


Country Report – Kenya, Rwanda, Tanzania, and Uganda

STINT
Stiftelsen för internationalisering av högre utbildning och forskning
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Foreword

Recognising the importance of intelligence and analyses for the development of international strategies for higher education and research at various levels of the knowledge system, STINT has compiled a series of brief country reports focused on their academic profiles and performance.

Released as a pilot series covering 16 countries, these country reports aim to provide national overviews using current and reliable data. The selection of countries is based on STINT's existing collaborations and other criteria, not least that the selected portfolio provides an interesting illustration of developments in the academic world:

- Brazil
- Canada
- Chile
- China
- India
- Indonesia
- Japan
- Malaysia
- Kenya, Rwanda, Tanzania and Uganda
- South Africa
- South Korea
- United States of America
- Vietnam

The reports give insight into each country's knowledge system as well as its demographic and economic context. Primarily, our intention is that both policy and decision makers, as well as practitioners within the Swedish higher education system, will utilise these reports in furthering international strategic collaboration at various levels.

Special effort has been made to include the latest available data. Data were collected in July 2020; for further details about the data and methods, see the Appendix. Several persons at STINT have been involved in the production of these reports: Erik Forsberg, Andreas Göthenberg, Niklas Kviselius, Tommy Shih and Hans Pohl, who was the project leader and developed the tables and figures.

Introduction

This section presents science, technology and innovation (STI) development in the four countries.[1,2]

Kenya

STI plays a critical role in catalysing Kenya's Vision 2030. Pursuing further development of STI could enhance Kenya's risk preparedness and help to buffer its development achievements against erosion by emergencies such as Covid-19. This ambition resonates with the aspirations of African Union's Agenda 2063 and the United Nation's Sustainable Development Goals (SDGs). Kenya's efforts to build STI systems include the establishment of enabling institutional arrangements. Through the establishment of the National Commission for Science, Technology and Innovation (NACOSTI), and affiliated agencies such as the Kenya National Research Fund and the National Innovation Agency, the country has strategically defined and aligned its knowledge needs and mobilised resources to ensure impactful outcomes. While there is general political agreement that STI is critical, the country still needs to find the best ways of effectively investing in STI. STI investment policy is focused on capacity building in education and research and development (R&D).

Knowledge production prominently features both state and non-state actors and is organised round formal education and research systems as well as informal systems such as Technical Vocational Education Training (TVET). Formal systems such as universities and public research institutions have supported knowledge production in various STI areas, particularly agriculture and health. The wider range of non-state actors, including think tanks and international and regional research centres, also

[1] For more details see A. Frost et al., Understanding knowledge systems and what works to promote science technology, and innovation in Kenya, Tanzania and Rwanda. Knowledge Systems Innovation Project (KSI), 2020.

[2] For more details see Science, Technology, and Innovation Policy Review of Uganda, UNCTAD, October 16, 2020.

contributes to this knowledge pool. Innovation hubs and fabrication labs can be found in the capital, Nairobi.

Rwanda

Rwanda's STI ecosystem is currently shaped by a transition to a knowledge and technology-driven economy capable of driving economic growth and supporting high quality of life. This transition from Vision 2020 to Vision 2050 is guided by the National Strategy for Transformation (2017–2024) that integrates other continent-level ambitions such as the African Union's Agenda 2063 and more broadly the SDGs. The country has also set up various policy and regulated frameworks for coordinating STI activities as well as funding support. Despite this, Rwanda continues to lag in research investments while also grappling to find appropriate approaches to design current and future investments that could potentially contribute to sustainable development.

Rwanda's public system supports the transformative potential of STI; the state plays the biggest role in financing and establishing knowledge-producing institutions including innovation hubs and universities. All public universities and their constituent colleges have been merged into the University of Rwanda. Emerging TVET institutions complement other public systems. These are aimed at equipping the youth to help the country to achieve the vision of its "Made in Rwanda" policy. Innovation hubs and fabrication labs support knowledge production as well as innovations in information and communications technology (ICT) to address widespread societal issues.

While the systems and institutions involved in knowledge production are more clearly set up in Rwanda than in other East African countries, challenges remain in building a critical mass of researchers and supporting potential co-producers of knowledge in the non-state sectors. Some explicit mechanisms supporting the delivering of STI to further the SDGs are in place. Most importantly, the establishment of the Science Granting Council has facilitated funding budgets for facilities such as industrial incubation centres and product laboratories as well as research supporting both formal and informal sectors. The governance framework has also created systems for enhancing appropriate funding for R&D activities through the

establishment of the National Research and Innovation Fund (NRIF), coordinated by the National Commission for Science and Technology. The government annually allocates 0.5% of the total budget to the NRIF, and there is recognition that more funding for STI activities is to be sourced through collaborative efforts in both bilateral and multilateral research projects.

Tanzania

STI is a key enabler for transformation and in achieving Tanzania's Vision 2025, the country's long-term framework for development. The vision emphasises the role of research and innovation; local entrepreneurship and technological development are to transform the country from a low-productivity agricultural economy into a semi-industrialised economy. This ambition resonates with the aspirations of African Union's Agenda 2063 and the SDGs.

Tanzania has taken various steps to build effective STI systems, including the establishment of various institutional arrangements to coordinate and fund research and innovation within the country. The Tanzania Commission for Science and Technology (COSTECH), plays a major role in coordinating and fostering STI activities, while the National Fund for the Advancement of Science and Technology is responsible for financing STI activities. Despite these efforts, the implementation of STI policies and design of effective STI strategies that can contribute to addressing societal challenges continue to lag. Emerging structures include innovation hubs, accelerators and incubators that complement industrial knowledge needs while linking local and non-local knowledge production and impact. Non-state actors such as think tanks and consultancy firms continue to spur international partnerships for enhanced knowledge production in various fields, including STI-related areas.

Uganda

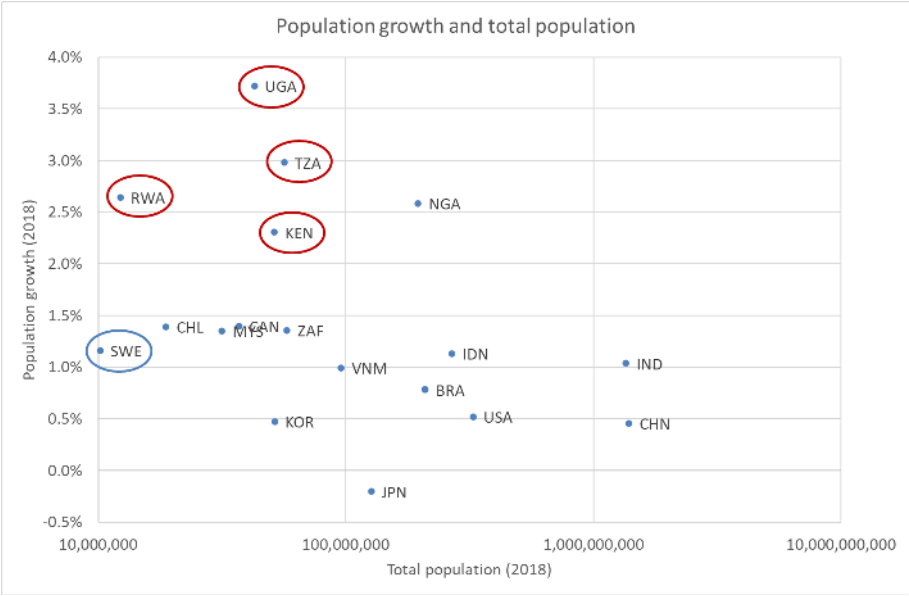
Uganda has had a robust development trajectory during the last 35 years. It has benefited from favourable natural resources and a relatively stable policy environment. The country's National Vision Statement, Vision 2040, states its ambition as achieving "a transformed Ugandan society from a peasant to a modern and prosperous country within 30 years." Opportunities identified in Vision 2040 include the oil and gas sector, tourism, minerals, and ICT industries. The vision cites several factors that favour growth and development, such as an abundant labour force, a central geographical location that facilitates trade, abundant water resources, and advantageous agricultural conditions.

The potential for industrialisation is vast, though it is dependent on the right framework conditions. These include developing general infrastructure, leveraging STI, managing land and urban development, nurturing the national human resource base, and providing peace and security. Focusing on innovation will energise transformational processes. However, several specific challenges present themselves to STI policymakers. To meet the nation's development challenges and enable Vision 2040, a revitalised effort is required to deploy STI as the catalyst of profound economic and social transformations.

Population and economic development

Tanzania is the most populous of these four countries at 58.0 million people, followed by Kenya with 52.6 million, Uganda with 44.3 million, and Rwanda with 12.6 million.

Figure 1: **Total population (logarithmic scale) and population growth**



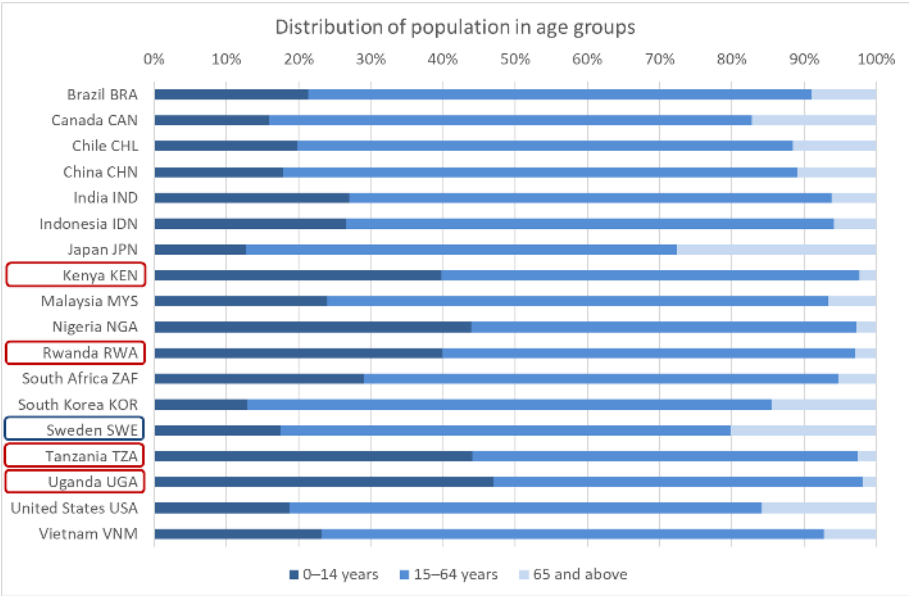
The four countries are grouped relatively closely together in terms of population growth, with Uganda showing the highest growth rate at 3.6% and Kenya the lowest at 2.3%.

According to UN forecasts, the population of Africa will have increased by 90% by 2050, compared to 2019. The population explosion is projected to continue in the following decades but will eventually taper off. By 2100, East Africa will be home to four of the continent's most populous countries: Ethiopia (115 million people in 2020), Tanzania, Uganda, and Kenya.

Many years of high fertility have created a high population momentum, meaning that even if the total fertility rate reaches replacement level (2.1 children per woman) in the next few years, large numbers of women will

still join the pool of reproductive women annually. Childbearing among these women will add to the population size for several decades to come.

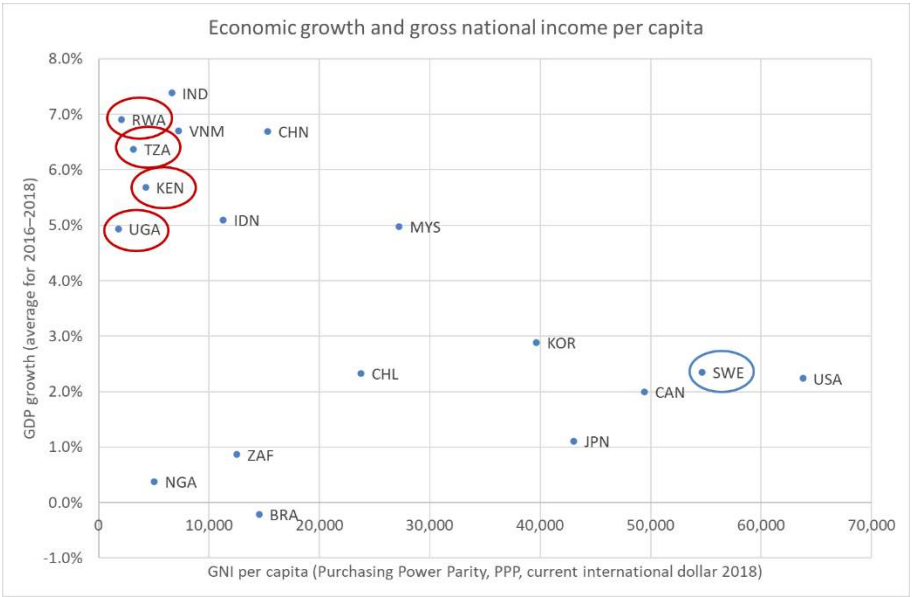
Figure 2: **The percentage of the population in each age group**



Decades of very high fertility in Africa coupled with rapidly declining child mortality have led to an age structure dominated by young people under the age of 25. The demographics of the East African countries, particularly those of Kenya, Rwanda, Tanzania, and Uganda, reflect those of Africa as a whole. Around 20% of the 168 million people in these four countries are between the ages of 15 and 24, falling under the UN definition of youth.

These countries will benefit from a demographic dividend, just like the Asian Tigers did, but eventually the population growth and high dependency ratio will exert pressure on basic services such as primary and secondary school capacity, healthcare, housing, and infrastructure. Rapid population growth will also put pressure on land, water, and other natural resources and this could contribute to food insecurity and resource-based conflicts.

Figure 3: **Gross national income (GNI) and gross domestic product (GDP) growth**

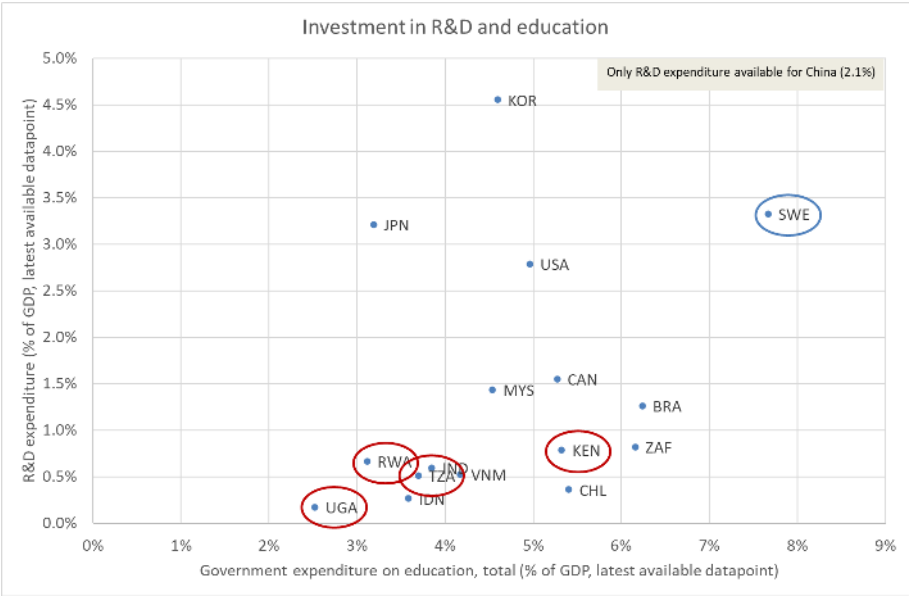


The four countries are grouped closely together regarding their gross national income per capita. Between 2013 and 2017, the average growth rate in the whole of East Africa was 6.7% – double the African average. In 2019, Kenya's economic growth averaged 5.7%, making the country one of the fastest growing economies in Sub-Saharan Africa. Economic growth in Rwanda exceeded 10% in 2019, driven mostly by large public investments to implement the National Strategy for Transformation. Strong growth was expected to continue in 2020. East Africa is overall one of the fastest growing regions in the world, accompanied by rapid social improvements. For example, average life expectancy has increased by 5.3 years over the past decade, with some countries registering historically unprecedented gains (for example, an increase of 8.5 years in Kenya and Rwanda).

The key development challenges in all four countries are still poverty, inequality, climate change, continuing weak private sector investment, and economic vulnerability to internal and external shocks. As a case in point, while the poverty rates of these countries have declined, the absolute number of poor citizens has not because of the high population growth rate. The

current economic outlook is highly uncertain, and risks are tilted to the downside.

Figure 4: **Expenditure on education and research and development (R&D), both as a percentage of GDP; data predominantly for 2017 or 2018**



Government expenditure on education in Kenya is over 5% of gross domestic product (GDP), which is higher than the expenditures on education in Tanzania, Rwanda, and Uganda. Kenya's expenditure on R&D in terms of a percentage of GDP is similar to that of South Africa and Rwanda. Tanzanian and Ugandan expenditure on R&D is less than 0.5% of GDP. In comparison, Swedish government expenditure is more than 7% of GDP for education and more than 3% for R&D.

Higher education institutions in Kenya, Rwanda, Tanzania, and Uganda

This section presents the development of higher education institutions (HEIs) in the four countries.

Kenya

In recent years, the Kenyan higher education sector has expanded. Where there were just five public universities in the country in 2005, there were 22 in 2015 with plans for as many as 20 new universities. Growth in the university sector has largely come through upgrading existing colleges. In addition, there are seventeen private universities and fourteen public and private university constituent colleges. An additional fourteen institutions have letters of interim authority to operate. All of these have the authority to award academic degrees. The growth in the number of universities has been accompanied by huge growth in enrolments. In the non-university sector, students attend public and private technical and vocational polytechnics, colleges (teacher and medical colleges), and other tertiary-level TVET institutions (e.g. technical training institutes, institutes of technology, and technical and professional colleges). Typically, programmes offered at these institutions are two to three years in length and lead to certificates, diplomas, and higher national diplomas. Current government plans call for the establishment of at least 20 new public universities, many in underserved regions, but recent budget cuts now call those plans into question. Meanwhile, shortages in lecturers continue to hinder quality enhancement and lead to ever growing student-to-faculty ratios.[3] There are reports on severe corruption in the Kenyan higher education sector.[4]

[3] For more details see N. Clark, Education in Kenya, World Education News, June 2, 2015.
[4] For more details see M. Kirya, Corruption in universities: Paths to integrity in the higher education subsector, U4 Issue 2019:10, U4 Anti-Corruption Centre.

Rwanda

The number of HEIs in Rwanda dropped drastically, from 54 to 40, between 2017 and 2018. This decrease is due to the merger of the eight Integrated Polytechnical Regional Colleges (IPRCs) into the Rwanda Polytechnic, as well as the closure of several private institutions over quality concerns. Most Rwandan HEIs (37 of 40) are private. For the most part these institutions are small, relatively new, specialised universities and HEIs, as well as religiously affiliated institutions and transnational providers like Carnegie Mellon University Africa (CMU-Africa). In 2018, 57% of all tertiary students were enrolled in private institutions. By contrast, despite enrolling 43% of students, there are only three public HEIs: the University of Rwanda (UR); the Institute of Legal Practice and Development, Rwanda's dedicated postgraduate institution for legal training; and Rwanda Polytechnic (RP). However, it should be noted that both UR and RP are large, multi-campus institutions. UR is the country's largest and preeminent multi-faculty research university with fourteen campuses and some 29,000 students. It was created in 2013 as a merger of all other public HEIs in Rwanda, including the National University of Rwanda. The Higher Education Council is the designated quality assurance body in Rwandan tertiary education. As in the case of medical training, advanced research education in Rwanda is still nascent. UR did not begin to offer PhD programmes until 2014, and is presently the only university in the country providing doctoral-level education. Admission requires a master's degree, and programmes involve at least three years of research and the defence of a dissertation.[5] CMU-Africa was established in 2011 and is the only US research university offering its master's degrees with a full-time faculty, staff, and operations in Africa. Born out of a partnership between CMU and the government of Rwanda, it addresses the critical shortage of high-quality engineering talent required to accelerate development in Africa.

[5] For more details see S. Trines, Education in Rwanda, World Education News, October 15, 2019.

Tanzania

Realising that the insufficient quality of the nation's workforce is a serious constraint to national development efforts, Tanzania drew up its Development Vision 2025. Among other things it envisages "a well-educated and learning society." Higher education in Tanzania, as elsewhere in Africa, is expected to be pivotal to national socioeconomic development. High-level technical and managerial staff are needed in leadership positions outside the education sector. Further, knowledge, creativity and the innovations required for sustainable national and international growth and development must be generated. Inadequate funding for higher education and research is a major problem in Tanzania. This regrettable situation is aggravated by endemic challenges of unstable partnerships and the unpredictable hand-outs from development aid. In fact, the funding of public universities and other HEIs in Tanzania largely depends on government grants, which in most cases are inadequate. The country faces unprecedented challenges to its education development agenda related to the funding and affordability of higher education. The problem seems to stem from the fact that education was free of charge in Tanzania until 1990s. However, with the increase in population and the number of students completing advanced secondary education, the government now faces the burden of providing free quality education. In Tanzania, the provision of higher education started around 1961, when the University of Dar es Salaam was established. Although there has been a significant increase in enrolments in HEIs, the demand for higher education is nonetheless far from being met. In Tanzania, access to and participation in higher education are determined by socioeconomic status, culture, religion, and gender.[6]

[6] For more details see C. Rupia, Challenges and Prospects in Tanzanian Higher Education, Makerere Journal of Higher Education, vol. 9, no. 2, pp. 51-58, 2017

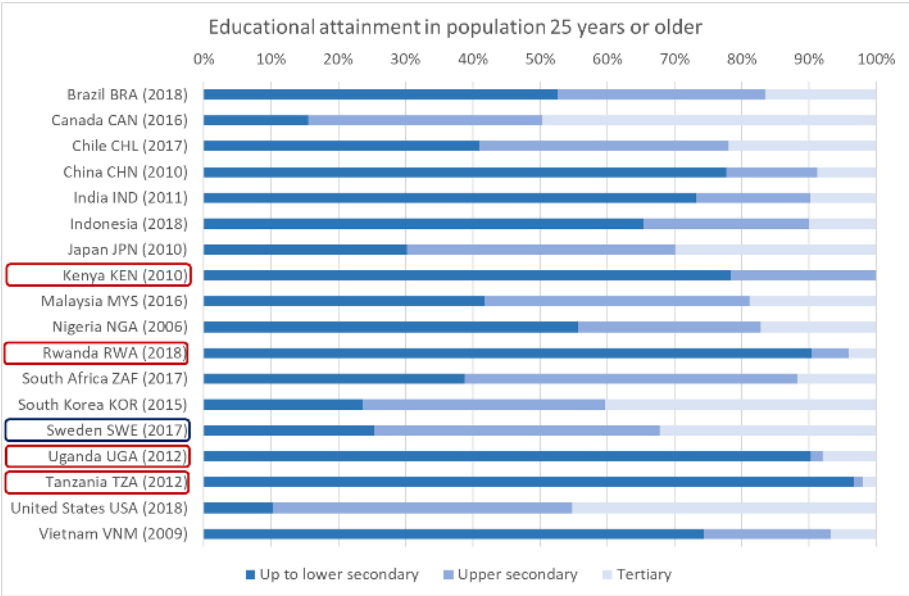
Uganda

Uganda's higher education system, once the envy of East Africa, is in dire straits. Strikes and protests by students, faculty, and staff over late pay, low salaries, tuition hikes, and safety concerns rock Ugandan universities every year. Low and late pay and a lack of academic freedom have made qualified professors hard to find and led to growing corruption, with degree forgery scandals implicating even the country's top university. The same challenges facing other levels of Ugandan education exacerbate these issues: rapid population growth and inadequate public funding. These concerns have led Ugandan reformers to call on the government to significantly increase its support of the country's HEIs if any hope of saving its universities is to remain. So far, there has been little response to those calls. Makerere University's high academic standards and solid research output have earned it a reputation as one of Africa's premier institutions of higher education. Prior to 1994, the Ugandan government funded the study of all students attending Makerere University. But the government's reluctance to increase funding meant that the university could not raise enrolment levels enough to meet the nation's growing demand for higher education. In response, the university introduced fee-paying students. Yet both government funding and private tuition fees proved insufficient to support an expansion in teaching facilities and infrastructure. More than a quarter century after the reforms, overcrowded lecture halls and student dormitories remain a concern, with reports of hundreds of students cramming into classes intended for fewer than 50. Despite these challenges, Makerere University remains one of the continent's top HEIs, but the issues outlined above are taking a toll.[7]

[7] For more details see R. Hassan, Education in Uganda, World Education News, October 8, 2020.

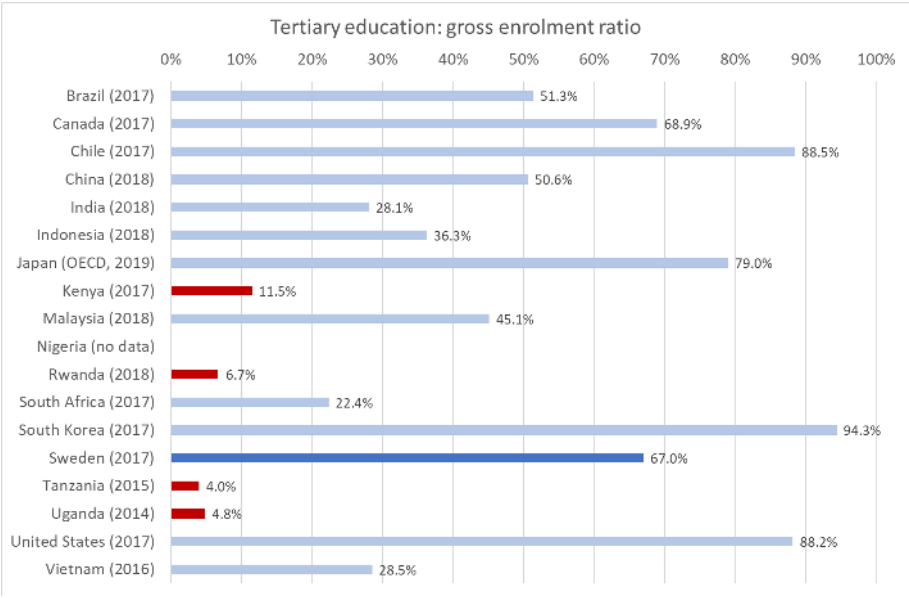
Educational attainment and student mobility

Figure 5: **Educational attainment**



There are no recent data on educational attainment for the populations of in Kenya, Uganda, and Tanzania. In Kenya, more than 20% of the population (25 years or older) had attained upper secondary education or higher (2010), while in Rwanda (2018) and Uganda (2012) about 10% of the population had attained upper secondary education or higher. Uganda stands out with almost 10% of the population having attained tertiary education (see Figure 5). Data indicate that over 95% of the population in Tanzania (2012) and about 90% in both Uganda and Rwanda had not attained upper secondary education or higher. By comparison, in Sweden about 40% of the population had attained upper secondary and more than 30% tertiary education (2017).

Figure 6: **Gross enrolment ratio for tertiary education**



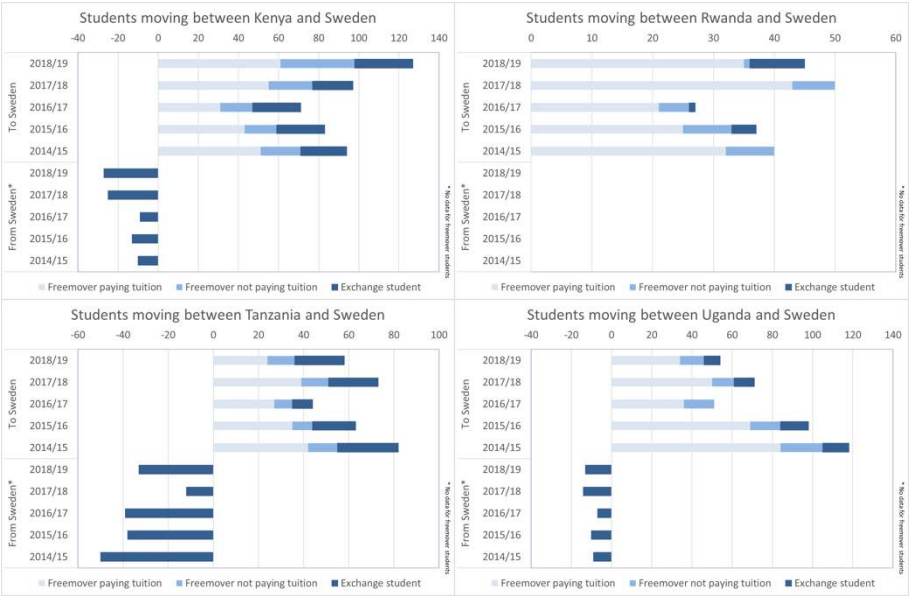
The gross enrolment ratio (GER) for tertiary education is indicated in Figure 6. This is the ratio of students enrolled in tertiary education divided by the 5-year age group starting from the official secondary school graduation age. The GER indicates the capacity of the education system to enrol students of a particular age group.

In Rwanda, Uganda, and Tanzania, the GER for tertiary education is very low at around 5% for each country. In Kenya it is slightly higher at 11.5%. The corresponding GER for Sweden is 67%.

Figure 7: **Inbound and outbound students, origins, and destinations**

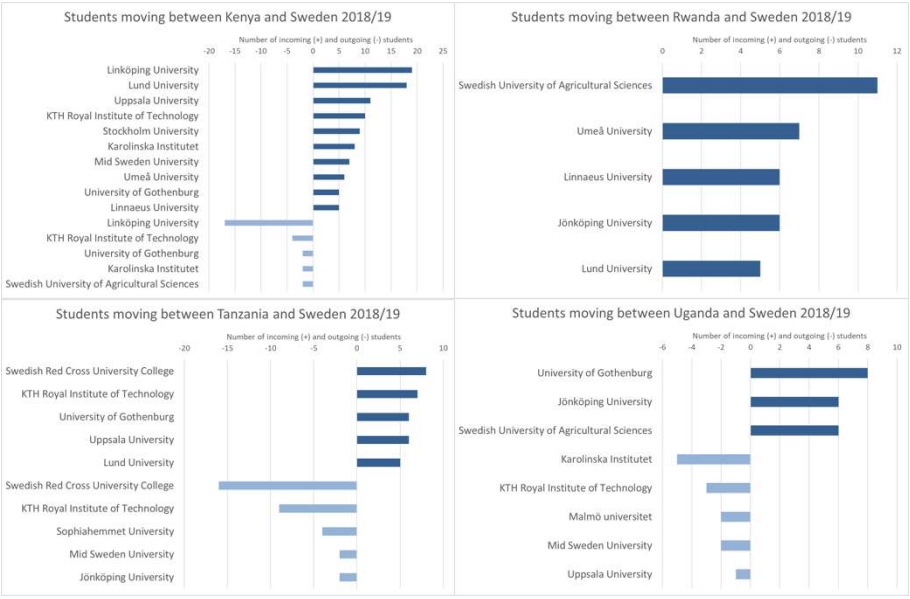
There are data from 2017 on the number of inbound students to Kenya and Rwanda. As can be seen in Figure 7, many inbound students come from neighbouring or other African countries and the total number of inbound students is under 3,000. There are a few thousand outbound students from each of the four countries. The most popular study destination for outbound students from all four countries is the United States. The second most popular study destinations differ between the four countries. These are Australia (Kenya), the Democratic Republic of the Congo (Rwanda), India (Tanzania), and the United Kingdom (Uganda).

Figure 8: **Inbound and outbound students to and from Sweden per year**



The numbers of inbound and outbound students to and from Sweden fluctuate from year to year and vary from a handful to a few dozen. The highest number of students coming to Sweden are from Kenya, while the largest number of outbound students from Sweden go to Tanzania.

Figure 9: **Inbound and outbound students to and from Sweden 2018/19, per higher education institution**



In the academic year 2018/19, the largest group of inbound students to Sweden from these four countries came from Kenya. They primarily attended programmes at larger universities, with Linköping and Lund as the top destinations. The majority of outbound students from Sweden to Kenya came from Linköping University. Rather modest numbers of students went to Sweden from the other three countries (34 or fewer). Few students went from Sweden to these four countries, with similar numbers going to Tanzania and Kenya, and none to Rwanda.

Research and collaboration with Sweden

The scientific production of Kenya, Rwanda, Tanzania, and Uganda is very small. Between 2015 and 2019, Kenya had the largest production of these four countries with 3,082 publications. Rwanda had a total of 427. The field-weighted citation impact (FWCI) is fairly high for all countries, especially for Rwanda at 3.30. An explanation is that many of these publications are internationally co-authored.

Table 1: **Selected publication indicators**

Based on publications 2015–2019							
Country	Annual publication volume (average)	Share of world	Annual volume growth 2015–2019	Citation impact	Share of int'l co-publ	Share of ac.-corp. co-publ.	Collaboration intensity with Sweden
		%	%	FWCI	FWIS	%	$NCII_{100}$
Brazil	79,128	2.54%	4.4%	0.90	0.79	2.1%	72%
Canada	110,493	3.55%	2.0%	1.51	1.31	4.2%	75%
Chile	13,929	0.45%	5.9%	1.22	1.42	2.0%	70%
China	559,913	17.98%	8.7%	1.02	0.55	2.4%	47%
India	164,707	5.29%	6.5%	0.82	0.43	1.2%	55%
Indonesia	24,572	0.79%	54.3%	0.92	0.58	0.7%	31%
Japan	133,011	4.27%	1.0%	0.95	0.69	5.4%	70%
Kenya	3,082	0.10%	7.2%	1.73	1.92	4.5%	124%
Malaysia	32,636	1.05%	5.8%	1.01	1.06	1.5%	30%
Nigeria	8,476	0.27%	14.0%	0.98	1.17	1.3%	36%
Rwanda	427	0.01%	11.2%	3.30	2.40	5.2%	203%
South Africa	24,423	0.78%	6.2%	1.26	1.29	2.9%	111%
South Korea	85,265	2.74%	2.0%	1.05	0.69	4.5%	35%
Sweden	42,975	1.38%	2.2%	1.68	1.55	8.3%	n/a
Tanzania	1,660	0.05%	7.8%	1.81	1.98	3.4%	178%
Uganda	1,741	0.06%	7.1%	1.76	2.04	4.8%	170%
United States	685,704	22.02%	0.9%	1.42	0.86	4.7%	74%
Viet Nam	7,649	0.25%	24.9%	1.43	1.67	2.2%	40%
World	3,113,580	100.00%	2.8%	1.00	1.00	2.6%	n/a

See the Appendix for detailed explanations of some of the indicators in Table 1.

Figure 10: **Annual co-publications per partner country**

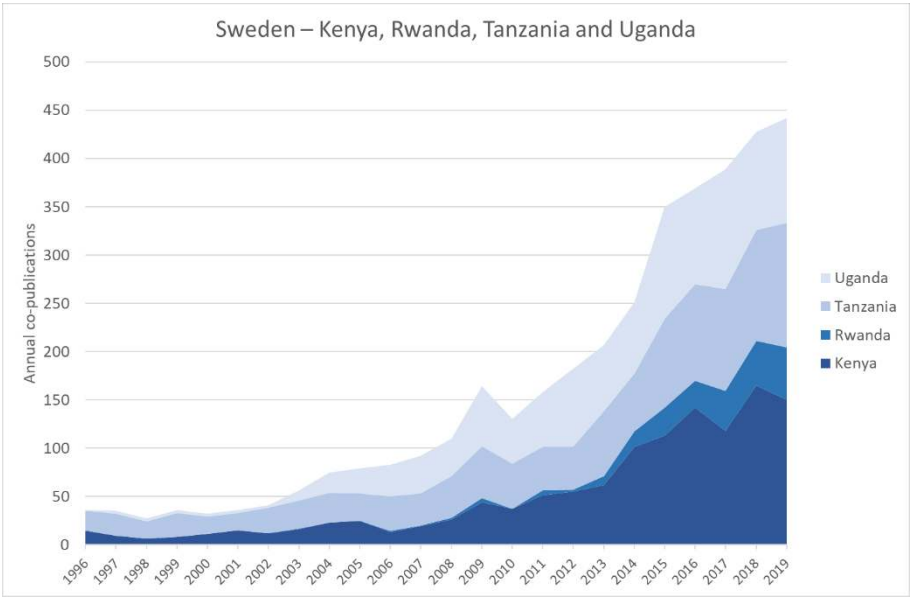
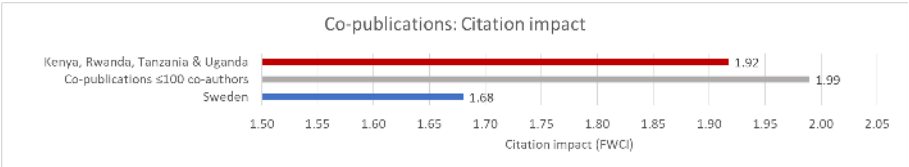
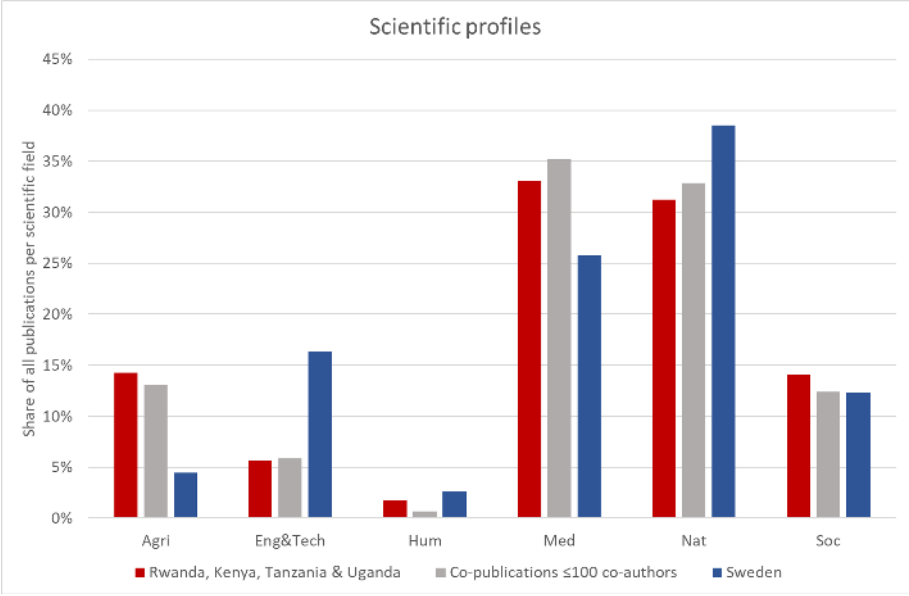


Figure 11: **Field-weighted citation impact for the four countries as a group, Sweden, and co-publications with ≤100 co-authors (2015–2019)**



The number of co-publications involving Sweden and Kenya, Rwanda, Tanzania and/or Uganda has increased during the last decade, as indicated in Figure 10. As a group, Kenya, Rwanda, Tanzania and Uganda have a higher FWCI than Sweden. Both Sweden and this group of East African countries benefit when researchers work together; as can be seen in Figure 11, Sweden particularly benefits from such co-publications.

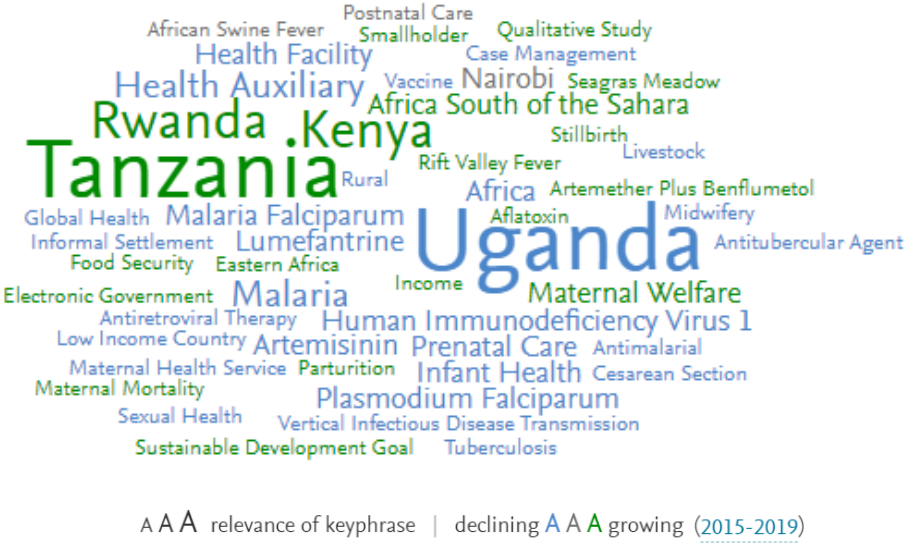
Figure 12: **Distribution of publications per scientific field (2015–2019)**



In Figure 12, the scientific profiles of research collaborations between Sweden and the four East African countries are compared with the overall profiles of Sweden and these countries. For example, approximately 14% of the publications involving one or more of the four countries are within the agricultural sciences. In Sweden, the share is clearly lower at 5%. If all scientific fields collaborated internationally to the same extent, the shares of co-publications involving both countries would typically lie between the national shares, as is the case for most fields. Medicine is overrepresented in the collaboration, whereas the humanities are underrepresented.

Whereas a high share of co-publications in agricultural sciences and medicine might be expected in collaborations with low- and medium income countries, the high share of co-publications in the natural sciences is more surprising.

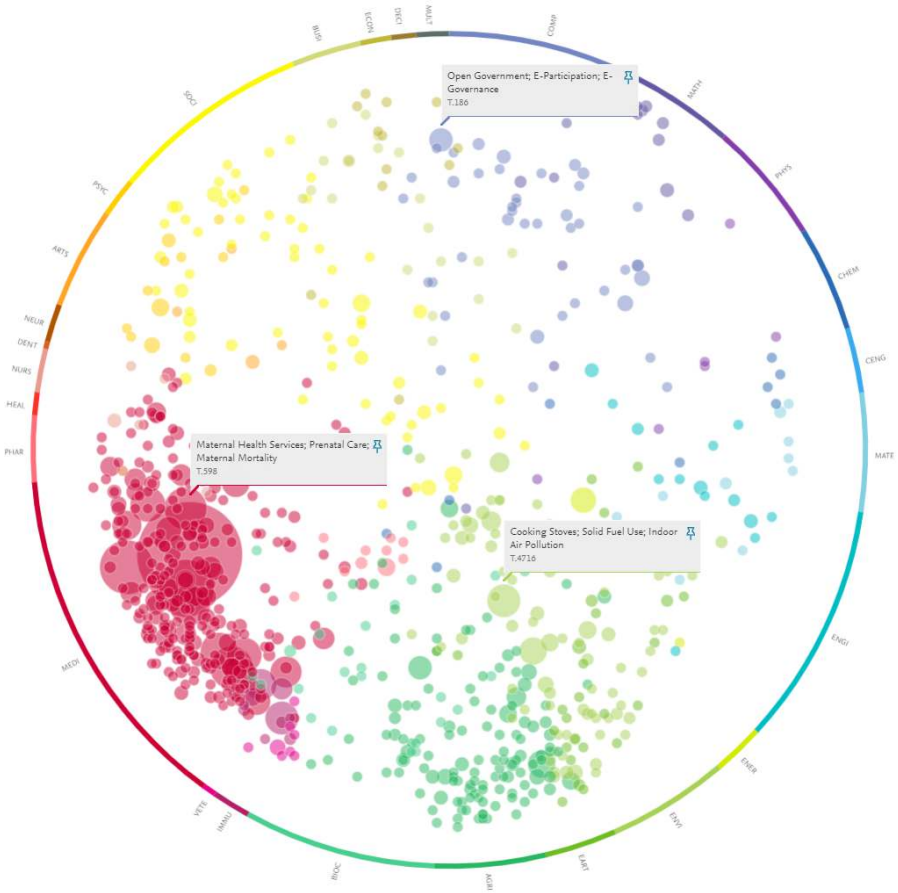
Figure 13: **Word cloud based on co-publications with ≤100 co-authors (2015–2019)**



The word cloud in Figure 13 was produced using Elsevier's Fingerprint Engine. It shows the most prominent keyphrases occurring in publications with co-authors affiliated institutions in Sweden and one or more of the four East African countries, based on their titles, abstracts and keywords. Large, green words signal highly relevant and growing keyphrases.

'Uganda', 'Tanzania', 'Rwanda' and 'Kenya' and several other words referring to the region are the largest keyphrases, whereas 'Sweden' does not occur. One interpretation is that the research done in collaboration between these countries has a stronger focus on the East African context. Other keyphrases such as 'malaria', 'informal settlement' and 'African swine fever' confirm a focus on predominantly East African topics. Several keyphrases pertain to medicine.

Figure 14: **Wheel of science based on co-publications with ≤100 co-authors (2015–2019)**



Publications involving Swedish and East African researchers are predominantly in medicine (see Figure 14). Another less dense cluster is in the area between agricultural and earth sciences. Apart from the mentioned clusters, the bubbles are fairly evenly distributed across the whole wheel, indicating comprehensive collaborations with several multidisciplinary co-publications. One of the larger bubbles represent e-government, combining computer and social sciences. Its size indicates that a high share of all included co-publications are on this topic.

Table 2: **The 20 institutions in Sweden with the highest share of co-publications with ≤100 co-authors (2015–2019). Only institutions with at least 300 publications during the period are included**

Institution	Co-publications with Kenya, Rwanda, Tanzania & Uganda (≤100 co-authors)	Share of all publications at the Swedish institution	FWCI
Stockholm Environment Institute	29	4.3%	4.80
Swedish University of Agricultural Sciences	306	3.4%	1.47
University West	27	3.1%	2.94
Dalarna University	23	2.2%	1.78
Royal Swedish Academy of Sciences	7	1.7%	13.05
Karolinska Institutet	545	1.5%	2.29
Umeå University	159	1.3%	2.36
Uppsala University	279	0.9%	1.78
Södertörn University	8	0.8%	2.94
University of Gothenburg	169	0.7%	1.61
Jönköping University	14	0.7%	0.45
Swedish Meteorological and Hydrological Ins	4	0.7%	4.10
Stockholm University	117	0.6%	4.10
Mälardalen University	14	0.6%	0.49
Blekinge Institute of Technology	7	0.6%	0.34
Linnaeus University	18	0.5%	0.87
IVL Swedish Environmental Research Institu	2	0.5%	1.22
Mid Sweden University	8	0.4%	0.50
Linköping University	60	0.4%	0.82
KTH Royal Institute of Technology	88	0.4%	1.89

Table 2 ranks Swedish HEIs and research institutes based on their co-publications with Kenya, Rwanda, Tanzania and/or Uganda (with up to 100 co-authors) as a share of their total publication output. All listed institutions have co-publication rates well above the Kenyan, Rwandan, Tanzanian and Ugandan shares of the total global publication volume (at 0.10%, 0.01%, 0.05%, and 0.06%, respectively). Some of the smaller Swedish HEIs rank highly in this list. This is typically due to one or a few prolific research collaborations between these and partner institution in Kenya, Rwanda, Tanzania and/or Uganda, which can have a significant impact, given the overall low volume of co-publications.

Figure 15: **Top ten Swedish institutions with the highest number of co-publications with ≤100 co-authors (2015–2019)**

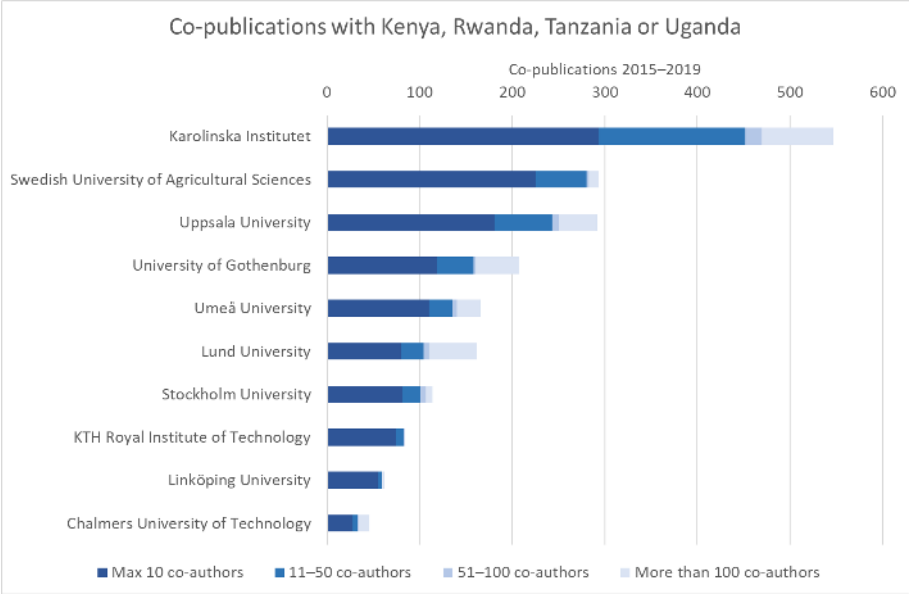


Figure 15 lists the ten Swedish universities with the highest numbers of co-publications with Kenya, Rwanda, Tanzania and/or Uganda, ranked according to the number of co-publications with up to 100 co-authors. These are all the same HEIs as the top ten Swedish universities by overall publication volume, yet in a different order. The ranking partially reflects the fact that medicine and agriculture are key fields for the scientific collaborations between Sweden and these four East African countries. As can be seen in Figure 12, the share of co-publications in these two fields are significantly higher than their share of Sweden's overall publication volume, following the publication shares of Kenya, Rwanda, Tanzania, and Uganda quite closely. This explains why the Swedish University of Agricultural Sciences ranks second here as opposed to tenth overall.

Figure 16: **Top ten institutions in Kenya, Rwanda, Tanzania, and Uganda with the highest number of co-publications with ≤100 co-authors (2015–2019)**

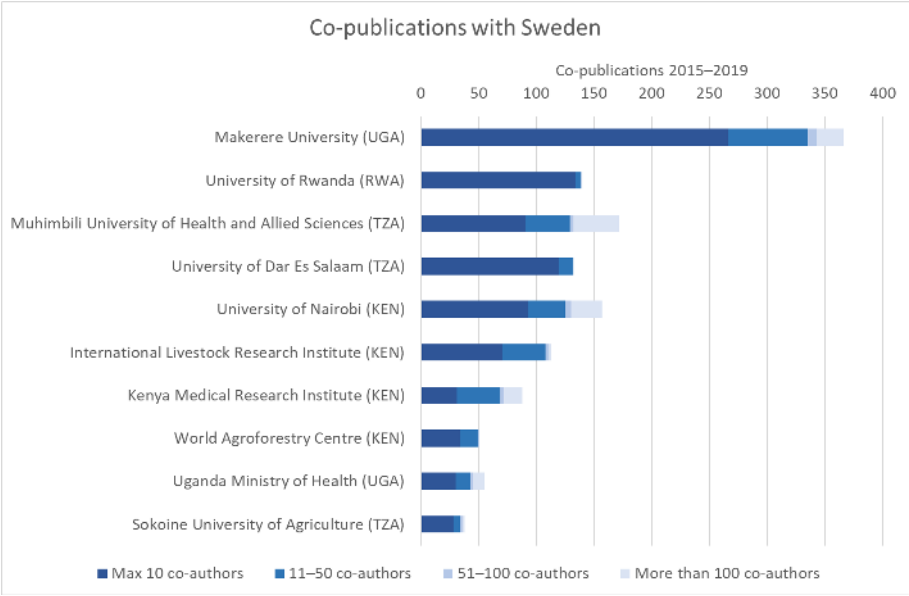


Figure 16 lists the ten universities and institutes in Kenya, Rwanda, Tanzania, and Uganda with the highest numbers of co-publications with Sweden, ranked according to the number of co-publications up to 100 co-authors. Makerere University, which ranks as the number one university in Sub-Saharan Africa (South Africa excluded), is clearly dominant. Half of the universities in the list focus on either agriculture or medicine, again emphasising the dominance of these fields in the research collaborations involving between Sweden and Kenya, Rwanda, Tanzania and/or Uganda.

Table 3: **Co-publication matrix for the top ten in both countries showing the number of co-publications with ≤100 co-authors (2015–2019)**

Publications 2015–2019 with up to 100 co-authors	Makerere University	University of Rwanda	Muhimbili University of Health and Allied Sciences	University of Dar Es Salaam	University of Nairobi	International Livestock Research Institute	Kenya Medical Research Institute	World Agroforestry Centre	Uganda Ministry of Health	Sokoine University of Agriculture	With Kenya, Rwanda, Tanzania or Uganda
Karolinska Institutet	160	6	82	8	43	1	35	-	30	1	470
Swedish University of Agricultural Sciences	37	12	4	7	39	79	3	39	-	20	283
Uppsala University	60	11	49	15	23	35	10	3	13	3	250
University of Gothenburg	26	43	6	13	14	4	4	2	6	1	161
Umeå University	35	25	13	4	4	5	15	1	4	1	140
Lund University	23	7	5	12	13	8	4	7	2	4	110
Stockholm University	3	10	1	28	4	7	1	1	-	3	107
KTH Royal Institute of Technology	18	3	-	25	6	1	2	5	-	-	84
Linköping University	6	10	2	5	6	1	2	1	-	-	59
Chalmers University of Technology	8	5	-	3	4	3	-	2	-	-	34
With Sweden	343	139	132	132	130	111	72	50	45	36	1,595

The co-publication matrix in Table 3 shows the co-publications (with up to co-authors 100 authors) between the top ten collaborating institutions in Sweden on the one hand and those in Kenya, Rwanda, Tanzania and Uganda on the other. This gives an indication of the distribution of the collaborations between Swedish and Kenyan, Rwandan, Tanzanian and Ugandan HEIs and research institutes. The blue/green bars represent the ratio of the number of co-publications between two HEIs/research institutes to the total number of co-publications (for the Swedish institution). Makerere University stands out as an important partner for all top ten Swedish institutions, with the exception of Stockholm University. The remaining collaborations are somewhat scattered; all institutions on both sides have a few important partners and few or virtually no collaborations with the others.

Appendix: Data and methods

Data

The report is based on data from the following organisations, accessed in June/July 2020:

- Population and economic data: World Bank, see https://databank.worldbank.org/home.aspx
- Educational attainment and student mobility: UNSCO, see http://data.uis.unesco.org, and the Swedish Higher Education Authority (UKÄ), see https://www.uka.se/statistik--analys/statistikdatabas-hogskolan-i-siffror.html (with one data point from the OECD for Japan)
- Research: Publication data from Scopus, the broadest available publication database, see https://www.elsevier.com/solutions/scopus?dgcid=RN_AGCM_Sourced_300005030

In some cases, there are clear differences in the student mobility data from UNESCO and UKÄ. Different reporting periods and definitions (see below) might explain some of these differences.

Methods

According to the UNESCO Institute for Statistics, an internationally mobile student is an individual who has physically crossed an international border between two countries with the objective to participate in educational activities in a destination country, where the destination country is different from his/her country of origin. For measuring international mobility in education, UNESCO, the OECD and Eurostat have agreed that the preferred definition of the country of origin should be based on students' educational careers prior to entering tertiary education. See http://uis.unesco.org/en/methodology#Q5

The research section includes several indicators and figures that might require further explanation.

Table 1, Selected publication indicators. The annual growth is calculated by using linear regression to approximate the volume development during the period 2015–2019. The field-weighted citation impact (FWCI) is a normalised indicator comparing the citations a publication receives with other publications in the same scientific field, from the same year, and in the same type of publication. If the FWCI is above one, the publication is more frequently cited than the world average, and vice versa. The field-weighted internationalisation score (FWIS) is normalised in a similar manner. A FWIS above one means that the publications are more international (include more international co-authorships) than the world average, and vice versa.[8] Academic–corporate co-publications include at least one academic and one corporate affiliation and at least two co-authors. Finally, the normalised collaboration intensity index (NCII) illustrates how the collaboration differs from a situation when Sweden (or another entity) collaborates with all countries in proportion to their share of all international co-publications globally. For example, authors with an affiliation in the United States participate in 16% of all international co-publications globally. In Sweden's international co-publications, the share of US co-authors is 11%. The NCII is calculated as the actual share divided by the 'expected' share, i.e. 11/16 = 67%, which indicates that US collaboration is underrepresented in Sweden's portfolio of international co-publications.[9]

Figure 12, Distribution of publications per scientific field (2015–2019). The scientific profile is calculated using the OECD categorisation of publications in six scientific fields: agricultural sciences, engineering and technology, humanities, medical sciences, natural sciences, and social sciences. For each field, the share of publications is calculated using the

[8] For more details, see Pohl, H., Warnan, G. and Baas, J. (2014), 'Level the playing field in scientific collaboration with the use of a new indicator: Field-weighted internationalization score', *Research Trends* 39, 3–8.

[9] For a more detailed description, see Pohl, H. (2020), 'Collaboration with countries with rapidly growing research: supporting proactive development of international research collaboration', *Scientometrics* 122(1), 287–307. https://doi.org/10.1007%2Fs11192-019-03287-6

number of publications within the field and the total number of publications in the dataset.

The **word cloud (Figure 13)** is a feature in SciVal, which uses the Elsevier Fingerprint Engine to extract distinctive keyphrases within the publication set. For more information, see https://www.elsevier.com/solutions/elsevier-fingerprint-engine

The **wheel of science (Figure 14)** is another feature directly available in SciVal. Each bubble represents a topic. The size of the bubble indicates the output of the entity on that topic. The position of the bubble is based upon the All Science Journal Classification (ASJC) categories of the journals in which the scholarly output is published. The position is related to the topic as a whole and is not affected by the entity examined. The greater influence an ASJC has over a topic, the closer the topic is dragged to its side of the wheel. As a result, the topics closer to the centre of the wheel are more likely to be multidisciplinary, compared to the topics along the edge of the wheel.

Note that a topic may be placed at the edge of the wheel, but still be considered multidisciplinary because it is equally influenced by a number of ASJCs that are located on the same side of the wheel.

STINT, the Swedish Foundation for International Cooperation in Research and Higher Education, was set up by the Swedish Government in 1994 with the mission to internationalise Swedish higher education and research.
STINT promotes knowledge and competence development within internationalisation and invests in internationalisation projects proposed by researchers, educators and leaderships at Swedish universities.

STINT promotes internationalisation as an instrument to:

- Enhance the quality of research and higher education
- Increase the competitiveness of universities
- Strengthen the attractiveness of Swedish universities

STINT's mission is to encourage renewal within internationalisation through new collaboration forms and new partners. STINT for example invests in young researchers' and teachers' international collaborations. Moreover, STINT's ambition is to be a pioneer in establishing strategic cooperation with emerging countries in research and higher education.

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