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Article *in* Journal of Environmental Management · March 2025

DOI: 10.1016/j.jenvman.2025.124938

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10 PUBLICATIONS **7** CITATIONS

Journal of Environmental Management 380 (2025) 124938

Contents lists available at ScienceDirect

Journal of Environmental Management

journal homepage: www.elsevier.com/locate/jenvman

Review

A review of the social and local dynamics in South Africa's water-energy-food nexus

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ARTICLE INFO

Keywords:
Accessibility
Affordability
Livelihoods
Socio-economic dynamics
South Africa
Water-energy-food nexus

ABSTRACT

Socioeconomic and environmental factors significantly shape the availability, accessibility, and affordability of water, energy, and food (WEF) resources in households and communities. In this review, we identify a significant gap in understanding how these factors intersect in the South African context, where inequalities in resource distribution persist. We critically examine the conditions influencing resource availability and explore the conceptual value of the WEF Nexus in guiding decision-making at local levels. Our findings highlight key barriers, including socio-economic disparities and systemic inefficiencies within governance, infrastructure, and resource management systems, which hinder the effective application of the WEF Nexus to improve livelihoods. We argue that integrating the WEF Nexus into decision-making requires a holistic, context-sensitive approach that prioritizes equity and sustainability. This review contributes to the discourse on resource management by offering actionable insights for policymakers and stakeholders to address water, energy, and food challenges in marginalized communities.

1. Introduction

The Water-Energy-Food (WEF) Nexus has gained increasing recognition as a critical framework for understanding the complex interconnections and trade-offs between essential resources. First highlighted at the Bonn 2011 Nexus Conference, this framework emphasized the need for an integrated approach to resource management for long-term sustainability (Hoff, 2011). In South Africa, the WEF Nexus was introduced through participation in international and national platforms, collaborations with multilateral organizations, and academic research, all drawing attention to its relevance in the Southern African Development Community (SADC). Within this region, resources are shared across transboundary systems, particularly water, which is vital in the context of South Africa's shared river basins. These include the Limpopo, Incomati, Maputo, and Orange River basins, which extend into the neighboring nations of Botswana, Lesotho, Mozambique, Namibia, Swaziland, and Zimbabwe (Fig. 1) (Kistin et al., 2009). Similarly, cross border interconnected energy infrastructures in the region allow for power sharing and trading through the Southern Africa Power Pool (SAPP), creating an opportunity to improve electricity supply in a region that experiences significant challenges in energy accessibility and affordability, impacting all sectors (Liu et al., 2017; Adeola et al., 2022; Mabhaudhi et al., 2021). Furthermore, food production and agricultural systems in the region are closely linked to water and energy availability, through food processing and irrigation, amongst others, which require reliable and affordable energy supplies. An integrated WEF Nexus strategy provides a crucial framework for South Africa and the broader region to balance competing demands and foster coordination across water, energy, and food systems, while enhancing resource efficiency and long-term economic growth and resilience (Simpson and Jewitt, 2019).

Despite growing recognition of the WEF Nexus, the management structure for these resources in South Africa and the wider region remains predominantly top-down and technocratic, stretching from national governments to provincial governments, local municipalities, and ultimately to communities, households, and individuals. This hierarchical framework often fails to account for how local communities and households might shape or be impacted by WEF decision-making. This exclusion is concerning, as social structural factors such as gender, race, class, and associated poverty significantly influence access to and

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https://doi.org/10.1016/j.jenvman.2025.124938
Received 30 July 2024; Received in revised form 4 March 2025; Accepted 8 March 2025
Available online 14 March 2025

security of these resources. South Africa, the most unequal country in the world (World Bank Group, 2023), provides a striking example of these social dimensions. With 13.8 million South Africans living below the poverty line (Stats SA, 2021), many face persistent food insecurity (World Bank, 2023). In remote, rural, and peri-urban communities, limited access to basic services such as water, energy, food, together with unemployment, exacerbates poverty. These socio-economic inequalities, compounded by resource scarcity and vulnerability to climate change, create a unique context for applying the WEF Nexus framework. Despite the existing academic and institutional efforts in advancing WEF-related research there remains a gap in integrating community-driven solutions for WEF resource insecurity. For instance, scholars like Mpandeli et al. (2018), Liphadzi et al. (2021), and Mabhaudhi et al. (2021) have addressed the complexities of water governance, food security, and climate change impacts on WEF systems. However, the approach remains largely top-down, often overlooking the importance of localized, inclusive approaches that consider the social dimensions of gender, race, and class.

The rising demand for food, water, and energy, driven by global population growth, industrialization, and urbanization, exacerbates climate change impacts and places greater pressure on South Africa's resource systems (Nhamo et al., 2020; Simpson and Jewitt, 2019). South Africa's National Development Plan (NDP) has projected significant increases by 2030 in the demand for water, food, and energy, by 35 %, 40 %, and 50 % respectively, in response to population growth (Mguni et al., 2020; Molajou et al., 2021). More than halfway through this period, the anticipated rise in resource demand has become evident, highlighting the need for more sustainable management and a deeper understanding of the interconnections between these resources at multiple levels. The NDP has been criticized for lacking a coherent strategy to integrate these sectors and for not providing a clear pathway to achieving this integration (Ngarava, 2024; Adeola et al., 2022; Mabhaudhi et al., 2018). In addition, challenges such as poor governance, resource mismanagement, and the lack of cross-sectoral collaboration further hinder progress toward these goals (Ngarava, 2024; Adeola et al., 2022). Mothelesi et al. (2022) corroborates, adding that South Africa is unlikely to meet the goals of the National Development Plan due to ineffective governance and weak policy implementation. This is underscored by the country's persistent energy and water shortages, which have led to rationing in municipalities and cities across the nation.

As South Africa grapples with these challenges, the need for an integrated, inclusive, and community-driven approach to the WEF Nexus has never been more urgent. The complexities of resource management demand a shift from top-down, technocratic models to ones that involve local communities, incorporate social dimensions, and address the needs of marginalized groups in a holistic manner. Without such an approach, the country's socio-economic inequalities and resource scarcity will likely continue to hinder sustainable development.

This article aims to bridge the gap by addressing the socio-economic aspects of the WEF Nexus at the household and community levels, focusing on marginalized groups such as women, youth, and children. By incorporating these social dimensions into the WEF Nexus framework, we seek to deepen our understanding of the interactions between water, energy, and food systems within South African communities. To achieve this, we adopted a scoping review methodology, following Armstrong et al. (2011) and Munn et al. (2018). This approach allows for the identification and mapping of existing evidence on the WEF Nexus research, exploring emerging trends and highlighting critical gaps in both research and practice. The primary objective of this review is to assess the accessibility, availability, and affordability of WEF resources, with a critical focus on their impact on livelihoods. South Africa's

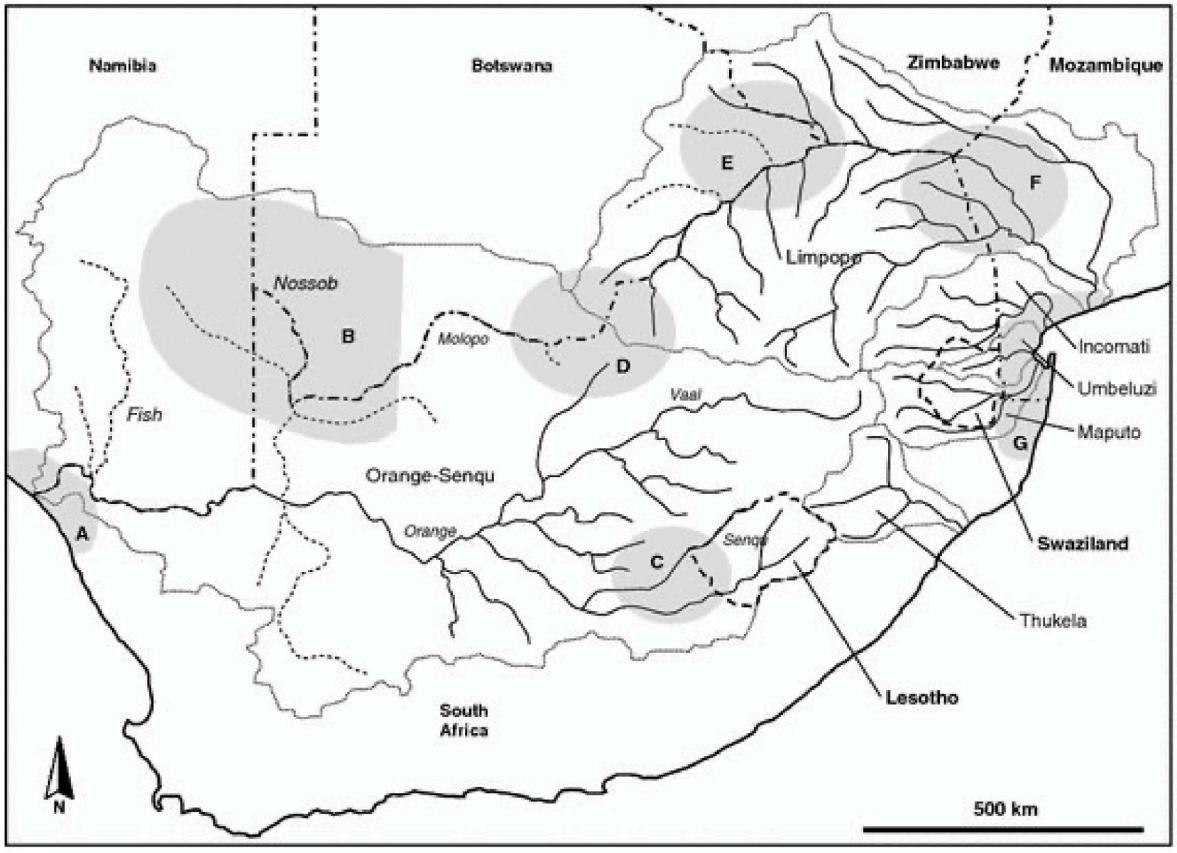

Fig. 1. Map of southern Africa, showing the six river basins with their main rivers and tributaries, plus the approximate extent of the seven shared aquifer systems that South Africa shares with neighboring countries, taken from Kistin et al., 2009), p. 4.

extreme socio-economic inequality underscores the need for more inclusive and sustainable resource management.

2. Methods

We employed a scoping review of the literature to identify and map the available evidence on the WEF Nexus in contemporary South Africa. This approach allowed us to explore a relatively new and broad topic, providing an opportunity to examine specific questions and inform practical applications (Armstrong et al., 2011; Munn et al., 2018). Munn et al. (2018) and Arksey and O'malley (2005) propose that a scoping review involve six main objectives: (1) identifying types of available evidence, (2) clarifying key concepts and definitions, (3) analyzing how research is conducted in the field, (4) outlining key factors related to the concept, (5) identifying precursors for scoping reviews, and (6) highlighting knowledge gaps. These principles guided our review and enabled us to draw on diverse source types to explore the applicability of the WEF Nexus in South Africa.

Our focus was on understanding the predominant social challenges linked to the WEF Nexus at local levels, and on identifying how the framework illuminates interactions and interdependencies in diverse contexts. We aimed to describe and analyze socio-economic factors influencing resource availability while critically examining the practical implementation of the WEF Nexus in community and household settings. Additionally, we sought to identify barriers hindering the effective application of the WEF Nexus and explore South Africa's unique socio-economic dynamics.

The initial mapping of existing reviews related to the WEF Nexus employed selected keywords and geographic criteria to identify pertinent literature (Table 1). This informed subsequent searches focusing on the WEF Nexus and its social factors in South Africa, further broadening the selection criteria (Table 2). Search strategies prioritized topics concerning water, energy, and food in "South Africa" or "Africa," with additional emphasis on "social" and "local" factors. Literature from outside South Africa and Africa was included to capture insights from underrepresented contexts and to enhance our analysis of WEF local applications. This iterative process aligns with rapid review methodologies, which utilize evidence summaries to support stakeholder discussions and policy development (Khangura et al., 2012).

Our search strategy employed three major databases – Web of Science (WoS), Google Scholar, and Scopus – to identify research publications on the WEF Nexus in South Africa. Scopus and WoS were chosen for their extensive coverage of peer-reviewed scientific literature across disciplines, including agriculture, environment, and social sciences (Adeola et al., 2022; Lulewicz-Sas, 2017). The search included articles published between 2011 and 2023, using the 2011 Bonn Conference as a starting point due to its significance in shaping WEF Nexus discussions. The initial search yielded 2890 documents, which were refined with the terms "social" and "local" to identify 851 documents. After eliminating duplicates and irrelevant studies, 68 articles focused on "Africa" and "South Africa" formed the foundation of our review.

Content analysis was employed to extract and analyze the main arguments and themes from the selected articles. Key insights into the challenges and complexities of the WEF Nexus were tabulated to facilitate comparisons and thematic analysis (Appendices A and B). Themes were further examined using Excel to support detailed analysis and data management. This approach allowed us to systematically explore the complexities of the WEF Nexus and reflect on its implementation in South Africa, providing a structured overview of the literature's findings.

Table 1
Search topics used in Web of Science and Scopus to retrieve water, energy, and food (WEF) nexus-related documents published in Africa and South Africa.

Search Topic (Row 1)	Area Restriction (Second Row)
Water, energy, food, and Nexus	[And Africa] [And South Africa]
Water, energy, food Nexus and social	[And Africa] [And South Africa]
Water, energy, food nexus, and Africa	[And Africa] [And South Africa]

Table 2
Selection criteria and justification.

Selection		Justification
Database	Web of Science (WoS), Google Scholar, and Scopus	Scopus and WoS are classified as having the greatest number of abstracts and citations of peer-reviewed scientific articles, books, and conference proceedings from a variety of scientific disciplines relevant to WEF, including natural resources, agriculture, environment, anthropology, and science among others
Timeframe	2011–2023	Documents searched are from 2011 to 2023, to gain an overview of the literature on the inception of the WEF Nexus and predictions of the demand for the three natural resource sectors. Initially, 851 documents were retrieved from the search engines, but duplicates were identified, and not all studies were relevant. In the end, we have drawn on 68 articles for this review, which include Water, energy, food "and social" and "local" and "Africa" and "South Africa".
Language	English	Ensuring data compatibility by restricting the research to one language.
Keywords searched	Water, energy, food, and Nexus	[And South Africa]
		[And Africa]
	Water, energy, food Nexus and social	[And Social]
Document types included	Peer-reviewed articles; proceedings papers; special issue editorial material	The selection of documents was done according to scientific standards to ensure that there is data coherence and comparability.
Documents excluded	Before 2011, Outside South Africa and Africa (exemption given to those that addressed WEF social issues)	

3. Results

3.1. Conceptual and operational challenges of the WEF nexus framework

In this scoping review, we identified critiques of the Water-Energy-Food (WEF) Nexus framework, particularly those concerning its conceptual clarity and practical applicability. While the framework aims to address the complex interdependencies between water, energy, and food systems, scholars argue that its translation from theoretical aspiration to practical implementation remains limited. For instance, Leck et al. (2015), Botai et al. (2021), and Taguta et al. (2022) highlighted persistent gaps in operationalizing the framework effectively.

Concerns about the originality and framing of the WEF Nexus were also evident. Benson et al. (2015) argue that it merely reconfigures existing approaches such as Integrated Water Resources Management (IWRM), while alternative framings, including the Energy-Water-Food (EWF) and Food-Energy-Water (FEW) models, have been suggested by Gain et al. (2015), Mabhaudhi et al. (2021), and Wichelns (2017) as potentially better representations of sectoral interdependencies. Furthermore, some scholars, including Huang et al. (2020), Cairns and Krzywoszynska (2016), Hussein and Ezbakhe (2023), and Simpson and

Jewitt (2019), critique the WEF Nexus as a "buzzword" – jargon that, despite its normative appeal, lacks analytic precision. It's broad framing often encompasses multiple policy issues without a clear strategy for implementation, again a concern raised by Mabhaudhi et al. (2021) and Simpson and Jewitt (2019).

Environmental and social dimensions are also frequently underemphasized within the framework. Cairns and Krzywoszynska (2016), Sivakumar (2021), and Bian and Liu (2021) underscore the exclusion of climate change and environmental impacts, limiting its relevance for marginalized populations facing resource insecurity. This is particularly concerning for groups such as women, youth, and rural communities, who often experience disproportionate impacts from resource scarcity and environmental degradation. The exclusion of these vulnerable voices highlights the WEF Nexus's limitations in addressing its population impact and so its capacity to address equity and social justice concerns.

Most studies disproportionately focused on technical and quantitative dimensions, often overlooking the socio-economic realities and lived experiences of affected communities, which include marginalized voices (women and children). This neglect of the human dimensions of the WEF Nexus has significant implications for policymaking and intervention design. Notably, the literature lacks a gender perspective, with minimal attention given to the differential roles and impacts on men and women within resource systems emphasized by the WEF Nexus framework. Additionally, Al-Saidi (2021) and Allouche et al. (2019) emphasize the need for more systematic and inclusive approaches to operationalizing the nexus, particularly in response to global disruptions like the COVID-19 pandemic.

The majority of studies draw on and describe quantitative research, reflecting that researchers have overlooked (or shown limited interest in) the human dimensions and socio-economic realities behind the data. Additionally, as noted above, the lack of a gender perspective in the discourse was noticeable, and the literature neglects the differential roles and impacts on women, youth, and marginalized communities. Furthermore, the practical challenges of translating research findings into actionable policies and interventions present significant hurdles. Most of the findings reflect a global perspective as there are limited WEF studies conducted in South Africa or the African continent. Evidence from other contexts was included to improve the analysis of the WEF Nexus and its local application.

3.2. Development and narratives/perspectives of WEF nexus research

Most of the 68 articles that underwent in-depth analysis were published between 2020 and 2023 (Fig. 2). Interest in WEF as a concept was initially provoked at a global level by resource crises in 2008, regional drought, and a rising interest nationally and regionally to move beyond sector-specific management (Botai et al., 2021). Interest increased after the Bonn Conference (Hoff, 2011), and in Africa, particularly from 2013.

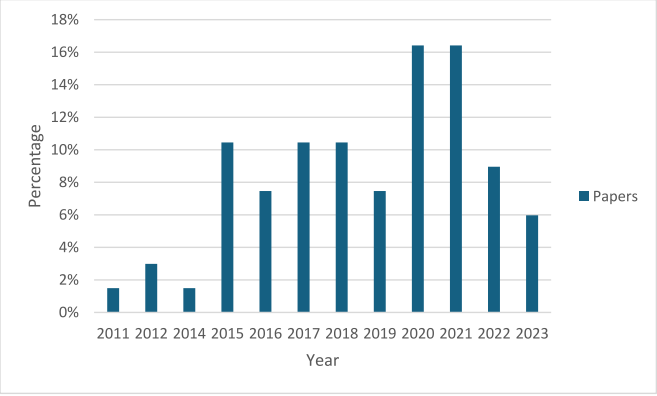

Fig. 2. Spread of articles analyzed.

More recent interest is likely driven by growing global concerns about climate change (Sivakumar, 2021) and government investment in research in climate change and in the WEF Nexus specifically.

Even though our search strategy targeted Africa and South Africa, approximately half of the articles we reviewed included global analysis, while the remaining articles focused on regional perspectives. This suggests that discourse on the WEF Nexus among South African researchers, drawing on country narratives, is limited, and that both researchers and policymakers are significantly influenced by global perspectives (Van Ittersum et al., 2016; Botai et al., 2021). South African resource availability and management are not surprisingly shaped by wider regional and global policies. Perhaps less understandable is that few studies contributing to WEF Nexus research in South Africa have been written by South African scholars. Additionally, authors frequently cite each other, promoting a consensus view of the WEF framework that is somewhat circular in its formulation. Such citation politics may explain why so few studies on WEF in South Africa criticize the WEF approach. Mkhwanazi (2023) highlights the extent to which researchers from the Global North publish without local voices, using local researchers only for data collection or conducting research without involving local researchers who might better understand the context. She advocates for considering the social and local context of the study phenomena for a holistic picture of the areas and issues under study. For WEF to gain relevance and traction in South Africa and for the approach to be further operationalized, it is vital that the perspectives of South African scholars and residents be included.

This type of citational politics and global emphasis applies to the WEF Nexus just as it does in other fields. Several factors contribute to this recurring trend. For instance, the resources for WEF Nexus research in Africa, including South Africa, mainly come from global funders (Adom et al., 2022) (but see further below). While this fosters international collaboration and support for research initiatives aimed at addressing WEF Nexus challenges in the region, it also privileges specific perspectives and research partnerships, as we describe below. Furthermore, it perpetuates the current trend whereby attention in the reviewed articles reflects a recognition of the interconnectedness of water, energy, and food systems on a global scale, much more than at national or local levels. This suggests that researchers, and policymakers, recognize the significance of understanding and addressing WEF Nexus challenges from a wider perspective that transcends geographical boundaries. Focusing on community-level perspectives offers a platform to integrate the unique challenges and opportunities related to WEF allocation and security. To the extent that there exists literature with this focus, there is evidence of a growing interest in understanding the specific dynamics of the WEF Nexus in South Africa and the African continent, and the importance of and need for context-specific approaches.

3.3. From conceptual framework to practical implementation

Most publications on the WEF Nexus comprised literature reviews (about 90 %), with a few quantitative studies utilizing secondary data and far fewer presenting new empirical data (see Appendix A). However, a few studies, including that by Adom et al. (2022), provide qualitative data and consider social dimensions relevant to the WEF Nexus. This study, conducted in South Africa's northeast Mpumalanga province, included interviews with policymakers, academics, and researchers, although not community members at a household level. The study highlighted a significant gap between the theoretical understanding of the WEF Nexus, its widespread publicity in government policies, and familiarity with and its practical application in local communities (Adom et al., 2022, p. 9). The authors further highlighted the absence of tangible projects in South Africa applying the Nexus approach, and the lack of a consistent framework for understanding the concept, resulting in limited awareness and understanding among residents of its relevance. They quote one interlocutor as follows:

> While the water-energy-food nexus is widely publicized in most government gazettes and policies as an alternative strategy to drive resource security for the country, nevertheless, the nexus concept is not visible or applicable to the local communities. These developments relate to the concept being foreign to the local communities. The government has not taken the time to explain the whole concept. They are not involved in the designing and implementation of the nexus idea. These have limited the awareness, knowledge, understanding, and trade-offs among the communities (2022, p. 9). Policymakers frequently reference the Nexus principle, but the tendency towards sectoral or siloed management approaches persists.

These findings resonate with observations by other authors, such as Nhamo et al. (2020) and Simpson and Jewitt (2019). Understanding the WEF Nexus has been integrated into various government policy statements. Awareness and understanding of the concept are deemed vital, yet programmatically limited, for effective resource management, and progress in achieving its objectives has been slow or negligible (Simpson and Jewitt, 2019; Nhamo et al., 2020). Few of the reviewed studies included the perspectives of individuals at the local community level. In social research, participants consisted of scientists and policymakers involved in resource management and sustainability (Daher et al. 2015; De Laurentiis et al., 2016; Liphadzi et al., 2021), without consideration for broader civil society, non-profits, or local community members who use and manage WEF resources every day. We also found no evidence of community engagement initiatives aimed at enhancing understanding of the WEF Nexus. An academic quoted by Cairns and Krzywoszynska stated, "I guess one of the other strengths of the nexus is that it provides a framework that integrates the science and the social sciences, and it might create higher status for the social sciences and I think that's important and that's useful" (2016, p. 168).

Outside the realms of science and policy, the practical application of the WEF Nexus remains limited. As a policymaker quoted in the same paper noted, "We'd use the term nexus when someone else talks at a conference or something, but it's not a term we would use day to day" (2016, p. 168). Therefore, the WEF Nexus primarily remains technical and relevant in academic and policy contexts, but it has not been adapted for dissemination and implementation at community and household levels. Community members are not consulted or informed, and lack a clear understanding of the nexus framework. Additionally, the framing used at various levels of government does not consider community perspectives and experiences regarding water, energy, and food as nexus resources.

Municipalities in South Africa often operate in silos, tackling water, energy, and agricultural issues as separate entities. For instance, the Department of Water and Sanitation DWS (2021) focuses on water resources, the Department of Mineral Resources and Energy DMRE (2019) oversees energy, and the Department of AgricultureLand ReformRural Development, DALRRD (2022) is responsible for agriculture, land, and rural development; no one department is dedicated to food, but food is deeply intertwined with agriculture and land use. This fragmented approach makes it difficult to create policies that reflect the close alignment of these sectors. Thus, municipalities deliver services like water and electricity in isolation, with little or no consideration of the integration of their systems.

Non-aligned policies at various levels of governance often hinder implementation. For instance, municipalities are at the forefront of service delivery, managing everything from water supply to electricity distribution. However, they frequently struggle to align their efforts with national frameworks like the National Development Plan (NDP) or the Integrated Resource Plan (IRP). Limited resources, capacity gaps, and a lack of coordination across departments partly contribute to this disconnect. Consequently, these policies, despite being well-intended, often fail to achieve their full impact, particularly where it matters most—at the community level (Department of Water and Sanitation, 2021; Department of Mineral Resources and Energy, 2020).

Another example is the energy sector, where the Integrated Resource Plan (IRP), a key component of the NDP, outlines South Africa's roadmap for power generation through 2030. It specifies how much electricity the country will require, the mix of energy sources needed to meet that demand, and ways to achieve this while minimizing costs and environmental impact (Department of Mineral Resources and Energy, 2020). The National Energy Act aims to ensure access to sustainable and affordable energy while promoting renewable sources. However, municipalities often implement these policies in isolation, overlooking opportunities to integrate water, energy, and agricultural priorities. Furthermore, limited guidelines and resources—such as human, financial, and structural capital – exist to support and translate these initiatives into action at the municipal level. Local governments frequently find themselves figuring out the "how" on their own (Department of Mineral Resources and Energy, 2020). This lack of a unified approach results in inefficiencies, even as communities face increasing challenges on a day to day basis, including water shortages and power cuts, and in association with climate change and resource scarcity (Department of Agriculture, Land Reform and Rural Development, 2022).

A few studies highlighted elements missing in the WEF Nexus that need to be integrated into the framework to enable the pursuit of government agendas. For instance, Mabhaudhi et al. (2019) focus on the crucial role of livelihoods in the WEF Nexus, advocating for a comprehensive and organized strategy such as an analytical livelihoods framework to enhance rural livelihoods. This approach aims to address resource management challenges and improve the livelihoods of disadvantaged rural populations, particularly in the context of climate change, intermittent water shortages, and interruptions in power supply. Mabhaudhi and colleagues (2019) recommend integrating efforts across the region to foster synergies and emergent benefits. The role of municipalities in South Africa is limited by their management of resources such as water and sanitation in silos; further, some resources are predominantly supplied through parastatals like Eskom Holdings SOC Limited and City Power Johannesburg (Pty) Ltd.

Limited attention is given to land and agriculture in theorizing the WEF Nexus. Although a few municipalities support community projects related to crops and animal farming, their efforts remain insufficient. Municipalities are not involved in applying the WEF framework, despite being the relevant entities to operationalize and implement this approach in local communities. We found no studies focusing on the municipal level and examining how the Water-Energy-Food Nexus is understood and prioritized within municipalities. By prioritizing food and nutrition security, a WEF Nexus approach can help alleviate trade-offs and highlight the interconnected relationships of food, energy and water. The challenge of implementing the WEF Nexus necessitates greater collaboration among local stakeholders.

Wolde et al. (2020) explored the relationship between community perceptions of the WEF Nexus and livelihoods. To implement local-based measures, they included stakeholders such as community-based organizations, other civil society actors, scholars, practitioners, decision-makers, policymakers, and employees in government entities and local municipalities. Drawing on their multi-method study conducted in the Gidabo Watershed in Ethiopia, they argue that all three nexus resources significantly impact livelihoods when assessed against six indicators: human, physical, social, financial, natural, and environmental:

> The local community perceives water to be the second most abundant and important nexus resource component next to food. However, the community's understanding of energy sources is very low, and this may affect the management of water for hydropower potential because, for Ethiopia, more than 90 % of energy sources come from water, which necessitates the proper management of tributaries that contribute to perennial rivers (2020, p. 12).

Wolde et al. (2020) suggested that while water is the primary component of the Nexus, its utilization efficiency is low. This indicates

that water used in the community, whether for agricultural, domestic, or industrial purposes, is not optimized. Inefficiencies include waste, poor distribution, and ineffective management practices, resulting in insufficient water available for various needs. Furthermore, the synergistic management of WEF Nexus resources by local communities is lacking, which could endanger the sustainability of people's livelihoods. In this research, community members emphasized the distinct advantages of each nexus component, as they continue to struggle with food, energy, and water security, and the ongoing challenges in efficiently accessing and managing these critical resources. The authors argue the potential of the WEF Nexus approach to improve various dimensions of local livelihoods, and that implementing the Nexus approach is essential for thoroughly assessing water availability and needs and understanding their interaction with energy and agricultural output.

Two studies stand out in elaborating on and incorporating vulnerabilities related to water, energy, and food (WEF) resources and the implementation of the nexus. Mguni and colleagues (2020) conducted research in the informal settlements of Bwaise and Kanyogoga in Kampala, Uganda. This research highlights the vulnerabilities faced by residents with limited access to water, food, and energy. The study investigated emerging vulnerabilities in the effective application and implementation of the WEF Nexus in an urban context, and identified energy access as the most significant challenge. Energy poverty—defined as the lack of access to reliable and affordable energy sources—hinders water purification efforts and restricts the consumption of nutritious meals that require substantial energy input. This lack of access further exacerbates the vulnerabilities of residents in the study area (Mguni et al., 2020). The research has direct relevance across the continent, where large numbers of people reside in informal settlements in inner city and peri urban areas, slums, and abandoned buildings.

Mguni and van Vliet (2020) utilized an ethnographic approach called "shadowing" to explore the concept of "vulnerability-as-experienced" within social practices. The researchers shadowed ten households that were purposefully selected based on their vulnerability to resource insecurity and socio-economic challenges as identified by local leaders (Mguni et al., 2020). In addition to shadowing, data collection included focus group discussions, semi-structured interviews with vendors and officials, literature reviews, and a vision-building workshop. The research concentrated on cooking practices, alternating between zooming in and zooming out to observe these practices along with the broader provision of water, energy, and food. Narrative analysis was employed to reveal vulnerabilities within the urban WEF Nexus, providing a comprehensive understanding of socio-economic interactions in the study areas (Mguni et al., 2020).

Mguni and van Vliet (2020) also describe coping strategies that often involve relying on shared elements of social networks linked to religious affiliation, length of residence, and neighborly norms. Practices such as borrowing food and charcoal or sharing cooking facilities illustrate the significance of an "ethics of proximity" in managing precarious consumption among households in impoverished communities (Mguni et al., 2020). People adapt to manage crises by skipping meals, prioritizing the needs of the young and sick, and turning to social networks to borrow food, energy, or cooking facilities. The study emphasizes how social dynamics, networks, and local normative values play a crucial role in access to water, energy, and food resources, addressing vulnerabilities as they arise in specific contexts. This practice remains evident even in situations of extreme resource scarcity, where neighbors continue to share limited resources and adjust to survive within their means. When people cannot cook or lack food, solidarity among residents, neighbors, and social groups emerges as a vital coping mechanism. This solidarity encompasses mutual aid and resource sharing, helping residents meet their daily needs despite resource shortages (Mguni et al., 2020). However, this should not be taken for granted; in areas that are demographically diverse, as is common in areas of immigrant settlement, low social capital and low community solidarity work against resource sharing.

A study by Musemwa and colleagues (2019) examined vulnerability to resource insecurity and socio-economic challenges in the context of the WEF in rural Eastern Cape, South Africa. This province has the highest levels of poverty and unemployment in the country, and limited access to essential resources including land. Households face insecurities related to food, energy, and water, alongside other social challenges, including unemployment, inadequate access to education, illness, and poor access to healthcare. Most residents in the province depend on social grants like unemployment benefits, old age pensions, and child support grants. The study employed statistical analysis to assess the extent of reliance on social grants (Musemwa, 2019). However, the authors did not enhance the economic data to gain insights into local perspectives or investigate the root causes of these insecurities. Their discussion of the WEF Nexus was presented as a general principle, with limited attention to the diversity within and among populations.

3.4. Water, energy, and food as local issues

Qualitative research is essential for identifying challenges in applying the WEF framework and facilitating its implementation at the grassroots level. This requires a multidisciplinary approach to tackle WEF challenges, and the need for more qualitative and local survey data. Sivakumar (2021) proposed the creation of a composite index and outlined the methodology for its development, discussing potential applications for assessing sustainable development progress and testing mitigation scenarios. Drawing on existing literature, reports, and data from organizations like the World Bank and United Nations institutions, Sivakumar identified sector-specific indicators and evaluated their limitations.

Sivakumar's findings indicate high levels of resource insecurity in South Africa. Approximately 74.3 % of participants reported a lack of access to water, while access to food was reported at only 22.9 %, and access to energy resources stood at 2.8 %. However, traditional methods of water usage raise concerns about accessibility and sustainability (Sivakumar, 2021). Energy is emphasized as crucial for enhancing household quality of life and stimulating broader economic growth (Sivakumar, 2021). Fluctuations in access to sufficient, potable water in South Africa illustrates the profound impact of water scarcity on local communities and agricultural production. Several provinces face significant challenges due to water scarcity, with events like 'Day Zero' in Cape Town bringing attention to the severity of droughts and their consequences for water accessibility and security. As highlighted by Mpandeli et al. (2018), Bian and Liu (2021), and Mokoena (2023), water scarcity disrupts commercial agricultural activities in regions like the Western Cape, known for its vineyards and fruit production, and the Free State, a key area for grain production, as well as household plots that support subsistence farming and income generation. These disruptions lead to increased food production costs and subsequent rises in consumer prices, as indicated by Du Plessis (2017) and Oelofse et al. (2018).

Despite the objectives outlined in the National Development Plan (NDP, 2010), vulnerability to food insecurity persists in South Africa. Studies by Simpson et al. (2019), Nhamo et al. (2022), and Adom et al. (2022) show that up to 60 % of households are affected by food insecurity, highlighting the urgent need for effective interventions. Furthermore, some communities face the complete unavailability of safe and potable water, and access to water increasingly depends on purchasing power. Where possible, their recourse is to buy from local shops (Mandindi et al., 2022; Mepaiyeda et al., 2020).

These challenges exacerbate existing socio-economic inequalities in South Africa. As emphasized by Mandindi et al. (2022) and Ncoko et al. (2020), impoverished households bear the brunt of acquiring WEF resources, widening socio-economic gaps in the country. People's inability to access essential resources like water impacts health and food security and perpetuates poverty and vulnerability. Addressing these challenges requires comprehensive strategies that prioritize equitable access to

WEF resources and address underlying socio-economic disparities.

Aside from these two studies, the WEF Nexus remains largely theoretical rather than practical, particularly at a community level. Most literature reviews of empirical research indicate that the WEF Nexus in South Africa is neither thoroughly studied nor practically applied. A knowledge gap consequently persists, especially regarding social and local dimensions (Nhamo et al., 2018; Wolde et al., 2020; Botai et al., 2021). Several authors argue that the WEF Nexus conceptually offers a framework for comprehending complex interrelations, synergies, and trade-offs, but without evidence of its practical implementation (Simpson, 2020; Naidoo et al., 2021). Scaling up the practical application of the WEF Nexus this remains difficult (Markantonis et al., 2019). Throughout the review, it became evident that the WEF Nexus is impractical because local-level research has not been conducted, and it is meant solely as a conceptual framework.

3.5. *Challenges in the practical implementation of the WEF nexus*

A substantial portion of the reviewed papers (60 %) concentrated on the methodological aspects of analyzing the WEF Nexus framework (Fig. 3), highlighting our concerns regarding the translation and practical value of the concept. Despite a surge in research activity, converting the theoretical framework into real-world practice continues to be challenging, as demonstrated in various African contexts Rodríguez et al. (2021); Sivakumar, 2021; Adeola et al. (2022); Adom et al. (2022); Nhamo et al. (2022). For example, Nhamo et al. (2018) noted the discrepancies between theoretical frameworks and practical applications (including community engagement) and stressed the necessity for more context-specific approaches. Likewise, Mabhaudhi et al. (2021) highlighted the difficulties of implementing the WEF Nexus framework in southern Africa due to region-specific complexities such as poverty and related socio-economic issues.

The limited number of empirical studies reflects real-world challenges, including insufficient funding, a lack of skilled personnel, political considerations, and inadequate regional commitment (Zara et al., 2022). Papers focusing on governance often analyze the institutional arrangements, decision-making processes, and policy frameworks that govern water, energy, and food systems (Adeola et al., 2022; Mabhaudhi et al., 2021). They examine power dynamics, stakeholder engagement, and the effectiveness of governance structures in addressing intersectoral challenges and promoting sustainable resource management. Similarly, discussions regarding the presence or absence of equality within the context of the WEF Nexus emphasize social justice, fairness, and distributional equity as ideals and values rather than as fields of governance and programs. Moreover, there is a notable lack of research on how water, energy, and food resources are affected by factors such as gender, socioeconomic status, ethnicity, and geographical location, which could reveal disparities and vulnerabilities both within and between communities (Wolde et al., 2020).

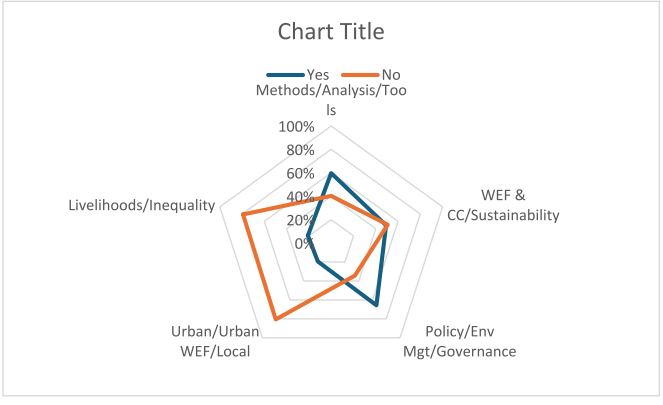

Fig. 3. Comparison of factors identified in WEF papers about governance, sustainability, equality, and local contexts.

As noted above, gender analysis was noticeably absent from the reviewed papers, despite the fact that accessing and managing WEF resources is gendered (Mason, 2012). Mason's (2012) research with families in the Philippines highlights how gender roles influence how households access and manage WEF resources. For instance, in households where the spouse stays at home, the responsibility for managing the household's water supply throughout the year typically falls on the wife (Mason, 2012). As one participant expressed: "In our family, it's always me. He's more focused on the financial aspects. I'm always the one who ensures that we have enough. We have many kids, so water is very important to us, especially drinking water. I always make sure there's enough in reserve" (Mason, 2012, p. 26). At the time of this research, men were the primary income earners, and their income was primarily used for purchasing water, while men physically carried water from source to home. In South Africa, the responsibility for collecting water and fuel for cooking (in the absence of electricity) generally falls to women and children. Recognizing the gendered similarities and differences in water, energy, and food management can provide valuable insights for policy and program development.

The limited literature on gender within the WEF nexus framework, as emphasized by Villamor et al. (2020) and Tantoh et al. (2021), suggests a gap in understanding the gendered roles and expectations related to accessing and managing these resources, as well as how trade-offs may be assessed differently based on gender. Understanding how gender roles intersect with asset ownership and distribution at the household level can inform public policy aimed at addressing inequalities and enhancing resource management strategies.

Youth participation in sustaining WEF resources is also a neglected category, as a number of articles emphasized. Zara and colleagues (2022) examined the social, cultural, and political implications of young people's connections with food within the WEF Nexus framework. Their study drew on a large-scale, interdisciplinary research project investigating young people's experiences of, participation in, and learning about the WEF Nexus in Brazil. This study integrated contemporary nexus thinking with perspectives from food scholarship and childhood and youth studies, employing an interdisciplinary approach involving ethnographic observations, qualitative interviews, and mixed-methods analysis. Their study illustrates how young people navigate connections with food within the broader WEF nexus context and argue that including young people in the WEF conversation is crucial. Summarizing the case of an 11-year-old boy from a poor family, they offer: "In his [Paulo] verbal narrative of the nexus web, Paulo highlights a key distinction between two types of food, the 'special food' which he and his family can only afford to eat on special occasions, and 'necessary food' for sustaining the body" (Zara et al., 2022, p. 730).

Sustainability also emerged as a central theme, with researchers exploring strategies for enhancing the resilience, efficiency, and environmental stewardship of WEF systems. They investigate trade-offs and synergies between resource use, economic development, and environmental conservation, aiming to foster sustainable practices meeting present needs without compromising future generations. However, local contexts are often generalized through secondary data or large data sets, with the voices of marginalized communities notably absent. The exception is the study in São Paulo and Rio de Janeiro (Zara et al., 2022), which highlighted the underrepresentation of the voices and experiences of youth and women in the WEF Nexus framework. We emphasize the importance of considering the local experiences of all people and acknowledging socio-cultural, economic, and ecological factors unique to specific regions or communities. A context-specific approach to WEF management is needed that recognizes the diversity of challenges and opportunities across different geographical and cultural settings.

4. Discussion

Through our scoping review, we identified significant hurdles that hinder the implementation of the WEF Nexus in South Africa (Adeola et al., 2022; Mabhaudhi et al., 2021). These challenges arise from entrenched sectoral approaches, policy limitations, and inconsistent regulations, which obstruct effective cross-sectoral collaboration. The lack of policy coherence and enforcement adversely affects critical sectors such as water security, agricultural production, and climate policies. However, there is a growing consensus on the need for further development and application of modeling tools, technological innovation, broader market participation, and improved governance structures to tackle these issues. Strengthening public-private partnerships, governance mechanisms, and institutional frameworks through practical demonstrations is essential for informed decision-making. We also identified a gap in translating theoretical frameworks into effective implementation methods and practical case studies.

We found very few qualitative studies on the WEF Nexus at the community level. There is also limited understanding of how (or if) the nexus operates at the household level. While themes such as climate change, sustainable development, and water resources have garnered significant attention in WEF Nexus research, there has been comparatively less focus on livelihoods, local contexts, and household-level dynamics. A predominant emphasis on policy and governance issues, combined with inadequate attention to social aspects, was evident throughout the literature. Studies, like those of Mabhaudhi et al. (2018a, b), highlighted a focus on identifying opportunities and policy implications, with relatively little exploration of technical aspects. Authors like Adeola et al. (2022) emphasized the challenge of implementing WEF concepts at the local level, given its predominance as a policy concept in academia.

We have identified a pressing need to adapt the WEF Nexus to the unique circumstances of Southern Africa and to acknowledge diversity across local contexts. Central to this adaptation is the integration of energy-efficient technological approaches to optimize WEF resource use. These approaches include innovations such as advanced water treatment technologies, agricultural techniques, and renewable energy solutions. This emphasis on technology highlights the ongoing exploration of more efficient solutions for sustainable resource management. For instance, in water-scarce regions like South Africa, the potential for water reuse and recycling, particularly in agriculture through the use of grey water, is promising (Adeola et al., 2022; Sivakumar, 2021). However, the practical application of these theoretical concepts requires a nuanced understanding of community attitudes toward the acceptability of grey water, water purity, hygiene, and risk.

Additionally, the optimization of renewable resources is a key technical approach within the WEF nexus, aligning with the Sustainable Development Goals (SDGs) (Adeola et al., 2022; Sivakumar, 2021; Mabhaudhi et al., 2019). It presents an opportunity to address equity and access issues regarding energy, offering alternative energy sources that can be deployed even in remote and underserved areas lacking transmission infrastructure. Solar-powered irrigation systems, for example, not only use clean energy sources but also provide sustainable water access to small-scale farmers, who are often women responsible for food production in rural communities. Ensuring advancements in energy access can subsequently improve the availability of other WEF resources, creating positive ripple effects across sectors. By integrating technologies such as energy-efficient food production systems and renewable water infrastructure with participatory processes, these initiatives become more inclusive and responsive to the needs of vulnerable groups. In addition, actively involving marginalized voices such as women, youth, and resource-constrained communities through participatory decision-making ensures that interventions are contextually relevant, equitable, and widely accepted. Such inclusive approaches not only promote resource efficiency but also address socio-economic disparities, fostering resilience in communities often excluded from resource management conversations.

The persistence of global disparities in the demand for and accessibility of essential resources emphasizes the need for comprehensive solutions, which the SDGs seek to address. Millions of people still lack access to necessities like potable water, sufficient water for food production, legal electricity connections, and safe alternative energy sources, compromising people's health and perpetuating cycles of poverty and vulnerability (Mason, 2012; Botai et al., 2021). In South Africa, many communities face challenges in accessing clean drinking water, often sharing standpipes where they exist in impoverished areas. Adequate water for agriculture remains scarce. Access to electricity often occurs informally, with individuals 'borrowing' and reimbursing household suppliers on an unofficial basis. Consequently, issues related to food production, security, and livelihoods become more pronounced. The interplay of water, energy, and food within the South African context underscores the importance of understanding and addressing these challenges at the local level.

The lack of studies examining the local context of the Water-Energy-Food (WEF) Nexus significantly limits efforts to understand the real-world implications for vulnerable communities and households. Without an in-depth examination of how these systems play out on the ground, especially for marginalized groups, resource management strategies often overlook crucial factors affecting everyday lives. One study that sought to address this gap was conducted by Khofi et al. (2025) in urban South Africa on WEF insecurities. Their findings demonstrated that WEF insecurities overlap with broader socio-economic and gender issues, including a troubling intersection between food insecurity and intimate partner violence. The inability of families to meet basic needs in the context of food insecurity can drive women into situations where they are more likely to tolerate or remain in abusive relationships due to economic dependency (Khofi et al., 2024; Khofi et al., 2025).

4.1. Top of form

While analyzing one sector can provide insight into its links with others, illustrating the nested view of WEF integration (Al-Saidi and Elagib, 2017), communities often fail to recognize WEF resources as an integrated nexus, viewing them separately. Communities struggle to see the interconnectedness of access to WEF resources as a cohesive whole (Wolde et al., 2020). Water is viewed by local communities as the second most abundant and important component of the nexus, after food, while understandings of energy sources are limited. This lack of awareness may hinder the effective management of water for hydropower potential, particularly in countries like South Africa, where a large portion of energy sources require significant amounts of water. Failing to acknowledge the interconnectedness of water, energy, and food resources can have serious consequences for local livelihoods (Wolde et al., 2020, p. 12). Grasping and implementing the nexus approach is crucial for accurately assessing water potential and demand, and understanding how these factors will affect or be affected by energy and agricultural production. By adopting a holistic view of the WEF Nexus, policymakers and stakeholders can create more effective strategies for resource management and tackle the complex challenges of food, energy, and water insecurity (Wolde et al., 2020).

In Fig. 4, we emphasize the discrepancy in the attention given to various components of the WEF Nexus, with water and food receiving more focus than energy. Although nine percent of energy studies may not seem negligible, it still represents significantly less attention compared to water and food.

To bring the Water-Energy-Food (WEF) Nexus to life in South Africa, we must adopt strategies that directly address the realities of communities on the ground. Local municipalities often work in isolation, and need support to take the lead in promoting integration across water, energy, and food systems. By ensuring their active involvement through community-driven programs and fair resource allocation, the WEF

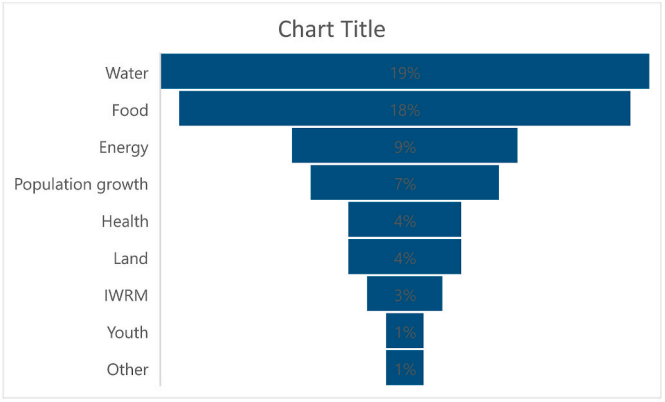

Fig. 4. WEF intersections in literature.

Nexus can become more inclusive and effective.

Recent collaboration projects between South Africa and the Netherlands highlight the significance of interdisciplinary research and partnerships with civil society in incorporating health approaches into the WEF Nexus framework (South African National Research Foundation NRF & Netherlands Organisation for Scientific Research NWO, 2024). The rise in such projects across the continent aims at providing valuable insights into how community engagement and the implementation of science can drive success. These projects involve a diverse array of stakeholders, including traditional leaders, chiefs, community members, and local authorities, who work together to co-create tailored solutions.

Academic institutions serve as essential partners, providing expertise, promoting knowledge exchange, and enhancing capacity-building initiatives. Policy frameworks are also vital, facilitating resource integration, encouraging innovation, and tackling systemic inequalities. Together, these collaborative efforts close the gap between theory and practice, illustrating the potential of the WEF Nexus as a mechanism for addressing inequality, empowering communities, and promoting sustainable development in South Africa. South Africa clearly requires more integrated frameworks that effectively connect the various interconnected sectors. Policies must transcend mere documentation; they should operate in practice, reflecting and accommodating the complexities inherent in individuals' lives and the diverse environments in which they reside.

5. Conclusion

As illustrated in this review, the WEF Nexus has clearly evolved into a valuable mechanism for assessing progress towards objectives such as the Sustainable Development Goals (SDGs). Authors advocate for a transition from mere 'nexus thinking' to practical 'nexus action,' as an opportunity for national governments to achieve SDG goals. This shift necessitates the active participation of policy and decision-makers and their engagement with communities (Simpson, 2020; Naidoo et al., 2021; Adom et al., 2022; Nhamo et al., 2022).

The research landscape surrounding the WEF Nexus reflects a multifaceted and evolving discourse. Over the years, scholarly attention to the WEF Nexus has grown rapidly, driven by a growing recognition of the intricate interdependencies of water, energy, and food systems. The themes that emerged from our review offer a roadmap for future research and action in the field of WEF Nexus in South Africa. From understanding the local context to bridging the gap between theory and practice, each theme provides a lens through which to examine the complexities and distinctions of the WEF Nexus. We have identified the need to incorporate gender perspectives, embrace qualitative methodologies, and enhance stakeholder and community engagement while also considering household-level needs. Gender and youth considerations emerge as crucial yet underexplored dimensions within the WEF nexus framework. Understanding gendered roles, asset ownership dynamics, and youth participation is essential in the context of the SDGs and the need globally and locally for sustainable development.

Challenges abound in implementing the WEF Nexus in practice, including entrenched sectoral approaches, policy constraints, and institutional inadequacies. These obstacles hinder effective cross-sectoral collaboration and integrated resource management, underscoring the need for enhanced governance structures and institutional frameworks. Promising examples of transdisciplinary research and practical demonstrations offer hope for addressing region-specific challenges and fostering sustainable development.

Policy implications include the need for context-specific approaches, technological innovations, and strengthened governance structures to effectively address region-specific challenges. Emphasizing community engagement and participatory decision-making processes will be instrumental in bridging the gap between theory and practice. Local-level applications of the WEF Nexus are hampered by a lack of qualitative data and a limited understanding of its utilization in translating policy into programs within governmental entities, including local municipalities.

The prevalence of literature reviews over empirical studies indicates a strong theoretical foundation but limited attention to practical applications and to translating ideas into actionable policies and strategies. Bridging this gap between theory and practice necessitates more empirical research, especially at local levels, to inform evidence-based decision-making and integrated resource management. Overcoming challenges to the practical application of an integrated approach requires a concerted effort to prioritize local-level research, ensure diverse perspectives, and empower communities. Only through collaborative and inclusive approaches can the WEF Nexus serve as a transformative tool for achieving sustainable development and improving livelihoods in South Africa and beyond. By embracing transdisciplinary approaches and fostering collaboration between researchers, policymakers, and local communities, we can work towards achieving sustainable resource management and resilience in the face of global challenges posed by the WEF nexus.

Given these outcomes, we advocate for intensified initiatives by governmental and parastatal entities, industry, and other pertinent stakeholders to augment local communities' awareness and understanding of nexus resources and their significance for livelihoods.

In this review, we achieved the following:

1. **Identification of Challenges:** We identified key challenges hindering the practical implementation of the WEF Nexus in South Africa, including limited empirical studies, financial constraints, and policy limitations.
2. **Exploration of Opportunities:** We explored opportunities for progress within these challenges, emphasizing collaboration, community involvement, and diverse perspectives as pathways to navigate the complexities of the WEF Nexus.
3. **Insights into Interplay:** By analysing the complex dynamics of socioeconomics, resource availability, and practical implementation, we provided insights into the interplay between water, energy, food, and broader social factors within the South African context.
4. **Recognition of Contextual Factors:** We recognized the significance of tailored solutions that address local needs, acknowledging the unique challenges and opportunities within South Africa and Africa at large.
5. **Call for Collaborative Approaches:** We have emphasized the necessity of collaborative and inclusive approaches to overcoming hurdles in the practical application of the WEF Nexus, highlighting their transformative potential for achieving sustainable development and improving livelihoods.

6. **Municipal/Local Government Engagement:** Collaboration can play a critical role in implementing the WEF nexus. This includes municipal and local governments, including other stakeholders, such as researchers, all government entities, policymakers, researchers, civil society, and people. We stress the need for high-quality data collection (qualitative and more quantitative) and analysis at the local level to inform evidence-based decision-making and policy formulation. Through strengthened local research and qualitative assessments, municipalities and local governments can better understand the intricate dynamics of the WEF Nexus within their communities, leading to more targeted interventions and sustainable outcomes.

Embracing the WEF nexus is crucial for countries in Africa, given significant natural resource shortages and socioeconomic vulnerabilities. However, bridging the gap between theory and practice remains a challenge, necessitating further research, innovative approaches, and practical demonstrations to leverage the WEF Nexus for sustainable resource use. These are necessary steps to achieve vital goals such as poverty alleviation and ensuring access to water, energy, and food for all (Mabhaudhi et al., 2018a,b; Botai et al., 2021).

CRediT authorship contribution statement

Lucy Khofi: Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Resources, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization. **Lenore Manderson:** Writing – review & editing, Writing – original draft, Validation, Supervision, Resources, Methodology, Formal analysis, Data curation, Conceptualization. **Memory Reid:** Writing – review & editing, Writing – original draft, Visualization, Validation, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Eileen Moyer:** Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Resources, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization.

Declaration of competing interest

All authors confirm that there is no conflict of interest.

Acknowledgments

The work was supported by the co-investigators, civil society partners, and collaborators of the Eco-Imagining project, funded by the Dutch Research Council (NWO) through the Merian Fund and the National Research Foundation (NRF) (Grants Nos. 482.20.110, PI: EM. Moyer; FWO210219587192, PI: L. Manderson). Khofi. L is supported by the NRF under grant No. PMDS2205046544.

APPENDIX A

Selected studies with a social element

Author	Title	Study Area and Population	Research Aims and Methods	Main findings	Key Points
Richmond K. Adom, Mathew D. Simatele and Mark Reid (2022)	Addressing the challenges of water-energy-food nexus programme in the context of sustainable development and climate change in South Africa	South Africa; broader global population. Primary data was collected in Mpumalanga province in South Africa.	Investigates policy gaps and implementation challenges of the nexus approach in South Africa. Mixed-method approach used for data collection. The study employed a concurrent mixed-method approach, utilizing both quantitative and qualitative methods to investigate the water-energy-food nexus. Qualitative data was gathered through in-depth interviews with 10 individuals representing various sectors such as government, power utilities, agriculture, environment, and NGOs in Mpumalanga Province. These interviews explored policy and implementation challenges, as well as alternative strategies to improve stakeholder collaboration in the nexus ecosystem. Additionally, quantitative data was collected using a semi-structured questionnaire distributed to 140 respondents from diverse backgrounds including households, community leaders,	The authors argue that while some level of progress has been attained to improve the livelihoods of the population using the nexus ecosystem, the broader goal of the concept has failed to materialise due to poor execution of the programme, which is exacerbated by lack of synergies, and establishment of collaborations and partnerships among the relevant actors mandated with the management of the three components and inadequate investment. This paper recommends a broader and coordinated approach to implementing the water-energy-food nexus programme with a broader objective of sustainable development goals (SDGs) framework	Discussion of challenges faced by South Africa's population in accessing water, energy, and food resources. Primary data collection limited to Mpumalanga. Comprehensive analysis of strengths and weaknesses of South Africa's water-energy-food policy framework. Broader implications for regions facing similar challenges. Analysis highlights implementation challenges and lack of synergies among relevant actors. Recommendations include broader and coordinated approach within the SDGs framework.

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Author	Title	Study Area and Population	Research Aims and Methods	Main findings	Key Points
			academia, students, farmers, and government department employees. The questionnaire utilized a nominal ranking system to gauge respondents' awareness and acceptance of different variables related to the nexus concept. This comprehensive approach allowed for a thorough exploration of issues and perspectives surrounding the water-energy-food nexus, including both qualitative insights and quantitative data analysis.		
Robert Cairns & Aleksandra Krzywoszynska	Anatomy of a buzzword: the emergence of 'the water-energy-food nexus' in UK natural resource debates	United Kingdom	The paper utilized a qualitative approach involving 20 semi-structured interviews with key stakeholders in the UK, representing various professional backgrounds engaged in discussions regarding food, energy, and water interdependencies. These stakeholders included academics from diverse disciplines, research funders, policymakers, civil servants, and representatives from private companies. Additionally, qualitative analysis was conducted on policy documents, funding calls, and academic papers related to the nexus concept. Half of the interviewees were selected based on their active involvement in nexus-related work, including published research, funding, or public discussions. The remaining interviewees were chosen from policy and private sectors for their engagement in nexus debates. To ensure participant anonymity, they were identified by their professional affiliations (e.g., academic, policymaker) in the text. Interviews, lasting from 25 min to an hour, were thematically coded in NVivo using a grounded, inductive approach to identify prevailing motifs and themes. Direct quotes from interviewees were italicized within the text. This comprehensive qualitative analysis provided insights into various perspectives and discussions surrounding	Critically analyzes the concept of the WEF nexus and its mobilization in UK natural resource policy debates. Argues that the term 'nexus' has become a buzzword with ambiguous meaning and normative resonance. Emphasizes the importance of maintaining a critical perspective in nexus research and policymaking.	Discusses the stakeholders involved in UK natural resource debates and their engagement with the WEF nexus concept. Utilizes discourse analysis and qualitative methods to explore the emergence and utilization of nexus terminology. Critiques the 'integrative imaginary' underpinning much of the UK discourse around the nexus concept. Warns against institutionalizing the nexus concept without proper critique. Highlights the importance of addressing power dynamics in proposed integration efforts.

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Author	Title	Study Area and Population	Research Aims and Methods	Main findings	Key Points
			the food-energy-water nexus in the UK context.		
Du Plessis (2017)	An investigation into the evidence of seasonal rainfall pattern shifts in the Western Cape, South Africa	Western Cape, South Africa	Data was initially obtained from both the Agricultural Research Council Institute for Soil, Climate and Water (ARC-ISCW) and the South African Weather Service (SAWS) to ensure a diverse range of sources. However, the datasets from ARC-ISCW were not sufficiently long, leading to their exclusion from the analysis. Daily rainfall data was chosen as it strikes a balance between monthly and hourly data, providing a suitable timeframe to capture trends without being overly generalized or too specific. Investigates presence of shifts in seasonal rainfall patterns, focusing on Western Cape, South Africa. Analyzes historical rainfall data from 20 stations with at least 100 years of records.	Employs statistical analysis, linear trend line distributions, time lag comparisons, cumulative distributions, moving average plots, and autocorrelation relationships. Aims to provide baseline information and stimulate further research on impact of climate change on seasonal rainfall patterns in Western Cape.	Examines historical rainfall data to identify evidence of shifts in seasonal patterns. Utilizes various analytical methods to explore relationships between daily rainfall indices. Aims to provide baseline information for further research on climate change impacts in the Western Cape.
Liphadzi S., Mpandeli S., Mabhaudhi T., Naidoo D., Nhamo L. (2021)	The Evolution of the Water–Energy–Food Nexus as a Transformative Approach for Sustainable Development in South Africa	South Africa	Discusses evolution of the Water-Energy-Food (WEF) nexus framework in South Africa, emphasizing its transformation from conceptual framework to analytical decision-support tool.	Details initiatives undertaken by Water Research Commission (WRC) and partners, particularly establishment of WEF Nexus Lighthouse program. Describes research trajectory across different Key Strategic Areas (KSAs) to inform resource management, decision-making, and policy. Emphasizes importance of integrated approaches in addressing water scarcity and other socio-economic challenges.	Focuses on South Africa's water research community, policymakers, and stakeholders involved in sustainable socio-economic development. Authors represent Water Research Commission (WRC) and other partners. Provides insights into achievements and challenges of implementing WEF nexus framework and its potential impact on policy and decision-making for sustainable development.
Mabhaudhi, T., Nhamo, L., Mpandeli, S., Nhemachena, C., Senzanje, A., Sobratee, N., … & Modi, A. T. (2019).	The water–energy–food nexus as a tool to transform rural livelihoods and well-being in Southern Africa	Southern Africa, specifically rural areas	The research was centered on countries in southern Africa, including Angola, Botswana, Comoros, the Democratic Republic of Congo (DRC), Lesotho, Madagascar, Mauritius, Malawi, Mozambique, Namibia, Seychelles, South Africa, Swaziland, Tanzania, Zambia, and Zimbabwe. This research utilized a water-energy-food (WEF) nexus analytical livelihoods model, incorporating a sophisticated comprehension of complex systems, to evaluate rural livelihoods, health, and overall well-being in southern Africa. The study proposed customized adaptation strategies	Assesses rural livelihoods, health, and well-being in southern Africa through WEF nexus analytical livelihoods model.	Emphasizes importance of integrated resource distribution, planning, and management to improve rural livelihoods and ensure inclusive socio-economic transformation and development. Applies WEF nexus analytical livelihoods model to assess rural livelihoods, health, and well-being in southern Africa.

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Author	Title	Study Area and Population	Research Aims and Methods	Main findings	Key Points
			tailored to the region to foster the development of resilient rural communities.		
Mguni, P., & van Vliet, B. J. (2020).	Rethinking the urban Nexus-Resilience and vulnerability at the urban Nexus of Water, Energy and Food (WEF). An introduction to the special issue	Urban communities, particularly marginalized groups	Introduces concept of urban Nexus of Water, Energy, and Food (WEF) and discusses importance of understanding interactions within nexus for building sustainable and resilient cities.	Argues for shift from solely physical system-level resilience approach to one considering social vulnerabilities and everyday practices related to WEF nexus	Discusses conceptual framework of urban WEF nexus and Resilience and Vulnerability at the Urban Nexus (ResNexus) project. Draws on case studies and existing literature to support arguments regarding importance of understanding social vulnerabilities and everyday practices related to WEF nexus. Authors represent researchers or experts in field of urban resilience, sustainability, and WEF nexus. May have expertise in social and political sciences, environmental studies, or urban planning.
Mguni, P., Van Vliet, B., Spaargaren, G., Nakirya, D., Osuret, J., Isunju, J. B., Ssekamatte, T., & Mugambe, R. (2020)	What could go wrong with cooking? Exploring vulnerability at the water, energy and food Nexus in Kampala through a social practices' lens	Informal settlements in Kampala, Uganda	Examines emergent vulnerabilities at the urban Nexus of water, energy, and food (WEF) in informal settlements of Kampala. The study employed an ethnographic approach known as "shadowing" to delve into the concept of "vulnerability-as-experienced" within social practices. Researchers shadowed ten households in Bwaise and Kanyogoga, Uganda, focusing on their cooking practices. These households were purposively selected based on vulnerability status as identified by local leaders. The research involved alternating between zooming-in and zooming-out perspectives to observe cooking practices and the broader provisioning of water, energy, and food. Data collection included shadowing sessions, focus group discussions, semi-structured interviews with vendors and officials, literature reviews, and a vision-building workshop. Narrative analysis was utilized to uncover vulnerabilities within the urban water-energy-food Nexus, offering a comprehensive understanding of socio-economic interactions in Ugandan urban areas.	Employs mix of qualitative research methods including observation, interviews, focus group discussions, and vision-building workshop.	Represents experiences and perspectives of poor households living in informal settlements in Kampala. Explores daily struggles and coping strategies in face of deteriorating water quality, rising energy prices, and food insecurity.
Mandindi, W. Z., Nyaba, L., Mketo, N., & Nomngongo, P. N. (2022).	Seasonal Variation of Drinking Water Quality and Human Health Risk Assessment: A Case Study in Rural Village of the	Eastern Cape Province, South Africa	The paper Investigates variations in metal occurrence, water quality, and human health risks between dry and wet seasons in rural village.	Examines concentrations of major and trace metals in drinking water samples, assesses physicochemical	Focuses on rural village in Eastern Cape Province, South Africa. Population indirectly affected includes individuals relying on village's drinking water

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Author	Title	Study Area and Population	Research Aims and Methods	Main findings	Key Points
	Eastern Cape, South Africa.			parameters, water quality indices, and health risk factors associated with metal contamination.	supply. Drinking water samples analyzed for major and trace metal concentrations using inductively coupled plasma-optical emission spectrometry (ICP-OES). Various physicochemical parameters assessed to understand overall water quality. Water Quality Index (WQI) calculated to determine overall quality of water samples. Health risks associated with metal contamination assessed using hazard quotient (HQ) and chronic daily intake (CDI) calculations, considering presence of potentially harmful metals such as As, Cr, Sb, Tl, and V.
			They gathered water samples from two distinct water sources (windmill and tap) using 1-L pre-cleaned polyethylene bottles. Before sampling, the bottles underwent cleaning with metal-ion-free soap solution followed by multiple rinses with deionized water. Sampling was conducted during both the dry and wet seasons spanning from 2019 to 2020. It is important to highlight that access to the windmill was unavailable during the wet season sampling period, resulting in the absence of windmill sample data for that season.		
Mokoena, A. (2023)	Questioning Day Zero: Rights, Provision, and Water Inequality in South Africa	Township of Khayelitsha, Cape Town, South Africa	Highlights how response to Cape Water Crisis exacerbated existing inequalities in water distribution within Khayelitsha township. Applies John Rawls' theory of distributive justice to demonstrate sociopolitical factors intersect with spatial inequality.	Population under study: residents living in informal settlements in Khayelitsha township, facing challenges related to water inequality. Methodology involves qualitative approaches: analysis of water management policies, in-depth interviews with service providers, and residents.	Research findings indicate prioritization of paying customers over needs of poor in water management policies, perpetuating water inequality. Sociopolitical factors intersect with spatial inequality to disadvantage marginalized communities. Sampling techniques and data collection methods ensure representativeness. Interviews conducted with diverse stakeholders to capture various perspectives. Focused on two settlements within Khayelitsha township for comparative understanding of water inequality.
Molajou, M., Pouladi, P., & Afshar, A. (2021).	Incorporating Social System into Water-Food-Energy Nexus	Farmers engaged in agricultural activities	Introduces conceptual socio-hydrological-based framework for WEF nexus. Focuses on impacts of farmers' agricultural activities on WEF systems	Integrates WEF nexus model with Agent-Based Model (ABM). Employs Association Rule Mining to understand farmers' decision-making processes. Data gathered	Aims to represent dynamic interactions between agricultural activities, socio-economic conditions, and WEF nexus. Provides insights for policymakers and

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Author	Title	Study Area and Population	Research Aims and Methods	Main findings	Key Points
			under different socio-economic conditions.	through observations, interviews, focus group discussions, and vision-building workshop.	stakeholders to address sustainability challenges.
Musemwa, L., Muchenje, V., Mushunje, A., Aghdasi, F., & Zhou, L. (2015).	Household food insecurity in the poorest province of South Africa: level, causes and coping strategies.	Eastern Cape Province of South Africa, 150 households	Focuses on determining level and causes of food insecurity among households. Utilizes Household Food Insecurity Access Prevalence (HFIAP) and Household Food Insecurity Access Scale (HFIAS) as assessment tools. The research was conducted in South Africa's Eastern Province, known for its high poverty rates among households. The study area included Nkonkobe and Tsolwani Local Municipalities, situated in the Amatole and Chris Hani District Municipalities, respectively. These regions were chosen due to their representation of impoverished communities within the province. A multi-staged sampling method was employed, beginning with the random selection of Chris Hani and Amatole District Municipalities from the eight existing district municipalities in the Eastern Cape Province. Within each selected district municipality, one local municipality was then randomly chosen. Tsolwani Local Municipality was selected from Chris Hani District Municipality, while Nkonkobe Local Municipality was chosen from Amatole District Municipality. Seventy households were randomly selected in Tsolwani, and 80 in Nkonkobe for participation in the study. Data collection took place in October 2012, with the primary food preparer in each household being interviewed at their home by trained enumerators under the researcher's supervision. In the absence of the primary food preparer, another adult who had been present and eaten in the household over the past four weeks was interviewed. A pre-tested structured questionnaire served as the primary data collection tool, covering	Employs HFIAP and HFIAS to assess food insecurity level. Data collected through interviews and surveys. Findings represent food security situation, causes, and coping strategies in Eastern Cape Province.	Provides insights into prevalence of severe food insecurity, primary causes, and coping strategies adopted by households in Eastern Cape Province of South Africa.

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Author	Title	Study Area and Population	Research Aims and Methods	Main findings	Key Points
			household socio-economic information and assessing the frequency of food insecurity occurrences using a scale ranging from "none" to "often." The questionnaire also delved into the causes of household food insecurity and strategies employed to cope with it. Responses were provided on behalf of the entire household and its members.		
Wolde, Z., Wei, W., Kunpeng, W., & Ketema, H. (2020).	Local community perceptions toward livelihood and water–energy–food nexus: A perspective on food security.	Gidabo Watershed in Ethiopia, East Africa	Evaluates effectiveness of WEF nexus approach in addressing resource insecurity and enhancing livelihoods at local scale. Identifies shortcomings in its application at local level based on survey data.	Utilizes survey data to assess local perceptions of WEF nexus within communities in Ethiopia. Triangulates findings with literature and case studies.	Calls for greater efforts from governments and stakeholders to improve WEF nexus security and enhance local community perceptions. Aims to inform decision-makers and practitioners working to improve resource security and livelihoods in these contexts.
Zara, C., Coles, B., Hadfield-Hill, S., Horton, J., & Kraftl, P. (2022).	Geographies of food beyond food: transfiguring nexus-thinking through encounters with young people in Brazil	Brazil, young Brazilians	Examines social, cultural, and political implications of young people's connections with food within WEF nexus framework. Integrates contemporary nexus-thinking with perspectives from food scholarship and childhood and youth studies. This case study, strategically positioned between São Paulo and Rio de Janeiro, offers a unique analysis of the wider regional dynamics and Water-Energy-Food (W-E-F) interconnections linking these two major cities. Over 30 months, the research program engaged with over 4000 young individuals aged 10 to 24, as well as professionals from the public and private sectors in the water, energy, food, and education domains. The emphasis on involving young Brazilians was intentional, providing insights into W-E-F nexus experiences in a country where a significant portion of the population falls within this age group. Additionally, it challenges conventional narratives by offering a fresh perspective from a Global South context and broadens the understanding of the W-E-F nexus by incorporating "bottom-up" perspectives often overlooked in existing research.	Employs interdisciplinary approach: ethnographic observations, qualitative interviews, mixed-methods analysis. Provides nuanced understanding of how young people navigate connections with food within broader WEF nexus context.	Aims to stimulate interdisciplinary dialogue and collaboration among researchers interested in understanding intersections between young people, food, and socio-environmental dynamics. Contributes to inclusive discourse on nexus-thinking by centering voices and experiences of young people.
MASON, L.R.	Gender and Asset Dimensions of Seasonal	Baguio City, Philippines;	This study aims to examine how gender and assets	Households manage complex water	Gendered roles exist in managing water portfolios,

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Author	Title	Study Area and Population	Research Aims and Methods	Main findings	Key Points
	Water Insecurity in Urban Philippines	neighborhoods include Dominican Hill, Irisan, and Hillside	relate to seasonal water insecurity in urban areas using qualitative methods. Methods include archival research, informal interviews, and in-depth interviews.	portfolios that change seasonally or more frequently.	with women often providing income for water purchases and men managing the logistics. Specific physical, financial, and social assets play a crucial role in reducing seasonal water insecurity. Implications for more gender-sensitive and asset-focused research and policy recommendations. This study contributes to our understanding of the social dimensions of seasonal water insecurity in urban areas and highlights the importance of considering gender and asset dimensions in water resource management and policy formulation.

APPENDIX B. : DATA for all reviewed articles

Authors/Reference	Argument/About	Population	Method	Representativeness/Audience
Abdi, H.; Shahbazitabar, M.; Mohammadi-Ivatloo, B. **Food, energy and water nexus: A brief review of definitions, research, and challenges. Inventions 2020, 5, 56.**	Food, energy and water nexus: A brief review of definitions, research, and challenges" is centered around the concept of the FEW (food, energy, water) nexus as a solution to the challenges posed by rapid consumption growth, natural resource scarcity, and global warming. It emphasizes the integrated management of these resources to achieve sustainability and improve the quality of life while preserving natural, human, and social capital. The paper reviews recent research in this area, discusses critical policymakers and conferences related to the FEW nexus, and addresses both the challenges and opportunities associated with its implementation.	Review of Food, Energy & Water Nexus globally	- Literature Review - Brief information about studies in different nexus. - Nexus Committee, Conferences, and Real Case Studies	65 papers were reviewed
Abrecht, T. R., Crootof, A. & Scott, C. A. 2018 **The water-energy-food nexus: a systematic review of methods for nexus assessment. Environmental Research Letter 13 (14), 12–18.**	The main argument of the paper is that while the water-energy-food (WEF) nexus approach offers a promising conceptual framework for addressing complex resource and development challenges, the systematic evaluation and use of WEF nexus methods in practice have been limited. The paper aims to review existing WEF nexus methods to build a knowledge base and promote further development of analytical methods that align with nexus thinking. Overall, the paper argues for the need for innovative, context-specific, collaborative, and implementable analytical tools and methods that	The paper systematically reviews 245 journal articles and book chapters to assess the current state of WEF nexus methods	Systematic review The methods employed in the paper involve a systematic review of existing literature on WEF nexus methods, analyzing the approaches used in various studies to evaluate water, energy, and food interlinkages. Their methods review reveals that explicit and reproducible methods to assess water, energy, and food systems together are limited. Only 30 % of peer-reviewed literature reviewed (73 of 245 articles) present nexus methods or propose specific analytical tools. Those without explicit methods instead utilize the nexus as a conceptual framework or offer descriptive	The paper suggests that while it provides a comprehensive analysis of existing WEF nexus methods, it also identifies limitations and gaps in the literature, indicating areas where further research is needed to develop more robust analytical tools and methods.

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Authors/Reference	Argument/About	Population	Method	Representativeness/Audience
	incorporate social and political dimensions, utilize interdisciplinary approaches, and engage stakeholders and decision-makers to address complex resource and development challenges effectively.		accounts of water, energy, and food systems.	
Adeola, O. M., Ramoelo, A., Mantlana, B., Mokotedi, O., Silwana, W., & Tsele, P. (2022). Review of publications on the water-energy-food nexus and climate change adaptation using bibliometric analysis: A case study of Africa. Sustainability, 14(20), 13,672.	The main argument of the paper is that understanding the relationship between the Water-Energy-Food (WEF) nexus and climate change adaptation is crucial for addressing basic needs like access to clean water, reliable energy services, and adequate food supply, particularly in Africa. The study reviews progress in this understanding using bibliometric analysis, focusing on the period from 1980 to 2021. Overall, the study aims to contribute to the growing body of literature on the WEF nexus by identifying dominant themes and emerging concepts in scholarly work related to Africa's WEF nexus and climate change adaptation.	The study analyzes 65 documents retrieved from the Web of Science (WoS) and Scopus databases, covering research on the WEF nexus and climate change adaptation in Africa.	Bibliometric analysis The methods employed in the study include bibliometric analysis, which involves analyzing publication trends, keywords, and thematic structures of the research literature.	The study finds that researchers from various countries around the world have contributed to the WEF nexus work in Africa. The countries with the highest number of publications include South Africa, the United Kingdom, the United States of America, Germany, Kenya, and Zimbabwe.
Adom, P. K., Amuakwa-Mensah, F., Agradi, M. P., & Nsabimana, A. (2021). **Energy poverty, development outcomes, and transition to green energy. Renewable Energy, 178, 1337–1352.**	The main argument of the paper is that there is a close connection between energy and development outcomes, and energy constraints could adversely influence development outcomes. Therefore, building resilience to energy constraints could be an effective strategy to improve development outcomes. The study analyzes the effect of energy poverty and the influence of the green energy transition on various development outcomes. Overall, the paper aims to provide insights into the relationship between energy poverty, renewable energy transition, and development outcomes, and discuss the policy implications of these findings.	The study considered data related to energy poverty and development outcomes across different regions or countries.	Analysis The methods used in the study involve analyzing the effects of energy poverty and renewable energy transition on development outcomes. The approach considers both short and long-term dynamics of these effects and examines how renewable energy transition may partially compensate for the adverse effects of energy poverty on development outcomes.	The study draws on empirical data or models to generalize its findings to broader contexts, such as regions or countries facing energy poverty and undergoing a transition to renewable energy.
Adom, R. K., Simatele, M. D., & Reid, M. (2022). **Addressing the challenges of water-energy-food nexus programme in the context of sustainable development and climate change in South Africa. Journal of Water and Climate Change, 13(7), 2761–2779.**	The paper addresses the urgent need for innovative technologies and comprehensive policy frameworks to tackle the challenges in the water, energy, and food nexus, exacerbated by the fast-growing global population and the impacts of climate change. It specifically focuses on South Africa's policies aimed at understanding the interdependencies of water, energy, and food systems and their impact on socio-economic growth and national development amidst climate change-induced environmental changes.	South Africa The paper discusses the challenges faced by South Africa's population in accessing water, energy, and food resources, as well as the broader global population affected by similar issues.	Case study Primarily, this paper explored the policy gaps and implementation challenges of the nexus approach in South Africa as a whole. Nevertheless, the primary data collection was limited to Mpumalanga. This paper's data was collected through a concurrent mixed-method approach of positivist (quantitative method in the form of questionnaire) and interpretivism (qualitative approach in the form of interviews and observations) paradigms	Limited to South Africa The paper aims to provide a comprehensive analysis of the strengths and weaknesses of South Africa's water-energy-food policy framework. While the focus is on South Africa, the findings may have broader implications for other regions facing similar challenges in managing the water, energy, and food nexus. However, the paper used Mpumalanga province as a Case Study, thus the sample is not representative of the entire South Africa, even though issues might be similar.

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Authors/Reference	Argument/About	Population	Method	Representativeness/Audience
Al-Saidi, M., & Elagib, N. A. (2017). **Towards understanding the integrative approach of the water, energy and food nexus. The Science of the total environment, 574, 1131–1139.**	The paper discusses the water, energy, and food nexus (WEF nexus), which has gained popularity in environmental management. It aims to review a wealth of publications to achieve two main objectives: (1) to understand the rationale behind the WEF nexus debate, and (2) to identify tools for analyzing interdependent resource issues within the nexus using an integrated framework of science and policy. Overall, the paper argues that while the WEF nexus has been successful in changing policy debates, there is a need for better issue prioritization and cross-linking between water, energy, and food resources. It suggests that nexus governance is the missing link in the WEF nexus debate, highlighting the importance of integrating governance frameworks to address interdependent resource issues effectively.	Addresses the broader global population affected by issues related to water, energy, and food scarcity, as well as policymakers and researchers involved in environmental management.	Literature review The methods used in the paper involve reviewing existing publications to gather insights into the WEF nexus debate and the tools available for analyzing interdependent resource issues.	As for representativeness, the paper aims to provide a comprehensive overview of the WEF nexus debate and the tools available for analyzing it. While it may not focus on specific regions or populations, its findings could have implications for various stakeholders involved in environmental management globally.
Arias, A., Rama, M., González-García, S., Feijoo, G., & Moreira, M. T. (2020). **Environmental analysis of servicing centralised and decentralized wastewater treatment for population living in neighbourhoods. Journal of Water Process Engineering, 37, 101,469.**	The article examines the planning and construction of large-scale wastewater infrastructure, comparing centralized and decentralized systems. It argues that while public entities or regulated monopolies typically handle large-scale infrastructure projects, smaller-scale initiatives may involve private companies or local collective efforts. With a growing population moving to urban areas where economic activities are concentrated, there's a need to reconsider decentralized wastewater treatment as a means of alleviating pressure on existing facilities. Overall, the article argues that decentralized wastewater treatment systems offer advantages in reducing the carbon footprint of residents and meeting water quality requirements for irrigation, despite higher initial construction costs. It suggests that such systems, especially suited for new urban developments, can offer environmental and economic benefits over centralized systems.	urban populations, especially those residing in areas experiencing rapid urbanization.	Environmental analysis The study evaluates four wastewater treatment systems—two centralized and two decentralized—from both environmental and economic perspectives. It uses these systems to assess how different wastewater treatment schemes impact the carbon footprint of residents in a neighborhood.	The findings of the study are representative of urban populations globally, particularly those facing challenges related to wastewater management in rapidly urbanizing areas.
Avraamidou, S., Milhorn, A., Sarwar, O., & Pistikopoulos, E. N. (2018). **Towards a Quantitative Food-Energy-Water Nexus Metric to Facilitate Decision Making in Process Systems: A Case Study on a Dairy Production Plant. ESCAPE. European Symposium on Computer Aided Process Engineering, 43, 391–396.**	The article addresses the need for a holistic approach to decision-making in Food-Energy-Water Nexus (FEW-N) systems and proposes a quantitative index to assess integrated FEW-N performance. It introduces a framework and metric for	The article doesn't focus on a specific population but rather on decision-makers involved in FEW-N systems, which could include policymakers, industry professionals, and researchers.	Case study The authors illustrate their framework and metric through a case study on a dairy production and processing plant. They develop a mixed-integer scheduling model to optimize the plant process, considering alternative pathways and trade-offs	The findings of the study is a representative of decision-making processes and optimization strategies in food production and processing industries, particularly those facing challenges related to water and energy use.

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Authors/Reference	Argument/About	Population	Method	Representativeness/Audience
	facilitating decision-making in FEW-N process systems.		between food, energy, and water elements. The components of the FEW-N metric in the case study encompassed the three FEW-N elements along with the profit component (Revenue minus Operating/Fixed Cost). Each FEW-N metric was utilized to formulate an optimization problem aiming to maximize the metric within the constraints of the CCP schedule model. Additionally, four other optimization problems were created and addressed to maximize profit and food production while minimizing energy and water usage, for comparison.	
Benson, D., Gain, A. K., and Rouillard, J. J. (2015). **Water governance in a comparative perspective: from IWRM to a 'Nexus' approach? Water Altern. 8, 756–773.**	The article discusses the concept of nexus thinking, which involves integrating water security with agriculture, energy, and climate concerns to transition societies towards greener economies and sustainable development. The article outlines several issues arising from the current debate on nexus thinking, including questions about its novelty, its relationship with existing environmental governance approaches like integrated water resources management (IWRM), and how it can be enhanced in national contexts.	The article does not focus on a specific population but rather on societies transitioning towards greener economies and sustainable development.	Comparative analysis The authors review the burgeoning nexus literature to establish common criteria and then examine its implementation in practice, particularly in comparison with established IWRM models. Evidence from the UK and Bangladesh is presented to assess the extent to which nexus thinking has been integrated into national policies and practices.	The findings of the study are representative of the debate surrounding nexus thinking and its implementation in national contexts, with a focus on the UK and Bangladesh as examples. The article provides insights into the relationship between nexus thinking and existing environmental governance approaches like IWRM and discusses opportunities for greater integration of nexus thinking within these frameworks.
Bian, Z.; Liu, D. (2021). **A Comprehensive Review on Types, Methods and Different Regions Related to Water–Energy–Food Nexus. Int. J. Environ. Res. Public Health 2021, 18, 8276.**	The article explores the concept of the water-energy-food (WEF) nexus, emphasizing the interconnectedness of water, food, and energy resources. It discusses the importance of controlling these resources collectively rather than separately due to their interlinkages. The study aims to better understand nexus thinking and showcase nexus analysis approaches and tools.	The article does not focus on a specific population but rather on the global perspective of managing water, energy, and food resources.	Literature review The study reviews the current state of the approach to the water-energy-food relationship and examines various methodologies for analyzing the WEF nexus. It provides an overview of available methods and instruments for nexus analysis, explores integration and optimization strategies, and discusses challenges and solutions.	The findings of the study represent the growing attention and research efforts in understanding and analyzing the WEF nexus globally. It discusses case studies from four regions—Asia, Europe, America, and Africa—to illustrate the intricacies of the nexus. Additionally, the study includes scientometric analysis to identify countries and keywords relevant to nexus research. Overall, the article aims to coordinate research efforts to address complex issues in nexus research and develop sustainable water, energy, and food systems.
Biggs, E. M., Bruce, E., Boruff, B., Duncan, J. M. A., Horsley, J., Pauli, N., … Imanari, Y. (2015). **Sustainable development and the water–energy–food nexus: A perspective on livelihoods. *Environmental Science & Policy*, 54, 389–397.** https://doi.org/10.1016/j.envsci.2015.08.002	The article addresses the water-energy-food (WEF) nexus as a conceptual tool for achieving sustainable development but critiques existing frameworks for not adequately incorporating sustainable livelihoods perspectives. The argument posits that livelihoods are integral to sustainable development and should be explicitly considered in nexus approaches.	The article focuses on human populations and their interactions with the natural environment within the context of achieving sustainable development.	The article presents a critical review of existing nexus approaches and identifies potential linkages with sustainable livelihoods theory and practice. It then proposes the concept of "environmental livelihood security" and develops an integrated nexus-livelihoods framework for examining the environmental livelihood security of a system.	The findings represent a synthesis of nexus approaches and sustainable livelihoods theory, aiming to deepen understanding of the interrelated dynamics between human populations and the natural environment. The proposed integrated framework has the capacity to measure and monitor environmental livelihood security at multiple spatial scales and institutional levels, aiming to contribute to national and regional

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				sustainable development targets while promoting equity among individuals and communities in local and global development agendas.
Botai, J. O., Botai, C. M., Ncongwane, K. P., Mpandeli, S., Nhamo, L., Masinde, M., Adeola, A. M., Mengistu, M. G., Tazvinga, H., Murambadoro, M. D., Lottering, S., Motochi, I., Hayombe, P., Zwane, N. N., Wamiti, E. K., & Mabhaudhi, T. (2021). **A Review of the Water–Energy–Food Nexus Research in Africa. Sustainability, 13(4), 1762.** https://doi.org/10.3390/su13041762	The article investigates the water-energy-food (WEF) nexus scholarship in the African continent, focusing on its strategic importance and evolution.	The study examines the scholarly literature on the WEF nexus in Africa, assessing its growth and development over time.	The research utilizes bibliometric science mapping and content analysis techniques to analyze trends, conceptual structures, intellectual patterns, and social structures within the WEF nexus literature accessed from databases like Web of Science and Scopus core collection.	The findings reveal an expansion in WEF nexus scholarship since 2013 and the emergence of hot topics such as modelling and optimization, climate variability and change, environmental ecosystem services sustainability, and sustainable development and livelihoods. The study identifies two main perspectives of WEF nexus research development: interdisciplinary and transdisciplinary domains. It also discusses paradigmatic shifts in WEF nexus research, moving from unconnected silo paradigms to interconnected systems that incorporate environmental, social-economic, and political drivers. The article suggests that Integrative Environmental Governance (IEG) theory could bridge the gap between WEF nexus research outputs and governance processes. Additionally, it highlights operational challenges and opportunities in transitioning WEF nexus research to practice in Africa, emphasizing the need for coordinated and collaborative research to achieve impact and move from WEF nexus thinking to WEF nexus practice.
Cairns, R., and Krzywoszynska, A. (2016). **Anatomy of a buzzword: the emergence of 'the water-energy-food nexus' in UK natural resource debates. Environ. Sci. Policy 64, 164–170.**	The article critically examines the concept of the water-energy-food (WEF) nexus, particularly in the context of its emergence and mobilization in natural resource policy debates in the UK.	The study focuses on the stakeholders involved in natural resource debates in the United Kingdom (UK) and how they engage with the WEF nexus concept.	Discourse analysis The research involves qualitative analysis to explore the ways in which the nexus terminology is emerging and being utilized by different stakeholders. It also involves critique and analysis of broader global science-policy trends.	The article argues that the term 'nexus' has become a buzzword, with its power stemming from its ambiguous meaning and normative resonance. It suggests that in the UK context, the mobilization of the nexus terminology reflects broader trends in global science-policy, including an emphasis on integration, technical solutions to environmental problems, efficiency gains, and technocratic forms of environmental managerialism. The article critiques the 'integrative imaginary' underpinning much of the UK discourse around the nexus concept and emphasizes the importance of addressing power dynamics in proposed integration efforts. It warns against the risk of institutionalizing the nexus concept without proper critique, highlighting the importance of maintaining a critical perspective in nexus research and policymaking.

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Authors/Reference	Argument/About	Population	Method	Representativeness/Audience
Daher, B. T., & Mohtar, R. H. (2015). **Water–energy–food (WEF) Nexus Tool 2.0: guiding integrative resource planning and decision-making.** ***Water International, 40*****(5–6), 748–771.**	The article introduces a framework and methodologies aimed at understanding the linkages between water, energy, and food resources, and provides quantifications of these linkages.	The target audience includes scientists and policymakers involved in resource management and sustainability.	The article presents a new modeling tool, the Water-Energy-Food (WEF) Nexus Tool 2.0, based on the introduced framework. This tool is designed to facilitate the evaluation of scenarios and the identification of sustainable national resource allocation strategies.	The case study focuses on Qatar, a hyper-arid Gulf country, where the WEF Nexus Tool 2.0 is applied. This suggests that the article aims to provide practical insights into resource management and sustainability in a specific context, while also offering a generalizable framework and methodology for broader applications.
De Laurentiis, V., Hunt, D. V., & Rogers, C. D. (2016). **Overcoming food security challenges within an energy/water/food nexus (EWFN) approach. Sustainability, 8(1), 95.**	The article addresses the challenge of feeding a projected population of nine billion people by 2050, considering constrained resources, environmental pressures from current food production methods, changing lifestyles, dietary shifts, and the impacts of climate change.	The target audience includes researchers, policymakers, and stakeholders involved in food security and sustainability.	The article proposes the application of a framework called the energy, water, and food nexus (EWFN) approach, which considers the interactions and connections between these three resources. Additionally, the article discusses the potential use of Life Cycle Assessment (LCA) as a methodology to provide evidence for promoting sustainable shifts in food production and consumption patterns.	While specific representatives are not mentioned, the article appears to advocate for a holistic approach to address food security challenges by integrating considerations of energy, water, and food resources and using LCA to inform decision-making processes.
Du Plessis. (2017). An investigation into the evidence of seasonal rainfall pattern shifts in the Western Cape, South Africa. Journal of South Africa 59 (4), 47–55.	The article investigates the presence of shifts in seasonal rainfall patterns in the Western Cape of South Africa, considering climate change.	The primary focus is on the Western Cape of South Africa, specifically analyzing historical rainfall data from 20 rainfall stations with at least 100 years of records.	Various analytical methods are employed, including statistical analysis, linear trend line distributions, time lag comparisons, cumulative distributions, moving average plots, and autocorrelation relationships. These methods are used to explore relationships between daily rainfall indices over a specified timescale.	While specific representatives are not mentioned, the article aims to provide baseline information and stimulate further research on the impact of climate change on seasonal rainfall patterns in the Western Cape of South Africa.
Endo, A., Tsurita, I., Burnett, K., & Orencio, P. M. (2017). **A review of the current state of research on the water, energy, and food nexus.** ***Journal of Hydrology: Regional Studies, 11*****, 20–30.**	The article reviews and analyzes research on the water, energy, and food nexus across various regions, including Asia, Europe, Oceania, North America, South America, the Middle East, and Africa.	The study focuses on regions across the world, including Asia, Europe, Oceania, North America, South America, the Middle East, and Africa.	The research involves reviewing 37 selected projects to identify four types of nexus research: water-food, water-energy-food, water-energy, and climate-related. The analysis also includes categorizing keywords used in the projects and examining the stakeholders involved.	The regions under study include various continents, with different focuses observed in each region. For example, North America and Oceania tend to focus more on water-energy and climate-related aspects, while Africa shows less emphasis on water-energy. The analysis also highlights the distribution of keywords and the involvement of different stakeholders, with a majority being research organizations.
Gain, A. K., Giupponi, C., & Benson, D. (2015). **The water–energy–food (WEF) security nexus: the policy perspective of Bangladesh. Water International, 40(5–6), 895–910.**	The article provides a review of the emerging literature on the water-energy-food (WEF) nexus and then analyzes the nexus specifically in the context of Bangladesh. It discusses how the WEF nexus concept is not yet recognized in the policy documents of Bangladesh, despite growing conflicts over these resources.	It primarily focuses on the water-energy-food (WEF) nexus concept, its recognition in policy documents, and conflicts over resources in the context of Bangladesh.	The article employs a literature review methodology to examine existing research on the WEF nexus and then applies an analysis specific to the context of Bangladesh. The analysis may involve examining policy documents, resource management strategies, and existing conflicts related to water, energy, and food in Bangladesh.	The representatives in this context refer to stakeholders involved in policy-making, resource management, and related sectors within Bangladesh. The article may discuss the lack of recognition of the WEF nexus concept among policymakers and advocate for policy integration as a solution to address conflicts over water, energy, and food resources.
Goga, S., & Pegram, G. (2014). **Water, energy and food: A review of integrated planning in South Africa. Understanding the Food Energy Water Nexus.**	The main argument of the article revolves around the challenges and opportunities associated with aligning planning and decision-making processes across the water, energy, and food sectors in South Africa. It highlights the need for coherence and	The article examines the challenges faced by South Africa in managing its water, energy, and food resources within the context of its overall development goals. It discusses the complexities of resource management and the need for integrated planning to address	The study reviews the alignment of planning and decision-making by the South African government in the water, energy, and food sectors, particularly in the context of climate change. It assesses various aspects such as integrated planning,	The article provides insights into the challenges and opportunities for integrated planning in South Africa, highlighting areas where coordination is lacking and suggesting areas for improvement. It represents the efforts to understand and

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	coordination in addressing development challenges while considering resource constraints and climate change impacts. Additionally, the article may argue for improved integration and collaboration among different sectors and stakeholders to achieve sustainable development goals effectively.	the food-energy-water nexus in the country.	infrastructure development planning, alignment of sectoral planning, institutional structuring, regulatory instruments, and regional integration.	address the complexities of resource management in the country, with implications for sustainable development and policy formulation.
Grafton, R. Q., McLindin, M., Hussey, K., Wyrwoll, P., Wichelns, D., Ringler, C., … & Williams, J. (2016). **Responding to global challenges in food, energy, environment and water: Risks and options assessment for decision-making. Asia & the Pacific Policy Studies, 3 (2), 275–299.**	The article presents an argument concerning the threats posed by global environmental change to food security. It explores three key discourses: sustainable intensification, the nexus approach, and resilience thinking, highlighting their significance in addressing these threats and ensuring food security. Additionally, the article proposes a causal, risks, and options assessment framework for decision-making to enhance responses to environmental risks and uncertainties.	The study population primarily includes researchers, policymakers, and stakeholders concerned with food security and global environmental change. It engages with existing discourses in these fields and aims to contribute to informed decision-making processes.	The article employs a discourse analysis methodology to review and analyze the three key discourses: sustainable intensification, the nexus approach, and resilience thinking. It synthesizes insights from these discourses to develop a causal, risks, and options assessment framework for decision-making. This framework is structured yet flexible, allowing for a systematic approach to addressing risks associated with global environmental change.	The article represents the efforts of researchers and experts in the fields of food security, environmental science, and policy analysis. It provides insights and tools for policymakers, stakeholders, and decision-makers to navigate the complex challenges posed by global environmental change to food security. By proposing a structured decision-making framework, the article aims to empower stakeholders to make informed decisions and enhance resilience in food systems.
Gupta, A. D. (2017). **Water-Energy-Food (WEF) Nexus and Sustainable Development. Water-Energy-Food Nexus: Principles and Practices, 229, 223.**	This chapter advocates for the integration of a nexus perspective into the sustainable development agenda. It critiques the achievements and shortcomings of the Millennium Development Goals (MDGs) and underscores the importance of adopting a nexus approach to address development issues effectively. The chapter emphasizes the interconnectedness among different disciplines and sectors in achieving the Sustainable Development Goals (SDGs).	The target audience includes policymakers, researchers, educators, and practitioners involved in sustainable development initiatives. The chapter aims to inform and engage individuals and organizations interested in understanding the complexities of sustainable development and the potential benefits of adopting a nexus approach.	The chapter utilizes a literature review methodology to examine the achievements and limitations of the MDGs and to evaluate the relevance of the SDGs in addressing development challenges. It analyzes selected frameworks and case studies related to the water-energy-food nexus to highlight the opportunities and challenges associated with implementing a nexus approach. Additionally, it discusses recent initiatives aimed at integrating research, education, and capacity development across disciplines.	The chapter represents the perspectives and contributions of researchers, policymakers, and practitioners involved in sustainable development efforts. It provides insights into the potential of a nexus approach to address complex development issues and offers recommendations for fostering interdisciplinary collaboration and capacity development. Overall, it serves as a resource for individuals and organizations seeking to promote sustainable development through integrated approaches.
Hoff, H. (2011). **Understanding the Nexus. Background paper for the Bonn2011 Nexus conference: The Water, Energy and Food Security Nexus.**	The paper presents initial evidence supporting the implementation of a nexus approach to enhance water, energy, and food security. It highlights the need for increased efficiency, reduced trade-offs, built synergies, and improved governance across sectors to address the challenges faced in ensuring these securities. **Key Points:** 1 **. Resource Constraints:** Human development has been inequitable, with a significant portion of the global population lacking access to essential resources. Overexploitation of natural resources further exacerbates the challenges faced. 2 **. Increasing Demand:** Population growth, changing lifestyles, and the need to improve food, water, and energy security	The paper emphasizes the inequitable distribution of human development, particularly affecting the "bottom billion" who lack secure food supplies and access to clean water, sanitation, or modern energy sources. It also discusses the growing global population and its impact on increasing resource demands.	The paper employs a comprehensive review of global challenges related to water, energy, and food security, supported by data and evidence from various sources. It discusses the implications of population growth, changing lifestyles, and climate change on resource availability and highlights the need for significant changes in production and consumption patterns.	The paper represents the views of experts and policymakers concerned with sustainable development, resource management, and climate change adaptation. It outlines policy recommendations aimed at addressing the challenges identified and promoting more sustainable approaches to resource management and urban development.

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	lead to growing pressure on limited resources, necessitating significant changes in production and consumption patterns. 3 **Urbanization:** The shift towards urban living promotes resource-intensive lifestyles and concentrates consumption and waste production. Cities need to adopt green and pro-poor development pathways to address these challenges effectively. 4 **Globalization:** While globalization can bring technological innovation and jobs to developing regions, it also externalizes resource extraction and exposes countries to market volatility. Equitable sharing of benefits and internalizing social and environmental externalities are crucial for sustainable development. **5. Resilience Challenges:** Combined pressures from population growth, urbanization, and globalization can undermine resilience in social-ecological systems, posing challenges to long-term sustainability and the protection of human rights to water and food. Overall, the paper underscores the importance of adopting a nexus approach to address the interconnected challenges of water, energy, and food security in the face of global environmental change.			
Huang, D., Li, G., Sun, C., & Liu, Q. (2020). **Exploring interactions in the local water-energy-food nexus (WEF-Nexus) using a simultaneous equations model. Science of The Total Environment, 703, 135,034.**	The article addresses the need to explore and quantify interactions within the Water-Energy-Food (WEF) Nexus, particularly focusing on equations governing these interactions. It argues that while existing research maps causal loops and hierarchy structures, equations for interaction exploration have been overlooked.	The study utilizes panel data from China's 30 provinces spanning from 2005 to 2016.	The article employs a Simultaneous Equations Model (SEM) to assess the intensities between related factors in China's local WEF-Nexus. It defines a local WEF-Nexus as consisting of core, peripheral, and interactive sub-nexuses, while separating the core sub-nexus from supply, consumption, and waste disposal processes.	The results highlight key positive and negative influencing factors within the WEF subsystem, such as effective irrigated area, secondary industry rate, crop sown area, food production, and chemical fertilizer use. Specific influences on water and energy subsystems, including urban green land and total population, are identified. Additionally, the study identifies system boundaries, feedback loops, and nexus points, offering insights into China's local WEF nexus and implications for policy development.
Hussain, S. A., Razi, F., Hewage, K., & Sadiq, R. (2023). **The perspective of energy poverty and 1st energy crisis of green transition. *Energy*, 127,487.IEA (2019). World Energy Outlook 2019. International Energy Agency.**	The article discusses the critical role of energy transition in the midst of an energy crisis, highlighting the challenges faced by policymakers in balancing energy security with sustainability. It emphasizes the need to address energy poverty while transitioning to greener energy sources and mitigating climate change.	Policymakers, energy companies, governments, and the general population are all affected by the energy crisis and the transition to renewable energy sources.	The article proposes a specific framework for inclusive investigations, considering the entire energy ecosystem and major influences, to enable policymakers to better drive the green transition. It suggests formulating energy policies that promote investments in both green and relatively more environmentally benign energy sources compared to high-emission hydrocarbons.	The article represents the perspectives of policymakers, energy industry experts, environmental advocates, and stakeholders concerned with energy security, sustainability, and climate change mitigation.

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Leck, H., Conway, D., Bradshaw, M., & Rees, J. (2015). **Tracing the water–energy–food nexus: Description, theory and practice. Geography Compass, 9(8), 445–460.**	The article discusses the growing attention to the Water-Energy-Food (WEF) nexus in various domains such as research, business, and policymaking. It reviews recent initiatives centered around the nexus concept, examines the challenges hindering interdisciplinary collaboration promoted by the nexus agenda, and explores ways to translate theoretical discussions into practical actions.	The population studied includes researchers, policymakers, and stakeholders involved in discussions and initiatives related to the WEF nexus at the global level. The review encompasses a wide range of literature and perspectives on the topic.	The methods employed involve reviewing recent initiatives and literature surrounding the WEF nexus, analyzing the challenges and barriers faced in implementing nexus approaches, and proposing strategies for operationalizing nexus concepts. The article employs qualitative analysis techniques to synthesize and interpret information from various sources.	Representatives in this context refer to individuals or organizations involved in promoting, researching, or implementing WEF nexus initiatives. These could include scholars, policymakers, representatives from international organizations, and industry leaders contributing to the discourse and actions related to the WEF nexus.
Liphadzi S., Mpandeli S., Mabhaudhi T., Naidoo D., Nhamo L. (2021) **The Evolution of the Water–Energy–Food Nexus as a Transformative Approach for Sustainable Development in South Africa. In: Muthu S.S. (eds) The Water–Energy–Food Nexus. Environmental Footprints and Eco-design of Products and Processes. Springer, Singapore.** https://doi.org/10.1007/978-981-16-0239-9_2.	The article discusses the evolution of the Water-Energy-Food (WEF) nexus framework in South Africa, highlighting its transformation from a conceptual framework to an analytical decision-support tool. It emphasizes the importance of integrated approaches in addressing water scarcity and other socio-economic challenges. The focus has shifted from Integrated Water Resources Management (IWRM) to the more polycentric WEF nexus, reflecting emerging global trends.	The study primarily focuses on South Africa's water research community, policymakers, and stakeholders involved in sustainable socio-economic development.	The article details the initiatives undertaken by the Water Research Commission (WRC) and its partners, particularly the establishment of the WEF Nexus Lighthouse program. It describes the research trajectory followed across different Key Strategic Areas (KSAs) to inform resource management, decision-making, and policy. The approach involves cross-cutting research, development, and innovation to address various societal and environmental challenges.	The authors represent the Water Research Commission (WRC) and other partners involved in the WEF nexus initiative in South Africa. They provide insights into the achievements and challenges of implementing the WEF nexus framework and its potential impact on policy and decision-making for sustainable development.
Liu, J., Yang, H., Cudennec, C., Gain, A. K., Hoff, H., Lawford, R., … & Zheng, C. (2017). **Challenges in operationalizing the water–energy–food nexus. Hydrological Sciences Journal, 62 (11), 1714–1720.**	The article discusses the challenges and advancements in understanding and managing the water–energy–food (WEF) nexus, emphasizing the need for enhanced scientific research and practical implementation strategies.	The article addresses the broader scientific community and policymakers involved in WEF nexus research and management.	The methods involve reviewing existing literature and identifying key challenges and opportunities in WEF nexus research and implementation. The article also advocates for future research efforts to focus on data enhancement and the development of integrated analytical tools.	Representatives in this context refer to stakeholders involved in WEF nexus research and management, including scientists, policymakers, and practitioners. The article aims to provide insights and recommendations to guide their efforts in addressing WEF nexus challenges effectively.
Liu, L.; Hejazi, M.; Patel, P.; Kyle, P.; Davies, E.; Zhou, Y.; Clarke, L.; Edmonds, J. **Water demands for electricity generation in the us: Modeling different scenarios for the water–energy nexus. Technol. Forecast. Soc. Chang. 2015, 94, 318–334.**	The article explores the water–energy nexus in the United States, particularly focusing on the significant water withdrawals for electricity generation. It highlights the challenges posed by growing electricity demands, a changing climate, and limited water supplies, and proposes an integrated modeling approach to understand these interactions and the role of national policies.	The population of interest includes regions within the United States, particularly focusing on states and their electricity generation and consumption patterns.	The study employs the Global Change Assessment Model (GCAM), which is extended to model the electricity and water systems at the state level in the U.S. (GCAM-USA). This integrated model covers the economy, energy, agriculture and land use, water, and climate systems. Seven scenarios are explored to estimate future state-level electricity generation and consumption, along with associated water withdrawals and consumption, under different socioeconomic and policy conditions.	The article represents policymakers, researchers, and stakeholders involved in water and energy management, as well as those interested in climate mitigation strategies and the implications of electricity generation on water resources in the United States.
Mabhaudhi, T., Mpandeli, S., Nhamo, L., Chimonyo, V. G., Nhemachena, C., Senzanje, A., … & Modi, A. T. (2018). **Prospects for improving irrigated agriculture in southern Africa: Linking water, energy and food. *Water, 10*(12), 1881.**	The review assesses the status of irrigated agriculture in southern Africa from a water-energy-food (WEF) nexus perspective, highlighting the region's water scarcity and the projected increase in water, energy, and food demand due to population growth and climate change. It questions whether expanding irrigated agriculture is a solution to improving water access, food security, and energy supply, considering the strain it would	The review acknowledges the projected increase in population within the region, indicating rising demands for water, energy, and food, which will exacerbate existing challenges.	The assessment utilizes a WEF nexus approach to evaluate gaps and opportunities for improving irrigated agriculture, emphasizing the need for integrated resources planning and management to mitigate trade-offs and unintended consequences. It suggests that technical planning should evolve around the WEF nexus framework to guide policy and decision-making.	The review represents the concerns of policymakers, researchers, and stakeholders involved in addressing water, energy, and food security issues in southern Africa. It advocates for a holistic approach that considers the interconnected nature of these resources and their impacts on agricultural productivity and regional development.

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	place on already limited resources.			
Mabhaudhi, T., Nhamo, L., Mpandeli, S., Nhemachena, C., Senzanje, A., Sobratee, N., … & Modi, A. T. (2019). **The water–energy–food nexus as a tool to transform rural livelihoods and well-being in Southern Africa.** ***International journal of environmental research and public health, 16*****(16), 2970.**	This study focuses on assessing rural livelihoods, health, and well-being in southern Africa through the lens of the water–energy–food (WEF) nexus analytical livelihoods model. It emphasizes the importance of integrated resource distribution, planning, and management to improve rural livelihoods and ensure inclusive socio-economic transformation and development.	About 60 % of southern Africa's population resides in rural areas, facing challenges such as limited access to clean water, affordable energy, and nutritious diets. These resource scarcities directly impact nutrition, human health, and overall well-being, particularly among poor rural communities.	The study applies a WEF nexus analytical livelihoods model with a complex systems understanding to assess rural livelihoods, health, and well-being in southern Africa. It calculates the integrated WEF nexus index for the region, indicating the level of sustainability and exposure to vulnerabilities. The analysis identifies an imbalance and uneven resource allocation, utilization, and distribution, often resulting from a fragmented approach to resource management.	The integrated WEF nexus index for southern Africa is calculated to be marginally sustainable, highlighting the region's exposure to vulnerabilities and its failure to meet developmental targets. The study emphasizes the importance of the WEF nexus as a decision support tool for guiding intervention strategies, enhancing synergies, and minimizing trade-offs to build resilient rural communities.
Mabhaudhi, T., Simpson, G., Badenhorst, J., Mohammed, M., Motongera, T., Senzanje, A., … & Mpandeli, S. (2018). **Assessing the state of the water-energy-food (WEF) nexus in South Africa. Water Research Commission (WRC): Pretoria, South Africa, 76.**	The article discusses the implementation and potential of the Water-Energy-Food (WEF) nexus approach in South Africa, emphasizing its importance for sustainable development.	The focus is on South Africa, with considerations for the broader Southern African Development Community (SADC) region. The target population includes policymakers, researchers, and stakeholders involved in resource management and policy development.	The study employs a literature review to assess past and ongoing work on the WEF nexus in South Africa, identifying opportunities, challenges, and gaps. It proposes a framework for linking the WEF Nexus to the Sustainable Development Goals (SDGs), particularly focusing on SDGs 2, 6, and 7. The article also outlines a research agenda for future studies on the WEF nexus in South Africa, including the development of integrated models, metrics, and participatory research approaches.	Representatives from the Water Research Commission (WRC) of South Africa are prominently involved in the study, leading the effort to promote the WEF nexus in the country. Additionally, policymakers, researchers, and stakeholders from various sectors are likely represented in the research process and in the proposed research agenda.
Mabhaudhi, T., Simpson, G., Badenhorst, J., Senzanje, A., Jewitt, G. P. W., Chimonyo, V. G. P., … & Nhamo, L. (2021). **Developing a Framework for the Water-Energy-Food Nexus in South Africa. In Climate Change and Water Resources in Africa (pp. 407–431). Springer, Cham.**	The article proposes a framework for linking the Water-Energy-Food (WEF) nexus to the Sustainable Development Goals (SDGs), with a focus on SDG 2 (Zero Hunger), SDG 6 (Clean Water and Sanitation), and SDG 7 (Affordable and Clean Energy). It emphasizes the need for integrated models and indices to assess WEF resources in South Africa and advocates for the development of a WEF nexus database. Additionally, the article highlights the importance of translating existing knowledge into policies for sustainable resource management and calls for participatory research to demonstrate the applicability of the WEF nexus at the local level, particularly focusing on impoverished communities.	The target population for this research includes stakeholders, policymakers, and researchers involved in resource management and sustainable development in South Africa. Additionally, it may involve community members, especially those from marginalized or impoverished areas, who are directly impacted by decisions related to the WEF nexus and SDGs.	The article employs a systematic analysis of existing WEF nexus frameworks found in academic and grey literature to develop a framework tailored for South Africa. The proposed framework integrates the three sectors of the WEF nexus, technological innovation, human well-being, the SDGs, and various drivers influencing the nexus. Future research directions are outlined, focusing on the development of integrated models and indices, translation of knowledge into policy, and participatory research methods.	The representatives involved in this research are experts and researchers in the field of resource management, sustainable development, and the WEF nexus, particularly focusing on the South African context. These representatives aim to contribute to policy development and decision-making processes by providing evidence-based recommendations and frameworks for sustainable resource management in the region.
Mandindi, W. Z., Nyaba, L., Mketo, N., & Nomngongo, P. N. (2022). **Seasonal Variation of Drinking Water Quality and Human Health Risk Assessment: A Case Study in Rural Village of the Eastern Cape, South Africa.** ***Water, 14*****(13), 2013.**	The study investigates variations in metal occurrence, water quality, and human health risks between the dry and wet seasons in a rural village in the Eastern Cape Province, South Africa. Specifically, it examines the concentrations of major and trace metals in drinking water samples and assesses physicochemical parameters, water quality indices, and	The study focuses on a rural village located in the Eastern Cape Province, South Africa. The population indirectly affected includes individuals relying on the village's drinking water supply.	• **Sample Collection and Analysis:** Drinking water samples were collected and analyzed for major and trace metal concentrations using inductively coupled plasma-optical emission spectrom-etry (ICP-OES). • **Evaluation of Physicochemical Parameters:** Various physicochemical parameters, including water hardness,	This study directly represents rural communities in the Eastern Cape Province, South Africa, affected by water contamination and associated health risks.

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	health risk factors associated with metal contamination.		were assessed to understand the overall quality of the water. • **Water Quality Index (WQI) Calculation:** WQI was calculated to determine the overall quality of the water samples. • **Health Risk Assessment:** Health risks associated with metal contamination were assessed using hazard quotient (HQ) and chronic daily intake (CDI) calculations, considering the presence of potentially harmful metals such as As, Cr, Sb, Tl, and V.	
Meadows et al. (1972). **D.H. Meadows, D.H. Meadows, J. Randers, W.W. Behrens III The Limits to Growth: a Report to the Club of Rome. A Report Fo the Club of Rome on the Predicament of Mankind Universe Books, Washington DC, USA (1972), p. 211**	The article discusses "The Limits to Growth," a book published in 1972, which presents computer modeling of exponential economic and population growth in the context of finite resource supplies. It outlines the key variables examined in the original model and the scenarios explored to understand the consequences of interactions between Earth's and human systems.	The book does not provide specific population data, but it discusses the implications of exponential population growth within the context of finite resources.	The authors utilized the World3 model to simulate interactions between various variables such as world population, industrialization, pollution, food production, and resource depletion. These variables were examined under three different scenarios to understand potential outcomes.	Global representative and assumptions
Meadows, D., & Randers, J. (2012). **The limits to growth: the 30-year update. Routledge.**	The article discusses "The Limits to Growth," a 1972 book that utilizes computer modeling to analyze the impact of exponential economic and population growth on finite resource supplies. The study was funded by the Volkswagen Foundation and commissioned by the Club of Rome.	The population is generalized globally	The authors employed the World3 model to simulate the consequences of interactions between the Earth's and human systems. Five key variables were examined in the original model: world population, industrialization, pollution, food production, and resource depletion. **Representatives:** The Club of Rome, which commissioned the study, and the authors Donella H. Meadows, Dennis L. Meadows, Jørgen Randers, and William W. Behrens III, can be considered representatives involved in the research and dissemination of "The Limits to Growth." This article explores the modeling and findings of "The Limits to Growth," emphasizing the variables considered and the scenarios presented by the authors in assessing the sustainability of global systems. 2/2	This article explores the modeling and findings of "The Limits to Growth," emphasizing the variables considered and the scenarios presented by the authors in assessing the sustainability of global systems.
Mepaiyeda, S., Madi, K., Gwavava, O., & Baiyegunhi, C. (2020). **Geological and geophysical assessment of groundwater contamination at the Roundhill landfill site, Berlin, Eastern Cape, South Africa. *Heliyon*, *6*(7), e04249.**	An integrated geological assessment of groundwater contamination near the Roundhill landfill in South Africa was conducted to understand the subsurface characteristics and establish links between groundwater and contaminants.	The study area includes groundwater samples from two boreholes and a leachate pond within the landfill.	Quantitative analysis involved measuring physico-chemical properties of groundwater samples, while qualitative assessment utilized electrical resistivity and time domain induced polarization (IP) measurements across three profiles using a double-dipole array.	Results indicate the presence of heavy metals (mercury, lead, arsenic) in groundwater samples above acceptable limits, likely due to the dumping of toxic waste. Resistivity and IP measurements revealed a layered earth structure with anomalous zones indicating a percolating leachate plume. Structural features such as fractures in the bedrock pose a risk for contaminant percolation into groundwater over time. Proper waste

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				classification and inspection are recommended before landfill disposal.
Mguni, P., & van Vliet, B. J. (2020). **Rethinking the urban Nexus-Resilience and vulnerability at the urban Nexus of Water, Energy and Food (WEF). An introduction to the special issue.** ***Journal of Integrative Environmental Sciences*****,** ***17*****(2), i-v.**	The article introduces the concept of the urban Nexus of Water, Energy, and Food (WEF) and discusses the importance of understanding the interactions within this nexus for building sustainable and resilient cities. It argues for a shift from a solely physical system-level resilience approach to one that considers social vulnerabilities and everyday practices related to the WEF nexus.	The population of interest is urban communities, particularly marginalized groups, living in cities where access to essential services such as water, energy, and food may be unevenly distributed. The article emphasizes the need to address vulnerabilities experienced by these populations in the context of urban resilience and sustainability.	The article employs a qualitative approach to discuss the conceptual framework of the urban WEF nexus and the Resilience and Vulnerability at the Urban Nexus (ResNexus) project. It also draw on case studies and existing literature to support its arguments regarding the importance of understanding social vulnerabilities and everyday practices related to the WEF nexus.	The authors of the article represent researchers or experts in the field of urban resilience, sustainability, and the WEF nexus. They may have expertise in social and political sciences, environmental studies, or urban planning.
Mguni, P., Van Vliet, B., Spaargaren, G., Nakirya, D., Osuret, J., Isunju, J. B., Ssekamatte, T., & Mugambe, R. (2020). **What could go wrong with cooking? Exploring vulnerability at the water, energy and food Nexus in Kampala through a social practices lens. Global Environmental Change, 63, 102, 086.** https://doi.org/10.1016/j.gloenvcha.2020.102086	The article examines emergent vulnerabilities at the urban Nexus of water, energy, and food (WEF) in informal settlements of Kampala, focusing on the challenges faced by poor households due to rapid urbanization and climate change impacts.	The study population consists of residents living in informal settlements, specifically Bwaise and Kanyogoga, in Kampala, Uganda.	The study employs a mix of qualitative research methods including observation, interviews, focus group discussions, and a vision-building workshop to explore the vulnerabilities of poor households in navigating challenges related to water quality, energy prices, and food insecurity.	The findings represent the experiences and perspectives of poor households living in informal settlements in Kampala, shedding light on their daily struggles and coping strategies in the face of deteriorating water quality, rising energy prices, and food insecurity.
Mohtar, R. H., & Daher, B. (2012). **Water, energy, and food: The ultimate nexus. Encyclopedia of agricultural, food, and biological engineering. CRC Press, Taylor and Francis Group.**	The article discusses the interconnectedness of water, energy, and food systems within the context of global challenges and the need for sustainable solutions.	The article addresses a global audience interested in understanding the interlinkages between water, energy, and food systems and the implications for strategic planning and decision-making.	The article employed a conceptual or theoretical approach to analyze the interconnections between water, energy, and food systems, drawing on existing research and literature in the field.	The authors represent experts or researchers in the fields of water resources, energy, food security, sustainability, or related disciplines, aiming to contribute to the discourse on integrated resource management and strategic planning. Global assumptions.
Mohtar, R. H., & Lawford, R. (2016). **Present and future of the water-energy-food nexus and the role of the community of practice.** ***Journal of Environmental Studies and Sciences*****,** ***6*****(1), 192–199.**	The article discusses the integrated management of water, energy, and food (WEF) resources as a response to global risks exacerbated by climate change, demographics, aging infrastructure, and other challenges.	The article addresses researchers, policymakers, and stakeholders involved in resource management and sustainability efforts.	The article employs a review of historical developments in WEF nexus thinking, presents connections to systems-science theory, proposes an interdisciplinary WEF nexus platform, and advocates for a WEF nexus community of practice (NCoP).	The article represents scholars, policymakers, and stakeholders interested in addressing the interconnected challenges of water, energy, and food security through an integrated approach.
Mohtar, R. H., & Lawford, R. (2016). **Present and future of the water-energy-food nexus and the role of the community of practice. J Environ Stud Sci 6, 192–199.** https://doi.org/10.1007/s13412-016-0378-5	The article discusses the integrated management of water, energy, and food resources (WEF) and highlights their increasing global risks due to factors like climate change, demographics, and aging infrastructure.	The target audience includes scholars, policymakers, and stakeholders interested in understanding and addressing the challenges associated with the WEF nexus.	The article employs a literature review approach to define the WEF nexus, discuss its historical developments, and connect it to systems-science theory. It proposes an interdisciplinary WEF nexus platform and calls for the establishment of a WEF nexus community of practice (NCoP) to promote integrative approaches and develop tools for sustainable resource management.	The authors represent experts in the field of environmental science, policy, and sustainable development, aiming to bridge the gap between science and policy and engage a wider community of stakeholders in addressing WEF nexus challenges.
Mokoena, A. (2023). **Questioning Day Zero: Rights, Provision, and Water Inequality in South Africa.** ***Human Organization*****, 82(3), 223–234**	The research findings highlight how the response to the Cape Water Crisis exacerbated existing inequalities in water distribution within the township of Khayelitsha. Despite constitutional recognition of water as a basic human right, the implementation of water management policies prioritized paying customers over the needs of the poor, perpetuating water inequality	The population under study is the township of Khayelitsha in Cape Town, South Africa, particularly focusing on residents living in informal settlements. These residents face significant challenges related to water inequality, exacerbated by the Cape Water Crisis and existing spatial inequalities within the city.	The research methodology employed in this study involved a combination of qualitative approaches, including analysis of water management policies, in-depth interviews with service providers responsible for water distribution in Khayelitsha, and interviews with residents from different settlements within the township. By employing multiple methods, the study aimed to comprehensively understand the complex	To ensure the representativeness of the study, careful attention was paid to sampling techniques and data collection methods. Interviews were conducted with a diverse range of stakeholders, including both service providers and residents, to capture various perspectives on water inequality. Additionally, by focusing on two settlements within the same township, the study aimed to provide a

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	in informal settlements. By applying John Rawls' theory of distributive justice, the study demonstrates how sociopolitical factors intersect with spatial inequality to uphold systems that disadvantage marginalized communities.		dynamics contributing to water inequality in the area.	comparative basis for understanding water inequality within Khayelitsha itself, rather than comparing it to distant or unrelated areas.
Molajou, M., Pouladi, P., & Afshar, A. (2021). **Incorporating Social System into Water-Food-Energy Nexus. Water Resources Management: An International Journal, 35 (13), 4561–4580.** https://doi.org/10.1007/s11269-021-02967-4.	The article introduces a conceptual socio-hydrological-based framework for the water-energy-food (WEF) nexus, aiming to explore the impacts of farmers' agricultural activities on WEF systems under different socio-economic conditions.	The study focuses on farmers engaged in agricultural activities within the context of the WEF nexus framework.	The study integrates a WEF nexus model with an Agent-Based Model (ABM) and employs Association Rule Mining to understand farmers' decision-making processes. Observations, interviews, focus group discussions, and a vision-building workshop were used to gather data.	The findings aim to represent the dynamic interactions between agricultural activities, socio-economic conditions, and the WEF nexus, providing insights for policymakers and stakeholders to address sustainability challenges.
Mpandeli, S., Naidoo, D., Mabhaudhi, T., Nhemachena, C., Nhamo, L., Liphadzi, S., … & Modi, A. T. (2018). **Climate change adaptation through the water-energy-food nexus in southern Africa.** ***International journal of environmental research and public health, 15*****(10), 2306.**	The article explores climate change adaptation opportunities and challenges in southern Africa, focusing on the water-energy-food (WEF) nexus perspective. It argues that conventional sectoral approaches to climate adaptation are insufficient, and advocates for an integrated WEF nexus approach to address cross-sectoral impacts and enhance resilience in the region.	The population of interest includes communities, policymakers, and stakeholders in southern Africa, particularly those vulnerable to climate change impacts on water, energy, and food security. Marginalized communities facing socio-economic challenges are particularly relevant.	The review methodology involves analyzing regional and international literature on climate change adaptation in southern Africa, with a specific focus on the WEF nexus. This includes literature on climate change impacts, adaptation strategies, and institutional frameworks related to water, energy, and food security in the region.	Representatives include researchers, policymakers, and practitioners engaged in climate change adaptation and sustainable development initiatives in southern Africa. Stakeholders from diverse sectors, including government agencies, non-governmental organizations, and academic institutions, are involved in shaping adaptation strategies and policies.
Musemwa, L., Muchenje, V., Mushunje, A., Aghdasi, F., & Zhou, L. (2015). **Household food insecurity in the poorest province of South Africa: level, causes and coping strategies.** ***Food Security, 7,*** **647–655.**	The study focuses on determining the level and causes of food insecurity among households in the Eastern Cape Province of South Africa, utilizing the Household Food Insecurity Access Prevalence (HFIAP) and the Household Food Insecurity Access Scale (HFIAS) as assessment tools.	The study involves 150 households residing in the Eastern Cape Province of South Africa. These households represent a segment of the rural population facing food insecurity challenges in the region.	The research employs the Household Food Insecurity Access Prevalence (HFIAP) and the Household Food Insecurity Access Scale (HFIAS) to assess the level of food insecurity among the selected households. Data collection involves interviews and surveys to gather information on household food security status and the factors contributing to food insecurity.	The study findings represent the food security situation and challenges faced by households in the Eastern Cape Province of South Africa. The research outcomes provide insights into the prevalence of severe food insecurity, the primary causes, and the coping strategies adopted by households in the region.
Ncoko, P., Jaja, I. F., & Oguttu, J. W. (2020). **Microbiological quality of beef, mutton, and water from different abattoirs in the Eastern Cape Province, South Africa. Veterinary world, 13(7), 1363.**	The study focuses on microbial surveillance in slaughter facilities to prevent meat contamination and foodborne diseases. It aims to determine the microbial quality of meat and water in selected abattoirs, emphasizing the importance of continual monitoring and adherence to regulatory standards.	The study population includes retrospective data from 2017 (n = 100) and prospective survey data from 2018 (n = 50) collected from abattoirs in the Eastern Cape Province of South Africa. Samples of meat and water from these facilities were analyzed for microbial contamination.	Retrospective and prospective data were utilized for analysis. Enumeration of aerobic plate count (APC) and Enterobacteriaceae was conducted, along with the isolation of *Escherichia coli* and Salmonella spp. using selective media. The study employed microbiological techniques to assess the microbial quality of meat and water samples collected from the abattoirs.	Eastern Cape Province, South Africa
Ndlovu, V. & Inglesi-Lotz, R. (2019). **Positioning South Africa's energy supply mix internationally: comparative and policy review analysis. Journal of Energy in South Africa 30 (2), 15–20**	The study emphasizes the importance of optimizing and diversifying South Africa's energy generation mix to meet developmental goals and enhance security of supply. It examines the evolution of the country's energy supply mix over the past 25 years and compares it with other countries such as BRICS companions and OECD members. Additionally, it discusses the heavy reliance on fossil fuels in BRICS countries and the need for appropriate policies to guide the transition	The study population includes South Africa and other countries such as Brazil, Russia, India, China (BRICS), and members of the Organisation for Economic Co-operation and Development (OECD). It assesses their energy supply mix and trends over time.	The study employs a descriptive approach to provide a detailed description of South Africa's energy supply mix and its evolution. It uses comparative analysis to assess South Africa's energy mix in relation to other countries, particularly BRICS and OECD members. Additionally, the study involves data collection and analysis from various sources to support its findings and recommendations.	Refer to individuals or entities involved in decision-making processes related to energy policy and planning in South Africa. This could include government officials, policymakers, energy industry stakeholders, and experts in the field of energy and sustainable development. Their perspectives and actions play a crucial role in shaping the direction of South Africa's energy sector, including decisions regarding the optimization and

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	towards a more diverse and sustainable energy mix.			diversification of the energy generation mix.
Nhamo, L., Mabhaudhi, T., Mpandeli, S., Dickens, C., Nhemachena, C., Senzanje, A., … & Modi, A. T. (2020). **An integrative analytical model for the water-energy-food nexus: South Africa case study. Environmental Science & Policy, 109, 15–24.**	This study focuses on addressing the missing link between cross-sectoral resource management and the full-scale adoption of the water-energy-food (WEF) nexus concept. It aims to develop analytical tools that provide evidence for policy and decision-making in the context of WEF nexus sustainability.	The population of interest in this study includes researchers, policymakers, and stakeholders involved in resource management, particularly in the water, energy, and food sectors. South Africa serves as the specific case study for the application of the developed analytical model.	The study employs the Analytic Hierarchy Process (AHP) to develop an analytical model for managing WEF resources in an integrated manner. This involves defining WEF nexus sustainability indicators and establishing quantitative relationships among WEF sectors. The model is applied to assess progress towards the Sustainable Development Goals (SDGs) in South Africa, providing insights into sector performance and identifying priority areas for intervention.	The representatives in this study encompass a diverse range of actors involved in WEF resource management, including government officials, policymakers, researchers, industry stakeholders, and community members. Their involvement is essential for the implementation of policies and interventions identified through the developed analytical model.
Nhamo, L., Mabhaudhi, T., Mpandeli, S., Nhemachena, C., Senzanje, A., Naidoo, D., … & Modi, A. T. (2019). **Sustainability indicators and indices for the water-energy-food nexus for performance assessment: WEF nexus in practice–South Africa case study.**	The study addresses the critical gap between cross-sectoral resource management and the full-scale adoption of the water-energy-food (WEF) nexus by introducing an analytical model. This model, developed using the Analytic Hierarchy Process (AHP), aims to provide evidence-based support for policymaking and decision-making in the management of WEF resources. By establishing sustainability indicators and quantitative relationships among WEF sectors, the study offers a comprehensive framework for integrated resource management.	The population under study encompasses regions or countries facing challenges related to resource management, particularly in the context of the water-energy-food nexus. While the study focuses on South Africa as a case study, its findings and methodology have broader applicability to other regions experiencing similar issues with cross-sectoral resource management.	The study employs the Analytic Hierarchy Process (AHP) as the primary methodological approach for developing the analytical model. AHP is a decision-making tool that allows for the systematic structuring and analysis of complex problems by breaking them down into hierarchies and evaluating criteria and alternatives. By utilizing AHP, the study is able to define WEF nexus sustainability indicators, establish quantitative relationships among sectors, and assess the performance of resource management strategies.	To ensure the representativeness of the study, the analytical model is developed using data and insights specific to South Africa as a case study. However, the study's methodology and findings are designed to be applicable to a broader context, making it relevant for regions facing similar challenges in resource management. Additionally, the use of quantitative indicators and the application of the model to assess progress towards Sustainable Development Goals contribute to the study's representativeness by providing a comprehensive and systematic approach to evaluating resource management practices.
Nhamo, L., Ndlela, B., Nhemachena, C., Mabhaudhi, T., Mpandeli, S., & Matchaya, G. (2018). **The water-energy-food nexus: Climate risks and opportunities in southern Africa. Water, 10(5), 567.**	The article addresses the challenges posed by climate change in southern Africa and emphasizes the need for an integrated and transformative systems approach to respond effectively. It highlights the shortcomings of current sectoral approaches to climate change adaptation and advocates for cross-sectoral mitigation and adaptation strategies, particularly within the water-energy-food (WEF) nexus framework.	The population of interest includes researchers, policymakers, practitioners, and stakeholders involved in climate change adaptation, resource management, and sustainable development in southern Africa. This encompasses a diverse range of actors from governmental and non-governmental organizations, academia, communities, and the private sector.	The study employs a literature review methodology to synthesize regional and international literature on climate change adaptation opportunities and challenges in southern Africa. It specifically focuses on the impacts of climate change on water, energy, and food resources, exploring mitigation and adaptation opportunities within the WEF nexus framework. The review also examines regional WEF nexus-related institutions and legal frameworks to inform policy recommendations.	Representatives involved in this study include policymakers, government officials, researchers, practitioners, community leaders, and representatives from relevant institutions and organizations working on climate change adaptation and sustainable development in southern Africa. Their engagement is crucial for developing and implementing cross-sectoral sustainable measures aimed at building resilient communities and achieving the Sustainable Development Goals (SDGs) related to poverty alleviation, food security, clean water and sanitation, and climate action.
Nkosi, M., Mathieha, F. & Odioyo, J. O. (2021). **Impact of land management on water resources a South Africa context. Sustainability 13 (2), 6–13.**	The article addresses the impacts of land use/land cover changes on water resources in South Africa. It highlights the challenges faced by the country, particularly in the context of water scarcity and domestic water supply, and emphasizes the need for better integrated strategic approaches to water resource and land management.	The population of interest includes researchers, policymakers, practitioners, and stakeholders involved in water resource management, land use planning, environmental conservation, and sustainable development in South Africa. This encompasses a diverse range of actors from governmental and non-governmental organizations,	The study utilizes a systematic review methodology to examine the impacts of land use/land cover changes on water resources in South Africa. It synthesizes existing literature on the subject to provide an overview of the challenges and implications for water availability and quality. The review also identifies possible solutions and recommendations to promote sustainable	Representatives involved in this study include policymakers, government officials, researchers, practitioners, community leaders, and representatives from relevant institutions and organizations working on water resource management and land use planning in South Africa. Their engagement is essential for implementing integrated strategic

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		academia, communities, and the private sector.	development and improve the integrity of South African water resources.	approaches and behavioral changes necessary to protect and preserve the country's water resources while promoting sustainable development.
Nyiwul, L. (2021). **Climate change adaptation and inequality in Africa: Case of water, energy and food insecurity. Journal of Cleaner Production, 278, 123,393.**	The article examines the relationship between social inequality and climate change policy actions in African countries. It investigates whether the needs of the poor influence mitigation and adaptation policies in the region, considering Africa's vulnerability to climate change and its high levels of inequality.	The population of interest includes researchers, policymakers, government officials, practitioners, and stakeholders involved in climate change policy, social inequality, development, and environmental sustainability in African countries. This encompasses a diverse range of actors from governmental and non-governmental organizations, academia, international agencies, civil society, and local communities.	The study utilizes statistical analysis, including fractional regression and data imputation methods, to analyze the relationship between social inequality and climate change policy actions in Africa. It constructs a statistical measure of social inequality for a group of 54 African countries and examines their Intended Nationally Determined Contributions (INDCs) to obtain data on mitigation and adaptation policy actions. The analysis estimates the intensity of the responsiveness of climate change policies to social inequality.	Representatives involved in this study include policymakers, government officials, researchers, practitioners, civil society organizations, and community leaders working on climate change mitigation and adaptation, social development, poverty alleviation, and environmental justice in African countries. Their engagement is crucial for understanding the implications of social inequality on climate change policy actions and for informing policy decisions to address the disproportionate impacts of climate change on vulnerable populations in Africa.
Oelofse, S., Muswema, A. & Ramukhatho, R. (2018). **Household Food Waste Disposal in South Africa: A Case Study of Johannesburg and Ekurhuleni. Natural Resources and the Environmental, CSIR, Pretoria.**	The article addresses the issue of food waste, particularly in the context of developing countries, with a focus on South Africa. It aims to provide primary data on household food waste disposal in South Africa, shedding light on a topic that has been relatively understudied in the region. By presenting empirical evidence, the study contributes to understanding the extent and nature of food waste in urban areas of South Africa and its implications for food security and sustainable development.	The population of interest includes researchers, policymakers, government officials, waste management practitioners, urban planners, and stakeholders involved in food security, sustainable development, environmental conservation, and waste management in South Africa and other developing countries. Additionally, the study may be relevant to international organizations, non-governmental organizations, and civil society groups working on issues related to food waste reduction and sustainable consumption.	The study employs municipal solid waste characterization studies using bulk sampling with randomized grab sub-sampling to collect primary data on household food waste disposal in Ekurhuleni and Johannesburg, two large urban metropolitan municipalities in Gauteng Province, South Africa. Data collection took place over a 6-week period during the summer in 2014 and 2016. The study calculates the food waste component of household waste and analyzes the amount of food waste disposed of into municipal bins per household per week. These findings are then extrapolated to estimate per capita food waste disposal rates in South Africa and compared to global estimates.	Representatives involved in this study include researchers, waste management experts, environmentalists, government officials from local municipalities and relevant departments (e.g., environmental affairs, urban planning), policymakers, and stakeholders engaged in sustainable development initiatives and food security programs in South Africa. Their engagement is essential for utilizing the study's findings to inform policy decisions, develop targeted interventions, and promote sustainable practices to reduce food waste and enhance food security in urban areas.
Rodríguez, D. J., Paltán, H. A., García, L. E., Ray, P., & St. George Freeman, S. (2021). **Water-related infrastructure investments in a changing environment: a perspective from the World Bank. Water Policy, 23(S1), 31–53.**	The article discusses the role of the World Bank Group (WBG) in financing infrastructure projects worldwide to address the global deficit in infrastructure. It highlights the WBG's policies and protocols for approving investments, focusing on financial, economic, social, and environmental considerations. Specifically, the article examines recent updates to WBG safeguards, particularly concerning climate change, resilience, and risk management. It introduces the Decision Tree Framework (DTF) as a tool developed to screen projects for climate vulnerabilities and identify risk management options, facilitating climate-informed project investment decision-	The article targets a diverse audience, including policymakers, development practitioners, project managers, environmental specialists, economists, financiers, and researchers involved in infrastructure development, climate change adaptation, and risk management. Additionally, stakeholders within the World Bank Group, international development organizations, government agencies, and non-governmental organizations (NGOs) working on infrastructure financing, climate resilience, and sustainable development would find the article relevant.	The article utilizes a review approach to examine the applications of the Decision Tree Framework (DTF) in screening projects for climate vulnerabilities and identifying risk management options. It outlines the four phases of the DTF: project screening, initial analysis, stress test, and climate risk management. Case studies and examples are used to illustrate the implementation of the DTF across various project contexts. Additionally, the article provides insights into ongoing efforts to incorporate resilience into the decision-making process and outlines future directions.	Representatives involved in this article include experts from the World Bank Group, including project teams, policymakers, and technical specialists responsible for project appraisal and approval. Additionally, representatives from partner organizations, government agencies, NGOs, and research institutions engaged in infrastructure development, climate resilience, and risk management contribute to the discussion. Their perspectives and experiences in applying the Decision Tree Framework and addressing climate vulnerabilities in infrastructure projects are essential for informing best practices and guiding future

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	making. The article reviews applications of the DTF across different phases and explores its utility in decision-making for project investments and prioritization.			efforts in infrastructure financing and development.
Simpson, G. (2020). **The development of the Water-Energy-Food Nexus Index and its application to the Southern African Development Community. University of KwaZulu-Natal.**	The thesis explores the development and significance of the water-energy-food (WEF) nexus framework for achieving resource security. It provides a comprehensive review of the WEF nexus, including its conceptualization, challenges in integration and optimization, and governance aspects. The thesis also addresses criticisms regarding distributional justice and governance issues associated with the WEF nexus approach. Through case studies and assessments, it examines the status quo within the WEF nexus fraternity and emphasizes the transition from 'nexus thinking' to 'nexus doing.' The core output of the research project is the development of a country-level composite indicator, the WEF Nexus Index, which quantitatively evaluates trade-offs necessary for sustainable development.	The thesis targets researchers, policymakers, practitioners, and stakeholders involved in resource management, sustainable development, and policy formulation. It is relevant to academia, government agencies, non-governmental organizations (NGOs), international organizations, and industries engaged in water, energy, and food security issues. Additionally, individuals interested in interdisciplinary approaches to address complex challenges related to resource management will find the thesis insightful.	The thesis employs a multidisciplinary approach, drawing on academic literature, grey literature, case studies, and assessments to explore various aspects of the WEF nexus framework. It utilizes qualitative and quantitative research methods, including literature review, case studies, indicator development, and data analysis. GIS-based mapping techniques are utilized to visualize spatial relationships within the WEF nexus. The development of the WEF Nexus Index involves a rigorous process of indicator selection and evaluation to provide a quantitative perspective on integrated resource management.	Representatives involved in the thesis include researchers, academics, policymakers, practitioners, and experts in fields related to water, energy, food security, and sustainable development. Stakeholders from national governments, international organizations, NGOs, and the private sector contribute to the discourse on the WEF nexus framework and the development of the WEF Nexus Index. Their perspectives and insights inform discussions on the challenges, opportunities, and implications of adopting integrated approaches to resource management. The thesis aims to provide actionable insights and tools for decision-making and policy development at national and regional levels.
Simpson, G. B., & Jewitt, G. P. (2019). **The development of the water-energy-food nexus as a framework for achieving resource security: a review. Frontiers in Environmental Science, 7, 8.**	The article explores the evolution of the water-energy-food (WEF) nexus concept since its emergence in policy and development discussions around 2011. It provides an overview of different interpretations of the WEF nexus and assesses its novelty in addressing interconnected resource challenges. The article examines the challenges associated with integrating and optimizing the components of the WEF nexus through the presentation of four case studies. It also acknowledges criticisms of the WEF nexus framework, including concerns about neglecting livelihoods and environmental considerations in assessments. Additionally, the article discusses governance considerations related to the implementation of the WEF nexus approach and evaluates its potential contribution to achieving the Sustainable Development Goals (SDGs).	The article is relevant to researchers, policymakers, practitioners, and stakeholders engaged in issues related to water, energy, food security, and sustainable development. It appeals to academics, government officials, non-governmental organizations (NGOs), international agencies, and industry representatives involved in resource management and policy formulation. Individuals interested in interdisciplinary approaches to addressing complex challenges at the nexus of water, energy, and food will find the article informative.	The article utilizes a comprehensive WEF index literature. It draws on academic literature, policy documents, and case studies in Southern Africa to illustrate the implementation and challenges of the WEF nexus framework. The article critically assesses the strengths and limitations of the WEF nexus approach through the analysis of case studies and identifies areas for improvement. Governance considerations and the potential of the WEF nexus to contribute to achieving the SDGs are discussed based on existing literature and empirical evidence.	Representatives involved in the article include researchers, policymakers, practitioners, and experts in fields related to water, energy, food security, and sustainable development. Stakeholders from government agencies, international organizations, NGOs, academia, and the private sector contribute insights into the evolution and implementation of the WEF nexus framework. Their perspectives inform discussions on the challenges, opportunities, and implications of adopting an integrated approach to address interconnected resource challenges. The article aims to provide valuable insights for decision-making and policy development in the context of sustainable development goals and resource management.
Simpson, G. B., Badenhorst, J., Jewitt, G. P., Berchner, M., & Davies, E. (2019). **Competition for land: the water-energy-food nexus and coal mining in Mpumalanga Province, South Africa. Frontiers in Environmental Science, 7, 86.**	The article discusses the interconnectedness of energy, food, and water security in Mpumalanga Province, South Africa, emphasizing the implications of coal mining on food security and water resources. It highlights the province's significance as a	The article targets policymakers, regulators, NGOs, industry stakeholders, researchers, and the public interested in energy, food, and water security issues, particularly in Mpumalanga Province, South Africa. It appeals to government officials,	The article employs a combination of literature review, case study analysis, and conceptual framework application to explore the interconnected nature of energy, food, and water security in Mpumalanga Province. It draws on existing	Representatives involved in the article include policymakers, regulators, NGOs, industry stakeholders, researchers, and community members in Mpumalanga Province, South Africa. Stakeholders from various sectors, including government,

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	major coal supplier and its abundant arable land, indicating potential conflicts between energy production and food security. The article argues that water availability and quality in Mpumalanga are under pressure due to mining and agricultural activities, leading to trade-offs among energy, food, and water security. It proposes the water-energy-food (WEF) nexus as a framework to evaluate resource security comprehensively and advocates for integrated policymaking to achieve sustainable development goals.	environmental organizations, mining companies, agricultural associations, academia, and local communities affected by resource extraction and land use changes in the province. Individuals and organizations engaged in sustainable development initiatives and interested in interdisciplinary approaches to addressing resource challenges will find the article relevant.	research, policy documents, and empirical evidence to illustrate the impacts of coal mining on food security and water resources. The WEF nexus framework is utilized to provide a holistic understanding of resource security challenges and identify potential solutions. The article advocates for the integration of WEF nexus science and data into public policy to address the complex issues facing Mpumalanga Province.	environmental advocacy groups, mining companies, agriculture, and academia, contribute perspectives on resource security challenges and potential solutions. The article aims to inform decision-making processes and advocate for integrated approaches to address energy, food, and water security issues in Mpumalanga Province.
Simpson, G., & Berchner, M. (2017). **Water-energy nexus-Measuring integration: towards a water-energy-food nexus index. Water Wheel, 16(1), 22–23.**	The article discusses the interconnectedness of water, energy, and food sectors and proposes the development of a Water-Energy-Food (WEF) nexus index to measure integration and sustainability across these sectors. It emphasizes the interdependencies and trade-offs among water, energy, and food resources and highlights the need for coordinated management strategies. The article argues that existing sector-specific indicators lack consideration of the nexus dynamics and proposes a composite index to assess the performance of the WEF nexus comprehensively. The proposed index aims to provide a quantitative measure of the nexus's sustainability and facilitate comparisons across cities, regions, or countries.	The article targets researchers, policymakers, practitioners, and stakeholders involved in water, energy, and food security, as well as sustainable development. It appeals to academics, government officials, international organizations, NGOs, and industry representatives interested in integrated resource management and policy formulation. Individuals engaged in addressing complex challenges at the intersection of water, energy, and food sectors will find the article relevant and informative.	The article employs a conceptual and analytical approach to explore the concept of the WEF nexus and propose the development of a composite index. It draws on existing literature, reports, and data from organizations such as the World Bank and United Nations to identify sector-specific indicators and assess their limitations. The article presents a rationale for the need for a quantitative WEF nexus index and outlines the methodology for its development. It discusses the potential applications of the proposed index in assessing sustainable development progress and testing mitigation scenarios.	Representatives involved in the article include researchers, policymakers, practitioners, and experts in fields related to water, energy, food security, and sustainable development. Stakeholders from government agencies, international organizations, NGOs, academia, and the private sector contribute insights into the challenges and opportunities of integrating water, energy, and food sectors. Their perspectives inform discussions on the development and implementation of the WEF nexus index and its potential implications for decision-making and policy development. The article aims to foster collaboration and interdisciplinary dialogue to address complex resource management challenges effectively.
Sivakumar, B. (2021) **Water-energy-food nexus: challenges and opportunities; Stochastic Environmental Research and Risk Assessment 35:1–2** https://doi.org/10.1007/s00477-020-01927-5(0123456789().,-volV)(0123456789.	The article addresses the pressing challenges related to water, energy, and food security, emphasizing the interconnectedness of these sectors and their implications for socio-economic development and environmental sustainability. It highlights the increasing demands for water, energy, and food due to population growth and improved living standards, as well as the potential threats posed by climate change. The article argues for an integrated approach to address these challenges, focusing on the concept of the Water-Energy-Food (WEF) nexus.	The article is targeted at researchers, policymakers, practitioners, and stakeholders involved in water, energy, and food security, as well as climate change adaptation and sustainable development. It appeals to academics, government officials, international organizations, NGOs, and industry representatives interested in interdisciplinary and multi-disciplinary research on the WEF nexus. Individuals engaged in addressing complex global challenges related to resource management and environmental sustainability will find the article relevant and informative.	The article employs a comprehensive literature review and synthesis approach to consolidate and analyze existing research on the WEF nexus. It draws on a wide range of sources, including academic publications, reports, and data from international organizations. The article identifies key factors influencing the WEF nexus, discusses methodological approaches for modeling its structure and dynamics, and explores its role in assessing socio-economic development and environmental sustainability. Additionally, the article provides guidelines for adaptation and mitigation strategies and proposes an integrated framework for interdisciplinary research on the WEF nexus.	Representatives involved in the article include researchers, policymakers, practitioners, and experts from various disciplines, including water resources management, energy policy, agricultural economics, environmental science, and climate change adaptation. Stakeholders from government agencies, international organizations, NGOs, academia, and the private sector contribute diverse perspectives and expertise to the discussion on the WEF nexus. The article aims to foster collaboration and knowledge exchange among stakeholders working on global resource management challenges, particularly in regions vulnerable to population growth and socio-economic development pressures.
Stats SA (Statistics South Africa) (2021). National Poverty Line: unpublished report: http://www.	Changes in the National Poverty Line and its Implications.	South African Population Living Below the Poverty Line. The findings provide insight	Cost-of-Basic-Needs Approach to Construct National Poverty Lines.	National Poverty Line Values for 2021 in South Africa. For 2021, the Food Poverty

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statssa.gov.za/publications/P03101/P031012021.pdf	The key findings highlight the changes in the National Poverty Line over time and the importance of these adjustments in maintaining the relevance of poverty measures.	into the number of people living below different poverty thresholds in South Africa, as defined by the National Poverty Lines.	The National Poverty Lines are constructed using the cost-of-basic-needs approach, which considers both food and non-food components of household consumption expenditure.	Line is set at R624, the Lower-Bound Poverty Line at R890, and the Upper-Bound Poverty Line at R1,335, providing representative thresholds for assessing poverty levels in South Africa.
The World Bank (2023). **The World Bank in South Africa: The World Bank's strategy in South Africa reflects the country's development priorities and its unique leadership position at sub-regional and continental levels.** https://www.worldbank.org/en/country/southafrica/overview	Impact of Electricity Supply Shortages and Socio-Economic Challenges on South Africa's Growth	• Employment levels remain below pre-pandemic levels, with women and youth disproportionately affected. • Poverty estimated at 62.6 % in 2022, slightly below the pandemic peak. • Inflation averaged 6.9 % in 2022, disproportionately affecting the poorest 20 % of the population.	• Analysis of GDP growth, employment trends, and inflation rates. • Assessment of the impact of electricity supply shortages, COVID-19 pandemic, and rising fuel and food prices on economic and social indicators.	• GDP growth slowed to 1.9 % in 2022 from 4.7 % in 2021. • Employment ratio increased slightly but remained weak at 39.4 % at the end of 2022 and 40.1 % in the second quarter of 2023. • COVID-19 Social Relief of Distress Grant extended until March 2024 to address socio-economic challenges. • Inflation averaged 6.9 % in 2022, with a higher rate of 8.2 % for the bottom 20 % of income earners. These findings provide insights into the impact of electricity shortages and socio-economic challenges on South Africa's growth, employment, poverty, and inflation rates.
van der Berg, S., Patel, L., & Bridgman, G. (2022). **Food insecurity in South Africa: Evidence from NIDS-CRAM wave 5. Development Southern Africa, 39(5), 722–737.**	The section discusses the significance of the fifth wave of the NIDS-CRAM survey results, focusing on household food insecurity and hunger trends in South Africa amid the ongoing COVID-19 pandemic. It highlights the persistently high levels of food insecurity and the need for continued support for vulnerable households, especially those with children.	This section outlines the population under study, which includes households in South Africa surveyed during the fifth wave of the NIDS-CRAM survey. It provides context regarding the survey methodology and the demographic characteristics of the population sampled.	The Methods section describes the research methodology employed in the NIDS-CRAM survey, including data collection procedures, sampling techniques, and statistical analysis methods used to analyze household food insecurity and hunger trends over time.	The Representatives section discusses the implications of the survey findings for policymakers, social welfare organizations, and other stakeholders involved in addressing food insecurity and hunger in South Africa. It emphasizes the importance of targeted interventions to support vulnerable households and mitigate the long-term impacts of food insecurity on children's development.
Van Ittersum, M. K., Van Bussel, L. G., Wolf, J., Grassini, P., Van Wart, J., Guilpart, N., Claessens, L., De Groot, H., Wiebe, K., Yang, H., Boogaard, H., Van Oort, P. A., Van Loon, M. P., Saito, K., Adimo, O., Agali, A., Bala, A., Chikowo, R., Kaizzi, K., . . . Cassman, K. G. (2016). **Can sub-Saharan Africa feed itself? Proceedings of the National Academy of Sciences, 113(52), 14, 964–14969.** https://doi.org/10.1073/pnas.1610359113	The significance of addressing cereal self-sufficiency in sub-Saharan Africa (SSA) by 2050 is crucial on a global scale. Currently, SSA faces a substantial gap between cereal consumption and production, with projections indicating a tripling of demand by 2050, far exceeding other continents. Closing the gap between current farm yields and yield potential is essential to maintain the current level of cereal self-sufficiency, requiring a significant acceleration in yield increase rates. Failure to achieve this acceleration could lead to extensive cropland expansion, biodiversity loss, greenhouse gas emissions, or increased import dependency. While global food demand is expected to rise by 60 % by 2050, SSA faces a disproportionately higher increase due to population growth and rising cereal demand. Meeting this demand solely through yield gap closure on existing cropland may not be feasible, necessitating other forms of	Sub-Saharan Africa (SSA) faces a unique challenge in meeting its future cereal demand due to its rapidly growing population, which is projected to increase 2.5-fold by 2050. This population growth will significantly exacerbate the region's already substantial cereal consumption gap, necessitating urgent measures to enhance agricultural productivity and achieve self-sufficiency.	To assess the feasibility of achieving cereal self-sufficiency in SSA by 2050, a comprehensive analysis was conducted using agronomically robust yield gap analysis for 10 countries in the region. Location-specific data and a spatial upscaling approach were employed to estimate the yield gap and identify potential strategies for intensification.	The findings of this study provide a representative overview of the challenges and opportunities associated with achieving cereal self-sufficiency in sub-Saharan Africa (SSA) by 2050. By focusing on 10 countries in the region and employing rigorous agronomic analysis, the study offers insights into the complex dynamics of cereal production and consumption and highlights the need for urgent action to address the looming food security crisis.

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	intensification such as increasing cropping intensity and expanding irrigated production area. Failure to achieve intensification goals could result in increased reliance on cereal imports or extensive cropland expansion, with significant environmental consequences.			
Wang, H., Huang, J., Zhou, H., Deng, C., & Fang, C. (2020). **Analysis of sustainable utilization of water resources based on the improved water resources ecological footprint model: A case study of Hubei Province, China. Journal of environmental management, 262, 110,331.**	The study addresses the pressing need for sustainable utilization of water resources, a critical issue with global significance. By focusing on the Water Resources Ecological Footprint (WEF), the research aims to enhance understanding of the ecological impact of water resource management practices. The proposed improved WEF model takes into account regional variations in water utilization patterns, providing a more accurate assessment of water consumption and supply dynamics. Through detailed analysis of Hubei Province, China, the study elucidates the spatial and temporal patterns of water utilization, offering valuable insights into the factors influencing water resource sustainability.	The study focuses on Hubei Province, China, which serves as a representative case study area for analyzing the sustainable utilization of water resources. By examining the population dynamics and urbanization levels within the province, the research aims to understand the implications of demographic factors on water resource management and allocation.	An improved Water Resources Ecological Footprint (WEF) model is proposed in this study to account for regional differences in water resource utilization. The methodology involves calculating per capita WEF, Water Resources Ecological Carrying Capacity (WEC), and Water Resources Ecological Pressure Index (WEPI) for each city in Hubei Province for the years 2005, 2010, and 2015. Spatial and temporal patterns of water utilization are analyzed using this model.	The findings of this study provide a representative analysis of water resource utilization patterns in Hubei Province, China, and offer insights into the regional variations in water consumption and supply. By considering factors such as urbanization levels and industrial composition, the study sheds light on the sustainability of water resource utilization across different regions within the province.
Wichelns, D. (2017). **The water-energy-food nexus: is the increasing attention warranted, from either a research or policy perspective? Environmental Science & Policy, 69, 113–123.**	This article critically examines the concept of the water-energy-food (WEF) nexus, which has garnered significant attention in recent years. It questions the novelty and effectiveness of framing water, energy, and food security solely within the nexus approach, highlighting longstanding efforts to integrate research and policy discourse across sectors and regions dating back to the mid-20th century. The article discusses challenges observed in previous initiatives like integrated natural resources management (INRM) and integrated water resources management (IWRM), raising concerns about the feasibility and efficacy of universally implementing a nexus approach. Ultimately, it calls for a critical reassessment of the value and implications of embracing the WEF nexus framework in policy and research.	The population under study includes researchers, policymakers, and practitioners interested in addressing water, energy, and food security challenges. This audience encompasses scholars from various disciplines, government officials, non-governmental organizations (NGOs), and international development agencies working in the fields of agriculture, energy, water resources management, environmental sustainability, and public policy.	The article employs a critical literature review approach to analyze the development and implementation of the water-energy-food (WEF) nexus framework. It synthesizes findings from scholarly articles, policy documents, and reports related to the nexus concept, integrated natural resources management (INRM), and integrated water resources management (IWRM). By critically examining the strengths, limitations, and implications of adopting a nexus approach, the article provides insights into its theoretical foundations and practical applications.	The findings and conclusions drawn in this article are representative of the broader discourse surrounding the water-energy-food (WEF) nexus framework. By synthesizing insights from existing literature and drawing on examples from previous initiatives, the article aims to provide a representative overview of the debate surrounding the nexus approach. While specific case studies and empirical data may vary, the critical analysis presented here offers valuable insights into the complexities and challenges of addressing interconnected water, energy, and food security issues.
Wolde, Z., Wei, W., Kunpeng, W., & Ketema, H. (2020). **Local community perceptions toward livelihood and water–energy–food nexus: A perspective on food security. *Food and Energy Security*, *9*(3), e207.** https://doi.org/10.1002/fes3.207	This article evaluates the effectiveness of the water-energy-food (WEF) nexus approach in addressing resource insecurity and enhancing livelihoods, focusing specifically on its implementation at the local scale. While the WEF nexus approach has shown success at	The target audience for this article includes policymakers, government officials, researchers, and community stakeholders involved in WEF nexus planning and implementation at the local level. By addressing the specific challenges and perceptions observed within local	The article utilizes survey data to assess local perceptions and understandings of the water-energy-food (WEF) nexus within communities in Ethiopia.The study area covers the Gidabo Watershed in Ethiopia, East Africa. Through qualitative analysis, it identifies trends and	The findings and recommendations presented in this article are representative of the broader discourse surrounding the implementation of the water-energy-food (WEF) nexus approach at the local level. While the specific challenges and perceptions may vary

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	the global, national, and transboundary levels, the article identifies several shortcomings in its application at the local level. These shortcomings stem from the unsustainable exclusion and exploitation of nexus resources on an individual basis, as evidenced by survey data collected from local communities. The article argues that community perceptions of the nexus are often skewed towards individual benefits rather than recognizing the interlinkages between water, energy, and food resources. In particular, the centrality of food (agriculture) in local communities highlights a missing link in understanding the connections between water, energy, and food production. Consequently, the article calls for greater efforts from governments and stakeholders to improve WEF nexus security and enhance local community perceptions.	communities, the article aims to inform decision-makers and practitioners working to improve resource security and livelihoods in these contexts.	patterns in how individuals perceive and prioritize nexus resources, particularly focusing on the role of food production in shaping community perceptions. By triangulating survey findings with existing literature and case studies, the article provides a nuanced understanding of the challenges and opportunities for implementing the WEF nexus approach at the local scale.	across different communities and regions, the article sheds light on common issues and barriers that hinder effective nexus planning and implementation. By highlighting the importance of addressing local perspectives and improving stakeholder engagement, the article contributes to ongoing efforts to enhance WEF nexus security and promote sustainable development at the grassroots level.
World Bank Group (2023). ***Overcoming poverty and inequality in South Africa: An assessment of drivers, constraints and opportunities*. World Bank.**	This report provides an assessment of South Africa's progress in reducing poverty and inequality since the end of apartheid in 1994, focusing particularly on the period between 2006 and 2015. It highlights the persistent and increasing levels of inequality in the country, despite efforts to address these issues. The report emphasizes the importance of understanding the intersectionality of poverty, noting that it disproportionately affects black South Africans, the less educated, the unemployed, female-headed households, large families, and children. Additionally, it underscores the spatial dimension of poverty, which remains concentrated in previously disadvantaged areas, reflecting the enduring legacy of apartheid. The report identifies skills and labor market factors as increasingly important in explaining poverty and inequality, presenting an opportunity for policy interventions to influence outcomes.	The target audience for this report includes policymakers, government officials, researchers, and civil society organizations involved in poverty reduction and social development initiatives in South Africa. By providing comprehensive insights into the drivers and manifestations of poverty and inequality, the report aims to inform policy discussions and guide decision-making processes at various levels of governance.	The report employs a mixed-methods approach, drawing on quantitative data analysis, literature review, and qualitative assessments to evaluate poverty and inequality dynamics in South Africa. It synthesizes findings from various sources, including national surveys, academic research, and government reports, to present a holistic picture of the socioeconomic landscape. Through rigorous analysis and interpretation of data, the report identifies key trends, patterns, and drivers of poverty and inequality, providing evidence-based insights for policy formulation and implementation.	The conclusions and findings presented in this report are representative of the broader discourse on poverty and inequality in South Africa. While the specific data and analyses may vary across different studies and reports, the overarching narrative of persistent inequality, spatial disparities, and the importance of labor market dynamics remains consistent. By offering nuanced insights into the complex nature of poverty and inequality in South Africa, the report contributes to ongoing efforts to develop targeted interventions and policies aimed at promoting inclusive growth and social cohesion.
Zara, C., Coles, B., Hadfield-Hill, S., Horton, J., & Kraftl, P. (2022). **Geographies of food beyond food: transfiguring nexus-thinking through encounters with young people in Brazil. Social & Cultural Geography, 23 (5), 715–738. DOI: 10.1080/14,649, 365.2020.1809010.**	This article examines the social, cultural, and political implications of young people's connections with food within the framework of the water-energy-food (WEF) nexus. It integrates contemporary forms of nexus-thinking with interdisciplinary perspectives from food scholarship and childhood and youth studies.	The target audience for this article includes scholars, researchers, and practitioners working in the fields of food studies, nexus-thinking, childhood and youth studies, and social sciences. By engaging with contemporary discourses and methodologies, the article seeks to stimulate interdisciplinary dialogue and	The article employs an interdisciplinary approach, combining ethnographic observations, qualitative interviews, and mixed-methods analysis to explore young people's interactions with the WEF nexus in Brazil. Through detailed descriptions of participants' everyday experiences, routines, and	The findings and insights presented in this article are representative of the lived experiences and perspectives of young Brazilians participating in the research project. While the focus is on a specific demographic group and geographic context, the implications of the study extend to broader discussions

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	The article emphasizes the need for a transfigured nexus-thinking approach that incorporates the everyday experiences, cares, relationalities, and politics of young people. By drawing on ethnographic and mixed-methods research conducted as part of a large-scale project focusing on young Brazilians, the article aims to enrich nexus-thinking with insights derived from lived experiences.	collaboration among researchers interested in understanding the complex intersections between young people, food, and broader socio-environmental dynamics.	perceptions, the article illuminates the complex socio-political dimensions of food-related practices. By grounding its analysis in empirical data, the article provides a nuanced understanding of how young people navigate and negotiate their connections with food within the broader context of the WEF nexus.	about the socio-political dimensions of food security, resource access, and environmental sustainability. By centering the voices and experiences of young people, the article contributes to a more inclusive and socially relevant discourse on nexus-thinking, highlighting the importance of incorporating diverse perspectives in academic and policy discussions.
Zeng, Y., Liu, D., Guo, S., Xiong, L., Liu, P., Yin, J., & Wu, Z. (2022). **A system dynamic model to quantify the impacts of water resources allocation on water–energy–food–society (WEFS) nexus. *Hydrology and Earth System Sciences, 26*(15), 3965–3988**.	This study addresses the urgent challenge of sustainable management of the water-energy-food (WEF) nexus by proposing a new approach that incorporates human sensitivity and reservoir operation into the system. By integrating these factors, the study aims to improve understanding of the interactions between WEF systems and society, thereby enhancing the efficiency of resource management. The study emphasizes the importance of considering human behavior and environmental awareness in modeling the WEF nexus to achieve long-term sustainability.	The target audience for this study includes researchers, policymakers, and practitioners working in the fields of water resources management, energy planning, food security, and sustainability. The study's interdisciplinary approach and focus on the WEF nexus make it relevant to a diverse range of stakeholders interested in addressing the complex challenges associated with resource management and environmental sustainability.	The study employs a system dynamics model to simulate the co-evolution behaviors of the WEF nexus across water, energy, food, and society (WEFS). Reservoir operation is integrated into the model to determine water supply for energy and food systems, while human sensitivity, represented by environmental awareness, is incorporated to adjust the co-evolution behaviors of the WEFS nexus through feedback loops. The proposed approach is applied to the mid-lower reaches of the Hanjiang River basin in China as a case study, using the Interactive River-Aquifer Simulation water resources allocation model to simulate reservoir operation.	The findings and insights presented in this study are representative of the interactions and dynamics observed within the WEFS nexus, particularly in the context of the Hanjiang River basin in China. By focusing on a specific geographic area and incorporating local socio-environmental factors, the study provides valuable insights into the challenges and opportunities for sustainable resource management. The results contribute to a better understanding of how human behavior and environmental awareness influence the dynamics of the WEF nexus, with implications for policy and decision-making at local, regional, and global scales.

Data availability

Data will be made available on request.

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