Meeting global challenges with coherent policies producing more researchers

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Abstract

Sustainable Development Goal 9 encourages building resilient infrastructure, fostering innovation, and promoting sustainable infrastructure by significantly increasing the number of researchers. Using Zimbabwe as a typical developing country, we analyzed ten continental, five regional, five national, and 32 sectoral science policies on their commitment to increasing the number of researchers. Our results showed that while the African Union urged member states to increase their number of researchers, the Southern African Development Community and most government departments in Zimbabwe largely ignored this recommendation. Interestingly, the national science, technology, and innovation policies in Zimbabwe have adopted the African Union guidelines. Our results suggest a lack of coordination between government departments in Zimbabwe. We propose a policy framework for increasing the number of researchers that fosters multilevel and multisectoral policy coordination, provides a link between policymakers and researchers, and promotes regional integration.

1 Introduction

To meet global challenges, developing countries must increase their research capacity, transition from being research consumers to research producers, and base their policies and practices on sound scientific evidence (Cooke et al. 2018). This is challenging because developing countries have low research funding (< 0.5% of their gross domestic product), few research personnel (less than 60 researchers per million inhabitants), and poor research infrastructure (Kahn 2022). While a few indigenous researchers can provide immediate solutions to global challenges by facilitating the adoption of frontier technologies developed abroad, overreliance on adoption/adaption of frontier technologies is not a viable approach for building a sustainable research base that can address future challenges (Harris 2004). Therefore, new and more indigenous researchers are needed to strengthen developing countries’ ability to define their own problems; identify priority areas; set objectives; conduct sound research; establish sustainable research infrastructure; and develop innovative products, processes, and concepts that promote social, economic, and environmental development.

Increasing the number of researchers per million inhabitants (researcher density) is essential to meet global challenges (Hintringer et al. 2021). This is probably because when many researchers address a common problem, they tend to differentiate themselves by searching for theories from other disciplines, which leads to the development of novel concepts, theories, and processes (Rothman et al. 2001). A recent global study found that research activity, as measured by research density, is an excellent predictor of economic growth over time (Cabello et al. 2016). In the health sector, a global study showed that increasing the number of health researchers in a country is associated with a decrease in disease burden due to an increase in health innovations (Wen et al. 2022). Similarly, the number of energy researchers in a country has been shown to be a key determinant of a country’s productivity in green innovation, with the number of patents correlated to the number of energy researchers (Yang et al. 2022). A recent study in South Korea that compared the applicability of R&D investment, number of people with tertiary education, number of patents by non-citizens, number of patents by citizens, and researcher density found that the last two quantifiable factors were better indicators of innovation (Hintringer et al. 2021). Therefore, researcher density is used as an indicator of science, technology, and innovation (STI) development in the Sustainable Development Goals (SDG Indicator 9.5.2) and OECD members (OECD 2021).

It has been proposed that researcher density in developing countries can be improved by increasing research funding, building continental research networks, and incentivizing researchers abroad to return to their country of origin (Atickem et al. 2019). There is evidence that investing in R&D can increase economic growth; however, successful R&D requires increasing researcher density. In addition, while continental research networks and returning researchers are helpful for knowledge transfer, they are not feasible for building a sustainable pipeline to train new researchers at the national or regional level. However, the scarcity of researchers in developing countries is often associated with political instability, poor governance, and lack of political will. These three issues can best be addressed by developing STI policies that outline procedures, guidelines, processes, and actions to increase researcher density at continental, regional, national, and sectoral levels.

To build resilient infrastructure, foster innovation, and promote sustainable infrastructure, synergies are required at different governance levels and between sectors to increase researcher density. This study seeks to answer the following question: Are STI policies in developing countries coherent with the goal of meeting global challenges by increasing researcher densities at national, regional, and continental scales? We answer this question by examining interlinkages in commitment to increasing researcher density across governance levels, that is, continental (African Union, AU), regional (Southern African Development Community, SADC), and national (Zimbabwe) levels, and assessing for consistency, coherence, and congruence in: (i) the Sustainability Development Goals and STI policies in Africa; (ii) the international objectives and national contexts; (iii) the actions proposed by diverse stakeholders; and (iv) social, economic, and environmental policies issued by different sectors or governance levels (OECD 2016). Finally, we proposed a framework for developing coherent and consistent STI policies across sectors and governance levels.

2 Methods

2.1 Case selection

We used an exploratory typical case-selection technique to assess political commitment to increasing researcher density in developing countries at multiple policy levels (Seawright and Gerring 2008). Zimbabwe was selected as a representative case for developing countries because the state of its research infrastructure, macro-economics, political outlay, and global relations are similar to those of most developing countries. Zimbabwe is a landlocked developing country in Southern Africa with a population of approximately 13 million people. It is a member state of the SADC and AU. Between 1990 and 2019, Zimbabwe’s annual gross domestic product per capita marginally increased from $1,300 to $1,464 (United Nations Statistics Division 2021). National research frameworks and science policies are generally underdeveloped and are currently undergoing extensive reform. In 1986, the Research Act

(Chap. 10:22) facilitated the establishment of the Research Council of Zimbabwe, which was mandated by the government on matters regarding sustainable development. Although Zimbabwe has a national science, technology, and innovation policy, currently, there is no functional national research funding body (Sanganyado 2021).

The Ministry of Higher and Tertiary Education, Innovation, Science, and Technology Development conducted a national critical skills audit report that showed a severe shortage of at least 90% high-skilled talent in the science and technology sectors (MHTESTD 2019). However, research professionals were not included in the critical skills category, even though they were considered crucial indicators of SDG 9 (United Nations General Assembly 2017). In 2012, the researcher density in Zimbabwe was 95 (full-time equivalent (FTE)), with 2,511 working in universities and 228 in the government (Hodgkinson and Pasirayi 2015). Between 2009 and 2016, agricultural researcher density increased by 21.9%, probably due to economic stabilization following the formation of the Government of National Unity (Fig. 1). The proportion of researchers with a PhD in the government sector remains low and unchanged (9%). This low researcher density has drastic consequences for the implementation of STI policies and overall attainment of global challenges. However, no annual updates on researcher density have been reported by the Zimbabwe National Statistics Agency since 2012.

2.2 Data

We used qualitative text analysis to assess vertical and horizontal policy coherence in STI policies, which targeted increasing researcher density, issued between 2002 and 2021 at the continental (AU), regional (SADC), national (Zimbabwe), and sectoral (AU, SADC, and Zimbabwe) levels. Analyzing STI policies over two decades allowed us to investigate the absorbance of continental and regional policy recommendations in national and sectoral policies over time. We used this as a possible indicator of the trickling-down of STI policies from the top governance level. Four types of data were used to analyze science policies to increase researcher density in the AU, SADC, and Zimbabwe: (i) publicly available government STI policies and parliamentary bills; (ii) science, technology, and innovation monitoring data from international organizations (i.e., the African Union (AU) and Southern African Development Community (SADC)); (iii) case studies and reports on coordination mechanisms; and (iv) data on overall researcher densities (http://data.uis.unesco.org/) and industry-specific research densities (International Food Policy Research Institute 2021). These sources offer a relatively objective perspective on STI policies in Africa, Southern Africa, and Zimbabwe. This allowed us to identify the challenges and opportunities to increase the number of researchers and develop a comprehensive framework. Detailed information on the objectives and website links to continental, regional, national, and sectoral STI policies are provided in the dataset deposited by Sanganyado et al. (2022).

2.3 Policy analysis

We measured policy consistency based on the presence (and clarity) of a specific policy goal to increase researcher density in the STI policies. The policy goals were ranked as *explicit* if they clearly stated that the number of researchers needed to be increased, *implicit* if they focused on increasing the training activities of the STEM workforce, and *absent* if no such goal was stated. Considering that the STI policies studied were issued internally (within Zimbabwe at the national or sectoral level) and externally (at the regional and continental levels), ranking policy goals made it possible to assess horizontal and vertical policy coherence. Policy congruence occurs when external or internal bodies attend to the same policy goal within the same timeframe. Therefore, to assess policy congruence, we apportioned the STI policies into three categories according to the time they were issued: pre-second STI policy (Mugabe era), post-second STI policy but prior to the Mnangagwa era (transition period), and during the Mnangagwa era. The frequencies of implicit and explicit policy goals within each period were used as an indication of policy congruence.

3 Results And Discussion

3.1 Internal policies

The total attention spent on increasing researcher density as a policy goal across different sectors varied significantly with the policy theme and political era (Table 1). Of the STI policies issued in the period spanning the issuing of the first and second STI policies, only communication and health policies implied or explicitly stated that researcher density had to increase. Ten policies were issued within the health theme, of which three, five, and two were issued during the Mugabe, transition, and Mnangagwa eras, respectively. The proportion of health policies that at least implied that researchers should increase in each period was 33.3%, 80%, and 0%, respectively. Considering that commitment to increasing researcher density was only implied in both the first and second STI policies, the high proportion of health policies (60%) explicitly stated that the policy goal in the transition period may not be attributed to the second STI policy. In 2012, Zimbabwe had the lowest number of full-time equivalent health researcher density (0.2 compared with 1,158 in Singapore) (https://www.who.int/observatories/global-observatory-on-health-research-and-development/indicators/health-researchers-in-full-time-equivalent-per-million-inhabitants-by-who-region-first-set-of-charts). It is possible that this damaging statistic helped increase attention to health researcher density. No such increase in attention was observed over the 20-year period for other policy themes, including climate change (n = 5, only one implied the policy goal) and transport and energy (n = 4, only 1 implied the policy goal). However, during the Mnangagwa era, only one policy (climate change policy) out of the 13 issued implied or explicitly started the researcher-density policy goal. The lack of attention on the policy goal during the Mnangagwa era at the horizontal internal level could be attributed to its absence in vertical internal policies. This disregard of researcher density was more evident in National Development Strategy 1 (2021–2025), which despite being research-centric focused primarily on intensifying research and development and establishing research infrastructure in different sectors such as agriculture and health, did not identify increasing researcher density as a national priority. This emphasis on establishing more research centers without a corresponding drive to increase researcher density could lead to infrastructural white elephants and ghost institutions because of the shortage of aptly skilled researchers. However, by recommending the establishment of a framework to ensure that researchers received competitive renumeration, recognition, and rewards, National Development Strategy 1 aligned with AU's Agenda 2063.

3.2 External policies

The AU Agenda 2063 explicitly stated that its member states should increase their number of researchers in the Science, Technology, and Innovation Strategy for Africa 2024 (STISA-2024). The STISA-24 built upon the AU Agenda 2063 which seeks to "catalyze education and skills revolution and actively promote science, technology, research, and innovation, to build knowledge, human capital, capabilities and skills to drive innovations and for the African century" (African Union Commission 2015). Through STISA-24, the African Union acknowledged that improving its research infrastructure and technical skills was a precondition for meeting global challenges (African Union Commission 2020). A recent study found that Africa contributed only 2.62% of global research output between 2015 and 2019 (Pandita and Singh 2022), a marked increase from approximately 1.0% in 2005 (Diop and Asongu 2022). This is probably because the African continent has less than 198 researchers compared with the global average of 1,150 researchers (Christoffels 2018). For this reason, the AU agreed to assist member states by equipping new scientists and researchers with (i) funding through initiatives such as the African Union Research Grants and the African Union Commission/United States Department of Agriculture Scientific Exchanges Program; (ii) training programs such as the Pan African University and Global Monitoring for Environment and Security and Africa Union (GMES and AU) Support Programme; and (iii) research infrastructure such as the Africa Pathogen Genomics Initiative. However, these initiatives have marginally helped in increasing researcher density across Africa; for example, GMES and AU trained only 4,932 participants in Earth observation with an 18 million USD budget since its inception, (GMES and AU 2021) while Pan African University had only 254 PhDs in 2019 candidates despite its 22 million USD budget (Pan African University 2020). This is probably because the AU relies heavily on external funding, such as the USA, the European Union Commission (GMES and AU 2021), and the Bill and Melinda Gates Foundation (Makoni 2020), which have their own priorities, other than increasing researcher density. Unfortunately, the AU did not set a target researcher density for its member state. This could have contributed to the lack of evaluation of changes in researcher density among AU member states in the past two reports on the progress of agenda 2063.

Promoting the mobility of researchers within SADC could help member states gain access to critical research skills, establish collaborations, and promote knowledge transfer, which are essential for meeting global challenges (MacHáček et al. 2022). However, the SADC does not have guidelines on how member states can cooperate to increase the number of researchers within the trading bloc. The SADC completely overlooks the importance of researcher density in Vision 2050. A word analysis of SADC Vision 2050 shows that the word 'science' or 'research' is mentioned only three times out of the 2,036 words in the document. This was a major negative development considering the SADC Industrialization Strategy and Roadmap 2015–2063 implicitly stated that its member states should increase the number of scientists and explicitly, women. The action plan proposed in 2017 focused on research infrastructure development, particularly the establishment of centers of excellence and restructuring curricula to emphasize science, technology, and innovation. The SADC Regional Indicative Strategic Development Plan (RISDP) 2020–2030 carried the same theme of increasing access to science, technology, and innovation education without explicitly stating the need to increase researcher density. Overall, while the SADC protocols and strategic plans align with AU's Agenda 2063, they do not provide exemplary leadership to promote academic mobility by explicitly stating that increasing regional researcher density is a goal expedient for meeting global challenges.

4 Proposed Policy Coherence Framework For Meeting Global Challenges

The lack of policy congruency in Zimbabwe was probably due to the lack of a national framework or platform for creating STI policies that connected national development strategies and regional integration plans to sectoral policies (Mbanda and Fourie 2020). We propose a policy framework that follows the guidelines developed in OECD (2017) to meet global challenges by promoting national, regional, and international cooperation, policy alignment, and integration, as discussed below (Fig. 2). Additionally, we modified the elements of policy coherence proposed by (Curran et al. 2018) to include research funding agencies, a proposed National Science and Technology Council, and a regional council of ministers to ensure horizontal and vertical policy coherence, as discussed in the following subsections.

4.1 Political commitment and long-term vision

Meeting global challenges depends on the political will of the government and the regional leaders. Political leaders can demonstrate their commitment by engaging with diverse stakeholders, including business and industry sectors, civil society, and academic bodies (e.g., the African Academy of Sciences, Zimbabwe Academy of Sciences, and Zimbabwe Young Academy of Sciences) to develop clear and measurable policy objectives (Clegg and Boright 2009). In 2000, the European Union initiated the European Research Area to improve Europe's global competitiveness by increasing the density and mobility of researchers (Cañibano et al. 2020). As a result, researcher density in Europe increased from 2,467 to 3,704 between 2000 and 2020 (**Fig. 3**). At the regional and continental levels, we recommend the establishment of an African Research Area that seeks to increase the researcher density across Africa from 98 to, at least, above the global average (i.e., 1,342). To achieve this, a clear financial commitment needs to be made at the continental, regional, and national levels, for example, setting aside at least 1.0% of the gross domestic product for research and development. In addition, there is a need to establish a continental, regional, and national research funding agency responsible for coordinating the acquisition and distribution of research funds (Sanganyado 2021). No such independent organization exists in Africa, SADC, and Zimbabwe.

4.2 Policy Coordination and Integration

Current policy coordination mechanisms in the African Union, SADC, and Zimbabwe rely on external coordination, whereby governments have autonomy in policy direction, while other stakeholders have little input (Table 2). The African Union and SADC have high coordination because the councils, committees, and agreements for STI policy coordination are based on a shared vision and long-term goals. Both organizations have an STI council that coordinates the STI policy-making processes. No such council exists in Zimbabwe, and this probably accounts for the low and atomistic policy coordination across the Zimbabwean sectors. To ensure that increasing researcher density is consistently and coherently embedded within all pertinent policies, Zimbabwe needs to establish a National Science and Technology Council at the cabinet level, similar to that in Namibia, Uganda, Kenya, Rwanda, and Zambia (Chataway et al. 2019). Unlike the Research Council of Zimbabwe, which focuses on coordinating research activities in Zimbabwe, the National Science and Technology Council engages and coordinates with different government ministries to ensure that the STI policies issued in Zimbabwe align with the SDGs. The National Science and Technology Council can also provide advice to the president of Zimbabwe, ensuring that long-term visions are grounded in sound scientific evidence. Additionally, the AU and New Partnership for Africa's Development established the African Ministerial Council on Science and Technology (AMCOST) in 2003 as a platform for coordinating the ministries of science and technology across Africa. However, coordination between ministries should extend beyond ministries' science and technology and foreign affairs to other ministries, local authorities, and institutions to avoid policy silos and incoherencies (Magro et al. 2014). To improve policy coordination and integration across various sectors, a recent study recommended identifying synergies and interconnections between sectors, evaluating core compatibility objectives, and aligning activities to the core objectives (Rasul and Neupane 2021).

4.3 Local, regional, and multi-stakeholder participation

The successful implementation of STI policies relies on synergistic interlinkages between national, regional, and sectorial goals. As recommended by the OECD, national STI planning and implementation committees, including the National Science and Technology Council, should not subjugate local and regional autonomy (OECD 2017). Thus, there is a need to create an independent platform for collecting inputs and feedback from multiple stakeholders. The platform should have at least one member with voting rights to the National Science and Technology Council. The local, regional, and private sectors are responsible for implementing researcher-density policies; thus, they need governmental support to ensure the long-term success of the vision. The Zimbabwean government should offer incentives to subnational, business, and industry actors to train, fund, or provide work opportunities to new researchers. For example, businesses or local authorities that partner with and fund local higher education institutions for training research and development staff could be offered a tax break.

4.4 Monitoring, evaluating, and assessing policy impacts

Science, technology, and innovation indicators such as researcher density can play a critical role in the formulation and implementation of STI policies in Africa (Siyanbola et al. 2016). For this reason, the African Union adopted NEPAD's African Science, Technology, and Innovation Indicators Initiative for monitoring, evaluating, and assessing STI policy impacts across the continent. In 2002, in the National Research and Development Strategy, South Africa identified researcher density as a key STI indicator for assessing the performance of national STI systems, the progress of short- and long-term plans, and benchmarking with other countries (Manyuchi and Mugabe 2018). Importantly, using researcher density enabled South Africa to set targets to increase the proportion of black and female researchers in the workforce. In contrast, while Zimbabwe obtained funds for conducting ASTII surveys in 2008, only a pilot survey was conducted, with unavailable results (AUDA-NEPAD 2022). At present, ZimStat is responsible for measuring and monitoring STI indicators, but no researcher density results have been reported since 2012. We recommend the establishment of a member within the National Science and Technology Council dedicated to monitoring and reporting STI indicators. At present, STI indicators, including researcher density, are not used as scientific evidence in policymaking, which could be the reason for the rampant inconsistencies and incoherencies.

5 Conclusion

Science, technology, and innovation are the main drivers of global economic growth and social progress. Developing countries, including Zimbabwe, require multiple policies from different sectors that are critically aligned to meet the global challenges. Our study shows that, between 2002 and 2021, several policy instruments from various sectors, such as energy, water, health, and industry, were published to leverage science, technology, and innovation in development. However, there was a lack of coherence and harmony among the policies at the national, regional, and continental levels regarding increasing researcher density, which may hinder the attainment of sustainability development goals. Additionally, the science policies at the continental, regional, and national levels analyzed in this study envisioned Africa as a knowledge consumer rather than a knowledge creator. It appears that these policies assumed that basic and applied research conducted outside Africa could be translated into feasible solutions to African problems. Success in science and technology requires intentional investment in attracting and developing creative, innovative, and committed talent while simultaneously building a conducive research infrastructure. Hence, increasing the number of researchers per million inhabitants from 90 to at least 1200 (comparable to that in high-income countries) by 2030 should be a national priority. This can be achieved by creating clearly defined opportunities for Zimbabwean researchers in the diaspora to participate in national research. However, increasing the participation of the scientific diaspora without adequate skills retention and recognition infrastructure may only offer a temporary opportunity to increase the number of researchers, since push factors such as lack of political and economic stability continue to prevail in developing countries. Future studies are required to examine the role of political reform in fostering science, technology, and innovation as drivers of economic change.

Declarations

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Ethical Compliance: All procedures performed in this study did not involve human participants, and thus study was exempt from the ethical standards of institutional and/or national research committees and adhered to the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

Conflict of Interest declaration: The authors declare that they have NO affiliations with or involvement in any organization or entity with any financial interest in the subject matter or materials discussed in this manuscript.

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Tables

Tables 1-2 are available in the Supplementary Files section.

Figures

Figure 1

The total agricultural research and development spending in Zimbabwe as a percentage of the agricultural output (AgGDP) and the total agricultural researchers in full-time equivalents between 2000 and 2016 (International Food Policy Research Institute 2021).

Figure 2

A proposed framework for developing coherent policies based on the eight OECD principles for fostering policy coherence (A-H) (modified and reprinted with permission of the copyright holder, Curran P, Dougill A, Pardoe J and Vincent K. (2018) Policy coherence for sustainable development in sub-Saharan Africa, London: Grantham Research Institute on Climate Change and the Environment and Centre for Climate Change Economics and Policy.

Supplementary Files

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