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State of African research: Snapshot of abstracts for the 2018 Women in Science Without Borders indaba

According to the African Union's *Agenda 2063*, the development of Africa depends critically on science, technology and innovation.¹ However, Africa contributes to only about 1.3% of the global investment in research and development (R&D). In response, the African Union and the New Partnership for Africa's Development (NEPAD) initiated a series of consultations in 2003 which resulted in Africa's Science and Technology Consolidated Plan of Action (2005–2014).¹ In South Africa, the Draft White Paper on Science, Technology and Innovation was released for public comment in September 2018.² This document acknowledges that there has been slow progress on the gender agenda in many countries and includes gender transformation in the pillars required for a South African responsible research and innovation approach. Measures to increase cooperation between relevant stakeholders include the development of gender-sensitive monitoring and evaluation mechanisms. There are, however, concerns that this document does not clearly articulate the required strategy that will enable science and technology to contribute to the solutions for some of the country's challenges.³ A number of independent views have suggested that a variety of methods and processes is required to find solutions to these challenges.^{3,4}

In 2018, the annual Women in Science Without Borders (WiSWB) Indaba (conference) was held in Johannesburg (South Africa) to highlight and emphasise particularly the contribution of women researchers within the science, technology, engineering, mathematics, medicine and innovation (STEMMI) ecosystem to effect positive outcomes in a world in which, in fact, half of the consumers of STEMMI offerings are women. The 2018 WiSWB conference was thus an opportunity to focus on, inter alia, transdisciplinary issues that particularly have an Africa-wide urgency, such as institutional capacity development, inclusive sustainable growth and regional integration, through a gender lens with the overarching theme of the conference in 2018 being 'Resilience in Diversity'. During the preparation leading up to the 2018 WiSWB conference it was also realised that there is a dearth of centralised online information related to transdisciplinary research for both South Africa and Africa in general, that has captured both technical expertise along with demographic details of researchers operating within Africa. In order to achieve the targets of *Agenda 2063*, it is essential that information about transdisciplinary research, including information about the researchers, be continuously captured and updated. So over and above the core purpose of the conference which was to provide a platform to present transdisciplinary research, an additional objective of the 2018 WiSWB was to investigate how this process of collecting metadata on research might work by piloting a template which captures both conference-submission details as well as details about the researchers themselves, including, but not limited to, information on demographics and research interests at the time of submission. A particular feature of interest was to investigate the mobility of researchers, that is, from where they were born to where they resided during submission for the conference. We would like to remind the reader that the conference was not discipline focused but rather problem focused. Hence to encourage interdisciplinarity, submissions from prospective participants (gender-inclusive) had to fall within one of a number of themes, which also cut across a number of South Africa's national priorities, namely, Clean Energy, Climate Change, Digital Revolution, Disaster Management, Education and Outreach, Food Security, Gender Studies, Health, Industrialisation, Science Diplomacy, Smart Cities and Water. The intent was to also facilitate the identification of potential national as well as international collaborators working within the same themes with the purpose of strengthening further research impact.

Data

Data used in the analysis were acquired from the submission portal that was used by the conference organisers to enable the authors to submit their abstracts for peer review for the conference. The drop-down options for various items in the submission form was designed to capture various aspects of the research as well as of the researchers. The analysis presented below is a subset from the submissions database restricted to the African-Arabian region submissions only. No information presented here is meant to identify any individual submission; rather the intent is only to use this information to present a snapshot of the science landscape during the period leading up to the 2018 WiSWB conference. This snapshot is also not meant to be generalised.

Summary statistics

Descriptive statistics of all African and African-Arabian submissions

Preliminary results reveal that the country with the most submissions was Nigeria (55%); more than 60% of submitters were in the 30–45 age group and almost 50% of the main authors had a doctoral qualification. Most of the first authors who submitted abstracts were female (Figure 1a) and in the 30–45 age bracket (Figure 1b), and had a postgraduate or doctoral qualification (Figure 1c). This was true for both the South African and the African-Arabian submissions. Most submissions had one or two authors (Figure 1d). Most affiliations were research and/or educational institutions (Figure 2a and 2b).

Descriptive statistics by theme

The largest number of submissions overall was under the Health theme (26%), followed by Food Security (17%) (Figure 3a) – which is indicative of these being the two most urgent transdisciplinary problems in the African-Arabian region in this period. The trend in South Africa was similar to the overall trend, although Clean Energy was somewhat more prevalent and Food Security somewhat less (Figure 3b).

The proportion of countries that submitted in each theme (Figure 4) also shows that the Health and Food Security themes were addressed by almost half of the 27 countries represented (14 and 13, respectively). Nigeria and South Africa generally had the most or second-most submissions for every theme.

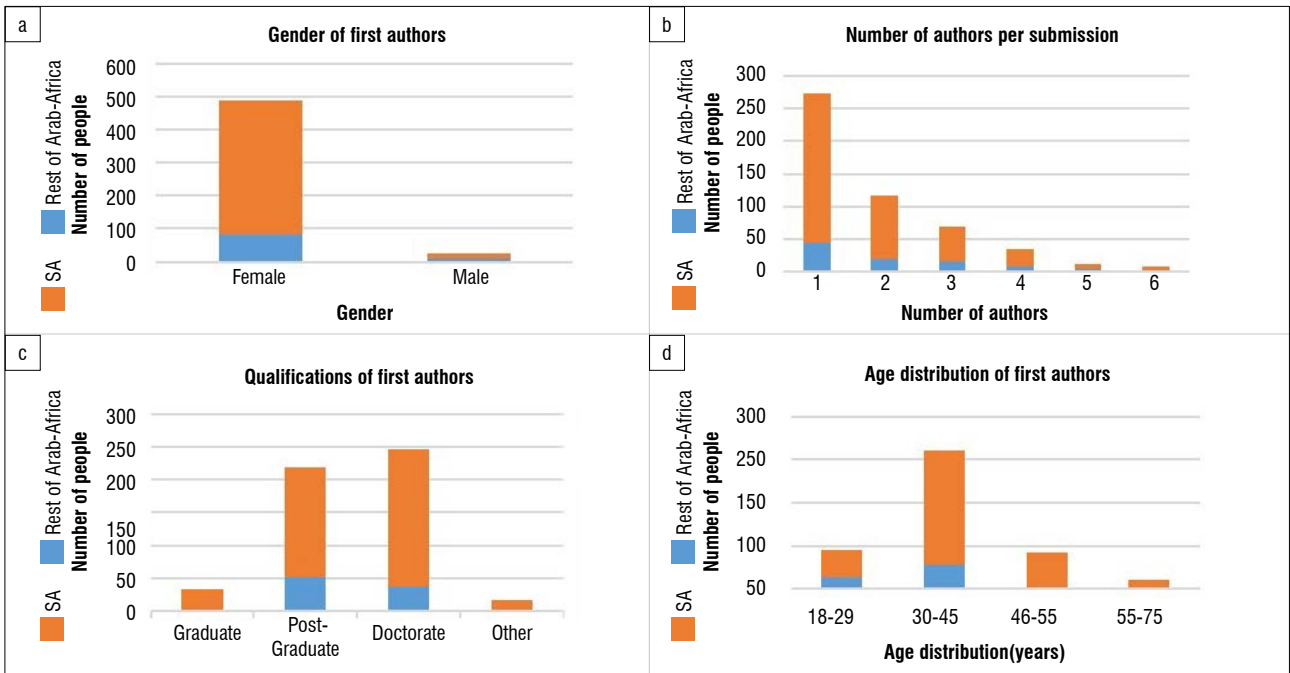


Figure 1: Descriptive statistics of all African-Arabian submissions including South Africa (SA): (a) gender, (b) number of authors, (c) qualification and (d) age.

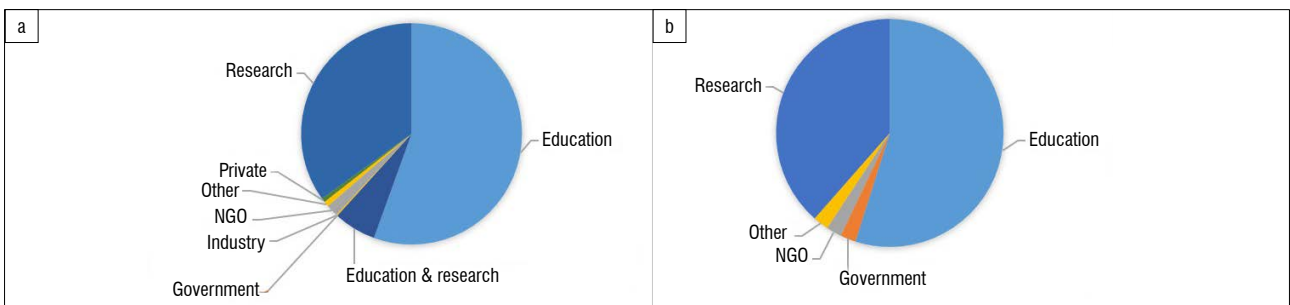


Figure 2: Affiliations represented by (a) African-Arabian and (b) South African submissions.

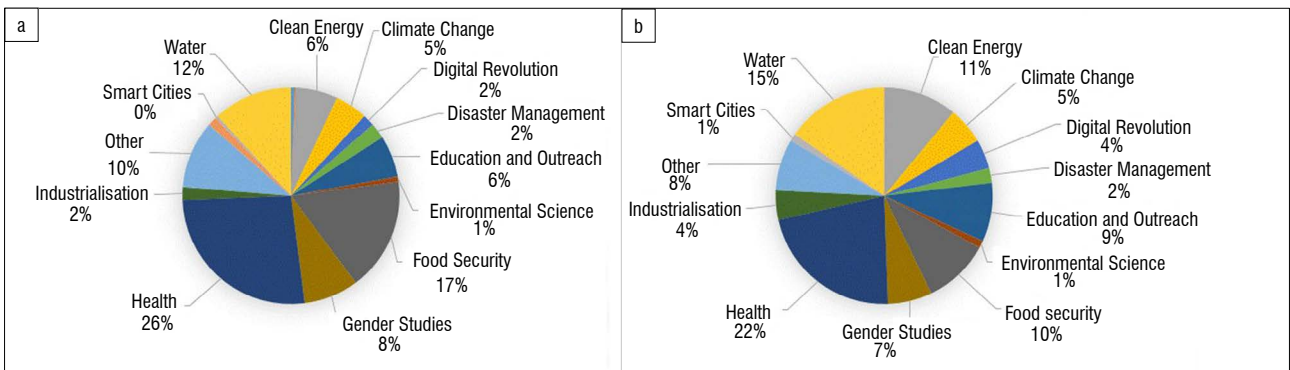


Figure 3: Themes represented by (a) African-Arabian and (b) South African submissions.

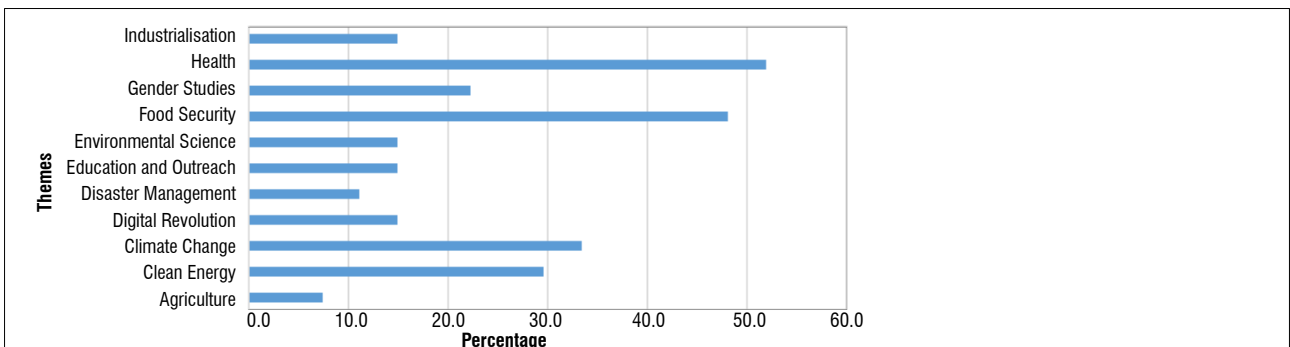


Figure 4: Proportion (%) of African-Arabian countries from which authors submitted in each theme.

Table 1 shows an example of the themes that were selected by the most submitters of abstracts in a particular country. This table shows that the Health theme was the most-selected theme in 12 countries. Although many of these countries had very few submissions and it is thus not generalisable to the whole country, this table provides an indication of the type of information that could be useful for a variety of purposes should the sample be increased. The table shows, for example, that 56% of abstract submissions from Tunisia were classified under the Health theme, 50% of all submissions from Ghana were in Gender Studies and 23% of all submissions from Ethiopia were Food Security related.

Kumu analysis of submission data for the African-Arabian region

An envisaged outcome of the conference was to establish a database of metadata from the submissions to identify common goals in the region using Kumu, an open-source mapping tool. Kumu (meaning teacher or source of wisdom in Hawaiian), is a web-based visualisation platform that can be used to map systems and improve the understanding of relationships (<https://docs.kumu.io/about/what-is-kumu.html>). Kumu allows shared access, which enables collaboration between individuals and teams. Kumu provided an ability to explore and visualise inherent complex relationships within the submission metadata, by location, age distribution, submission themes and research interests. A spatial component was applied to show different features by location. All features were displayed by age category.

Figure 5a represents the spatial distribution of all African-Arabian submissions (any type), colour coded by the age range of the main author. The locations of South African submissions are shown in Figure 5b. In the 2018 WiSWB, Nigeria was the leading contributor with the majority of them in the 30–45-year age group. Very few submissions came from north and west Africa. Overall, there were very few submissions from authors older than 46 years of age.

Submissions by theme and age category

The themes most selected by submitters, by age category, are mapped in Figure 6a–f.

South African themes

South African submissions were mostly from metropolitan areas, which is a consequence of the location of the leading tertiary institutions. More data visualisations can be obtained from the link: <https://embed.kumu.io/ce17de8afaf6e5a6577f5f4ffe79e83a>.

Areas of interest

In addition to the theme, submitters were requested to indicate area of interest. These areas may give a broader perspective on potential areas of collaboration.

Further analysis for combination of submission features

An example of further ways to interrogate the collected data is the location of different age groups by their qualifications (Figure 7a–c). As expected, most of the graduates were in the lowest age group (18–29 years).

Table 1: Theme with the highest number of submissions for each country

Most-selected theme by each country	Country	% Total submissions by country (total number by country)
Clean Energy	Burkina Faso	100% (2)
	Uganda	100% (1)
	Algeria	50% (2)
Health	Jordan	100% (2)
	Malawi	100% (1)
	Oman	100% (1)
	Mauritius	75% (4)
	Benin	67% (9)
	Yemen	67% (3)
	Kenya	50% (8)
	Cameroon	40% (5)
	Egypt	30% (20)
	Nigeria	28% (286)
Water	Sudan	24% (21)
	South Africa	22% (92)
	Mozambique	100% (1)
Food Security	Tunisia	56% (9)
	Rwanda	100% (1)
	Botswana	67% (3)
	Ethiopia	23% (13)
	Congo	50% (2)
	Tanzania	29% (7)
	Zimbabwe	100% (1)
Climate Change	Madagascar	50% (2)
	Tanzania	29% (7)
	Congo	22% (2)
Gender Studies	Ghana	50% (18)

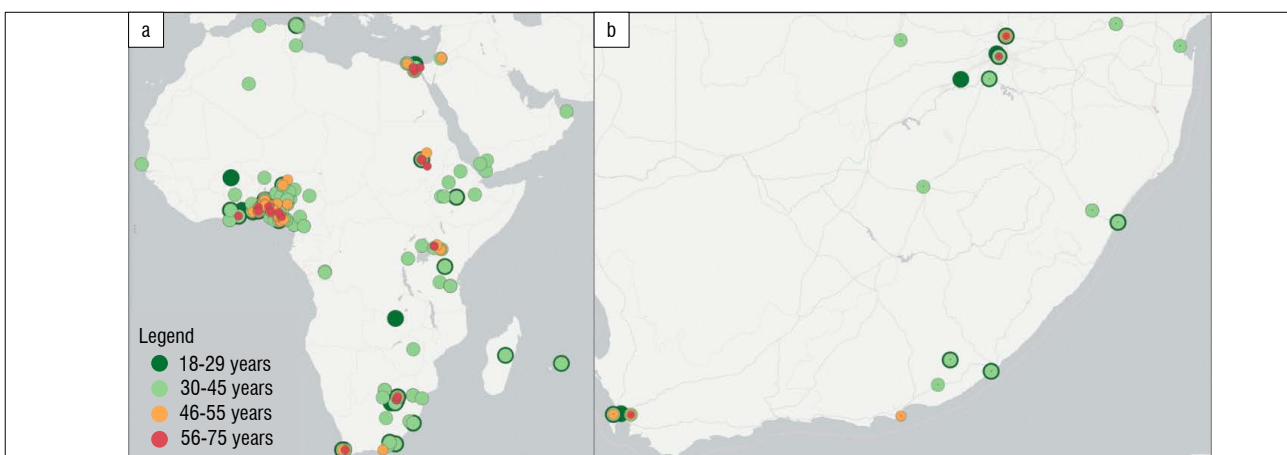


Figure 5: Cities represented by all (a) African-Arabian and (b) South African submissions, by age category.

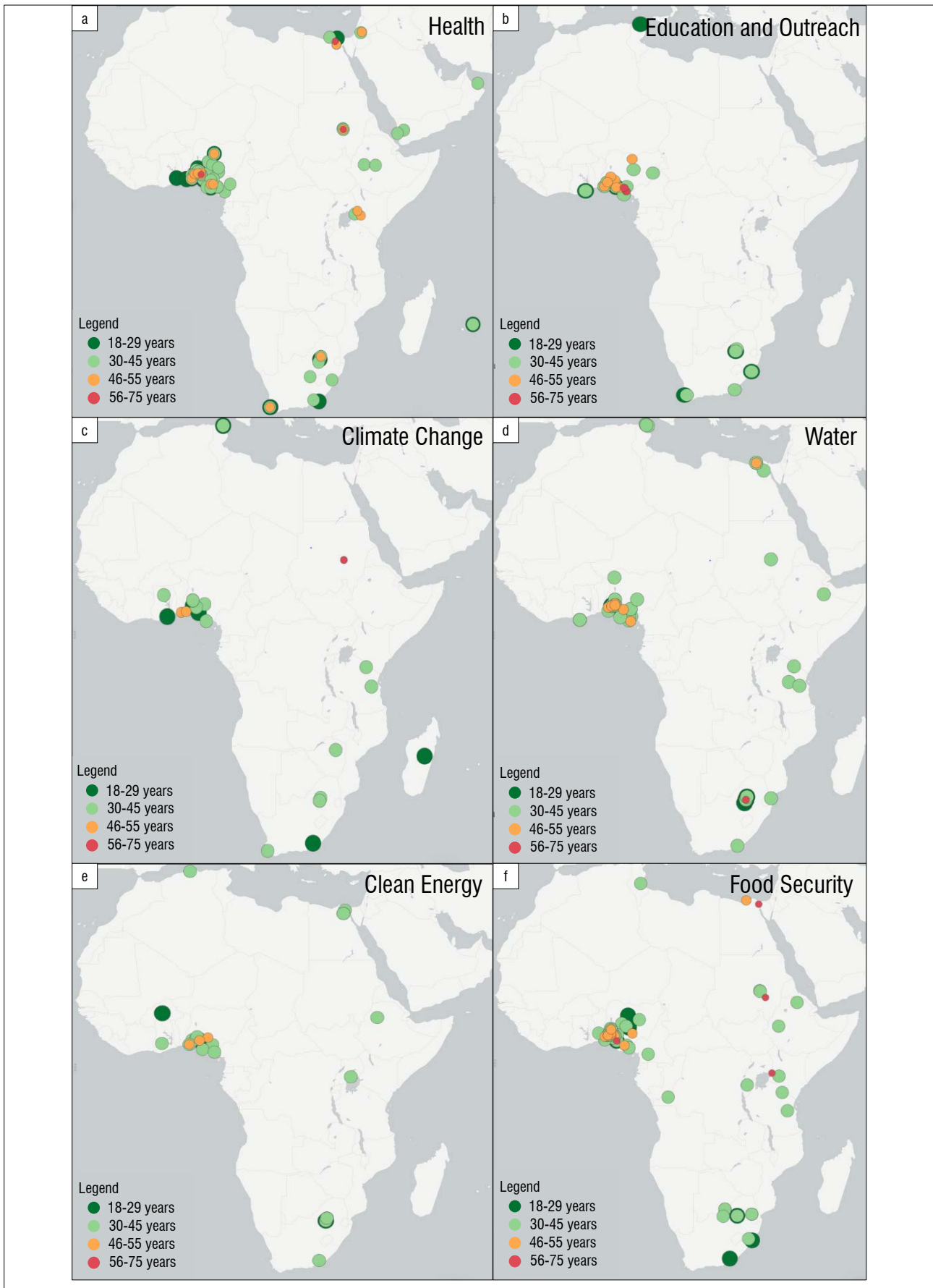


Figure 6: The most common themes selected by submitters, by age category.

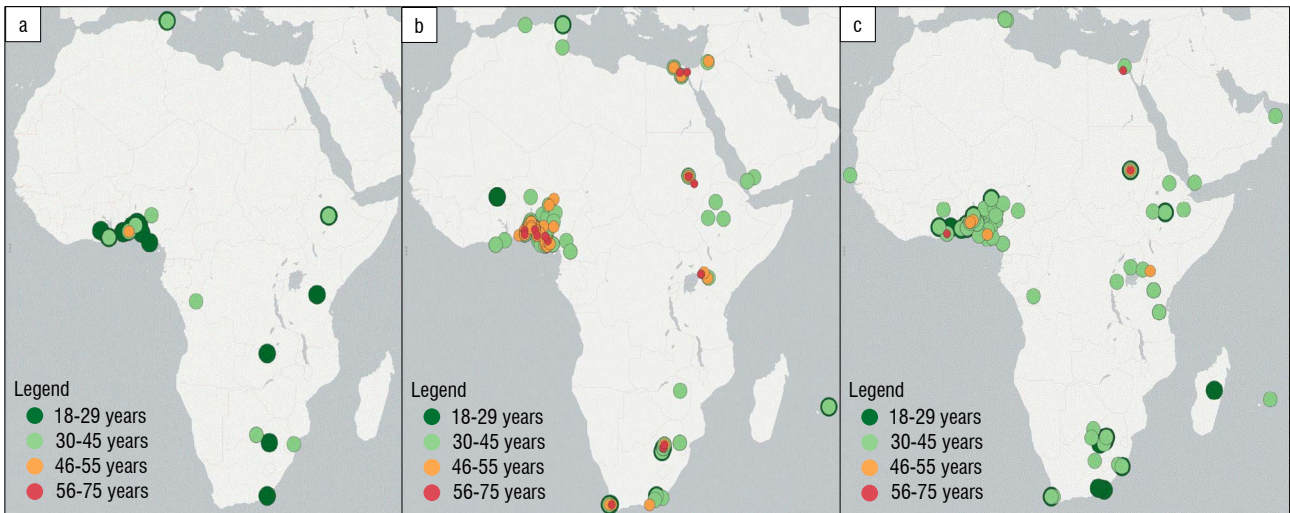


Figure 7: Age distribution by (a) graduate, (b) postgraduate and (c) doctoral qualifications.

It is interesting to note that most of the 56+ age group featured in the postgraduate category, while the 30–45-year group had a prominent presence in the doctorate category.

The birth countries of first authors who indicated that their country of birth was different from the country from which they were submitting, are indicated in Figure 8. This figure provides an indication of the degree of migration by researchers. It is encouraging to note that researchers from a variety of countries, even from outside of Africa, are working within the African continent to pursue higher education and research.

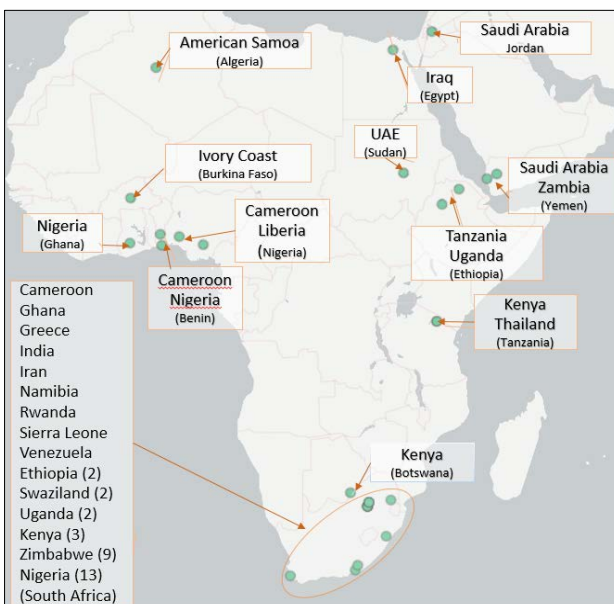


Figure 8: Birth country of author where it differed to country of residence (country of submission in brackets).

Concluding remarks and recommendations for the way forward

We have presented some findings from the abstract peer-review process of the 2018 WiSWB. A specific focus has been on the technical details as well as details related to the broader demographic and interdisciplinary nature of the submissions.

To effect any of the objectives of Africa’s Science and Technology Consolidated Plan of Action (2005–2014), it is vital to measure what

needs to be managed. During the preparations leading up to the conference, a rapid desktop search on R&D expenditure in Africa found only a few online references that provide government expenditure in STEMMI R&D, and then for only some countries.⁵⁻⁷ Even for South Africa, there is no single portal that provides details of headcount and full-time equivalents by gender, age, qualification or specialisation, let alone over time. No central location was found where similar data are archived on a regular basis for reference purposes. This gap in readily available R&D metadata motivated the collection of submission information to allow a snapshot view of the interplay among gender, age, qualification, location and research interests at the time of submission. The intent was thus to not only focus on traditional disciplines but particularly on how it can be applied across different themes to solve real-world problems. This information enabled us to visualise the state of various related factors across the continent.

Although the 2018 WiSWB conference was gender-inclusive, almost all submissions overall, as well as from the African-Arabian region, were by female authors. Hence, it provided an adequate data set to assess the landscape of research opportunities for female STEMMI researchers, by age, country and qualification. Also, the themes provided a potential proxy for the pressing problems in their respective countries. Given that the submission portal was piloted, it is acknowledged that it can, and should, continuously evolve to be more representative and relevant. It goes without saying that analysing obsolete data for impactful planning in R&D is a futile exercise. African countries should also adopt the practice of maintaining and sharing records on R&D expenditure on an annual basis regarding all aspects of data using the format of the US-NSF⁸, and make the data accessible for monitoring and evaluation purposes.

In conclusion, it is recommended that the African Union champions the setting up of a taskforce to coordinate the collection of detailed research profiles of researchers and research outputs. This initiative will assist in meaningful consolidation of R&D data to understand the status quo, and to identify locations for interventions as appropriate, to provide tangible inputs to help make the African Renaissance a reality.

Acknowledgements

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