synergy
16.7.2	6.b.1	Synergy
6.1.1	1.4.1D	Synergy
6.1.1	11.1.1D2	Synergy
6.1.1	2.1.1	Synergy
6.1.1	2.1.2	Synergy
6.1.1	2.2.1	Synergy
6.1.1	2.2.2	Synergy
6.1.1	2.3.1	Synergy
6.1.1	2.3.2	Synergy
6.1.1	2.4.1	Synergy
6.1.1	4.1.1	Synergy
6.1.1	4.2.1	Synergy
6.1.1	4.2.2	Synergy
6.1.1	4.3.1	Synergy
6.1.1	4.5.1	Synergy
6.1.1	4.a.1	Synergy
6.1.1	5.2.1	Synergy
6.1.1	5.2.2	Synergy
6.1.1	8.4.1	Synergy
6.1.1	8.4.2	Synergy

Source	Target	Link type
6.2.1	1.4.1D	Synergy
6.2.1	11.1.1D2	Synergy
6.2.1	2.1.1	Synergy
6.2.1	2.1.2	Synergy
6.2.1	2.2.1	Synergy
6.2.1	2.2.2	Synergy
6.2.1	2.3.1	Synergy
6.2.1	2.3.2	Synergy
6.2.1	2.4.1	Synergy
6.2.1	4.1.1	Synergy
6.2.1	4.2.1	Synergy
6.2.1	4.2.2	Synergy
6.2.1	4.3.1	Synergy
6.2.1	4.5.1	Synergy
6.2.1	4.a.1	Synergy
6.2.1	5.2.1	Synergy
6.2.1	5.2.2	Synergy
6.2.1	8.4.1	Synergy
6.2.1	8.4.2	Synergy
6.3.1D	14.5.1	Synergy
6.3.1D	2.3.1	Synergy
6.3.1D	2.3.2	Synergy
6.4.2	14.5.1	Synergy
6.5.1	5.1.1	Synergy
6.5.1	5.5.1	Synergy
6.6.1	14.5.1	Synergy
6.b.1	16.7.1	Synergy

Source	Target	Link type
7.2.1	6.3.2D	Synergy
7.2.1	6.4.1	Synergy
7.2.1	6.4.2	Synergy
8.1.1	6.a.1	Synergy
9.2.1	6.3.2D	Constraint
9.2.1	6.6.1	Constraint
9.5.1	6.3.1D	Synergy