Making the World a Better Place to Live:

African Research and Education Networks' Contributions to the UN SDGs

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In September 2015, 193 countries came together at the United Nations General Assembly (UNGA) and agreed on a blueprint to create a better and more sustainable world. They adopted the Sustainable Development Goals (SDGs), as '*an urgent call for action by all countries - developed and developing - in a global partnership*'[1], designed to be realised by 2030.

Since then, governments, and non-governmental organisations alike, have aligned their activities with the SDGs as a roadmap to making their impact on the development of the global society and also realise global relevance. This alignment has reaped benefits for both the global society and these governments and organisations which includes increase in global influence and ability to attract funding from the UN and other global funding organisations.

Research and Education Networks (RENs) in Africa, both national (NRENs) and regional (RRENs) have also been contributing their best efforts to the achievement of the SDGs by helping to tackle urgent social issues and thereby creating value in several fields, including education, health, agriculture, gender equality, economic growth, and innovation. Unfortunately, this contribution has been, largely, underreported.

This paper seeks to contribute to remedying the situation by sharing evidence of the contribution of Africa and enhancing the visibility of the work done so far by the RENs.

1. The role of African RENs

The SDGs have become a benchmark to measure the success and relevance of an organisation or a project. Naturally, SDGs have attracted wide interest from policy and decision makers. A common misconception is that only governments are expected to drive them. Within the science, education, and innovation ecosystem, NRENs and RRENs play a crucial role in helping to meet these Global Goals by contributing towards them directly and indirectly.

Directly means through a direct service provision, such as better and more reliable internet connectivity to schools and universities, which makes access to education easier for many in the community. Indirectly, means that RENs use their activities and infrastructure as an enabler of other services and benefits that directly impact the SDGs. This is called a "multiplier effect" because the effects of their direct contributions to SDGs are multiplied and affect many other areas. For example, by providing internet connectivity to research institutes, NRENs also support the vital research that these institutes carry out in the fields of food science and safety, environmental sustainability, water and ocean management, to name just a few.

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[1] Do you know all the 17 SDGs? United Nations, Department of Economic and Social Affairs, Sustainable Development https://sdgs.un.org/goals#:~:text=At%20its%20heart%20are%20the,developing%20%2D%20in%20a%20global%20partnership.

By highlighting such examples and showing that their activities are SDG-tailored, African RENs will be more viable for funding and wield advocacy power. Presently, the primary roadblock in this field is the lack of awareness among decision-makers of what added value NRENs and RRENs can bring to higher education. This awareness gap may also extend to a lack of knowledge of how the ICT revolution has affected the education world, as nowadays, students and teachers are turning more digital and mobile. Therefore, if RENs are not telling the world how they are contributing to making the world a better place, they are missing an opportunity.

For this purpose, this paper showcases some of the concrete examples of the direct contributions of RENs to SDGs: SDG 4 (Quality Education), SDG 5 (Gender Equality), SDG 8 (Decent Work and Economic Growth), SDG 9 (Industry, Innovation, and Infrastructure), SDG 13 (Climate Action), and SDG 17 (Partnerships for Sustainable Development). In addition, this paper will share examples of how, through these direct contributions, RENs have an indirect impact on other SDGs.

2. Direct contributions to the SDGs

SDG 4: Quality Education

NRENs are leaping barriers to education in the African world through e-learning. They provide affordable and reliable high speed internet connectivity and associated services to higher education institutions and research centres. Thanks to lower connectivity prices and user-dedicated services, they help schools, vocational centres and universities provide a better research, teaching and learning experience and more opportunities to their learning community.

At the height of the COVID-19 pandemic, NRENs became the lifeline for many research and education institutions across Africa, as they provided alternative options to the normal learning approach which was unsettled by the pandemic.

An example of this was the Research and Education Network of Uganda (RENU) which brought metro eduroam to over 500 hotspots countrywide, providing off-campus Wi-Fi connection to users who could not visit their university campus. Building on the success of this service, in September 2022 RENU launched eduroam on the Go, a pocket-size routing device that enables researchers and university staff to connect to eduroam fulltime and not only from a few fixed locations. Both innovations work with the same authentication infrastructure as eduroam, so the features of security and gratuity for the users remain unchanged. Meanwhile, in Kenya, university students could access their online education resources thanks to KENET's partnerships with commercial Internet Service Providers offering discounted data bundles.

However, once a student is connected, what about the services they can access? Students need to be able to follow online courses, join trainings, download study materials, and upload their assignments. With these needs in mind, NRENs like ZAMREN in Zambia, TENET in South Africa, SLREN in Sierra Leone, MARWAN in Morocco and CCK in Tunisia offered free access to video conferencing tools, like Zoom and Jitsi, and platforms for Learning Management Systems like Moodle to their member institutions to help lecturers and students sustain teaching, ensuring learning continued across the continent during the pandemic.

By giving students the same opportunities to connect and have access to material and training, NRENs are providing them with the prospect of better employment opportunities. Ranging from ICT workshops and capacity building tutorials – like the Campus Technology Internship Program (CTIP) run by Eko-Konnect in Nigeria and the Somali Network Operators' Group (SomNOG) by SomaliREN – to hackathons for young girls – like ICT4Girls also in Nigeria, these and other internship programmes and training courses that NRENs run contribute to the employability of the local university graduates and

improve service delivery, aiming to bridge the gap between today's advanced computing and networking technologies in the continent's higher education community.

SDG 5: Gender Equality

African women are still a minority in the research field and academics of science. However, there has been significant progress in the field in comparison to other world's regions, such as sub-Saharan Africa which counts a 33% share of female researchers in all subject areas, while in North Africa, Tunisia, is the first country in Africa with a 55% share of female researchers[2].

Although there is still a lot of mileage to go, women are now more than ever making their way into leadership and other technical roles within African NRENs. For example, the national networks in Algeria, Tunisia, Madagascar, and Zimbabwe have women at their helms. Likewise, the national networks in Ghana and Benin have employed women in leadership positions within the organisations.

By giving girls and young women ICT education and the confidence to pursue ICT studies and careers and gaining access to attractive roles, NRENs and RRENs are helping women to become economically sound, and that is a source of other types of women empowerments. An example of that is the abovementioned ICT4Girls Hackathon for young girls run by Eko-Konnect in Nigeria and the Women-in-WACREN program run by the regional research and education network WACREN providing courses and workshops in ICT to over 2000 young women in Western Africa giving them a jump-start for their career.

Several NRENs and their member institutions have also provided equal opportunities to their personnel and students beyond the field of ICT. Through dedicated and focused training and mentorship programs they have been addressing the existing gender inequalities and worked to improve the opportunities available to women. An example of this was SANReN in South African and the University of Uganda, which have been running gender equality awareness training. Meanwhile, the University of Rwanda has been running mentorship programs and training for young girls. Furthermore, through its Center for Gender Studies (CGS) the University of Rwanda works in support of the government's gender equality objectives.

By adopting policies and joining initiatives that promote gender equality in the public sector, organisations ensure that scholarships are assigned equally to women and men, female students receive child support if needed, and that student mentorship is available equally to both genders. In 2022, Makerere University in Uganda has become the first public sector institution in the country to enrol in the United Nations Development Programme's Gender Equality Seal Initiative, designed to promote accountability for gender equality and women's empowerment in public sector institutions.

African RENs are making efforts in collaboration with the AfricaConnect3 Project to highlight the achievements and successes of their women in STEM by giving them more visibility in a series of online interviews and blogs on International Women's Day. Other member institutions are celebrating and recognizing progress and innovations made by women and girls in engineering and technology through organizing dedicated events – similar to the Harare Institute of Technology (HIT) in Zimbabwe hosting the Women in Technology Event on International Women's Day. HIT has also been collaborating with Wikipedia to improve the visibility of women under the Wiki Loves Women initiative.

SDG 8: Decent work and economic growth

Several aspects of our daily life and the challenges that our society faces are interconnected, and so are the activities run by RENs. In this case, education is strongly intertwined with a more sustainable and inclusive economic growth and better employment opportunities for all.

Elaborating on what was introduced in the paragraph on SDG4, both RRENs and NRENs actively offer online training and workshops to raise the capacities of their staff and that of the African community at large. The knowledge shared allows the beneficiaries to access a plethora of information from anywhere in the world. One of the targets of SDG8 is to substantially reduce the proportion of youth not in employment, education, or training. By executing their mission and increasing access to educational facilities and training opportunities, all RENs are a direct example of this target. With access to affordable digitised educational infrastructures, these high capacities raise the human capital development in African countries, equip more people with tech-related skills and eventually foster job creation.

Eko-Konnect and WACREN's ICT workshops and hackathons for young female students are an example of training courses that have helped them gain essential skills for the job market. Similarly, every year, RENU runs the Industrial Training Program for undergraduate students to be exposed to cross-functional operations and activities, in the form of hands-on working experience.

At the outbreak of the COVID-19 pandemic, the UbuntuNet Alliance offered online training to e-learning instructors and NREN engineers. Similarly, in 2021 the Arab States Research and Education Network (ASREN) ran a five-month-long workshop for NRENs' applications and systems engineers in the Arab region to build and deploy a national federation and join eduGAIN.

Thanks to the relevance and urgency of their work as well as their 360-degree understanding of the ICT world, NRENs also help shape public policies that play an important role in the economic development of their countries, such as TENET's regulatory submissions on behalf of the South African university community to various governmental authorities to provide advice for the improvement of existing national policies in the field of digital technologies, identity management and cloud infrastructure.

SDG 9: Industry, Innovation, and Infrastructure

The global internet connectivity network created between the pan-European Regional Network - GÉANT and the regional networks in Africa (the UbuntuNet Alliance, WACREN, and ASREN) is a regional and transborder infrastructure that is resilient, sustainable and reliable. This infrastructure facilitates the contribution that African NRENs make to economic development and human wellbeing on an international level but, more specifically, to the upgrading of the technological capabilities of the local communities by facilitating innovation, prioritizing affordability, and promoting inclusion.

From the inception of the initiative to provide affordable internet connectivity to Africa through this infrastructure, upgrades have led to more and more countries being connected as the AfricaConnect project progresses and the network grows in each instalment of the project. Not only is it sustainable, but it is expanding and growing to ensure that the benefits that can be offered through it, continue to spread across the region.

By leveraging on economies of scale made possible by RRENs, NRENs are able to provide internet connectivity at more affordable rates, better than private sector players and hence enable a more inclusive and fair research environment, especially in developing or less developed countries. Under the AfricaConnect3 project, upgrades to the internet connectivity infrastructure ensure continued increased capacity offerings to member countries while lowering per-unit prices. This, in

turn, allows for the seamless delivery of content, data, and services to users, enhancing their experience and enabling more effective collaboration and knowledge sharing. Additionally, these upgrades will see the connection of more countries and thereby extending the benefits to students, staff, and researchers. Most recent upgrades include that done by the UbuntuNet Alliance.

As a means of enhancing scientific research, upgrade the technological capabilities of industrial sectors, some of the infrastructure services that are offered by NRENs are extended to industry players as technological accelerants of productivity. A good example is in Uganda where RENU continues to upgrade its eduroam infrastructure to increase the access to internet for not only research and education institutions, but also penetrating into industry players such as airports and motor companies, making a significant contribution to the industry.

It is also worth mentioning the progress of RENs in open science. Through the LIBSENSE initiative RENs are building a community of practice across Africa to advance open science and open access. LIBSENSE seeks to leverage RENs to build capacities, enhance advocacy and develop shared platforms for the library communities across the continent. As the access to data, resources and platforms is open to everyone, innovation is spurred.

Finally, NRENs also enhance scientific research and innovation possibilities and upgrade the technological capacities of their member institutions. There are several examples of scientific experiments and innovations that NRENs have contributed to through their services by providing advanced dedicated connectivity to data-demanding users and bandwidth-hungry applications: the undersea ANTARES neutrino telescope, the ATLAS experiment, the Square Kilometre Array, and the Utafiti Africa platform are just some of them.

SDG 13: Climate change

Climate change is the world's "code red" warning[2]. With humanity's time to act running out rapidly, it is imperative that every organisation plays its role in slowing down climate change. RENs have been doing their part to combat climate change by considering their environmental impact and embracing more affordable and scalable mechanisms for climate change-conscious planning and management. This is a good first step towards tackling the current crisis and enabling countries to transform into cleaner and more resilient economies.

In line with this, some NRENs have placed an emphasis on adopting greener ICT policies to reduce the carbon footprint of their networks. CCK in Tunisia is working towards the establishment of a Data Centre fully compliant to energy saving standards. The Centre is expected to obtain the Green Data Centre label and the NREN is currently working with Deutsche Gesellschaft für Internationale Zusammernarbeit (GIZ) to instal photovoltaic panels to generate electricity.

Research infrastructure provided by NRENs provides a good mechanism to facilitate climate change education and research. For example, the National Authority for Remote Sensing and Space Sciences (NARSS), which is connected to Egypt's scientific NREN (ENSTINET), is using the provided connectivity to predict dust, sandstorms as well as monitor air pollution and oil spills in an effort to solve the biggest and most urgent environmental challenges. Similarly, WACREN has initiated a new programme called the WACREN Climate Programme aiming to offer services to climate research organisations, climate researchers, scientists and product innovators and meteorological agencies in

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[2] SDG 13 overview https://sdgs.un.org/goals/goal13

the WACREN enclave, riding on the back of in-country RENs. The services include data storage, cloud computing for analyses, and enabling weather stations.

SDG 17: Partnerships for the Goals

RRENs and NRENs bring together academic, scientific, research and institutional members. They are by definition associations of members and, as such, enable the creation of partnerships.

They are constantly developing, promoting, and benefiting from regional and international collaborations. Through mutually agreed terms and improved coordination mechanisms, RENs have been implementing global partnerships and capacity-building activities in a variety of fields, from network, services, open science to cybersecurity and cloud engineering for almost three decades.

For example, through peering, the pan-European network connects the regional networks which, in turn, are able to provide NRENs with a high-performance, highly resilient peering facility (up to 100Gbps), allowing access to a wide range of commercial network and cloud service providers.

RENs also collaborate with development partners and like-minded international organisations, such as the European Commission, Internet Society (ISOC), World Bank, the Open Researcher and Contributor ID (ORCID) and Network Startup Resource Centre, among many others. All cross-continental, cross-sector and multi-stakeholder collaborations aim to promote knowledge sharing and a global transfer of technical and operational expertise. To name a few, in 2021 LA Referencia, RedCLARA, the Latin America & Caribbean Action Network (LACAN) and ASREN signed an agreement to ramp up open science activities and continue information and infrastructure sharing between Latin America and the Arab States. In the same year, WACREN and the Regional Universities Forum for Capacity Building in Agriculture (ROFORUM) signed a memorandum of understanding about research data sharing and open access publishing of agricultural research data in Africa.

Other partnerships that have been formed through the years include the one between the Brazilian NREN, RNP, and the Mozambican MoRENet aimed to support an intense exchange of information on a number of areas ranging from telehealth to cybersecurity, including exchange training programmes for ICT specialists.

RENs have also set up several initiatives for regional and global capacity building, such as LIBSENSE, the Emerging NREN Programme and the Africa Training Initiative, alongside various training workshops in the areas of trust & identity, cybersecurity, cloud and network engineering.

SDG17 is about strengthening the means to implement and achieve sustainable development. All capacity building programmes are aimed to develop skilled staff who are equipped to support the NRENs and their members' networks to ensure the effectiveness and sustainability of African e-infrastructures and continue to contribute to SDGs.

The "multiplier effect"

RENs do not operate in a vacuum. Their contributions to SDGs do not end in the areas mentioned above but their support for a more inclusive access to digital infrastructures across the continent has spill-over effects on many other SDGs.

In other words, RENs connect and provide internet services to various hospitals and research institutes working on combatting health diseases (SDG3). Internet connectivity results in better administration, and aids in the provision of services such as remote scanning and operation of patients, similar to RENU which provides internet connectivity to a hospital facility in Uganda enabling remote surgery and training.

NRENs support the connectivity needs for the Digital Earth Africa platform addressing some of Africa's greatest sustainability challenges – like food insecurity (SDG2) by helping support sustainable farming practices through collecting information about ground cover, crop health and coastal environments, in addition to water management (SDG6) and climate change (SDG13).

NRENs also provide connectivity services to research centres and institutions working on combatting climate-related hazards. Similar to Egypt's scientific NREN (ENSTINET) that connects the National Authority for Remote Sensing and Space Sciences (NARSS) which is the pioneering Egyptian institution in the field of satellite remote sensing and plays a vital role in predicting dust and sandstorms (SDG13) giving asthma sufferers a breather (SDG3).

The internet connectivity provided by NRENs is key to enhance applications in geosciences and environmental sciences (SDG15). Soil mapping is one of these data-intensive activities which require reliable and high-speed bandwidth and seamless access to global data. The University of Zambia has been benefitting from ZAMREN's high speed bandwidth to create digital soil mapping to monitor soil degradation and provide inputs to sustainable land management.

Other examples include KENET which supports connectivity needs of end users working at the TAITAGIS project in Taita-Taveta University aiming at boosting access to geoinformatics education and training in the forestry, agriculture (SDG2), water resources (SDG6), health (SDG3), and education (SDG4) sectors, to be better equipped to collect and analyse environmental and climatic data to aid at adaptation to climate change, preparations for natural disasters and environmental protection (SDG13).

Furthermore, KENET Virtual Lab supports related research to preserve vital food source in Kenya and maintain sustainable growing methods of cassava plant (SDG2). And the Moroccan NREN MARWAN provides the connectivity needs to researchers and scientists in Ibn Zohr University working on food sustainability challenges (SDG2) by creating thematic maps of the Agadir region using remote sensing and GIS technology to help land management authorities take action to protect the area.

Conclusions

From providing students and learners with the necessary connectivity to access vital learning material to empowering female figures in the science and research fields. From equipping the community with the necessary skills to increase employability to improving the local digital infrastructure and, finally, to foster global partnerships. These are just some of the examples of the impact and value of African RENs on the wider R&E community. But as this paper detailed, this impact does not stop there. Instead, it spills over to improving the students' learning experience and their opportunities in the job market, contributing to crucial research projects, and enhancing healthcare services.

Despite the significant efforts to incorporate the SDGs into national strategies and development plans, the ambition of African countries to fully meet them by 2030 is hampered by the fact that sustainable development remains elusive in some areas, even more so in the age of the COVID-19 pandemic and political instability. Therefore, a growing emphasis is being placed on realising national, regional, and global synergies in an effort to achieve the development agenda.

This is paper collected evidence that NRENs and RRENs present an excellent promise for accomplishing significant progress in the achievement of some SDGs and have proved fundamental to ensure equality in access and promotion of innovation.

In a world where SDGs have become a parameter to measure the very purpose of existence of an organisation and its value, it is of the utmost importance that RENs start promoting their work in a way

that major world's actors and organisations understand and are interested in. This paper hopes to serve as a guideline for RENs to frame their activities as to align them to the needs and priorities of their existing and potential donors.