





## Article

# Assessing Progress towards Sustainable Development Goals through Nexus Planning

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**Abstract:** Sustainable Development Goals (SDGs) acknowledge the inter-linkages between human wellbeing, economic prosperity, and a healthy environment and, hence, are associated with a wide range of topical issues that include the securities of water, energy and food resources, poverty eradication, economic development, climate change, health, among others. As SDGs are assessed through targets to be achieved by 2030 and monitored through measurable indicators, this study applied the nexus planning model to monitor and evaluate progress towards SDGs using South Africa as a case study. The study highlighted pathways to ensure socio-ecological sustainability and environmental health by establishing the connectivity between SDGs and nexus approaches. The linkages between SDGs and nexus planning facilitated the sustainable management of resources in an integrated manner. They addressed the cross-sectoral synergies, value-addition, and trade-offs within interlinked sectors. The connectedness of current challenges facing humankind (climate change, rapid urbanisation, migration, and the emergence of novel infectious diseases) require transformative approaches that address these cross-cutting challenges holistically. Managing the intricate relationships between distinct but interconnected sectors through nexus planning has provided decision support tools to formulate coherent strategies that drive resilience and sustainability. The established linkages between nexus planning and SDGs have strengthened cross-sectoral collaboration and unpacked measures for cooperative governance and management through evidence-based interventions. As food production, water provision, and energy accessibility are the major socio-economic and environmental issues currently attracting global attention; the methodology promotes attaining sustainability by 2030.

**Keywords:** food security; water security; energy security; water–energy–food nexus; water–health–environment–nutrition nexus



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## 1. Introduction

Natural resources are under pressure to meet the demands of a growing population, yet they are being depleted worldwide [1,2]. In 2017, over 1.06 billion people, predominantly from rural areas, had no access to safe and affordable energy, and half of these people live in sub-Saharan Africa [3]. As of 2016, some 793 million people in the world were still undernourished, and 2.4 billion had no access to improved sanitation [4]. Moreover, ecosystems are degrading at an alarming rate, as evidenced by a declining trend in the

productivity of a fifth of the Earth's land surface covered by vegetation between 1998 and 2013 [5]. Significant drivers of the stress on ecosystems include, but are not limited to, increasing demand for food due to rampant population growth and dietary transitions, accelerated economic development, rapid urbanization, environmental modifications, climate variability and change, among others [6]. The projected population increase in the human population to about 9 billion people by 2050 would cause a rise of 80% in energy consumption and a 60% increase in food demand [3,4]. The changes may require allocating more freshwater resources to agriculture, a sector already using nearly 70% of available freshwater resources [7]. These environmental and societal changes adversely modify the socio-ecological system, altering wildlife habitat and causing wildlife to move closer to human habitats [8]. Increasing wildlife–human interactions have seen the emergence of novel infectious disease from wildlife, such as the Ebola [9,10] and COVID-19 [11].

Resource depletion and degradation, impacts of climate change, the emergence of novel infectious diseases, socio-economic inequities, among other stresses, resulted in the launching of the 2030 global agenda on sustainable development by 198 countries, members of the United Nations (UN) in 2015, in an attempt to promote sustainability in resource management and ensure a healthy human–environment relationship [12]. The 17 Sustainable Development Goals (SDGs) are a call to action by all countries to promote prosperity while protecting the planet [12]. The Goals are monitored through 169 targets that collectively describe the world's progress towards achieving a sustainable future [12]. The SDGs are designed to recognise the interlinkages between human wellbeing, economic prosperity, and a healthy environment [12]. The recognition of the interlinkages in the current challenges in the SDGs context witnessed the prominence of nexus thinking as a lens to address interlinked and cross-cutting challenges in a holistic manner [13]. The water–energy–food (WEF) nexus had already emerged as a polycentric approach promoting resource management sustainability [14]. However, other nexuses that include the water–health–environment–nutrition (WHEN) nexus and urban nexus, among others, have since emerged [15]. The term “nexus planning” was derived from the fact that there are many other nexuses and not only the WEF nexus that has generally used [16].

The term “nexus planning” refers to interconnectedness and interlinkages between sectors, including the synergies and trade-offs related to their management [16,17]. Previous studies have summarised these interlinkages as “water for food and food for water, energy for water and water for energy, and food for energy and energy for food” [18,19]. This term emphasises the securities and the transferability of challenges from one sector to another and motivates a holistic approach to resource management [16,20]. The Food and Agriculture Organisation (FAO) defines nexus planning as an analytical tool for quantifying the interactions among linked but distinct sectors [21]. Therefore, the concept is three dimensional as it can be used as a conceptual framework, for discourse or as an analytical tool [22,23]. Thus, the essence of nexus planning is the integrated management of interlinked sectors/resources to mitigate trade-offs and maximise synergies that enhance sustainability. In the context of the current study, nexus planning refers to the application of nexus thinking (WEF and WHEN) to informing decision making.

Nexus planning is a transformative approach in that it differs from previous decision-making approaches that have been considered to be sector-specific and “siloeed” [15,17]. This has often resulted in trade-offs, which have undermined sustainability and meaningful beneficiation. For example, within southern Africa, the call for irrigation expansion is exacerbating water scarcity [24]. At the same time, such irrigation expansion is impeded by a lack of energy [17]. The analyses by Nhamo et al. [22] highlighted that there was unsustainability due to an overemphasis on food security without careful coal mining, driven by energy considerations, which was threatening food security in Mpumalanga. This province possesses almost 50% of the country's arable land [25]. Whilst a report by Mabhaudhi et al. (2018) [26] confirmed that conflicts in policies, which were not always integrated, created implementation challenges, and threatened sustainable development.

As the post-2015 focus has shifted towards implementing the SDGs and assessing the progress being made towards attaining a sustainable planet by 2030, a significant research challenge is developing tools and models to monitor and evaluate implementation progress by countries and interpret the data related to their monitoring [27,28]. Another challenge is aligning national policies and development plans with SDGs to avoid conflicts and policy incoherence [28,29]. Research and decision-making initiatives have been testing methods to effectively monitor and evaluate progress in implementing SDGs and reporting back to the global body [30]. The SDGs were developed so that each of the targets is assessed through one or more indicators that keep track of progress towards set targets. The indicators are the backbone of monitoring progress towards sustainable development by 2030, depending on data availability.

Congruence between nexus planning and the SDGs has many advantages, and nexus planning is proposed as a “fitting approach” for integrating and assessing SDGs implementation [31]. The essence of nexus planning is to ensure resource security, enhance environmental and human health, and achieve sustainability [15,22]. The method simplifies understanding the intricate and systematic interactions between the natural environment and human activities [22,32]. Nexus planning is an apt platform to manage natural resources across sectors, sustainably, and spatial scales, thus, relevant to assessing progress towards sustainable development over time.

There is currently a surge in global recognition of the importance of nexus planning in leveraging the implementation process for SDGs and subsequent monitoring and evaluation, particularly towards making informed decisions on goals, targets, and indicators [15,22]. As a cross-sectoral approach, the WEF nexus supports the integration of indicators across sectors and clarifies how best resources can be allocated between competing needs, making nexus planning the aptest tool to support strategic interventions that lead towards sustainability by 2030 [22,33,34]. The method integrates the three intricately related resources and clarifies the complex and dynamic interlinkages between resources, therefore, linking it directly to related SDGs. Therefore, this study demonstrates how nexus planning is used to assess progress towards sustainability, comparing the status of resources management in South Africa between 2015 and 2018. The nexus approach was used to evaluate the sustainability of resource management and for proposing pathways to achieve sustainability.

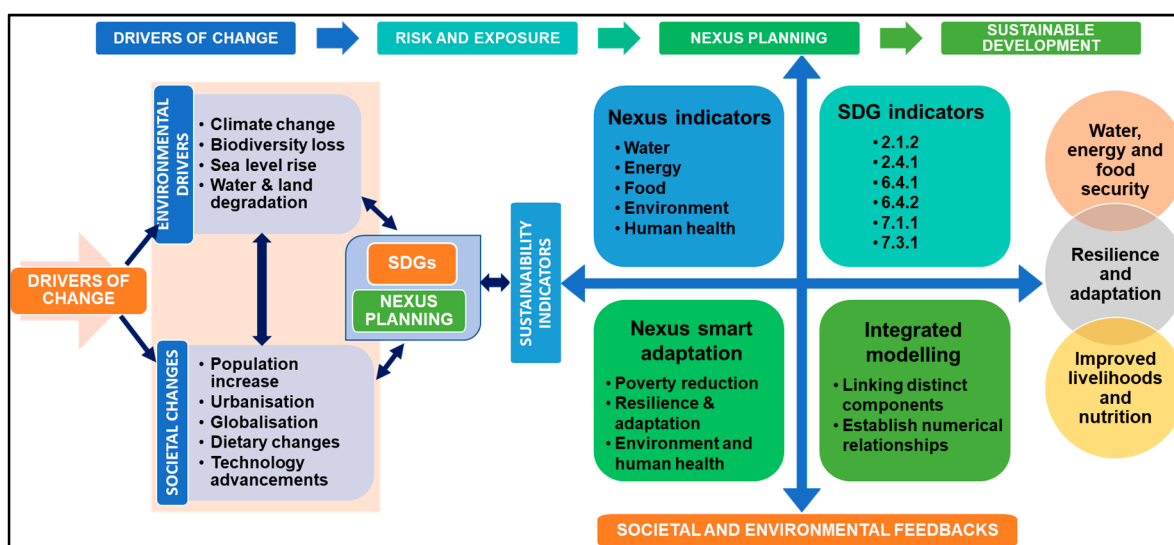
## 2. Materials and Methods

### 2.1. Methodological Framework to Assess Progress towards SDGs

Linking nexus planning and SDGs encompasses five thematic themes: (i) description of nexus analytical tool, (ii) defining WEF nexus sustainability indicators, (iii) linking nexus planning and related SDGs indicators, (iv) periodic assessment and monitoring of SDGs performance, and (v) benefits of periodic SDGs monitoring (Figure 1). A water–energy–food nexus integrative model was adopted in this study [22]. The model defines the indicators for a particular nexus under consideration and calculates composite indices to establish an integrated numerical relationship among distinct but interlinked sectors [16,22]. By establishing the numerical relationships between distinct indicators, the model identifies areas needing immediate intervention to balance resource use and achieve sustainable management. Establishing indices for each indicator at different time intervals provides pathways to assess SDGs progress.

The rationale is based on establishing quantitative relationships among the intricately connected drivers of change and translating that relationship into meaningful interventions that promote sustainable development. This facilitates understanding how socio-economic, environmental, and ecological interactions influence negative change, and ultimately unsustainability. The processes unravel societal and environmental outcomes affected by these interactions (food security, ecosystem services, and social welfare), which are best explained through sustainability indicators [16,22]. Nexus modelling is a preferred transformative approach in integrated analyses, using sustainability indicators, to provide

quantitative relationships among intricately connected sectors and provides pathways towards nexus smart adaptation and sustainable development (Figure 1).



**Figure 1.** A conceptual framework linking nexus processes with Sustainable Development Goals (SDGs).

Social-ecological systems are complex interactions between human (economic and political trends, population dynamics, changing diets and nutrition, and advances in science and technology) and natural (landcover changes, land and soil degradation, climate change, biodiversity loss, sea-level rise, and air pollution) components [35,36]. It is paramount to understand these relationships holistically to transition towards sustainable development. Nexus planning connects these interactions by defining, measuring, and modelling progress towards sustainability through indicators formulated around resource utilisation, accessibility, and availability [22]. Nexus modelling develops knowledge-based tools to assess vulnerability and resilience, promoting interventions that enhance healthy human–environment interactions. The tools facilitate identifying simultaneous resource security and conservation pathways by analysing societal and environmental feedbacks (social, ecological, political, and economic determinants).

## 2.2. Criteria for Selecting Nexus Planning Sustainability Indicators

Nexus planning emphasises the integrated management of resources and ensures their security (water, energy, and food) while concurrently safeguarding the sustainability of socio-ecological interactions [16,22,37,38]. At the same time, the security of these essential resources and environmental sustainability form the heart of sustainable development [39,40]. These broad linkages between nexus planning and SDGs facilitate an assessment of progress towards the 2030 SDGs [22]. Therefore, as a transformative approach, nexus planning provides the pathways and tools to assess progress towards sustainable development through sustainability indicators [33,41]. Sustainability indicators are simplified decision-support tools that facilitate understanding of the interrelations among distinct but connected sectors [42,43]. Thus, the essence of indicators is to convert complex relationships into simple numerical expressions that make assessment easier [42,43].

As the nexus approach is directly related to SDGs in that both are concerned with environmental sustainability and resource security, and the former providing tools to assess progress towards SDGs, the selection of nexus sustainability indicators is, therefore, based on indicators that measure the security of resources as well as promote the sustainability of socio-ecological interactions. Selected nexus indicators are directly linked to the drivers of resource security and environmental sustainability [22]. Other indicators that could be relevant are including during the assessment as pillars, as proposed by Nhamo et al. [22]. An integrated smart attribute of nexus planning is identifying different

interventional priorities to enhance sustainability [22]. Therefore, the linkages between nexus planning and SDGs cemented by using indicators as guiding instruments to either evaluate progress in implementation or establish numerical relationships between distinct sectors/components [22,44].

### 2.3. Linking Nexus Approaches to Related SDGs

As already alluded to, the nexus's value is its documentation of the cross-sectoral and integrated management of resources and simplifying the intricate interlinkages between distinct sectors or components of a system. In this study, the approach is designed to ensure that any planned developments in one sector should only be implemented after considering the impacts (synergies, trade-offs, and implications) in the other sectors [16,22,33]. As nexus planning sustainability indicators are directly linked to related SDG indicators, it is vital for evaluating SDGs implementation progress [16,22]. Both nexus planning and SDGs serve the same purpose of ending poverty and achieving economically and environmentally sustainable outcomes. The former serves as an approach to spearhead the implementation of nexus-linked SDGs. Table 1 lists nexus planning indicators, as well as the related SDG indicators.

**Table 1.** WEF nexus indicators and pillars, and the linked SDG indicators.

Nexus Type	Sector	Nexus Planning Indicator	SDG Indicator
WEF	Water	Proportion of crops/energy produced per unit of water used.	6.4.1
		Proportion of available freshwater resources per capita	6.4.2
	Energy	Proportion of population with access to electricity	7.1.1
		Energy intensity measured in terms of primary energy and GDP	7.3.1
	Food	Prevalence of moderate or severe food insecurity in the population	2.1.2
		Proportion of sustainable agricultural production per unit area	2.4.1
WHEN	Water	Proportion of population using safely managed drinking water services.	6.1.1
		Proportion of bodies of water with good ambient water quality	6.3.2
	Human health	Mortality rate attributed to unsafe water, sanitation, and poor hygiene	3.9.2
	Environment	Forest area as a proportion of total land area	15.1.1
		Proportion of land that is degraded over total land area	15.3.1
	Nutrition	Prevalence of moderate or severe food insecurity in the population	2.1.2
		Prevalence of malnutrition	2.2.2

The relationships between the SDGs and the two nexus types were established: the water–health–environment–nutrition (WHEN) nexus [16] and the water–energy–food (WEF) nexus [22]. SDG indicators directly linked to both the WHEN and WEF nexuses indicators (e.g., a direct measure of available water resources, a direct measure of food security, or a direct measure of energy accessibility) are shown in Table 1. The focus is on indicators directly falling under the WHEN and WEF nexuses frameworks to ensure water, energy, and food security, improve efficiency in resources management to attain sustainability, and ensure human and environmental health [15]. These nexus planning attributes link the approach to SDGs 2, 3, 6, 7, and 15.

### 2.4. Data Sources and Availability

The recognition of the importance of the WEF nexus as a decision support tool to assess the progress in implementing SDGs has gathered momentum worldwide; how-

ever, the main obstacle to achieving this has been data unavailability. Data availability is central in informing and weighting indicators during the pairwise comparison matrix (PCM) process [45]. Even where data could be available, it usually is heterogeneous [46]. Data uniformity is necessary mainly for comparison purposes, particularly across countries [47]. The variations in data collection and storage bring a host of challenges, including data disparity, mismatch, and a plurality [47]. Its availability is essential for evaluating trade-offs and synergies and reducing conflicts and vital aspects of sustainable development [48]. Therefore, data availability is key for establishing indicator weights during the PCM process.

Data at regional and national levels are generally available from open-source databases like FAOSTAT, AQUASTAT, and World Bank Indicators. At the national level, data is also obtainable from national statistical agents. Importantly, where data is not readily available, existing, and planned earth observation missions present reliable and long-term data sources [49,50]. For example, the Landsat Mission provides uninterrupted land and atmospheric information backdating from 1972 to date.

The success of sustainable development hinges on reliable data availability at all levels [51]. Publicly available data derived from remote sensing, ground stations or models, at any spatial scale is valuable for WEF nexus assessments. Recent advances in sensor technologies and remote sensing methods to collect, analyse, and store data have facilitated the quantification, and ultimately the establishment of numerical interlinkages between the WEF sectors and assess progress in implementing the SDGs [52]. For example, water use efficiency, crop water productivity, cropped area, and landuse change detection can be mapped and calculated using satellite data [53]. The other advantage of remotely sensed data is integrating, or fusing data obtained or derived at different spatial and temporal scales or from different satellites [54].

### 3. Results and Discussion

#### 3.1. Overview of WEF and WHEN Nexus Indicators in South Africa

An overview of both WEF and WHEN nexus indicators for South Africa for 2018 is given in Table 2 [55]. We used the Analytic Hierarchy Process (AHP), a Multi-criteria Decision Making (MCDM) process, to develop relational indices for each indicator [16,22].

**Table 2.** Overview of the WEF nexus indicators for South Africa.

Indicator	Short Name	2015	Units
Proportion of population using safely managed drinking water services	Water accessibility	74	%
Proportion of bodies of water with good ambient water quality	Water quality	46.92	%
Proportion of available freshwater resources per capita	Water availability	821.4	m <sup>3</sup>
Proportion of crops produced per unit of water used	Water productivity	26.2	\$/m <sup>3</sup>
Proportion of population with access to electricity	Energy accessibility	84.4	%
Energy intensity measured in terms of primary energy and GDP	Energy productivity	8.7	MJ/GDP
Prevalence of moderate/severe food insecurity in the population	Food self-sufficiency	6.2	%
Proportion of sustainable agricultural production per unit area	Cereal productivity	5.6	kg/ha
Mortality rate due to unsafe water, sanitation, and lack of hygiene	WASH mortality	13.7 pple	per 100,000 pop
Forest area as a proportion of total land area	Forested area	7.6	%
Proportion of land that is degraded over total land area	Degraded area	60	%
Prevalence of moderate or severe food insecurity in the population	Food insecurity	52	%
Prevalence of malnutrition	Malnutrition	6.2	%

Source: World Bank Indicators, 2021.

The Nexus-SDG linked indicators (Table 2) form the basis to assess progress towards sustainability over time. The indicators are related to each other through the AHP, a multi-criteria decision method (MCDM) to establish the numerical relationship, simplify understanding those intricate relationships, and identify priority areas for intervention [22,33]. Changes in the relationships between indicators and the progress towards sustainability are best assessed, for example, after every five years when meaningful change is noticeable. Therefore, the AHP can be run at intervals of five years (2015, 2020, 2025, and 2030) to assess progress towards the SDGs.

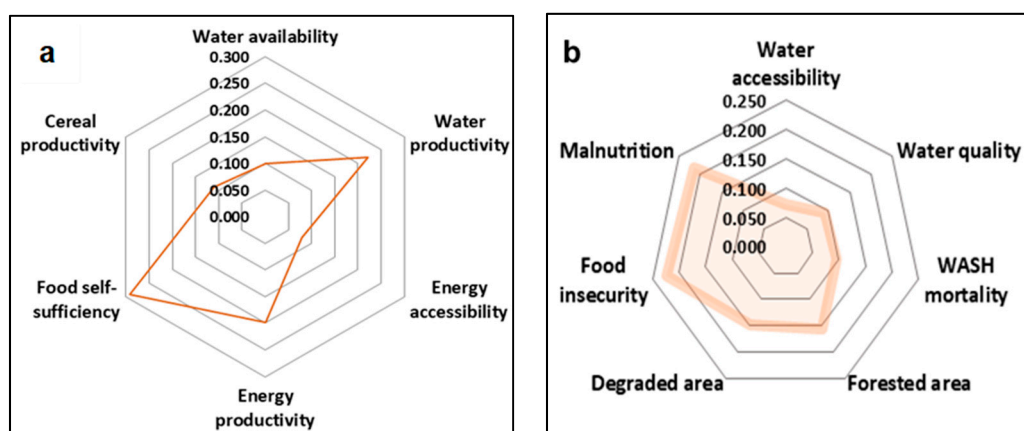
For South Africa, the period up to 2030 also aligns with the National Development Plan (NDP)—Vision 2030, which outlines the country’s development goals and priorities [56]. The NDP identifies agriculture as a key sector for job creation and poverty eradication; water and sanitation are linked to improved human wellbeing; energy as crucial to the industrialisation agenda; and human health and wellbeing as a key outcome of sustainable development [56]. Thus, the indicators used are relevant to South Africa’s planning and priorities.

### 3.2. WEF and WHEN Nexuses Composite Indices for South Africa

Composite indices for the WEF and WHEN nexuses indicators for 2015 for South Africa are given in Table 3. The indices are derived through the integrative model developed by Nhamo et al. [16,22]. The indices are quantitative relationships between the indicators, providing an overview of the state of resources management. The numerical relationship and the changes taking place in SDG implementation are best expressed using a spider graph, which illustrates the changes over time (Figure 2). As alluded to above, the indices are also useful for identifying priority areas for intervention and guiding the implementation of the NDP. For example, due to historical imbalances caused by apartheid, 19% of people living in rural areas and 33% of the total population, respectively, lack access to a reliable water supply and basic sanitation services [57].

**Table 3.** WEF nexus composite indices for South Africa for the year 2015.

Nexus Type	Indicator	Composite Indices (2015)
WEF	Water availability	0.126
	Water productivity	0.128
	Energy accessibility	0.141
	Energy productivity	0.111
	Food self-sufficiency	0.314
	Cereal productivity	0.180
WHEN	Water accessibility	0.073
	Water quality	0.092
	WASH mortality	0.095
	Forested area	0.155
	Degraded area	0.147
	Food insecurity	0.224
	Malnutrition	0.215

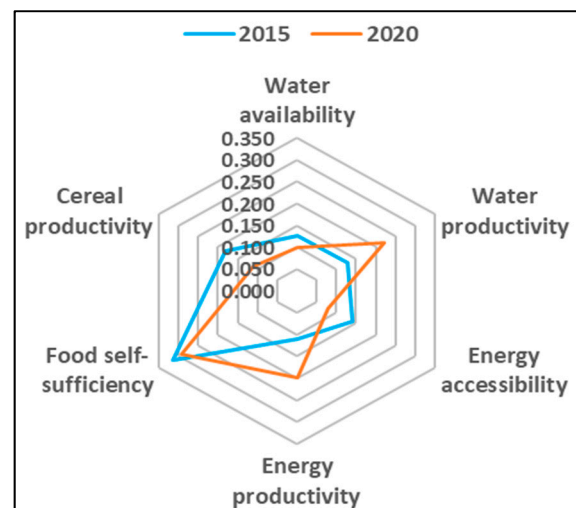


**Figure 2.** Quantitative relationships between the indicators representing the WEF nexus (a) and the WHEN nexus (b) in South Africa in 2015.

### 3.3. Assessing and Interpreting WEF and WHEN Nexus Status and Progress towards SDGs

The indicators for the nexus types are presented in the form of spider graphs (Figure 2). Both the WEF and WHEN nexus indicators present deformed relationships between indicators, but the interpretations are different. For the WEF nexus (Figure 2a), the centrepiece is intended to be circular to indicate a balance in resource management. However, for the WHEN nexus (Figure 2b), the centrepiece needs to reduce significantly in some indicators to improve human and environmental health and reduce the risk of novel infectious diseases. For example, malnutrition and food insecurity indicators need to be reduced drastically, improve water accessibility, water quality, and rehabilitate degraded lands and increase forested areas to ensure a healthy socio-ecological system.

The process is repeated for each of the reference years to assess changes that would have taken place and whether SDGs' progress is positive or negative. This is exemplified in Figure 3, which compares the WEF nexus indicators between 2015 and 2020. In both reference years (2015 and 2020), the country was focusing more on food security (food self-sufficiency), but in 2020 there was a general improvement in water productivity.



**Figure 3.** Changes in WEF nexus indicators between 2015 and 2018. The comparison is necessary to assess progress towards SDGs.

However, the progress achieved in some of these indicators is not always regarded as positive as it could have been achieved at the expense of other sectors. This is true in this case, as some indicators contracted during the same period, as evidenced by the spider graphs' irregular shape. Without compromising food security and the advances made in water productivity, interventional processes would inform policy and decision making to consider allocating more resources to improving the other indicators to achieve sustainable development. A sustainable socio-ecological system is achieved when the centrepieces or the spider graphs become circular, unlike the current status where the graphs remain irregular in shape.

The results are of both the WEF and WHEN nexus status, and progress are broadly indicative of the South African context. For the WEF, the results confirm the emphasis on agriculture as a vehicle for addressing poverty, unemployment, inequality, and food security. This has witnessed a significant improvement in investments to increase agricultural productivity in the rural areas and increasing area under irrigation. This reflects the southern African context, where food security and sovereignty are policy priorities [24]. The water-sanitation and health (WASH) challenges continue to persist, despite best efforts to address them; this is because old spatial planning laws continue to impede gridded access to clean and safe water and sanitation in rural, peri-urban, and informal areas. In this regard, off-grid WASH solutions and circular economy approaches are being investigated as an alternative.



#### 4. Way Forward

As already alluded to, balanced and sustainable resource management requires that all indicators attain the highest possible index of the “best” performing indicator without compromising other indicators, resulting in a circular shape of the spider graph. Balanced resource management may suggest that resources are being managed holistically to achieve sustainability but can still be classified as unsustainable if the indices remain low. An assessment of the changes in SDGs implementation taking place over time provides the required evidence on integrating strategies to operationalise the WEF nexus to manage resources in an integrated manner from a nexus planning perspective.

The spider graph reveals a country’s strengths and weaknesses, indicating priority areas for intervention, making nexus planning a valuable transformative and adaptation decision support tool for integrated resources management. Different scenarios can be developed from the information that is derived from nexus planning analysis. Thus, nexus planning is an essential approach for tracking resource utilisation and management at a given time. Nexus planning has evolved into a multi-purpose and polycentric decision support tool that simplifies and frames complex interactions between socio-economic and environmental concerns. However, further research is needed on developing scenarios to inform decision making on balancing resource management and achieve the 2030 global agenda on sustainable development.

However, it should be noted that each nexus type has its dynamics and could be interpreted differently, as shown in the WEF and WHEN nexus types. The essence of nexus planning in sustainable development is its capability to track progress towards SDGs over time and guide decision making on priority areas for intervention. However, a five-year interval period is considered the best interval as it would show significant changes in SDGs implementation. Baseline data from national statistical agencies could be the best for this analysis if readily available.

While the case study focused on South Africa, the findings of this study apply to countries in southern Africa, specifically, and the global South, broadly. These countries share a similar history, context, and developmental challenges. The development of nexus planning tools and models facilitates an assessment of resource management and progress towards sustainable development. As the approach has grown into an indispensable decision support tool to achieve sustainability by 2030, the following important highlights need to be noted:

1. Nexus planning offers the potential to monitor progress towards achieving SDG targets. Some nexus indicators used to generate composite indices are quite holistic and may need to be unbundled to translate to specific SDG indicators. For example, malnutrition is a broad term used to describe a condition where an individual is unhealthy due to under or overconsumption of certain nutrients [4,58]. Linking malnutrition data and composite index to SDGs requires a breakdown into different forms of malnutrition (stunting, wasting, overweight, and anaemia) as stated in SDG indicators 2.2.1, 2.2.2, and 2.2.3. Breaking down into the different forms of malnutrition as defined by the SDG indicators gives a better understanding of nutritional needs and guides countries in prioritizing nutritional interventions. The robustness of the approach is also heavily dependent on the availability of appropriate data directly linked to SDG indicators.
2. Data scarcity at different spatial scales is the major limitation to the success of nexus planning. The more the nexus planning indicator data available, the better it can be linked to SDG indicators resulting in more robust composite indices and sufficient evidence that can be used to prioritize interventions. Moreover, nexus planning is proposed approximately six years after the launch of SDGs and the lifespan of SDGs implementation is ending by 2030. Given that assessment is recommended at a five-year interval period to show significant changes in SDGs implementation, there is insufficient time to allow enough assessment before SDGs are phased out. A

one-time assessment will not be conclusive enough to show the trend of the progress of SDGs implementation.

3. There is a need to upscale the use of nexus planning as a decision tool to leverage the implementation process and progress towards SDGs and subsequent monitoring and evaluation to all southern African countries and at the regional level. A good understanding of SDG indicators and the definition of terms is needed to gather and use appropriate data to successfully link nexus planning indicators to SDG indicators. Platforms for easy accessing and sharing data at regional and national levels from open-source databases, national statistical agencies and remote sensing, ground stations, or models would need to be created. Development of protocols and data guidelines accompanied by training may also be beneficial to ensure uniformity and comparable data. The nexus planning approach as a decision tool to assess progress towards development agendas should not just be limited to SDGs. It can be extended beyond 2030 to assess other regional developmental agendas like the Africa Union Agenda 2063: The Africa We Want and SADC Vision 2050.

## 5. Conclusions

Nexus planning has tracked the intricate linkages between different sectors and has shown the progress made towards implementing the related SDGs in South Africa. Resource management remains on the lower end of unsustainability, as evidenced by increasing poverty and hunger at the household level, water scarcity, and energy insecurity. The following common principles guide both nexus planning and the SDGs: (a) promotion of sustainable and efficient resource use, (b) access to resources for vulnerable population groups, and (c) maintenance and support of underlying ecosystem services. These linkages have transformed nexus planning into a “fitting approach” to assess SDGs implementation over time while promoting the integration of indicators across sectors and reducing the risk of sector-specific SDG actions that usually result in competition between the otherwise related but distinct sectors. The advantage of nexus planning in assessing SDGs’ implementation is its capability to analyse trade-offs and synergies between indicators, indicating priority areas for intervention, making it a catalyst to achieve the 2030 global agenda on sustainable development. This can only be achieved if there are enough data and expertise to allow for robust assessments. Nexus planning is a transformative approach that promotes integrated resource planning, a guide in decision making in the advent of climate change and resource degradation and depletion, a decision support tool for formulating coherent policies and strategies, a governance and management tool for simultaneous water, energy, human health, environment, and food security, as well as job and wealth creation in the long-term. This implies that it is not limited to assessing SDGs but can be extended beyond 2030 to assess other regional developmental agendas like the Africa Union Agenda 2063 and SADC Vision 2050.

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