

## WEF NEXUS

### Breaking the silos: WRC's WEF nexus research transforms policy and practice

*South Africa has quietly emerged as a global thought leader in one of the world's most urgent conversations: how to secure the future of water, energy, and food. At the centre of this effort is the Water Research Commission (WRC), which has spent more than a decade pioneering the water–energy–food (WEF) nexus approach, a transformative way of tackling interconnected challenges that threaten livelihoods, economies, and ecosystems. Article by Sylvester Mpandeli, Stanley Liphadzi, and Luxon Nhamo.*



Research on the WEF nexus gained momentum in 2011 following the Bonn 2011 Conference, where it was introduced by the Stockholm Environmental Institute (SEI) (Hoff, 2011). This marked the realisation that the current exploitation and silo-based management of the three sectors was unsustainable, as resources were depleting and degrading at an alarming rate (UNGA, 2015). The SEI provided initial evidence on how the WEF nexus can improve water, energy, and food security by enhancing efficiency, reducing trade-offs, building synergies, and strengthening governance across sectors.

The SEI report (2011) also recommended policy harmonisation. Consequently, there was a consensus among world leaders and researchers to shift from the existing linear economic model to a systematic, transformative, and holistic approach that

fosters sustainable development (UNGA, 2015). Alongside other research institutions, the WRC, with its partners, started engaging in WEF nexus research, contributing to the global transformation agenda and discourse. While the WRC had been promoting integrated approaches before this time, such as integrated water resources management (IWRM), the focus now shifted towards the more polycentric WEF nexus in line with global trends.

In 2012, the WRC established the WEF Nexus Lighthouse, a flagship research, development and innovation programme encompassing all WRC research themes to oversee work on the WEF nexus in South Africa. Several research projects across these themes are aligned with the WEF Nexus Lighthouse, following a structured research pathway to guide resource management, decision-making, and policy.

This article details how the WEF nexus has evolved and highlights the WRC's role in holistically addressing diverse societal and environmental challenges through the WEF nexus. It also emphasises the progress made by WRC and its partners in transforming the WEF nexus from theory to practice, as exemplified by developing conceptual or discursive frameworks and transforming them into practical analytical decision-support tools. Policies influenced by the WEF nexus WRC-funded projects have enhanced livelihoods and advanced sustainable socio-economic development, contributing towards the realisation of the 2030 Global Agenda on sustainable development (Nhamo et al., 2025).

To date, the WRC has funded over 40 WEF nexus research projects, and its research managers are actively contributing to the research and publishing articles in internationally peer-reviewed journals. WEF research findings have provided local solutions with a global impact. Notably, the WRC-funded research has defined WEF nexus indicators, developed a WEF nexus analytical model, and applied the theory of change as a process to operationalise the WEF nexus (Nhamo et al., 2020). The results have benefited South Africa and have had substantial global influence, as evidenced by the high number of citations of its WEF nexus-related publications (Cho et al., 2023). South Africa and the southern African region are now recognised as global thought leaders in WEF nexus research, development, operationalisation, and implementation.

Through a bibliometric analysis, the article demonstrates the progress made in implementing and operationalising the approach. This was achieved through an impact research approach that assessed the contribution of the WRC in WEF nexus research. The data were obtained from the Scopus database (Figure 1). The focus was from 2012 to 2025, which witnessed a surge in WEF nexus research and innovations.

### Milestones in WEF nexus research in South Africa

The WRC-led research on the WEF nexus reveals a clear evolution, where early work primarily involved literature reviews, framing the approach as a conceptual framework and discourse tool. However, recent research has transitioned towards developing the approach into an analytical and operational framework. Initial WEF nexus studies, funded by the WRC, successfully presented the approach as a conceptual model that simplifies human understanding of the complex connections among WEF sectors and promotes coherence in

policy-making, thereby supporting sustainable development (Mpandeli et al., 2022). Several publications and reports from this period highlight the WRC's contribution to the WEF nexus and introduce innovative products that encourage transdisciplinary, transformative, and integrated research globally (Cho et al., 2023). Driven by the challenge of transforming the WEF nexus into a practical, evidence-based operational framework, the WRC has since developed WEF nexus analytical models and harmonised policy frameworks to facilitate coherent policy decisions for sustainable development.

### Bibliometric analyses by author, country, and institution

The top five countries leading in the WEF nexus are China, the United States of America, South Africa, Germany, and Brazil, with South Africa occupying the third position. Only three of the BRICS countries, namely China, South Africa, and Brazil, are within the top ten countries. South Africa and Egypt are the only African nations in the top twenty. These findings align with a study conducted at the University of Pretoria in 2023, which identified South Africa, the WRC, and its research managers as among the top contributors to WEF research worldwide (Cho et al., 2023). The WRC has largely funded South Africa's WEF nexus research for the past twelve years. The WRC and its partners have produced numerous research articles and reports on the WEF nexus across various spatial scales, including households, catchments, local municipalities, provincial, national, and regional levels. In collaboration with the National Research Foundation (NRF), the WRC has invested significant financial and human resources to support research on the WEF nexus and other transformative initiatives.

While the South is doing well, the bibliometric analysis found that a lack of funding hinders research growth in the rest of Africa, along with inadequate institutional support, a lack of collaboration networks, poor research priorities, and low human capacity development. These challenges are compounded by low self-motivation, limited research capacities and self-efficacy, and a burdensome workload (Cho et al., 2023). However, South Africa seems to have overcome these challenges, leading in multiple collaboration publications (MCPs) (Figure 2), indicating a significant level of researcher collaboration within Africa and internationally. However, there is still a significant amount of single-country publications (SCP).

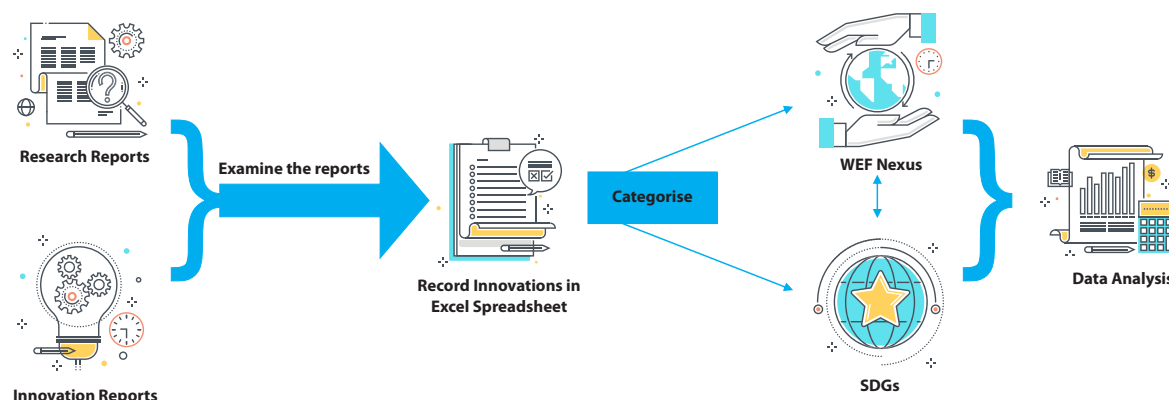


Figure 1. An analysis of the search process used to collect WEF nexus research outputs.

Cho et al., 2023)

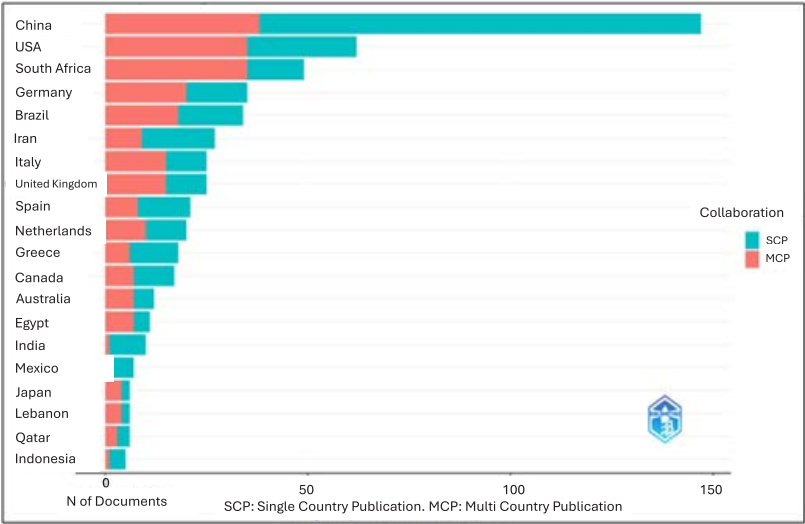


Figure 2. Country contribution to WEF nexus research.

Cho et al., 2023)

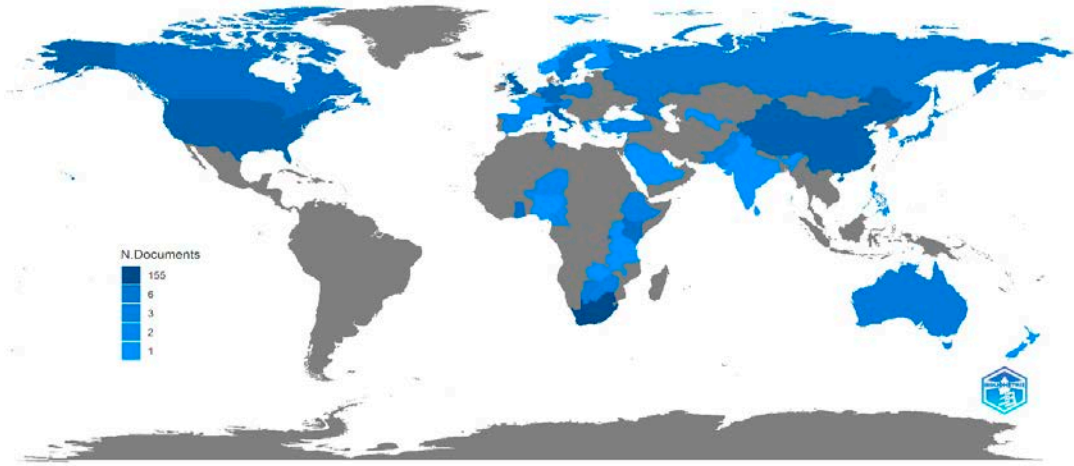
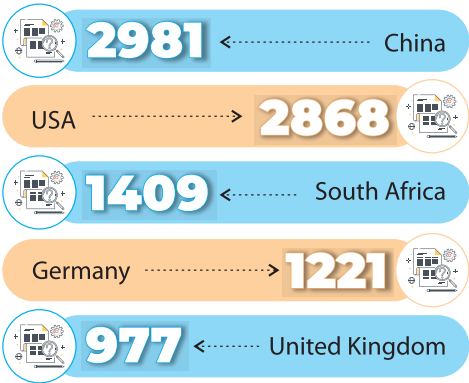


Figure 3. Country specific WEF Nexus publication productivity.

The heat map shown in Figure 3 supports Figure 2 regarding country-specific WEF nexus research publication productivity, where South Africa compares itself with the United States of America and China. The dark colour indicates countries with the highest publication productivity, while the lighter shades show decreasing levels. Countries coloured grey have no publication productivity at all or no publications discoverable/indexed in the academic databases.

As a water-scarce country, South Africa needed to invest in research that promotes water use efficiency, especially considering the recurrence of drought events, among other extreme weather events, in the country. Extreme weather events significantly affect climate-sensitive agriculture, water, and energy sectors, which are the key WEF nexus sectors. In addition, the country’s National Development Plan (NDP) goals are linked to the global sustainable development goals. The country is obligated to achieve both the NDP goals and the SDGs by 2030. As a result of the financial resources invested in WEF nexus research, South Africa ranks third among the countries with the most WEF nexus publications worldwide (Figure 4).

The top five countries in terms of the number of WEF nexus publications:



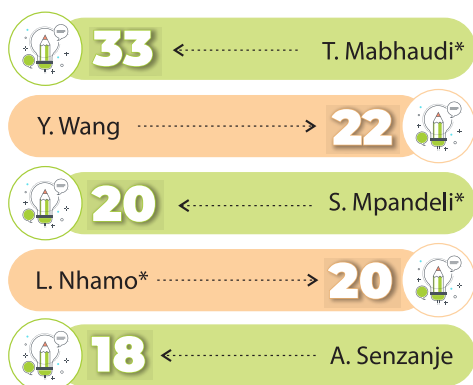
China and the United States exceed South Africa in total citations because these countries are more developed and have more resources for research funding. South Africa remains the only African nation in the top ten for the most cited countries. Globally, researchers from South Africa are among the top five in publication volume, making a significant contribution to the WEF nexus body of knowledge (Figure 5). South African authors

Cho et al., 2023

have taken on the role of promoting the African perspective and encouraging research collaboration among African scholars in WEF nexus research. The ten most published South African authors, listed in order of merit, include T. Mabhaudhi, S. Mpandeli, L. Nhamo, A. Modi, D. Naidoo D., and A. Senzanje, all supported and funded by the WRC.

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### Top five most relevant authors in WEF nexus research in the world in 2025.

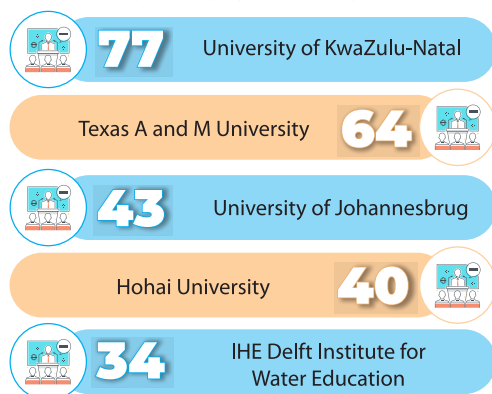


\* South African authors

In terms of the most WEF nexus research published by institutions in the world, the University of KwaZulu-Natal (UKZN) is topping the list, with 77 publications. South Africa has two other institutions in the top ten, namely the University of Johannesburg (UJ) and the University of Venda (UNIVEN). These South African institutions are mostly funded by the WRC. The results further confirm that the WRC made the right decision by investing in the WEF nexus. As the WRC, we believe that we need more universities, science Councils and NGOs to be actively involved in the WEF nexus, not only in South Africa, but across the African continent.

Cho et al., 2023

### Top five WEF nexus research published institutions in the world.



### Conclusions and recommendations

This article reviews how countries have performed in WEF nexus research over the past decade. WEF nexus research is vital for shaping the global transformation agenda and achieving the SDGs, especially as key resources continue to decline and deplete due to various drivers of global change, including climate change, rapid urbanisation, and growing population numbers.

The article emphasises the contributions of researchers from

South Africa in WEF nexus research and global change. Currently, authors from South Africa are leaders in this field. A unified effort within and across WEF sectors is necessary to address the increasing challenges of resource insecurity. An expanding body of innovative solutions, created by the WRC, aims to tackle water, energy, and food shortages. Although the WRC has been pioneering WEF nexus research globally, its cross-sectoral and comprehensive adoption remains slow. Nevertheless, this approach is essential for tackling humanity's grand challenges and realising the SDGs. Developing a research agenda to guide WEF nexus research, development, and innovation is a fundamental part of the WRC's strategy to fund focused initiatives that broaden the evidence base, showcase the WEF nexus through pilot studies, and incorporate research outputs into national policy.

This article traces the development of WEF nexus research and innovation in South Africa and highlights the influence of the country's researchers on the field. The WRC primarily funds this research in South Africa, driven by the recognised importance of the WEF nexus in tackling national and regional priorities, such as resource insecurity, rising poverty and inequality, increasing unemployment, and urbanisation. WRC-funded WEF nexus research has produced innovations that support the transformational agenda. As a result, WRC research has transitioned from a purely theoretical approach to a practical, operational decision-support tool.

Notably, it includes creating an integrated and analytical WEF nexus model that simplifies understanding the complex linkages among WEF resources, demonstrating how resources are managed and identifying priority areas for intervention. These innovations have provided evidence and spurred policy changes to facilitate the shift from a linear to a circular economic model. However, further research is necessary to develop context-specific scenarios that reduce uncertainty caused by current sector-based and linear resource management approaches.

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