IFLA WLIC 2017 WROCŁAW

Submitted on: 19.06.2017

Synergies for Libraries in the Least Developed Countries: the Technology Bank in Pursuit of Sustainable Development

Barbara Aronson
Research4Life, Geneva, Switzerland.
E-mail address: barbara.aronson2@gmail.com

Tomás González
United Nations Office of the High Representative for the LDCs, LLDCs and SIDS (UN-OHRLLS), New York, NY, United States of America.
E-mail address: gonzalezt@un.org

Kimberly Parker
World Health Organization, Geneva, Switzerland.
E-mail address: parkerk@who.int

Cathrin Stöver
GÉANT, Amsterdam, Netherlands.
E-mail address: cathrin.stover@geant.org

Americo B. Zampetti
United Nations Office of the High Representative for the LDCs, LLDCs and SIDS (UN-OHRLLS), New York, NY, United States of America.
E-mail address: zampetti@un.org

Abstract:

Without rapidly building up capacities in Science, Technology and Innovation (STI), the Sustainable Development Goals (SDGs) will remain a distant dream for the nearly one billion people living in the Least Developed Countries (LDCs). The creation of the Technology Bank (TechBank) was included in SDG 17 and in December 2016 the UN General Assembly formally established it. The overarching objective of the TechBank is to help the LDCs build the STI capacity that they need to promote the structural transformation of their economies, eradicate poverty and foster sustainable development.

As the TechBank's Strategic Plan envisions, one area of its work will be on Digital Research Access and Networking, including a component for promoting National Research and Education Networks (NRENs) and a related area of work on Digital Access to Research (DAR). The NREN Facilitation is

expected to promote high-speed connectivity between institutions, campuses and scientists from LDCs and development partners and facilitate onward global connectivity among other goals. DAR should leverage the existing Research4Life partnership to increase online access to scientific journals, books, and databases and provide information access training for librarians and other relevant constituencies. The unique juxtaposition of these two elements: enhancing data-communication networks and connectivity and ensuring the access and capacity to use content delivered via that connectivity is a synergy that will be explored in this paper.

Keywords: Sustainable development; technology transfer; information access; ICTs; library catalysis

INTRODUCTION

The importance of science, technology and innovation (STI) for development that raises living standards and expands the horizon of opportunities has been present in the literature on economic development and also in international discussions for decades [1]. The rising importance of knowledge across the board, from economic competitiveness in the context of increasingly complex global value chains, to progress in virtually all social sectors, from health to education, from communication to governance, and the widening STI gap between the Least Developed Countries (LDCs)[2] and the rest of the developing world, are among the main arguments in favour of a LDCs-specific initiative.

There is a vast body of empirical studies that explore how technology diffusion operates through various channels. In the case of the LDCs, limited absorption capacity, weak intellectual property systems and an inadequate scientific and technical base are often cited among the factors preventing them from upgrading their technological capabilities[3].

The 1995 Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS) acknowledged the particular case of the LDCs by granting them special consideration[4]. Despite the enactment of this provision, its impact on enhanced capabilities through technology transfer in the LDCs has been modest, as attested by several analyses on this matter[5].

In the United Nations (UN) context, the objective of establishing a multilateral institution to promote Science, Technology and Innovation (STI) specifically geared to the needs of the LDCs emerged during the negotiations of the Istanbul Programme of Action for the LDCs for the Decade 2011-2020. [6] There UN member states stressed the critical role played by STI as a vehicle for structural transformation. To address this challenge, the UN established a new institution – the Technology Bank for the LDCs (hereinafter the TechBank) - to improve the LDCs' scientific research and innovation base, promote networking among research institutions and help the LDCs to access and utilize critical and appropriate technologies.[7] The fledging new institution, which is expected to be operational in 2018, promises to be a major step forward to enhance the contribution of STI to the sustainable development of the LDCs. In this context two key areas of work for the TechBank are expected to be on Digital Research Access and Networking, including a component for promoting National Research and Education Networks (NRENs) and the related area of work on Digital Access to Research (DAR).

The paper is organized as follows: section 1 reviews the development case for an initiative devoted to improving the STI base of the LDCs and the strategic priorities that such initiative

intends to pursue; sections 2 and 3 look at specific practical role that Digital Research Access and Networking can play in this context with section 2 focused on digital access to research and section 3 on national research and education networks; section 4 concludes by exploring the unique synergies at play in Digital Research Access and Networking.

1. IMPROVING THE STI BASE IN LDCS

Reducing the scale and depth of poverty in most LDCs will require a transition from activities in low- to high-added value sectors. Hence the emphasis placed on structural transformation as a process that shifts the productive structure of an economy towards dynamics that promote economic growth and sustainable development, and lead to an increase in the living standards, particularly of marginalized groups and the poor. [8]

The organization of large enterprises and industries dispersed across countries, with multi-layered networks operating across national boundaries and supported by information systems that allow spreading both manufacturing and services activities to separate locations, have resulted in new forms of functional organizations, with different levels of specialization on processes and materials at different stages of the development and production of goods and services. This complex web of economic relationships between firms located in different countries has reshaped the international division of labour. However the LDCs, with some notable exceptions, especially in the textile and apparels sector, remain primarily providers of commodities and raw materials, with important but negative implications for their economic performance and sustainable development.

Structural transformation requires modernizing the economy, moving at least partly away from traditional sectors towards more knowledge-based ones and enhancing the knowledge-content of existing industries and activities so as to increase value and returns to scale, and create new productive employment that reduces poverty and vulnerability by ensuring stable and predictable income.

An assessment of the difficulties faced by the LDCs to transform and diversify their economies suggests that low barriers to trade or spill-overs resulting from foreign direct investment will not per se increase access to technology and foster a knowledge-based economy. Limited institutional and domestic capacities to absorb knowledge and inadequate technical resources constrain their ability to upgrade their technological capabilities.

However, eliminating poverty and promoting sustained growth and sustainable development will require access to knowledge and technology, as well as the ability to generate endogenous scientific and technical knowledge that is relevant to the local context. Without a resolute effort in harnessing the potential of STI for sustainable development LDCs prospects will remain bleak.

A business as usual scenario is unpromising. The gap between the LDCs and the rest of the world in the capacity to generate and apply scientific and technological knowledge has been increasing. Countries of the Organization for Economic Cooperation and Development spent on average 2.4 per cent of GDP on research and development in 2015,[9] which dwarves the tiny amounts devoted to research and development in the LDCs.[10] This lack of resources is compounded by a narrow indigenous base of scientific literacy, which leads the LDCs to be highly reliant on the acquisition of technologies from abroad.

This trend separates the LDCs also from many others in the developing world, which in recent years have heavily invested in STI, placing them in a competitive position with countries in the North. The United Nations Educational, Scientific and Cultural Organization (UNESCO), in its Science Report 2010, stressed the dramatic increase of investments in science and technology by leading nations in the developing world and their positive impact on economic growth, while observing that, "by contrast, the group of least developed countries … still plays a marginal role".[11]

A useful indicator of the STI situation in LDCs is the number of articles published in scientific and technical journals by those countries. The number of scientific and engineering articles published in the fields of physics, biology, chemistry, mathematics, clinical medicine, biomedical research, engineering and technology, and earth and space sciences using the set of journals covered by Science Citation Index and Social Sciences Citation Index was 6556 in 2013 for the nearly billion people living in the least developed countries combined, up from 5675 in 2011.[12] This very limited production is in stark contrast with the advances registered in other parts of the developing world,[13] which today account for some 20 per cent of all science articles published in peer reviewed international journals are authored by researchers, even though knowledge production remains quite concentrated in six countries (Brazil, China, India, Malaysia, Mexico and Turkey), whose scholars contributed over 79% of the South's science publications in 2013.

The total worldwide number of scientific publications in 2014 exceeded 1.2 million, of which a mere 0.6 per cent were from LDCs, despite the their large share of world population (around 12 per cent).[14] This mirrors the very limited number of researchers from the LDCs, who only represent 0.8 percent of total.[15]

Another telling indicator of the modest STI base of LDCs is in the low number of patents filings. The combined number of applications filed by nationals of the LDCs was 628 in 2013 (up from 516 in 2010), accounting for a mere 0.07 per cent of patents filed by all countries in the developing world (totalling 940,165). Only very few of LDCs reported patent filings and most of them were concentrated in Asian LDCs and especially Bangladesh (303 filings). [16] These figures are particularly striking if compared with those in the rest of the developing world. For instance Viet Nam alone filed 3,995 patents.[17] Similarly the number of filings at the US Patents and Trademark Office show a very poor performance of the LDCs with only 23 filings in 2013 for all the LDCs, as compered for instance with 52 and 288 filings for Egypt and Malaysia respectively.[18]

This very low STI base makes it necessary to work on many fronts. On the one hand substantial investments of time, effort and resources are required to build the capacity of indigenous STI and eventually harness that capacity into productive activities, higher paying jobs, increased resilience to shocks and disasters and better management of natural resources and the environment. On the other hand adaptation and absorption of existing technologies remains necessary, as it was for the "newly industrialized countries", which used technologies from abroad to grow their industrial base before being able to generate their own scientific and technical knowledge.[19]

In all areas the LDCs need support. Building the STI base requires long-term investments to foster quality human resources, build facilities, procure equipment, develop relationships with research, firms and markets abroad, and secure online connectivity so that researchers

can interact with their peers, and access online publications. Ensuring absorptive capacities requires at least some technological expertise to be able to integrate external knowledge into the local economy.

The TechBank intends to address these challenges by helping LDCs build their domestic STI capacities to absorb appropriate technologies and generate knowledge. The TechBank aims at building the STI capacities of the LDCs through a variety of activities directed to support the development of national and regional innovation ecosystems that can attract outside technology, generate home-grown research and innovation and take them to market.[20] In this context two future areas of practical work stand out: Digital Access to Research and National Research and Education Networks. We will look at these in turn.

2. DIGITAL ACCESS TO RESEARCH AND RESEARCH4LIFE

Research4Life is an obvious existing UN partnership that could be leveraged by the TechBank for rapid delivery of results. The Research4Life public private partnership (PPP) has been active in more than 100 lower income countries, including all the LDCs, since 2002. The Research4Life framework has been negotiated and refined over 16 years, and has become a model for other access initiatives[21]. The partnership brings together UN agencies, 180 international publishers, universities and other organisations to provide researchers and others in the developing world with online access to high-quality international academic and professional journals, books, databases and other information resources (STP). The Research4Life partners are formally committed at least through 2020, with an additional 5-year extension in view. New publisher partners join regularly.

Research4Life takes into account developmental growth in countries by providing two levels of eligibility. All LDCs automatically qualify for the first level. Access fees, only applied at the second level, are kept remarkably low. LDCs, by virtue of their official status at the base of the global income hierarchy, automatically qualify for free access, as do a number of other developing nations whose relatively higher income levels still remain low. Thus, eventual graduation from LDC status is unlikely to impact free access for years afterwards, and even then only to a marginal annual fee.

Research4Life comprises four programmes operating online portals:

- **Hinari** (Access to Research for Health—www.who.int/hinari) was launched in July 2001 and opened for access in January 2002, offering an online library that comprises one of the world's largest collections of biomedical literature. Hinari is led by WHO in collaboration with Yale University.
- **AGORA** (Access to Global Online Research in Agriculture—www.fao.org/agora), launched in 2003, is led by the Food and Agriculture Organization (FAO), and with the support of Cornell University provides access to STP in agriculture and related biological, environmental and social sciences.
- **OARE** (Online Access to Research in the Environment—www.unep.org/oare), launched in 2006, is led by the United Nations Environment Programme (UNEP), offering access to the world's environmental science literature.
- **ARDI** (Access to Research for Development and Innovation—www.wipo.int/ardi) was launched in 2009 by the World Intellectual Property Organization (WIPO) to provide access to research publications addressing applied sciences and technology in the service of innovation. ARDI joined Research4Life in 2011.

- A fifth programme has been approved by the Research4Life partners, and is expected to be active online in the coming year. **GOALI** (Global Online Access to Legal Information) is being developed by the International Labour Office (ILO), and will focus on providing access to academic content in all subject areas of law, aiming to strengthen legal frameworks and institutions in the developing world.

The Research4Life programmes share "back-office" resources, including an umbrella website; portal host server; authentication database; content database; Customer Relation Management (CRM) system supporting the 8000+ registered institutions; usage statistics system; and registration page. Distributed resources include customized websites for the programmes, which are hosted by each sponsoring agency; and the electronic publications, which are held on the servers of the publisher partners. The Research4Life programmes collaborate on user training; communications; advocacy; "collection development" (building content); and monitoring and evaluation, including regular five-year reviews of the programmes and the partnership.

While Research4Life has established itself in all the LDCs, penetration and use are well below potential. Research4Life has learned through experience that concerted in-country campaigns (e.g. advocacy and user training) can overcome barriers to penetration and use. But accomplishing this in the more challenging environments of the LDCs has been out of reach of Research4Life's current capabilities.

Objectives and purpose of DAR:

To achieve its overall objective of "strengthen[ing] national capabilities and provide[ing] expertise to the world's least developed countries, ensuring that they are no longer left behind in achieving internationally agreed development goals", the TechBank will need to:

- Advocate to LDC governments for the importance of science and technology education and research.
- Leverage local champions.
- Produce measurable results quickly, to encourage commitment in the LDCs and in the donor community.
- Stimulate the production of high-quality research in the LDCs, including international research collaboration, both South-South and South-North.

By working with Research4Life as a new UN partner for the initiative, the TechBank will build on what Research4 Life has already accomplished, and produce results for and in the LDCs which are beyond the reach of the current partnership. Research4Life has proven that online access to the world's STP is possible in all the LDCs, although not without hurdles that need to be surmounted. A Digital Access to Research for LDCs Initiative led by the TechBank will ensure that the LDCs make the best possible use of this access.

The planned Digital Access to Research for LDCs Initiative will enable the TechBank to establish its "brand" and credibility quickly within the countries, with tangible, measurable results. It will enable the TechBank to create strong in-country networks, and to open channels for regular feedback from the LDCs to the TechBank. The substantial improvement in the scientific and technical information infrastructure in the LDCs that the Digital Access to Research for LDCs Initiative brings will enhance the ability of national institutions to train researchers and produce high quality research, laying the groundwork for the broader programme of activities of the TechBank.

Beneficiaries and expected accomplishments:

At country level, "information infrastructure" comprises two interactive elements: access to high-quality, relevant, up-to-date STP; and the capacity to integrate it appropriately in all relevant activities, such as teaching, continuing education, research, policy making, professional practice and public awareness. Building a national information infrastructure is essential for strengthening major functions within the country (education, health, the economy, etc.) to achieve internationally agreed development goals. Nevertheless, there are numerous barriers to be overcome, particularly in LDCs. These can be:

- Institutional: e.g. lack of capabilities to manage efficient internet access of key constituencies.
- Economic: many of the most important scientific journals and other STP are costly; online bandwidth in LDCs is more expensive – in real terms – than in higher-income countries.
- Generational: students and junior researchers are often the first to embrace new technologies, while the older generation of teachers and senior researchers, who are more resistant, hold decision making power within their institutions.
- Linguistic: the overwhelming majority of the world's STP is published in English.

Research4Life has had significant success in surmounting these barriers, particularly in the lower income countries. While there are variations from country to country, certain common "indicators for success" have become evident:

- High-level advocacy. Targeting the major decision-makers in the different national sectors is essential for achieving broad-based support, such as institutional budgets for internet access, and integration of "information literacy training" in university curricula and continuing-education programmes.
- Identifying and leveraging local champions. Local champions "spread the word" to their colleagues, and they also provide invaluable feedback about local needs, including identifying STP content gaps in particular for LDCs. Locally published content would be of particular interest.
- Training, training, training. The quantity and complexity of high-quality STP can be barriers to effective use in any setting, and especially in situations where there has been no access to high-quality STP for many years. Information literacy training helps users overcome these barriers and make the information work for them. Training workshops create immediate and long-lasting results, as measured by usage statistics on the publishers' websites and qualitative feedback.
- Improving the "user experience". Online interfaces, training materials and training workshops in national languages all help users to take optimum advantage of the Research4Life systems, even when the information they eventually retrieve is in English. Feedback from users also makes it clear that, at least initially, they prefer to find information in accustomed ways (for example via a simple web search). This means that the STP access offered by the Research4Life systems must be optimized to ensure that any new information is discoverable in familiar ways.

The planned Digital Access to Research for LDCs Initiative will build on these "lessons learned", and on the "local champions" already identified, to help the LDCs quickly maximize the potential of the resources offered through Research4Life to build robust national information literacy and information infrastructure. This in turn will strengthen capacity in the countries to train researchers and professionals and to support research and innovation.

Main activities:

The Digital Access to Research for LDCs Initiative will follow an incremental approach. The initial areas of work are:

- In country support: Intensive advocacy, training and capacity building.
- Technology: Reinforcing the Reasearch4Life technical architecture, and streamlining the "user experience".

In-country support:

Beginning with ten countries in the first year, the in-country support programme will be engaged in all 47[22] countries by year 6. Countries will transition through five stages, building toward self-sufficiency and eventual "graduation". The normal Research4Life framework will ensure that some country support is sustained even after a country graduates from LDC status.

As Research4Life already has users in all the LDCs, an informed selection can be made of the countries which appear to be at an "information tipping point", where a concerted effort will create the most significant results. Each year the in-country support will be expanded to include some countries at "tipping point" and some presenting a more challenging environment for quick uptake of STP. After Year 1, "champions" and trainers from the first countries will be directly involved in rolling out support in the next group of countries, creating regional networks and South-South collaboration.

In-country activities will include:

- Identifying "champions" for Country Focal Points to coordinate activities in-country.
- Training trainers, organizing workshops.
- Establishing workshop and support-centre venues, including "pop-up" structures.
- Creating professional networks through workshops which bring together students, researchers and professionals from different institutions, disciplines and functions (e.g. researchers, librarians, IT personnel).
- Providing technical support to IT personnel in national institutions.
- Training librarians and others to act as "support centres" within their own institutions and eventually as country-wide support experts.
- Providing feedback to improve and tailor services from the Research4Life-LDC initiative.
- Conducting surveys at workshops and generally among users to create baselines and measure activity and progress.

Upgrading and stabilizing Research4Life technical architecture:

A initial focus of this area of work will be on improving the way the users experience the STP access, particularly in response to user feedback as the in-country activities roll out in the LDCs. Improving the user experience, along with a major advocacy and training push in the LDCs will, in turn, create a significant increase in demand for Research4Life access, and put pressure on the technology, databases and infrastructures and services underpinning the access, for example the Help Desk environments and the website content management systems.

3. NATIONAL RESEARCH AND EDUCATIONS NETWORKS IN THE TECHBANK CONTEXT

Improving the architecture will only achieve results if the broader information communication technologies (ICT) situations in the LDCs is also improving. As Research4Life has learned well over the years, access to STI research alone can only push change forward at a slow pace. Other barriers, including communication network barriers, must be addressed.

What are NRENs?

NRENs are high-speed data-communications networks that are independent of the commercial internet and are dedicated to meeting the needs of the academic and research communities, i.e. the scientists of a country as well as its educational community. NREN infrastructure allows researchers, teachers and students to share information electronically in a reliable and timely fashion and to work together effectively across the globe. As the scientific community pushes at the boundaries of knowledge, researchers rely on dedicated data communications networks to provide greater speeds, timely delivery, seamless global reach and a very high level of resilience. This is what NRENs deliver.

NRENs customarily interconnect research and scientific institutions, as well as universities and tertiary education institutions within their national boundaries. Typically, an NREN provides the national backbone for connected campuses. NRENs then interconnect on a regional level into Regional Research and Education Network (RRENs) backbones, which then again connect to each other on a global scale.

Beyond these "pipeline" backbones, NRENs also provide a consistent federated approach to trust, identity and authentication infrastructure, allowing authenticated access to services such as roaming by enabling groups that trust each other, to extend that trust in linkages to ever greater circles of connections.

Today, about 110 countries across the globe have existing and interconnected NRENs supporting scientific advancement on a global scale.

NRENs and Theory of Change

It is widely acknowledged[23] that national development is in many ways driven by the level of research and research output, as well as the consequent intellectual property generation of the country. Furthermore the modern global research environment demands easy access to advanced ICT infrastructure and applications; easy access to the intellectual property generated around the world; and collaborative work with teams that are often transnational. For historical and other reasons, researchers in LDCs have been kept out of this global intellectual discourse, with negative impact on development in the countries. While it is not the only reason for the general under-development, the digital connectivity divide that for a long time isolated LDC-based researchers from the global research and education community has been a major contributing factor[24].

By ensuring the availability of high-speed low cost connectivity for research and education, paths for communication and collaboration are established among researchers in LDCs, with Europe, and with other parts of the world. This opens up not only effective research

collaboration but also creates immediacy of access to intellectual resources (human, output, and advanced applications) in Europe and around the world. The opportunities for collaboration also enable LDC-based researchers to learn from the more technologically advanced countries, and therefore build resident research capacity in LDCs. This in turn leads to increased capacity to generate intellectual property output (research results and patents) that, apart from addressing both local and global challenges, will lead through the intellectual property chain to national development and poverty reduction.

At the infrastructure level, collaboration among national research and education networks will enable NRENs in LDCs to build the kind of cutting edge engineering and managerial expertise that is required to ensure sustainable availability of advanced e-infrastructures. Sustainable availability of cutting edge expertise will call for engagement with and changes to the entire structure of engineering training, extending to universities and industry. This contributes directly to the reduction of the digital divide, a significant cause of which is acute shortage of technical human capacity[25]. The digital divide can therefore be addressed from two perspectives: infrastructure (connectivity and e-applications) and human resource (engineering and related expertise).

NRENs vs Commercial Internet Service Providers

One of the comments sometimes made about NRENs, by universities, but also funding organisations is that their access charges can appear expensive where compared with 'equivalent' commercial offerings in the national telecoms marketplace.

As Davies explains in a case for NRENs,[26] the cost of an Internet connection is generally expressed in terms of the speed of operation of the access Interface. Thus, as an example, an interface might have an annual price for 622 Mbps of access. Whilst this is a very simple measure, and 'easily understood,' it is also an extremely inaccurate way of defining value for money. The access speed of operation is one limited factor in determining performance. More important parameters, specifically in the scientific community are the information transfer capacity that an interface is capable of providing, particularly when network usage is high, and the quality of the capacity expressed in terms of error rate, stability of network, created delay etc.

In commercial networks individual access points are normally connected to the network via a concentrator function. The purpose of the concentrator is to share a single connection to the access network among a number of user interfaces. As an example, ten 622 Mbps user interfaces might be connected to a single Gigabit Ethernet access. The ratio between the sum of the user interface capacity and the network access is known as the contention ratio. Access concentration works on the assumption that not all user interfaces will be used simultaneously. Nevertheless, when network demand is highest, there will be insufficient capacity to handle the traffic offered.

Comparing value for money between NREN and Commercial networks is therefore not simply a matter of comparing access prices. Commercial networks generally use a 'headline' access price as their competitive selling factor. In contrast NREN networks are generally optimized for performance. They seldom, if ever, use Access Concentrators and are usually scaled to carry the expected traffic without loss. In order to properly evaluate value for money it is really necessary to understand the scaling and construction of the network that will carry the traffic and the user requirements for performance.

Apart from this argument of value for money based on the technical architecture, the NREN community offers an additional value which the commercial environment cannot offer: *community*. More than 100 NRENs across the globe are connected directly to each other. Leaders, managers, as well as engineers form part of one large global community, allowing for easy communication and problem solving, advancing the possibility of global collaboration. Together and on a global scale they offer the infrastructure needed for global scientific collaboration. This cannot be achieved in a commercial environment.

NRENs in LDCs

For the scientists in LDCs to actively participate and draw benefit from the TechBank, including the DAR component, they will need to have affordable access to data communications infrastructure nationally, regionally and globally. In the majority of the countries across the globe this access to data communications infrastructure is provided to scientists through the hierarchy of campus network, NREN, RREN and global interconnections. Collaboration with existing NRENs and facilitation in launching new ones can support the TechBank on the following levels:

- Dedicated and interconnected data communications capacity
- Authentication of users through federated identity services offered seamlessly by NRENs
- Strong RRENs in the developing world "spreading the word" about the TechBank activities and objectives to the scientist, even in LDCs where NRENs do not yet exist
- Community and established human relationships between NRENs and the scientists in the respective country

Since there are LDCs in which NRENs do not yet exist or are just recently emerging, it may be critical to the long term success of the TechBank to actively engage in the national conversation in these cases and advocate with national and international funding bodies, national government and regulatory authorities to ensure the connectivity needs of the scientific community are adequately addressed. The RRENs existing in all regions of the developing world offer an experienced and expert starting point for such advocacy.

4. DAR AND NRENS TOGETHER IN THE TECHBANK

Both Research4Life and the NREN development efforts of communities like GÉANT[27] have noted instances where a synergistic approach could have created a much more enabling environment for STI in LDCs. Research4Life has received feedback many times from researchers frustrated by the barriers such as slow bandwidth or network interruptions, all of which impede their ability to retrieve the vast array of scientific publications made available by Research4Life publishers partners.

Similarly, new NRENs often are challenged about what research resources can be made immediately available via the enhanced connectivity even before the scientists and educators in the country have a chance to grow their collaborations in their new enabling environment.

Connecting these two elements is an obvious point of synergy, with the TechBank well placed to be the incubator to ensure that network access and federated trust relationships are

designed and developed in parallel with immediate access to the international scientific literature and intertwined through advocacy at the national, provincial and institution level.

Librarians and Information Technology working together

One source of slow uptake of existing opportunities for STI in LDCs is the isolation and lack of coordination between groups such as librarians and campus computing support. A holistic approach to encouraging NRENs by highlighting the valuable content channelled via Research4Life and boosting the use of the evidence provided via Research4Life through national, regional and global research collaborations is an obvious step, and one that the TechBank is eminently suited both to incubate, and turn into action. Involving librarians and IT specialists in working together to achieve stronger results creates a knock-on effect for many other enabling efforts that will result in the LDCs leading their own technological enabled development and helping each other transform.

This disconnect between Information Technology (IT) and library staff in institutions is not unique to LDCs, but wherever it occurs, efforts to overcome that distance prove fruitful. A very recent initiative that demonstrates the key importance of IT and librarians working together is RA21: Resource Access in the 21st Century[28] which has "a goal of facilitating a seamless user experience for consumers of scientific communication." RA21 is working to solve problems in the areas of network security and user privacy. With NRENs and DAR working together within the TechBank, any unique needs of LDCs can be surfaced and included in the explorations being fostered by initiatives like RA21. Without that collaboration, the LDC voice in these efforts is likely to be weak at best and lost at worst.

The TechBank will be able to start from proven sources of inspiration and innovation, and librarians are being invited to take their place in the transformation that will allow their countries to leapfrog forward to achieve the Sustainable Development Goals along with the remainder of the world.

Disclaimer

The views expressed are personal and do not necessarily represent the views of the organisations with which the authors are affiliated.

References

[1] Transfer of technology and knowledge sharing for development. Geneva: UNCTAD; 2014 (UNCTAD Current Studies on Science, Technology and Innovation, No. 8; http://unctad.org/en/PublicationsLibrary/dtlstict2013d8_en.pdf, accessed 9 March 2017).

[2] About LDCs. In: UN Office of the High Representative for the Least Developed Countries, Landlocked Developing Countries and Small Island Developing States [website]. New York: United Nations; 2017 (http://unohrlls.org/about-ldcs/, accessed 3 March 2017).

[3] See for example Xu B. Multinational enterprises, technology diffusion, and host country productivity growth. Gainesville, FL: Department of Economics, University of Florida; 1999.

[4] See TRIPS Article 66.2 stating that: "Developed Country Members shall provide incentives to enterprises and institutions in their territories for the purpose of promoting and encouraging technology transfer to the least-developed country members in order to enable them to create a sound and viable technological base".

[5] See for instance: Correa CM. Intellectual Property in LDCs: Strategies for enhancing technology transfer and dissemination. Background Paper No. 4 for The Least Developed Countries Report 2007. New York and Geneva: UNCTAD; 2007 (http://unctad.org/Sections/ldc_dir/docs/ldcr2007_Correa_en.pdf, accessed 2 May 2017) or Moon S. Meaningful technology transfer to the LDCs: a proposal for a monitoring mechanism for TRIPS Article 66:2. Geneva: ICTSD, 2011.

[6] In 2010, the United Nations Conference on Trade and Development (UNCTAD) Least Developed Countries Report put forward the notion of a "Technology Licensing Bank for LDCs" to address the increasing difficulties faced by the LDCs to incorporate adequate knowledge that is relevant to their development needs (due to wide-spread intellectual property protection strategically used by high-technology firms in developed countries), limited capacities to negotiate licenses and poor access to information on available technological options. See The Least Developed Countries Report 2010: towards a new international development architecture for LDCs. Geneva: UNCTAD; 2010. For a review of the international initiatives see Roffe P, Comment: Technology transfer on the international agenda. In Maskus KE, Reichman JH, editors. International public goods and transfer of technology under a globalized intellectual property regime. Cambridge (UK): CUP; 2005: 257-264.

[7] See Resolution A/71/L.52, adopted on 23 December 2016 by the United Nations General Assembly. It officially establishes the Technology Bank, recognizing "the importance to improve least developed countries' scientific research and innovation base, promote networking among researchers and research institutions, help least developed countries access and utilize critical and appropriate technologies", while "building upon bilateral initiatives, the coordinated support by multilateral institutions, including the relevant entities of the United Nations system, such as the Technology Facilitation Mechanism, and the private sector." The Technology Bank will be financed by voluntary contributions from Member States and other stakeholders, including the private sector and foundations.

[8] Hausmann R, Hwang J, Rodrik D. What you export matters. J Econ Growth, 2007; 12(1), 1-25.

[9] OECD. Gross domestic spending on R&D [indicator]; 2017 (http://10.1787/d8b068b4-en, accessed 24 April 2017).

[10] For instance, Burkina Faso spent 0.20 per cent of GDP on research and development in 2009; Burundi 0.12 per cent; Ethiopia, 0.60 per cent in 2013; Gambia, 0.133 per cent in 2011; Lesotho, 0.013 per cent in 2011; Madagascar, 0.01 per cent in 2014; Tanzania 0.53 per cent in 2013; Togo 0.27 percent in 2014 and Uganda, 0.47 per cent in 2010. UNESCO Institute for Statistics. Gross domestic expenditure on R & D as a percentage of GDP. In Science, technology and innovation indicators, January 2015 (http://data.uis.unesco.org/Index.aspx?queryid=192, accessed 2 May 2017).

[11] See UNESCO, Science Report 2010: the current status of science around the world. Paris: UNESCO; 2010, 5.

[12] Scientific and Technical Journal Articles. World Development Indicators, [data] Washington, DC: World Bank. (http://data.worldbank.org/indicator/IP.JRN.ARTC.SC ,accessed 7 June 2017)

[13] For instance, in 2011, Argentina published 3,863 scientific articles, India 22,481.

[14] An encouraging note is that between 2012 and 2014 the LDCs saw a sharp increase of scientific publications from 4191 to 7447. See UNESCO Science Report: towards 2030. Paris: UNESCO; 2015, 36.

[15] Ibid, 32.

[16] OHRLLS, State of the Least Developed Countries 2016, 6. (https://unohrlls.org/custom-content/uploads/2016/08/State-of-LDCs2016.pdf, accessed 2 May 2017).

[17] Ibid.

[18] UNESCO Science Report: towards 2030, op cit, 38.

[19] Duller H. Role of Technology in the Emergence of Newly Industrializing Countries. ASEAN Economic Bulletin, 1992; 9, 45-54.

[20] See Supporting the operationalization of the Technology Bank for the Least Developed Countries: a 3-year Strategic Plan, 2016 (http://unohrlls.org/custom-content/uploads/2017/01/Strategic-Plan-of-the-Technology-Bank-for-the-LDCs-8-August.pdf, accessed 2 May 2017).

[21] WIPO Launches On-line Tool to Facilitate Access to Targeted Scientific Information. Geneva: WIPO; 2009 (http://www.wipo.int/pressroom/en/articles/2009/article_0025.html, accessed 27 April 2017) and Global Online Access to Law (GOAL) to Further Sustainable Development. Lyon, France: IFLA; 2014 (http://library.ifla.org/id/eprint/1045, accessed 27 April 2017).

[22] Equatorial Guinea is scheduled to graduate from LDC status mid-2017.

[23] See Tusubira FF, Ndiwalana A, Dindi S, Obbo H. The Impact of improved access and connectivity on intellectual property output: Baseline Report, 2012? (https://www.ubuntunet.net/sites/default/files/the_impact.pdf, accessed 10 May 2017)

[24] Ibid.

[25] See Fuchs C, Horak E. Africa and the digital divide. Telematics and Informatics, 2008; 25, 99-116.

[26] Davies D. NREN network access - evaluating value for money, 2016 (https://issuu.com/geantpublish/docs/nren_network_access_____evaluating_, accessed 2 May 2017).

[27] GÉANT is Europe's leading collaboration on network and related e-infrastructure and services for the benefit of research and education, contributing to Europe's economic growth and competitiveness. The organization develops, delivers and promotes advanced network and associated e-infrastructure services, and

supports innovation and knowledge-sharing amongst its members, partners and the wider research and education networking community.

[28] RA21: Resource Access in the 21st Century [website]. Oxford and The Hague: STM, [undated] (http://www.stm-assoc.org/standards-technology/ra21-resource-access-21st-century/ , accessed 28 April 2017).