9. Mapping Research Systems in Kenya, Tanzania, and Rwanda and their Relation with the Sustainable Development Goals

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9.1. Introduction

Scientific research is a critical ingredient to develop knowledge-based economies where knowledge drives productivity, social wellbeing, and the achievement of socio-economic needs. Without scientific capacity, the skills and capabilities available in a country are constrained, and therefore, the ability to absorb, adapt, and develop new ideas and technologies is limited. However, in lower-income contexts like Kenya (KE), Rwanda (RW), and Tanzania (TZ), the organisation of the economy is often unfavourable to the application of science and technology in production. Hence, it is frequently argued that it is too difficult to demonstrate how research will lead to benefits and that it wastes

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resources that could be used in other types of interventions (e.g., to reduce poverty). Given the budget constraint, it is critical to better understand which areas of research should be prioritised in order to improve the socio-economic impact of research investments in these contexts.

In this chapter, we investigate the strengths and weaknesses of the research systems in KE, RW, and TZ versus the main challenges they face. Our central assumption is that a misalignment between the investment in research areas and the socio-economic challenges may reduce the effectiveness of the investments in research to address those goals.[3] Our main objective is to understand the extent to which the research priorities in these countries are aligned with their major socio-economic challenges. In this vein, we intend to bring prioritisation and directionality to the debate about science policy investment.

In what follows, we will first focus on the background of our analysis. Then we will describe the data and methodology used. Afterward, we will discuss the results obtained. Finally, we will put forward some conclusions.

9.2. Background

Total research output per capita in low-income countries is small when compared to high-income countries. Since spending on science and technology is low and, invariably, a fraction of what is promised by governments in these contexts,[4] the majority of research in these countries is still based on international collaboration and funding from foreign donors.[5]

Foreign understanding of problems, priorities, and criteria for funding often influence research in low-income countries. Thereby, since these latter have scarce resources to support their research programmes, it is important to better

3. We use the term 'societal needs' (or goals) in a broad way, capturing all explicit or implicit demands for new knowledge to address specific of general challenges/goals from nutrition to environmental sustainability.

4. Linda Nordling, 'The African science decade that wasn't,' *Research Professional News*, December 19, 2019. http://bitly.ws/qAw6

5. Joanna Chataway, et al., 'Science Granting Councils in Sub-Saharan Africa: Trends and tensions,' *Science and Public Policy* 46, no. 4 (March 2019): 620–31. https://doi.org/10.1093/scipol/scz007; United Nations Education, Scientific and Cultural Organisation, UNESCO, *Science Report: Towards 2030* (Paris: UNESCO Publishing, 2015).

understand if international funders are supporting research that is aligned with recipient countries' main socio-economic challenges or not. If they are, research collaboration networks that promote this alignment could be a relevant instrument to improve research capabilities and address socio-economic challenges along with domestic investment. If they are not, it can be argued that international research funding organisations may need to rethink how they structure and organise their research funding programmes and priorities.

Similar questions about the relation between research priorities and societal needs have been raised by several scholars, mostly focusing on high-income research-intensive countries. In this train of thought, science policy and innovation scholars have long debated whether it is more beneficial for societies to allow science and scientists to define their priorities or to steer science to address societal needs in the light of the stark inequalities investment in research contribute maintaining.[6]

Based on recent investigations of high-income countries' research and knowledge investment,[7] Wallace and Rafols suggest adopting the term 'research portfolio' to characterise the distribution of countries' research activities aimed at advancing knowledge to address socio-economic needs and challenges.[8] Recent evidence indicates that research portfolios are driven by different incentives, which may privilege certain research areas with respect to others,[9] in ways that privilege parts of the society that may be less in need of scientific advances (but have higher purchasing power). The distribution of research portfolios can be

6. Vannevar Bush, *Science: The Endless Frontier* (Washington: American Council of Learned Societies, 1945); Michael Polanyi, John Ziman, and Steve Fuller, 'The Republic of Science: Its Political and Economic Theory,' *Minerva* 1, no. 1 (1962): 54–73. https://www.jstor.org/stable/41821153; Michael Gibbons, et al., *The New Production of Knowledge: The Dynamics of Science and Research in Contemporary Societies* (London: Sage, 1994); Richard R. Nelson, 'The Moon and the Ghetto revisited,' *Science and Public Policy* 38, no. 9 (November 2011): 681–90. https://doi.org/10.1093/scipol/38.9.681; Richard R. Nelson, 'On the uneven evolution of human know-how,' *Research Policy* 32, no. 3 (June 2003): 909–22. https://doi.org/10.1016/S0048-7333(02)00093-8

7. Federal RePorter, 'Federal ExPorter,' March 6, 2020. http://bitly.ws/qD44; National Institutes of Health, 'RePort: Research Portfolio Online Reporting Tools,' accessed May 3, 2022. https://report.nih.gov

8. Matthew Wallace and Ismael Rafols, 'Research Portfolio Analysis in Science Policy: Moving from Financial Returns to Societal Benefits,' *Minerva*, *53*, no. 2 (June 2015): 89–115. https://doi.org/10.1007/s11024-015-9271-8

9. Ibid.

explained by a number of factors. Scientific and technological paradigms define limited spaces of prioritisation, which depends on past and current development in science and technology.[10] Path dependencies related to sunk costs, externalities, and accumulation of knowledge also contribute to defining future priorities.[11] The distribution of resources available to invest in research, and the 'power to make investment decisions'[12] contribute to defining whose priorities are more relevant. The 'lack of voice'[13] of those who are most in need and would benefit most from improvements in 'socio-economic needs'[14] reduces the likelihood for research investments to prioritise the needs of the most marginalised. Lastly, the 'research community'[15] has its incentives dictated by career paths and evaluation. Despite the fact that they are generated, it is important to systematically investigate if there is a misalignment between research priorities and societal demands.[16]

Evidence has been collected mainly in the area of health research while studying the relation between the prioritisation of research investment and disease burden.[17] These studies seem to find that the largest chunks of health

10. Giovanni Dosi, 'Technological paradigms and technological trajectories: A suggested interpretation of the determinants and directions of technical change,' *Research Policy* 11, no. 3 (June 1982): 147–62. https://doi.org/10.1016/0048-7333(82)90016-6; Thomas S. Kuhn, *The Structure of Scientific Revolutions* (Chicago: University of Chicago Press, 1962).

11. Robin Cowan and Philip Gunby, 'Sprayed to Death: Path Dependence, Lock-in and Pest Control Strategies,' *The Economic Journal* 106, no. 436 (May 1996): 521–42. https://doi.org/10.2307/2235561; Richard R. Nelson and Sidney G. Winter, *An Evolutionary Theory of Economic Change* (Cambridge: The Belknap Press of Harvard University Press, 1982).

12. Joanna Chataway, Joyce Tait, and David Wield, 'Understanding company R&D strategies in agro-biotechnology: trajectories and blind spots,' *Research Policy* 33, no. 6–7 (September 2004): 1041–57. https://doi.org/10.1016/j.respol.2004.04.004

13. Albert O. Hirschman, *Exit, Voice, and Loyalty: Responses to Decline in Firms, Organizations, and States* (Cambridge: Harvard University Press, 1972).

14. Laurens Klerkx and Cees Leeuwis, 'Institutionalizing end-user demand steering in agricultural R&D: Farmer levy funding of R&D in The Netherlands,' *Research Policy* 37, no. 3 (April 2008): 460–72. https://doi.org/10.1016/j.respol.2007.11.007

15. Barry Bozeman and Daniel Sarewitz, 'Public values and public failure in US science policy,' *Science and Public Policy* 32, no. 2 (April 2005): 119–36. doi:10.3152/147154305781779588

16. Elizabeth C. McNie, 'Reconciling the supply of scientific information with user demands: an analysis of the problem and review of the literature,' *Environmental Science & Policy* 10, no. 1 (February 2007): 17–38. https://doi.org/10.1016/j.envsci.2006.10.004; Daniel Sarewitz and Roger A. Pielke Jr., 'The neglected heart of science policy: reconciling supply of and demand for science,' *Environmental Science & Policy* 10, no. 1 (February 2007): 5–16. https://doi.org/10.1016/j.envsci.2006.10.001

17. Hugo Confraria and Lili Wang, 'Medical research versus disease burden in Africa,' *Research Policy* 49, no. 3 (April 2020): 103916. https://doi.org/10.1016/j.respol.2019.103916; James A. Evans, Jae-Mhan Shim, research are not directed toward diseases that impose the highest-burden on people's life. For example, Cassi et al. focus on the prioritisation in policy. They show that societal concerns in relation to obesity, as perceived by policymakers, do not match very well with prioritisation in research on obesity.[18]

There is scarce research that investigates research priorities beyond high-income countries and health. One of the few examples is Ciarli and Rafols's study.[19] It uses data on publications about rice to investigate if country publication profiles are correlated to the main societal needs related to rice production. They find some obvious alignments, but also some worrying misalignments driven by the factors listed above. For instance, countries with a higher per capita caloric intake from rice and higher rates of malnutrition, do not invest more in research related to human consumption.[20] It is mainly exporters that invest more than other countries in topics related to human nutrition. In this chapter, we move beyond specific sectors such as health and agriculture and examine the entire research portfolio. For simplicity, we focused on three East African countries that score differently with respect to several indicators of science, technology, and innovation, and employed the SDGs as proxies for societal needs.

9.3. Data and Methods

We used Web of Science (WOS) and Scopus publication data as a proxy for scientific output and the Sustainable Development Goals (SDGs) as a proxy for socio-economic challenges. We downloaded bibliometric data (full record except for references) for all publications with at least one author from one of

and John P. A. Ioannidis, 'Attention to Local Health Burden and the Global Disparity of Health Research,' PLOS One 9, no. 4 (April 2014): e90147. https://doi.org/10.1371/journal.pone.0090147; Alfredo Yegros-Yegros, et al., 'Exploring why global health needs are unmet by research efforts: the potential influences of geography, industry and publication incentives,' *Heal Research Policy and Systems* 18 (May 2020): 47. https://doi.org/10.1186/s12961-020-00560-6

18. Lorenzo Cassi, et al., 'Improving fitness: Mapping research priorities against societal needs on obesity,' *Journal of Informetrics* 11, no. 4 (November 2017): 1095–1113. https://doi.org/10.1016/j.joi.2017.09.010

19. Tommaso Ciarli and Israel Rafols, 'The relation between research priorities and societal demands: The case of rice' *Research Policy* 48, no. 4 (May 2019): 949–67. https://doi.org/10.1016/j.respol.2018.10.027

20. Ibid.

the three countries (KE, RW, and TZ) between 1990 and 2017. This included 49,651 documents from WOS and 51,055 documents from Scopus.[21] Then we merged the two datasets by creating identifiers using DOIs, titles, publication year, and journal names. When the same publication existed in both datasets, we tried to save the fields with more or better information. The final dataset included 49,046 publications for which an abstract is available, including articles, reviews, conference proceedings, books, and book chapters.

Regarding SDGs data, the aim was to measure the relative salience of a societal challenge with respect to other societal challenges in a given country to compare it with relative research specialisation. To measure a proxy for socioeconomic challenges, we collected all the UN SDG indicators for all periods available and we checked those indicators having data availability for KE, RW, and TZ between 2012 and 2017. After compiling a set of indicators with complete data (see Appendix A TABLE 13), we run a principal component analysis per SDG to obtain a single index. In this light, we followed the next steps:

For the selected indicators, we did a linear transformation, by converting each indicator/country into a score between 1 (best) and 0 (worst):

$$N_{ct} = \frac{Worst_t - x_{ct}}{Worst_t - Best_t}$$

Next, we reversed some variables for consistency (see Appendix A TABLE 13), forcing higher values to represent better results. For each variable, we then calculated the relative distance of each indicator/country to the frontier of that indicator (top5% - percentile 95) and we changed all values below zero to zero. After this transformation, higher values represented the worst results concerning the SDG targets (higher challenges relative to countries at the frontier).

Subsequently, we calculated Z-scores for each relative distance to the frontier (top5%). Ulteriorly, we computed a principal component analysis (PCA)[22] for each SDG with more than one indicator available. Also, we forced the PCA

21. We also downloaded Dimensions data but since abstracts were unavailable, we could not use it.

22. J. Edward Jackson, *A Use's Guide to Principal Components, Wiley Series in Probability and Statistics*. (Hoboken: John Wiley & Sons, Inc., 1991).

to estimate only one component per SDG. Later, we predicted the scores of all SDGs for all countries and we normalised the results between 0 and 1 (1 = Worst country; 0 = Best country). Finally, we transformed the normalised scores into percentages to make them comparable with publication shares.

Analysis

In the first part of our analysis, we studied the national and international research collaboration networks of research institutions in KE, RW, and TZ and the relevance of each research organisation in the overall research network. We used co-authorship as a proxy for research collaboration.

Then, we used 'overlay maps'[23] to graphically examine how research priorities have changed through time in each of the three countries across different topics. We created maps by using semantic similarity between publications (VOSviewer topic modelling algorithm) to identify the main research topics. In doing so, we also employed WOS categories to measure the relative research specialisation in given topics of KE, RW, and TZ in relation to the world research specialisation.[24] As a result of this exercise, we sought to have a better understanding of the dynamics of research in KE, RW, and TZ, strengths, weaknesses, and future opportunities.

In the second part of our analysis, we followed Ciarli and Rafols to study the relation between revealed research priorities and socio-economic demands.[25] We examined the extent to which the distribution of investment in research across societal challenges (calculated by the share of publications associated with a SDG) is related to the salience of the socio-economic challenges (SDG scores). In order to do this, we first had to allocate each publication to SDGs. To do so, we defined a topic/keyword query for each SDG that would allow us to retrieve all publications related to that SDG (research priorities). Once we defined

23. Ismael Rafols, Alan L. Porter, and Loet Leydesdorff, 'Science Overlay Maps: A NewTool for Research Policy and Library Management,' *Journal of the American Society for Information Science and Technology* 61, no. 9 (September 2010): 1871–87. https://doi.org/10.1002/asi.21368

24. Beka Balassa, 'Trade Liberalisation and "Revealed" Comparative Advantage,' *The Manchester School* 33, no. 2 (May 1965): 99–123. https://doi.org/10.1111/j.1467-9957.1965.tb00050.x

25. See Ciarli and Rafols, 'The relation between research, 949–67.

the term/keywords per SDG, we searched all publication titles and abstracts and allocated to a SDG all publications that contained at least one term of the relevant query. To define the query, we followed the next steps:

- We searched the UN SDG website and Wikipedia for SDG descriptions and we used topic modelling (NLP) to extract the most relevant and frequent terms used in each SDG.
- We combined our list of terms with lists of keywords defined in earlier research[26] and we asked several experts on STI and development to revise the queries.[27]
- After defining a robust set of terms per SDG, we went back to our dataset of publications authored by at least one researcher in KE, RW, and TZ to retrieve those containing keywords associated with each SDG per country.[28]

Finally, we graphically analysed the relative salience of each SDG for the three countries' societal needs as measured by the salience of the SDG indicator relative to the best performer. Plus, we examined the relative specialisation in each of the 17 topics related to SDGs research priorities).

In order to map the role that different funding organisations may play in shaping research priorities, we analysed which funding institutions supported research in KE, RW, and TZ in a given SDG. To do so, we used the acknowledgement paratext of scientific publications in WOS where authors acknowledge the financial support from the funding agencies.[29] Thus, we focused only on

26. Colombian Administrative Department of Science, Technology, and Innovation, Colciencias, *Libro Verde: Política Nacional de Ciencia e Innovación para el Desarrollo Sostenible* (Bogotá: Panamericana Formas e Impresos, 2018). http://bitly.ws/qDpZ

27. 'About,' African Centre for Technology Studies, accessed May 4, 2022. https://acts-net.org/ksi/index.php/about

28. The same publication can be associated to multiple countries and SDGs. We used the full-counting method.

29. Confraria and Wang, 'Medical research,' 103916; Rodrigo Costas and Thed N. Leeuwen, 'Approaching the "reward triangle": General analysis of the presence of funding acknowledgments and "peer interactive communication" in scientific publications,' *Journal of the American Society for Information Science and Technology* 63 (June 2012): 1647–61. https://doi.org/10.1002/asi.22692; Nicola Grassano, et al., 'Funding publications from 2009 to 2017 because wos only provides systematic information from the funding text of acknowledgements for publications since August 2008. Next, we utilised OpenRefine[30] and manual searching methods to group different name variations for the same funding institution mentioned in the acknowledgements section of our sample of publications. After that, we analysed only those sponsoring research in KE, RW, and TZ with more than 10 publications (appearing more than 0.03% of times) between 2009 and 2017. We ended up with 178 funding institutions associated with at least one publication in our dataset. Besides calculating the number of publications with acknowledgements to a specific funding institution by SDG and country, we also classified each funding institution into six group types following the G-finder classification.[31] These groups were: 1) Kenyan public funding; 2) Rwandan public funding; 3) Tanzanian public funding; 4) public funding not based in KE, RW, and TZ (including multilateral funders such as World Health Organisation and United Nations); 5) philanthropic funding; and 6) corporate funding.

9.4. Results

Publication Trends in Kenya, Rwanda, and Tanzania

The scientific output of researchers in Africa has increased considerably in recent years,[32] but it is still between two and three percent of the world's share.[33] Relying on wos data only,[34] FIGURE 14 plots the number of total publications per capita for KE, RW, and TZ between 1990 and 2017. We found that the increase in publications from 2005 to 2006 has also been accompanied by a rise in research

Data from Publication Acknowledgments: Coverage, Uses, and Limitations,' *Journal of the Association for Information Science and Technology* 68, no. 4 (April 2017): 999–1017. https://doi.org/10.1002/asi.23737

30. We used the text facet cluster function to list all affiliations and then we grouped affiliations based on three different keying algorithms (fingerprint, n-gram and metaphone3).

31. Policy Cures Research, 'G-FINDER: tracking funding for global health R&D,' last modified March 24, 2022. https://gfinder.policycuresresearch.org/PublicSearchTool/

32. Hugo Confraria, Jaco Blanckenberg, and Charl Swart, 'The characteristics of highly cited researchers in Africa,' *Research Evaluation* 27, no. 3 (July 2018): 222–37. https://doi.org/10.1093/reseval/rvy017

33. UNESCO, *Science Report: Towards 2030*.

34. The shares of publications with an author from a specific African country are similar in both datasets (66% for Kenya, 32% for Tanzania, and 5% for Rwanda).

productivity (number of publications per population). Likewise, Kenyan scientific productivity has followed the African average, whereas researchers in Rwanda and Tanzania have produced around half the African average publications per capita in the last 5 years of the analysis.

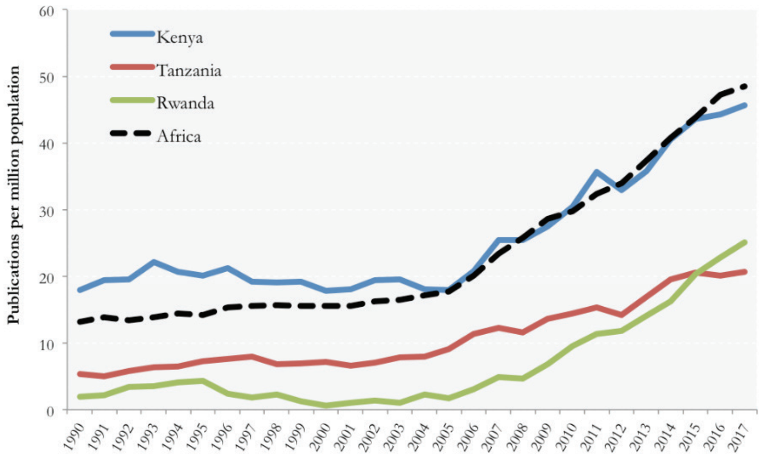

FIGURE 14. Trends in Scientific Productivity – KE, RW, and TZ versus Africa Average.

Source: WOS.

Research Networks in Kenya, Rwanda, and Tanzania

To identify the main actors and the main linkages of the research systems in KE, RW, and TZ, we built several networks of institutional research co-authorships in these countries. FIGURES 19, 20, and 21 (see Appendix B) show our construction of a network graph with 20 institutions that produced more publications at WOS. Each node represents one research organisation in one of the three countries. The size of the node indicates the number of publications. Edges plot the co-authorship between organisations. An edge means that there are at least two publications authored by researchers in each of the organisations represented by the connected nodes. The thickness of the edges represents the number of co-authored publications.

In FIGURE 19 (see Appendix B), we analysed the top-10 collaborators (national or international) of each Kenyan institution identified before. We found that the University of Nairobi has a central position in the Kenyan research network since it is a top-10 collaborator of most other Kenyan institutions. Kenya Medical Research Institute (KEMRI) also has a central position in the network, but it has a very high intensity of collaboration with foreign institutions, especially in the US and UK. The other Kenyan research organisations in this graph (top publishers) also seem to collaborate more often with foreign institutions than with Kenyan ones. For example, among the top-10 collaborators of the 'African Population and Health Centre,' only one is from Kenya (i.e., the University of Nairobi).

In FIGURE 20 (see Appendix B), we did the same analysis for the two Rwandan main research organisations. We found that the University of Rwanda and Rwanda Biomedical Centre are the main collaborators of each other and that Harvard University is the second top collaborator of both organisations. It is also clear that most of the collaborators are specialised in health-related areas like the National Institutes of Health (NIH, USA) or the Swiss Tropical and Public Health Institute.

FIGURE 21 (see Appendix B) maps the main co-authorship networks for Tanzanian top research organisations. As for the previous countries, the main collaborators of Tanzanian research organisations are also foreign organisations (US and UK mostly). The University of London, NIH (USA), and London School of Hygiene and Tropical Medicine (LSHTM) have gatekeeping positions because they all are top collaborators of at least three Tanzanian institutions within the system. We did not identify any KE or RW institution that is the main collaborator of any Tanzanian institution.

In sum, we could see a high level of collaboration between KE, RW, and TZ research organisations and foreign institutions, but a low level of collaboration between Kenyan, Rwandan, and Tanzanian research organisations.

Research Specialisation in Kenya, Rwanda, and Tanzania

In this section, we investigate which scientific areas and topics Kenyan, Rwandan, and Tanzanian researchers have prioritised between 1990 and 2017. In FIGURE 15, we combined WOS and Scopus publications data and we use VOSviewer NLP algorithms to analyse the main topics present in the abstracts of all publications identified.[35] We identified topics by co-word similarity after filtering the main terms from all publications' titles and abstracts,[36] terms forming a topic if they appear together (in the same publication) in more than an average pair.

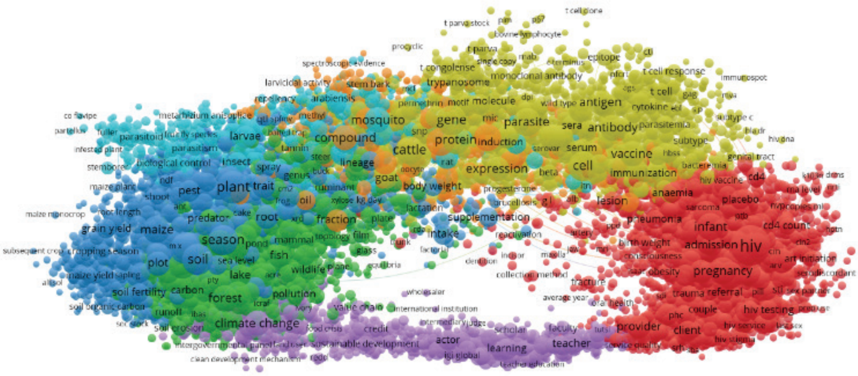

FIGURE 15. Map of Topics More Frequent in Research Done by Researchers from KE, RW, and TZ between 1990 and 2017[37]

Source: WOS and Scopus.

Most topics in KE, RW, and TZ reported in FIGURE 15 seem to be related to health issues (e.g., pregnancy, HIV, vaccine, gene, and parasitoid), agriculture (e.g., maize, pest, and grain yield), environmental sciences (e.g., pollution, wildlife, and forest), and social sciences (e.g., learning, teacher, and sustainable development). Using VOS viewer clustering algorithm, we grouped these topics in seven clusters of terms related to different areas: 1 – Clinical medicine/HIV/pregnancy (red); 2 – Environmental sciences (green); 3 – Agriculture (dark

35. Nees Jan van Eck, et al., 'A comparison of two techniques for bibliometric mapping: Multidimensional scaling and VOS,' *Journal of the American Society for Information Science and Technology* 61, no. 12 (December 2010): 2405–16. https://doi.org/10.1002/asi.21421; Ludo Waltman, Nees Jan van Eck, and Ed C.M. Noyons, 'A unified approach to mapping and clustering of bibliometric networks,' *Journal of Informetrics* 4, no. 4 (October 2010): 629–35. https://doi.org/10.1016/j.joi.2010.07.002

36. Relevant terms are those that appear frequently across all publications, but do not appear in too many publications. This is because terms that appear in all publications are paired with all other terms and therefore, they are not useful to distinguish between more or less frequent pairs of terms.

37. The proximity of terms and clusters created based on the co-occurrence of terms in abstracts using the VoSviewer algorithm.

blue); 4 – Human and animal diseases (yellow); 5 – Social sciences/sustainability (purple); 6 – Malaria /parasites (light blue); 7 – Biomedicine (orange). It is important to note that clusters 4 and 7 were not easily classifiable because they include terms from many different fields.

Since the above analysis on research specialisation is limited to publications co-authored by researchers in KE, RW, and TZ, we could not establish if these patterns of specialisation are peculiar to East African countries or follow a global pattern in research. On the other hand, in order to understand if there are any areas of research that are totally missing from the research map of KE, RW, and TZ, in FIGURE 22 (see Appendix C) we compared the research specialisation of the three countries with the global specialisation in the 251 WOS categories.[38] We divided the relative specialisation of KE, RW, and TZ in a given category (the share over total publications in the country) with the relative specialisation in the world publications (the share over total publications in the world).

Research on WOS categories such as tropical medicine, parasitology, infectious diseases, and agronomy in KE, RW, and TZ is above the share of research devoted to those categories internationally. Their research specialisation in infectious, parasitic, and vector diseases is probably due to the high disease burden that Eastern African countries face in these diseases in relation to the rest of the world.[39] In contrast, WOS categories related to engineering, physics, and 'high-tech' receive extremely low attention in research in all three countries, with respect to their relative importance internationally. Some of the 50 'neglected' research areas include industrial engineering, neuroimaging, cell and tissue engineering, automation and control systems, and biomedical engineering.

Relation between Investment in Research Areas and Socio-economic Challenges (SDGs)

The next question is whether such strong and narrow specialisation in health and agriculture is connected to the relative importance of the SDGs that may benefit from such research in KE, RW, and TZ. In this section, we discuss the

38. Because we need to use WOS categories, this analysis is focused on publications from WOS.

39. Confraria and Wang, 'Medical research.'

extent to which the research produced by researchers in these countries is associated with topics related to the SDGs. We first built a list of terms that relate to each SDG. Using them, we created a query of keywords/terms per SDG to search for publications containing those terms in all the abstracts of our dataset of publications.

Having analysed the research priorities in KE, RW, and TZ across SDGs, we needed a measure of relatively more problematic SDGs for the three countries to study the relationship between the research priorities and socio-economic demands (as measured by SDGs). For each SDG we devised an index between 0 (the country is among the best performers in the world (top5%) and 1 (the country is the worst performer in the world). One of the major findings is that the countries are top performers in SDG13 – Climate action. This is mainly due to their low CO_2 emissions per capita compared to the rest of the world. Another important result is that SDG9 – Industry, infrastructure, and innovation is the one where the three countries are performing worst. This SDG includes indicators such as the quality of overall infrastructure and internet use by the population. Finally, despite differences between KE, RW, and TZ, their relative position in SDGs 1 – No poverty, 2 – Zero hunger – and 6 – Clean water and sanitation is also low.

Having a measure of the revealed research priorities and the relative burden posed by each SDG, we could study the extent to which the distribution of investment across research topics associated with specific SDGs is related to the major socio-economic challenges (SDGs) in KE, RW, and TZ. The distribution of investment in research was calculated by the number of publications associated with a specific SDG divided by the total number of publications in a country/period. The distribution of socio-economic challenges was calculated by the share of a SDG challenge index score in the total amount of scores in a country/period. FIGURES 16, 17, and 18 plot the relative research prioritisation across all SDGs on the right, and the relative SDG burden on the left.

Our major finding is that, overall, the distribution of SDGs burdens faced in the three countries is more uniform than their research specialisation would suggest. The high prioritisation of SDG 3 (i.e., Good health and well-being) across all countries, would suggest that the perception of the SDG3 burden is significantly higher than for the other SDGs. Instead, the burden faced by the three countries, according to international SDGs benchmark indicators seem to be mostly in SDG1 – poverty (Rwanda), SDG2 – Zero hunger (Rwanda), SDG6 – Clean water and sanitation (all three countries), SDG9 – Industry, infrastructure and innovation (all three countries) or SDG14 – Life below water (KE and TZ). This apparent misalignment between the focus of research and the challenges faced by countries in terms of SDG indicators may undermine the development of (research) capabilities to study the contextual conditions to best achieve the SDGs targets in which countries perform worst.

Research Funding

We discussed that the research agenda of countries such as KE, RW, and TZ may be influenced by foreign donors and funders. Given the highly skewed specialisation towards one specific SDG, it is important to understand who the major funders are across SDGs and if such prioritisation is related to how countries are performing on the different SDGs. In order to understand who is funding the research related to specific SDGs, we used the funding acknowledgements paratext of all publications with at least one author from the countries in question between 2009 and 2017.

FIGURE 23 (see Appendix D) shows that 32% of the publications with Kenyan authors have had at least one foreign public funder (foreign government or multilateral funder, not located in KE, RW, or TZ). The second biggest funder group is philanthropic institutions (e.g., Bill and Melinda Gates Foundation and Wellcome Trust) and only 4% of the publications have had a Kenyan funder mentioned in the funding acknowledgements. It is important to emphasise that these acknowledgements' data has limitations; thereby, for 42% of the publications, we could not identify any funder. This can be because there are publications that do not receive institutional research funding or because the author forgot or decided not to include research funding acknowledgements. There are also 1866 Kenyan publications (around 10%) that report a funder in the acknowledgements but which we could not identify. Also, we found that funding from corporations is less than 2%. Lastly, the SDG with more relative funding is SDG 3 (i.e., Health and well-being).

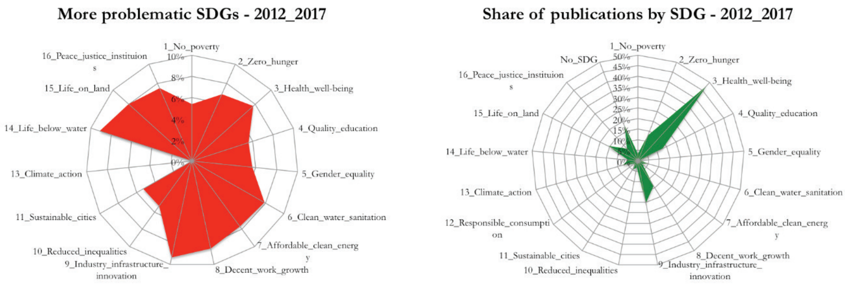

FIGURE 16. Kenya Main Societal Challenges versus SDG Research Production 2012 – 2017

Source: WOS, Scopus, and UN.

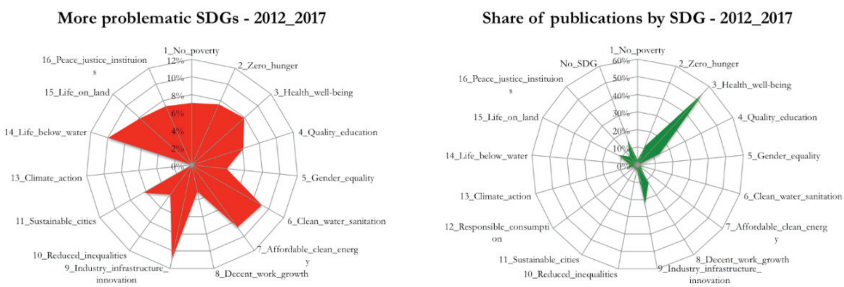

FIGURE 17. Tanzania Main Societal Challenges versus SDG Research Production 2012 – 2017

Source: WOS, Scopus, and UN.

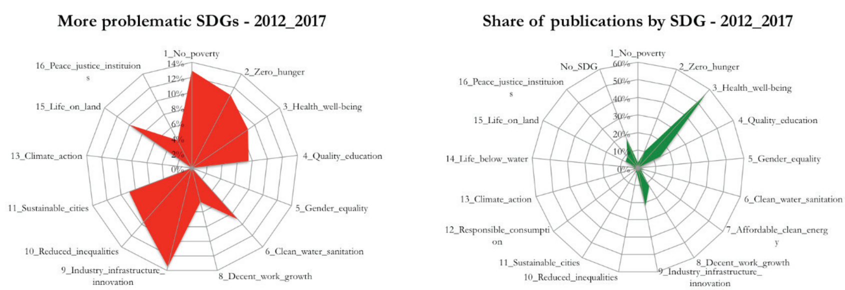

FIGURE 18. Rwanda Main Societal Challenges versus SDG Research Production 2012 – 2017

Source: WOS, Scopus, and UN.

FIGURE 24. (Appendix D) shows similar results for publications produced by Rwandan researchers. Findings indicate that 29% of the research there is funded by foreign public funders, 7% by philanthropic institutions, 3% by Rwandan institutions, and 1% by corporations. We could not identify funders in 243 publications (11%) and 48% of the publications have no funding reference.

As for Tanzania, the distribution is very similar (see Appendix D FIGURE 25). We found that 33% of the research there is funded by foreign public funders, 11% by philanthropic institutions, 3% by Tanzanian institutions, and 1% by corporations. We could not identify funders in 1171 publications (11%) and 40% of the publications have no funding reference.

We also took a closer look at the main funders supporting research in specific SDGS. TABLE 14 (see Appendix E) reports the top-20 funders in KE by SDG between 2009 and 2017. Some key findings are that NIH is the major research funder across all SDGS; Wellcome Trust and Gates Foundation funded more than 10% of all publication in SDG3; the EU funded more than 9% of the publications in SDG 13, 14, 15; DFID funded 2.5% of the publications; and there is a low representation of national funders.

TABLE 15 (see Appendix E) reports the top-20 funders in Rwanda by SDG during the same period. Here since the number of publications analysed is smaller than in the Kenyan case, the percentages of funders' shares in some SDGS are prone to small changes. Still, the major findings are that: NIH, which is the major research funder across almost all SDGS; the Swedish government (e.g., SIDA) and the Dutch government (e.g., NOW and NUFFIC), which are important funders in some SDGS; finally, there is a low share for national funders (<2% of total).

TABLE 16 (see Appendix E) shows the top-20 funders in Tanzania by SDG between 2009 and 2017. It evidences that NIH is the major research funder in all SDGS; Gates foundation, EU, and Wellcome Trust are again important funders; MRC (the UK or ZA) are important in SGD 3 and 5; lastly, low share for national funders (<2% of total).

Overall, our analysis of the research funding landscape shows a strong dependence of the research systems in KE, RW, and TZ on external research funding (public non-African and philanthropic organisations). It is guided towards different SDGs, but the largest emphasis of external funders is on health-related research (SDG3 – Health and well-being).

9.5. Discussion and Conclusions

In this chapter, we analysed the research systems in Kenya, Rwanda, and Tanzania in order to understand to what extent the research priorities in these countries are aligned with their main socio-economic challenges. The challenges faced by these countries are various and interrelated, ranging from poverty to hunger, health, education, innovation, and jobs. In order to make sense of such complexity, we estimated how these countries perform against benchmark countries with respect to the global challenges defined in the SDGs indicators. To measure research priorities, we delved into the research specialisation of KE, RW, and TZ in topics related to each SDG by allocating publications from the Web of Science (WOS) and Scopus to SDGs using a query developed using SDGs descriptions.

On one hand, we found that in the three countries there is a high research prioritisation in SDG3 (Good health and well-being). Also, results revealed that there is very little research capacity in engineering and physical sciences, poverty, hunger, or life below water, which seems at least as challenging as health across the three countries. On the other hand, we concluded that the distribution of socio-economic challenges is more uniform than their research specialisation would suggest. These findings show that the SDGs' research areas, which receive the most funding (mainly from foreign funders) and whose researchers publish most in international journals, are not necessarily the research areas where the countries do worst with respect to SDGs indicators. Such misalignment between the investment in research areas and the socio-economic challenges may reduce the effectiveness of the investments in research to address those challenges.

In line with previous studies, we also saw a high dependence in KE, RW, and TZ on international research collaboration and international (public and philanthropic) research funding that is mostly centred on health research-related areas. Some of the biggest funders include the NIH (all institutes combined), Wellcome Trust, Bill and Melinda Gates Foundation, and European Union (i.e., EU, ERC, and EC).

Our analysis has limitations, and the results must be interpreted with caution since scientific publications in WOS and Scopus are imperfect estimates of research efforts in a specific SDG and country. Both WOS and Scopus underrepresent journals from lower-income regions[40] and may give a biased picture of the research prioritisation in these countries.[41] This is even though they are reliable databases that are vastly used for bibliometric studies. Second, SDG indicators are limited estimates of socio-economic challenges since we used composite indexes and many relevant indicators for certain SDGs are not available in lower-income regions. Third, the research priorities were approximated by the number of publications per SDG divided by the total number of publications in a country. This did not allow comparing with the world relative distribution, as this would require whole access to WOS and Scopus since socio-economic challenges are measured in relation to the world frontier in a specific SDG. Both indicators are shares but they have different benchmarks. Finally, the marginal impact of increasing research investments in areas related to a certain SDG on the improvement of that SDG may not be the same for all SDGs. For instance, local studies on health (SDG3) may lead to significant improvements in the health outcomes of a country (although we do not find evidence of this), whereas more local research on poverty (SDG1) may not lead to similar marginal improvements. Future research should look carefully at this issue and also consider spill-overs between SDGs and positive and negative interactions among them, and how these may guide research prioritisation and building of research capabilities to address different challenges. Furthermore, since many of the publications that we identified have multiple authors, it would be important to understand the roles of Kenyan, Tanzanian, and Rwandan researchers in these collaborations.

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41. Ismael Rafols, Ciarli Tommaso, and Diego Chavarro. 'Under-Reporting Research Relevant to Local Needs in the Global South. Database Biases in the Representation of Knowledge on Rice,' paper presented at *15th International Conference on Scientometrics and Informetrics*. Istanbul, Turkey, June 29 – July 3, 2015. http://bitly.ws/qAwM

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Appendix A

TABLE 13. Variables Used for Approach 2

SDG	Description	Reversed
1_No_poverty	Poverty headcount ratio at $1.90/day (%)	
2_Zero_hunger	Cereal yield (t/ha)	Yes
	Prevalence of stunting, under - 5s (%)	
	Prevalence of wasting, under - 5s (%)	
3_Health_well - being	Adolescent fertility (births per 1,000)	
	HIV prevalence (per 1,000)	
	Life Expectancy at birth (years)	Yes
	Maternal mortality (per 100,000 live births)	
	Death rate from NCDs (per 100,000)	
	Neonatal mortality (per 1000 live births)	
	Subjective wellbeing (0-10)	Yes
	Incidence of tuberculosis (per 100,000)	
	Traffic deaths (per 100,000)	
	Under 5 mortality (per 1000 live births)	
	UHC Tracer Index (0-100)	Yes
	Infants who receive 2 WHO vaccines (%)	
4_Quality_education	Net primary school enrolment rate (%)	Yes
	Mean years of schooling (years)	Yes
5_Gender_equality	Unmet demand for contraceptives (%)	
	Female labour force participation (% male)	Yes
	Women in national parliaments (%)	Yes
6_Clean_water_ sanitation	Population using at least basic sanitation services (%)	Yes
	Population using at least basic drinking water services (%)	Yes

SDG	Description	Reversed
7_Affordable_clean_ energy	Access to clean fuels (%)	Yes
	CO2 from fuels and electricity (MtCO2/TWh)	
	Access to electricity (%)	Yes
8_Decent_work_ growth	Access to bank account or mobile - money (% adult pop.)	Yes
	Unemployment rate (%)	
9_Industry_ infrastructure_ innovation	Quality of overall infrastructure (1 - 7)	Yes
	Internet use (%)	Yes
	Mobile broadband subscriptions (per 100)	Yes
10_Reduced_ inequalities	GINI index	
11_Sustainable_ cities	Improved water source, piped (%)	Yes
	Annual mean levels of fine particulate matter in cities (population weighted)	
	Satisfaction with public transport (%)	Yes
13_Climate_action	CO2 emissions from energy (tCO2/capita)	
14_Life_below_water	Ocean Health Index - Biodiversity (0-100)	Yes
	Ocean Health Index - Clean waters (0-100)	Yes
	Ocean Health Index - Fisheries (0-100)	Yes
	Fish caught by trawling (%)	
15_Life_on_land	Freshwater sites, mean protected area (%)	Yes
	Terrestrial sites, mean protected area (%)	Yes
	Red List Index of species survival (0-1)	Yes
16_Peace_justice_ instituions	Corruption Perception Index (0-100)	Yes
	Government efficiency (1-7)	Yes
	Property rights (1-7)	Yes
	Feel safe walking at night (%)	Yes

Source: Prepared by authors.

Appendix B

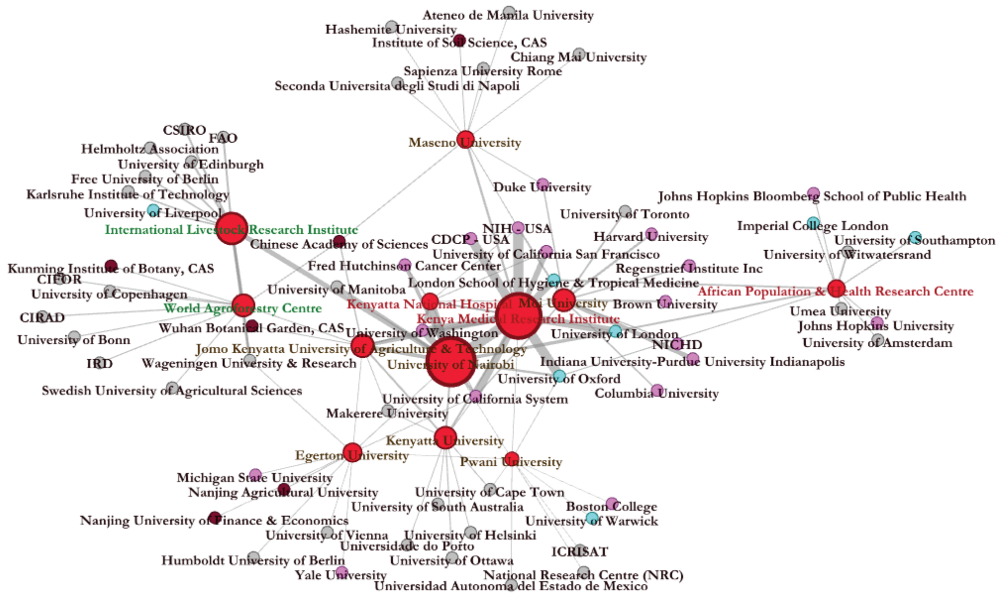

FIGURE 19. Collaboration Research Networks between Kenyan Institutions and Other Institutions (Top 10 Collaborators) in All Fields[42]

Source: WOS.

42. Node colours: Kenya (red), USA (pink), UK (light blue), China (brown); node size: number of publications (min=115, max=2116); edge size: number of collaborations (top10 for each Kenyan institution); labels: academic (brown), research institute (green), health institute (red), and government (blue).

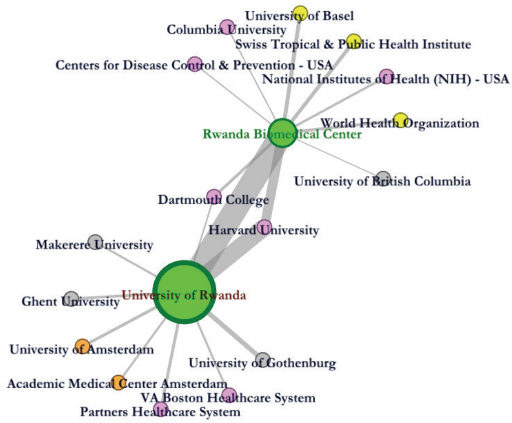

FIGURE 20. Collaboration Research Networks between Rwandan Institutions and Other Institutions (Top 10 Collaborators) in All Fields[43]

Source: WOS.

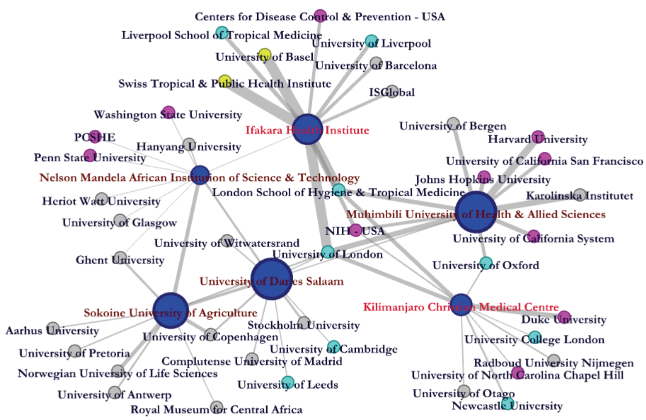

FIGURE 21. Collaboration Research Networks between Tanzanian Institutions and Other Institutions (Top 10 Collaborators) in All Fields[44]

Source: WOS.

43. Node colours: Rwanda (green), USA (pink), Netherlands (orange), Switzerland (yellow); node size: number of publications (min=146, max=579); edge size: number of collaborations (top10 for each Rwandan institution); labels: academic (brown), research institute (green), health institute (red), government (blue).

44. Node colours: Tanzania (blue), USA (pink), Switzerland (yellow), UK (light blue); node size: number of publications (min=205, max=934); edge size: number of collaborations (top10 for each Tanzanian institution); labels: academic (brown), research institute (green), health institute (red), government (blue).

Appendix C

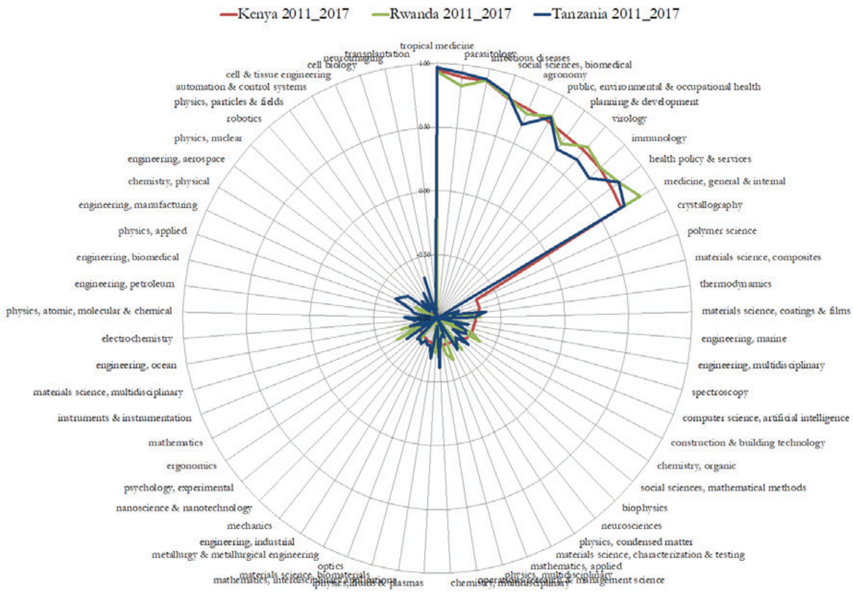

FIGURE 22. Research Specialisation in KE, RW, and TZ Compared to the World (wos)[45] [46]

Source: wos.

45. Normalised relative comparative advantages were calculated between 2011 and 2017.

46. From the original 251 areas, we excluded humanities-related areas and ended up analysing 223 areas. The only areas displayed in this graph are the ones of high specialisation (>0.6) and low specialisation (<0.6) for the three countries.

Appendix D

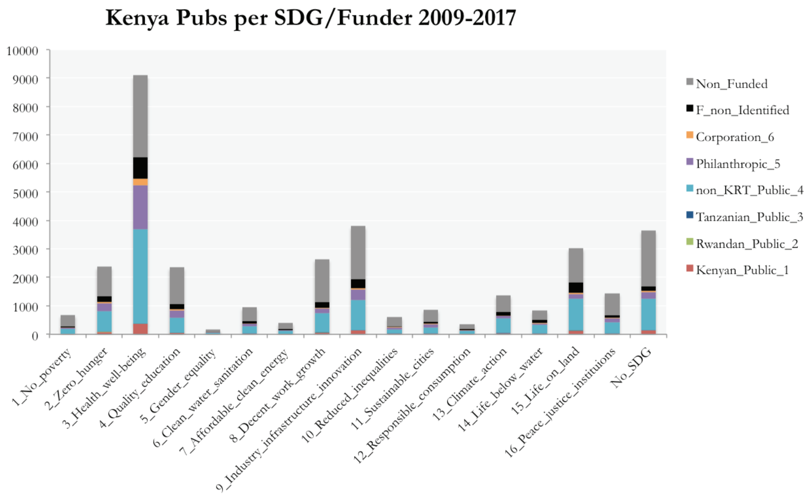

FIGURE 23. Share of Publications Associated with a SDG per Funding Type – Kenya

Source: WOS and Scopus.

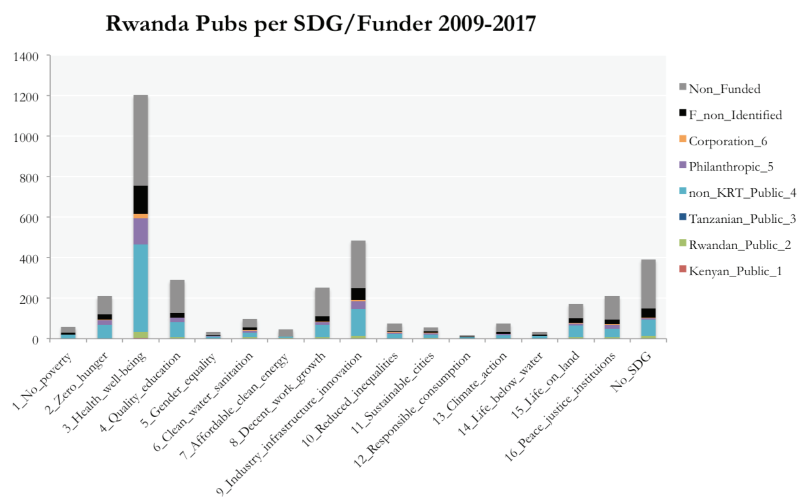

FIGURE 24. Share of Publications Associated with a SDG per Funding Type – Rwanda

Source: WOS and Scopus.

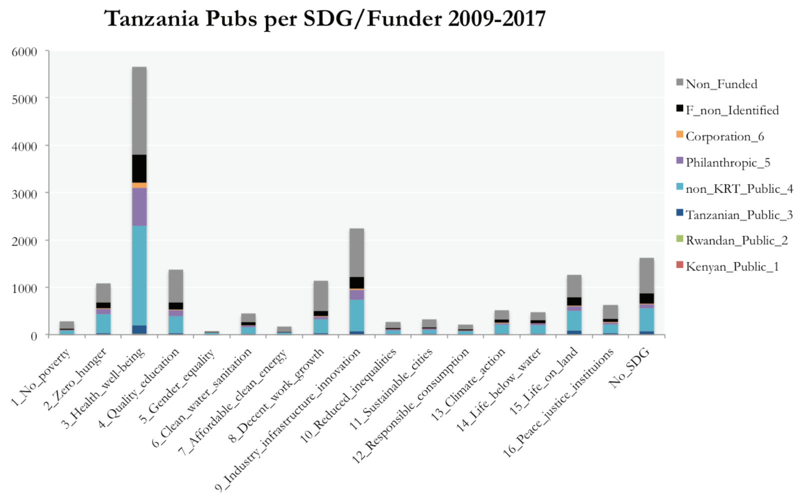

FIGURE 25. Share of Publications Associated with a SDG per Funding Type – Tanzania

Source: WOS and Scopus.

Appendix E

TABLE 14. Top 20 Funders (Share) per SDG – Kenya. 2009 – 2017

	1_No_poverty	2_Zero_hunger	3_Health_well - being	4_Quality_education	5_Gender_equality	6_Clean_water_sanitation	7_Affordable_clean_energy	8_Decent_work_growth	9_Industry_infr_innovation	10_Reduced_inequalities	11_Sustainable_cities	12_Responsible_consumption	13_Climate_action	14_Life_below_water	15_Life_on_land	16_Peace_justice_instituions	No_SDG	Total
NIH_4	10%	13%	26%	14%	16%	9%	11%	9%	12%	17%	12%	10%	13%	17%	11%	15%	11%	3296
Wellcome_ Trust_5	5%	6%	12%	7%	5%	3%	2%	3%	5%	9%	12%	1%	1%	2%	1%	6%	2%	1280
Gates_ Foundation_5	4%	6%	10%	5%	8%	5%	3%	3%	5%	7%	6%	3%	3%	1%	2%	5%	3%	1139
EU_4	4%	6%	5%	2%	4%	5%	8%	6%	5%	5%	4%	7%	11%	9%	9%	3%	4%	950
USAID_4	4%	5%	6%	3%	5%	3%	3%	4%	4%	5%	2%	2%	3%	3%	3%	4%	2%	754
DEU_Gov_4	2%	3%	2%	1%	0%	3%	1%	2%	3%	2%	2%	9%	4%	2%	4%	0%	6%	623
MRC_4	1%	3%	6%	3%	2%	2%	1%	1%	2%	5%	2%	1%	0%	1%	0%	2%	1%	581
NSF_4	2%	2%	2%	1%	0%	2%	2%	2%	2%	2%	2%	1%	6%	3%	6%	2%	4%	580
DFID_4	5%	3%	4%	2%	7%	2%	2%	3%	3%	4%	4%	2%	4%	2%	3%	4%	1%	488
CDC_4	0%	2%	4%	2%	1%	1%	1%	0%	1%	1%	3%	0%	0%	0%	0%	2%	1%	402
CGIAR_4	3%	5%	1%	1%	2%	2%	9%	3%	3%	2%	1%	3%	7%	3%	5%	1%	1%	371
SWE_Gov_4	3%	3%	2%	1%	2%	2%	3%	1%	1%	2%	7%	2%	2%	2%	2%	1%	1%	356
KEMRI_1	1%	2%	3%	1%	1%	1%	0%	0%	1%	2%	2%	0%	0%	1%	0%	2%	0%	293
WHO_4	1%	1%	2%	1%	4%	1%	1%	1%	2%	2%	1%	0%	0%	0%	0%	2%	1%	237
CFAR_4	0%	1%	2%	1%	2%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	1%	0%	217
PEPFAR_4	0%	0%	2%	1%	2%	0%	0%	0%	1%	1%	0%	0%	0%	0%	0%	1%	0%	216
BEL_Gov_4	1%	2%	1%	1%	1%	1%	1%	1%	1%	1%	0%	0%	2%	2%	2%	0%	1%	201
NNSFC_CN_4	0%	0%	0%	0%	0%	1%	1%	1%	1%	0%	0%	2%	2%	0%	1%	0%	3%	193
NLD_Gov_4	0%	1%	1%	1%	1%	2%	1%	1%	1%	0%	0%	1%	2%	2%	2%	1%	1%	187
BBSRC_4	1%	1%	1%	0%	4%	0%	1%	1%	1%	1%	0%	2%	1%	0%	1%	0%	1%	185
Total	681	2371	9097	2348	168	947	391	2638	3796	597	859	356	1364	830	3018	1437	3644	19339

Source: WOS and Scopus

TABLE 15. Top 20 Funders (Share) per SDG – Rwanda. 2009 – 2017

	1_No_poverty	2_Zero_hunger	3_Health_well - being	4_Quality_education	5_Gender_equality	6_Clean_water_sanitation	7_Affordable_clean_energy	8_Decent_work_growth	9_Industry_infr_innovation	10_Reduced_inequalities	11_Sustainable_cities	12_Responsible_ consumption	13_Climate_action	14_Life_below_water	15_Life_on_land	16_Peace_justice_ instituions	No_SDG	Total
NIH_4	17%	9%	19%	9%	12%	2%	6%	5%	10%	20%	9%	11%	4%	15%	4%	12%	7%	265
Gates_ Foundation_5	0%	9%	7%	6%	3%	8%	0%	2%	4%	8%	5%	0%	5%	0%	0%	7%	0%	85
EU_4	0%	2%	5%	1%	3%	2%	0%	1%	3%	5%	9%	6%	1%	0%	2%	1%	2%	78
USAID_4	2%	5%	5%	3%	0%	1%	0%	2%	4%	3%	0%	0%	0%	0%	2%	0%	1%	76
SWE_Gov_4	3%	3%	3%	3%	18%	4%	4%	2%	2%	7%	9%	0%	5%	3%	3%	4%	5%	72
NLD_Gov_4	3%	5%	4%	3%	0%	6%	0%	6%	3%	1%	4%	17%	7%	3%	12%	2%	1%	72
BEL_Gov_4	2%	3%	3%	2%	3%	0%	0%	2%	2%	0%	2%	0%	1%	0%	1%	2%	2%	54
Univ_Rwanda_2	3%	0%	1%	1%	3%	7%	9%	3%	2%	1%	5%	6%	3%	9%	5%	1%	3%	46
EDCTP_4	0%	0%	3%	1%	3%	0%	0%	0%	0%	3%	0%	0%	0%	12%	0%	2%	0%	43
MRC_4	2%	2%	3%	2%	0%	1%	0%	0%	2%	11%	0%	0%	0%	0%	0%	1%	0%	41
Wellcome_ Trust_5	2%	3%	3%	1%	0%	2%	0%	1%	2%	5%	7%	0%	1%	0%	1%	1%	0%	40
NSF_4	0%	1%	1%	1%	0%	0%	0%	0%	2%	3%	2%	0%	0%	3%	2%	1%	4%	37
WHO_4	2%	1%	3%	1%	3%	2%	0%	2%	1%	3%	4%	0%	0%	0%	0%	1%	0%	37
CFAR_4	3%	2%	3%	0%	0%	0%	0%	0%	2%	0%	0%	0%	0%	3%	0%	3%	0%	35
DorisDuke_ Found_5	0%	1%	3%	2%	0%	2%	0%	3%	3%	1%	0%	0%	0%	0%	0%	3%	0%	35
DFID_4	0%	3%	2%	1%	0%	1%	0%	0%	2%	4%	4%	0%	0%	0%	0%	1%	0%	34
Harvard_4	3%	2%	2%	2%	3%	1%	2%	2%	3%	1%	0%	0%	0%	0%	0%	4%	0%	32
CDC_4	0%	1%	2%	2%	3%	0%	0%	1%	1%	0%	5%	0%	0%	0%	0%	0%	0%	31
NNSFC_CN_4	0%	1%	0%	0%	0%	5%	0%	1%	2%	1%	0%	0%	4%	0%	5%	0%	3%	27
RWA_Gov_2	0%	1%	2%	2%	3%	0%	0%	1%	1%	0%	5%	0%	1%	0%	1%	1%	0%	27
Total	59	211	1203	290	34	98	47	252	485	74	55	18	75	34	172	211	392	2157

Source: WOS and Scopus.

TABLE 16. Top 20 Funders (Share) per SDG – Tanzania. 2009 – 2017

Funder/SDG	1_No_poverty	2_Zero_hunger	3_Health_well - being	4_Quality_education	5_Gender_equality	6_Clean_water_sanitation	7_Affordable_clean_energy	8_Decent_work_growth	9_Industry_infr_innovation	10_Reduced_inequalities	11_Sustainable_cities	12_Responsible_consumption	13_Climate_action	14_Life_below_water	15_Life_on_land	16_Peace_justice_instituions	No_SDG	Total
NIH_4	11%	20%	25%	13%	33%	12%	6%	11%	13%	15%	13%	10%	12%	14%	12%	14%	11%	1843
Gates_ Foundation_5	5%	8%	9%	5%	0%	7%	3%	4%	5%	4%	3%	4%	2%	1%	1%	4%	3%	623
EU_4	5%	5%	7%	5%	4%	6%	2%	5%	5%	4%	4%	7%	7%	8%	7%	3%	4%	578
Wellcome_ Trust_5	1%	3%	7%	3%	1%	2%	1%	1%	3%	5%	6%	0%	2%	3%	2%	2%	2%	460
MRC_4	2%	3%	7%	3%	18%	1%	1%	2%	3%	4%	2%	1%	1%	0%	1%	2%	1%	396
SWE_Gov_4	4%	3%	3%	2%	11%	4%	5%	3%	2%	4%	2%	6%	4%	7%	3%	4%	4%	327
USAID_4	3%	4%	4%	3%	5%	2%	1%	3%	3%	1%	1%	3%	2%	1%	1%	2%	1%	304
NSF_4	1%	2%	2%	1%	0%	3%	1%	1%	2%	1%	2%	0%	4%	3%	4%	2%	4%	277
DFID_4	3%	2%	3%	2%	10%	2%	3%	2%	3%	5%	4%	2%	3%	2%	2%	3%	1%	246
DNK_Gov_4	1%	2%	2%	2%	0%	3%	0%	1%	2%	2%	3%	0%	1%	2%	1%	1%	1%	187
DEU_Gov_4	1%	3%	1%	1%	1%	2%	1%	2%	2%	3%	3%	4%	3%	2%	2%	2%	2%	176
NOR_Gov_4	2%	1%	2%	1%	0%	0%	2%	1%	2%	2%	2%	3%	2%	2%	2%	1%	2%	164
BEL_Gov_4	1%	1%	1%	1%	0%	3%	0%	1%	1%	0%	2%	2%	3%	2%	2%	0%	3%	152
WHO_4	0%	1%	2%	2%	1%	1%	0%	1%	1%	2%	1%	2%	0%	1%	0%	1%	0%	140
TZA_Gov_3	1%	1%	2%	1%	3%	0%	1%	1%	1%	1%	1%	0%	1%	0%	2%	2%	1%	135
NLD_Gov_4	1%	2%	1%	1%	0%	3%	1%	1%	1%	1%	1%	1%	3%	4%	2%	1%	1%	129
PEPFAR_4	1%	1%	2%	1%	1%	0%	0%	0%	1%	1%	0%	1%	0%	0%	0%	2%	0%	116
EDCTP_4	1%	1%	2%	1%	0%	0%	0%	0%	1%	1%	0%	0%	0%	0%	0%	0%	0%	114
CDC_4	0%	1%	2%	1%	1%	0%	0%	0%	1%	0%	0%	1%	0%	0%	0%	2%	0%	109
Univ_Dar_es_ Salaam_3	1%	1%	0%	0%	0%	1%	2%	1%	1%	1%	1%	1%	2%	2%	3%	1%	2%	100
Total	281	1078	5654	1376	73	442	177	1144	2249	269	328	210	520	470	1262	633	1618	10187

Source: WOS and Scopus.