Access to research in the Global South:
Reviewing the evidence

Sara Gwynn
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*"Everyone has the right to freedom of opinion and expression; this right includes freedom to hold opinions without interference and to **seek, receive and impart information and ideas through any media and regardless of frontiers**."*
Article 19 of the 1948 UN Declaration of Human Rights

Introduction

INASP has done work around enabling access to research for over 20 years. In that time, publishing, technology and the environment in which researchers in low- and lower-middle-income countries (LLIMCs) work has changed enormously. The funding environment for such work has also changed significantly.

As INASP embarks on a new phase of work, it has chosen to reflect on those changes in order to help it to make informed decisions about if and how to take this area of work forward.

To date, INASP has worked to enable access to research because:

1. Access to research strengthens a country's capacity to address development issues
2. Researchers in LLIMCs need/demand access to research
3. Those needs/demands are not adequately met

This review considers the evidence around the extent to which these assumptions hold true in 2018.

Reviewing the evidence on access impact

The study holds in mind that the ultimate goal of INASP's work is development impact, and aims to provide an evidence-informed report of the extent to which access to e-resources that are published in the Global North can contribute to such impact and the current access situation in LLIMCs. It is not intended as a review or evaluation of INASP's work in this area to date.

Methods used

Given the extensive literature and the scale of this study, it was not possible to carry out a systematic review of the literature. Instead, existing systematic, scoping and meta-analysis reviews have been used wherever possible. Where no review was available, the recent literature has been searched via CORE, DOAJ, ResearchGate, Google Scholar and Google.

Only papers published in English and which were either free to access or provided by the author were included.

When looking at single studies on access to e-journals in LLIMCs, only papers published in the last three years were considered because a) this is a rapidly evolving landscape and what was true three years ago may not be so now and b) it made the amount of information to be included more manageable.

Together, these limitations mean that much relevant research will be missing from this report. Despite this, it is reasonable to believe that it does provide reliable evidence to help inform INASP's decision making.

REVIEW PARAMETERS

This review considers:

- Access in LLMIC countries
- Access to e-books and e-journals that are published in the Global North

Except where stated, the rest of this document will use 'access to GNERs' (Global North e-resources) as shorthand for these criteria.

This review does not consider:

- Access to research published in LLMICs
- Access to research in paper format
- Access to online learning, networks, mentoring and other research support

Findings

Does research strengthen a country's capacity to address development issues?

The use of research is frequently included in LLMICs', development funders' and development organizations' strategies and priorities, and the impact of research on sustainable economic, social and political development is reported via many case studies, evaluations and reviews. For example, DFID's Research Review (DFID 2016, p6) concludes that:

> *"Research has saved and changed the lives of millions of people across the developing world. From drought-tolerant maize, to speeding up tuberculosis diagnosis, to affordable energy paid for through mobile phones."*

Although there is a lack of robust research in this area, recent systematic reviews by Newman (2014) and Oketch *et al* (2014) look at the impact of evidence on international development and the impact of tertiary education (TE) on development.

Newman's review considered the literature around the impact of investment in research on socioeconomic development and found evidence that research activities can lead to development impacts including:

- An increased capacity to adapt and make use of existing research and knowledge is likely to have a large impact on economic growth
- Human capital built through investment in research and research capacity building "*can have multiple positive impacts on development including via the spill over of former researchers into government and industry and the generation of research experts who can act as policy advisors*" (Newman 2014, p49)
- Research in public institutions or through public–private partnerships can create products and technologies that directly help poor people (though many have proved not to have the expected impact)
- Research can help to ensure policies and practice have the desired impact through improved understanding of the context, and what works and why

The evidence also indicates that research in LLMICs is:

- Unlikely to lead to substantial commercialization of products in the short to medium term
- Unlikely to improve teaching quality—in HICs evidence shows there is no strong link between research outputs and teaching quality, and in LLMICs there is no evidence of a strong link

Newman proposes a new Theory of Change to capture the process by which evidence can contribute to development impact.
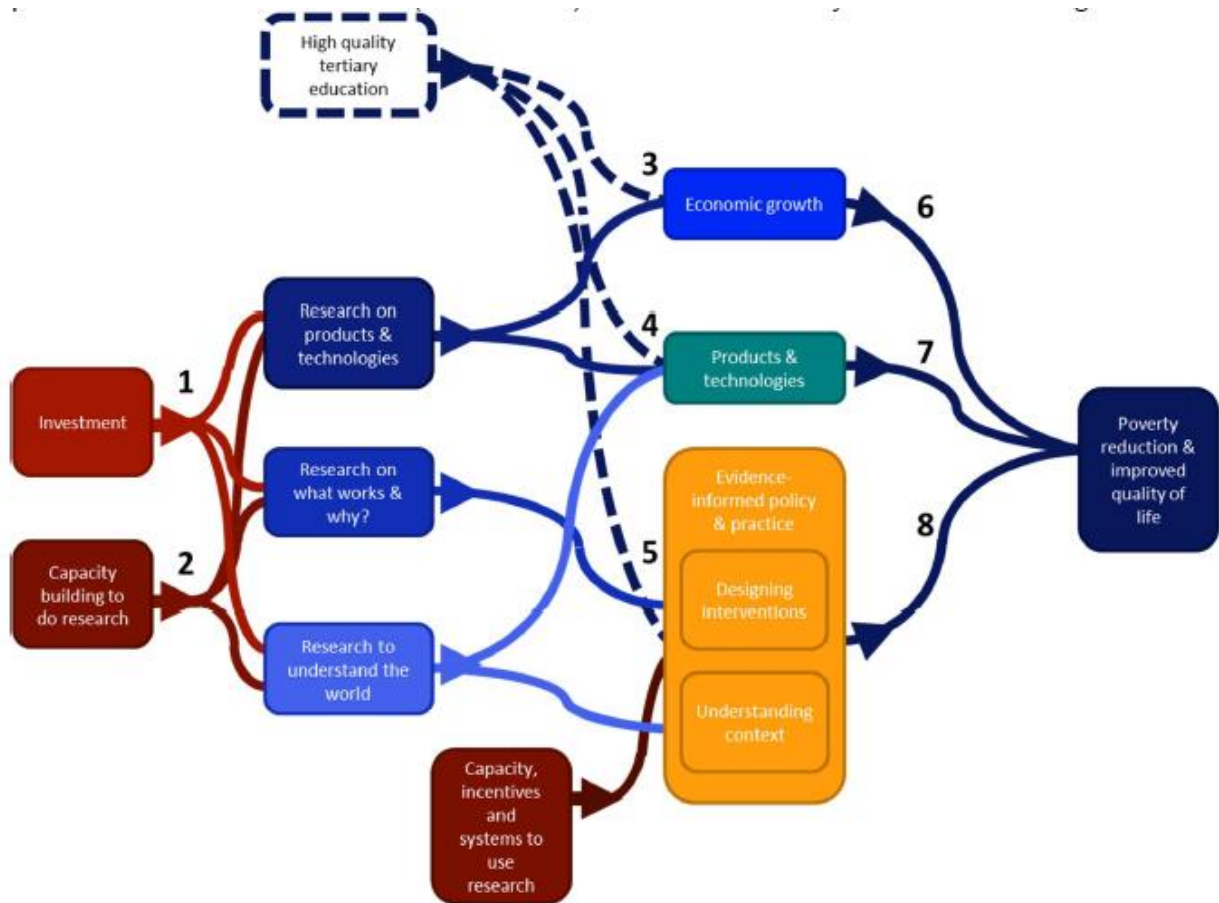
Figure 1: Updated Theory of Change (Newman 2014, p50).

Newman notes the following needs:

1. Investment in a variety of types of research
2. Effective capacity building
3. Capacity to adapt and absorb (rather than produce new) products/technologies
4. Research to understand and respond to the needs of potential users of products/technologies that can directly benefit the poor
5. Research about a) the context (what outcomes should be sought),b) what works and why. (Newman notes this relies on decision makers having the capacity, incentives and processes that enable them to make use of this research)

and the following evidence:

6. Economic growth is necessary but not sufficient to drive positive socioeconomic development
7. Products and technologies can have direct positive socioeconomic impacts
8. Using research evidence to inform policy and practice contributes to socioeconomic development

Newman also notes the key role of tertiary education in the research system, including building absorptive capacity and developing capacity to use emerging products/technologies.

Oketch *et al* report a "*significant lack of research*" (Oketch 2014, p7) on the role of tertiary education (TE) in development but identify three pathways to development impact by TE: teaching, research and innovation, and service (i.e. "*direct engagement of institutions with the local community and broader society*" (Oketch 2014, p11)) and their conceptual framework assumes that TE impacts development through the combined effects of all three.

Like Newman's review, Oketch *et al* found that "*In the aggregate, there is very little macro-level evidence that TE contributes to development in LLMICs through research and innovation. However, there is some evidence to suggest that the proportion of workers with higher education within a given context may increase the likelihood of technological uptake and adaptation. There is also limited evidence that research outputs may impact development at local level by increasing the productivity and efficiency of SMEs*" (Oketch 2014, p34) and note that "*New technologies cannot be adapted to local conditions unless there are educated members of the workforce familiar with current research and innovation*" (Oketch 2014, p14).

Following their review, the authors propose an updated framework:
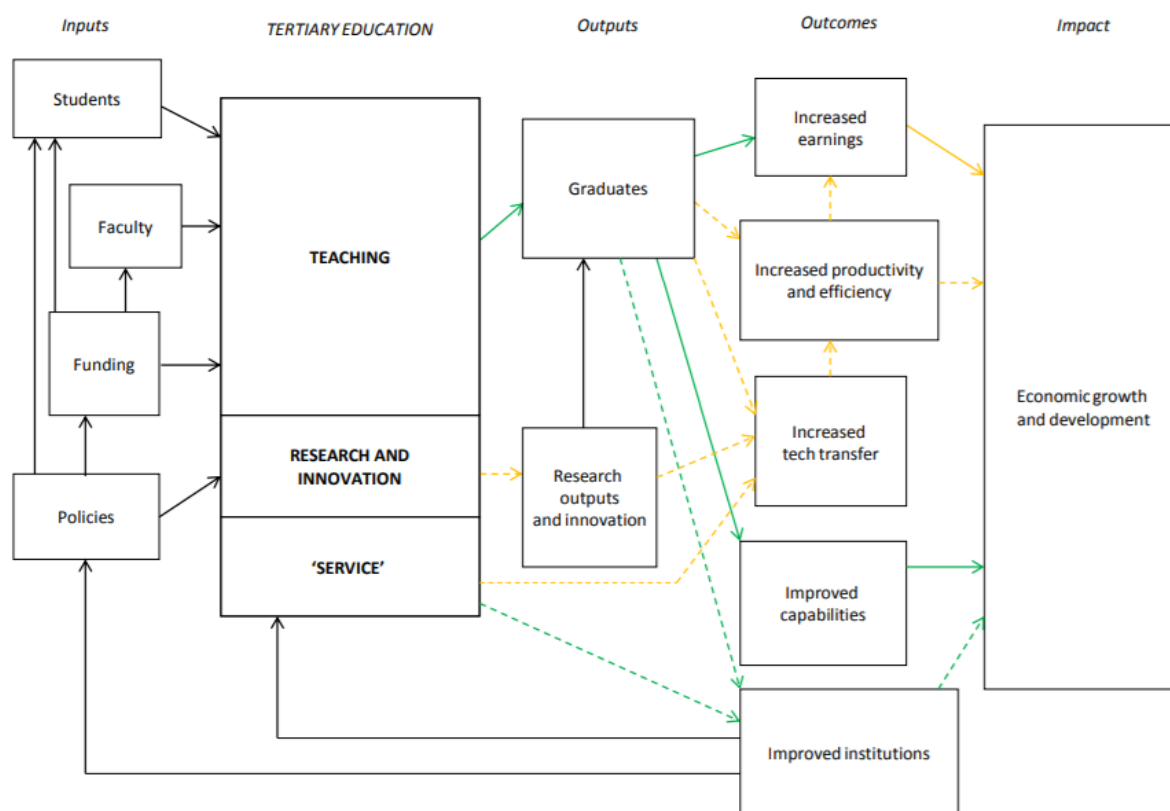

Figure 2: Revised conceptual framework. Green arrow = consistent evidence of impact, yellow arrow = inconsistent evidence, dashed arrow = limited evidence of impact (<20 studies) (Oketch 2014, p54).

This indicates that there is some evidence that the outputs of research and innovation in TE can have outcomes in terms of increased technology transfer, increased productivity and efficiency and so impact on economic growth and development.

They note that it was not possible to investigate regional and national differences in the functioning of these pathways to impact and that:

> "*It is clear that local, national and regional context do influence—and even determine— the nature and effectiveness of [tertiary education] and, consequently, its impact on society*". (Oketch 2014, p54).

Their framework also makes a number of assumptions (such as sufficient access to and quality of primary and secondary education; equality of access, opportunities and experiences within tertiary education; access to postgraduate programmes; and academic freedom) and the authors note that:

> "as these conditions really [sic] hold in LLMICs, the lack of impact observed in some studies may not indicate a lack of validity of the pathway in question, but may be the result of certain barriers within the system such as poor quality teaching and curriculum, or the lack of conducive research environment" (Oketch 2014, p.6).

Discussion

The evidence drawn together in these two systematic reviews suggests that, although not a cure-all, research can help LLMICs to meet their development goals by contributing to economic growth, building human capital, developing products and technology that will directly benefit poor people, and feeding into policy and practice.

However, it is worth bearing in mind that even amongst the 'flagship' universities in Africa, for example, there are continuing issues. The 10-year HERANA project identified five key lessons[1]:

1. There is no consensus at institutional, national or global level of the role that universities should play in society, and particularly development

2. Little government support, policy or financial, was offered to help universities to become research-led

3. Future development of universities needs to be evidence led, with improved collection, analysis and institutionalisation of data on performance

4. Donor funding tends to be project focussed and based on the donor's own programmes of ideologies and so "*bear a greater resemblance to consultancy activities than academic research projects*" which makes it difficult for institutions to realise their research strategies

5. *Universities struggle with diverse functions and "African higher education systems generally remain undifferentiated and decoupled from national developmental goals*"

Acknowledging that research often sits within challenging institutional, national and global contexts, the next section considers the extent to which access to research, specifically through GNERs, is part of the research systems, research uptake or research capacity strengthening frameworks in LLMICs.

What role does access play in research/uptake systems and who needs access to what?

In considering this question it is useful to consider two different reasons for accessing research:

1. Accessing research as a building block for new research
2. Accessing research to inform policy and practice

For the first of these, the academic research cycle is well established and, although there is some variation, they generally involve a cyclical or spiral process of formulating the research question, carrying out a review of the literature, designing the study, collecting data, analysing data, writing up results, disseminating/communicating results, formulating new policy or practice, implementing new policy or practice, reflecting and evaluating outcomes/impact, and formulating new research questions.

A diagram developed by INASP, for example, includes this process at its centre. The figure aims to capture a system with researchers, policymakers and practitioners at the heart of the process (and should arguably also include the communities and end users it seeks to benefit—see, e.g., Kim 2018,

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[1] See www.universityworldnews.com/article.php?story=20180328135155625

p16). Publishers, information professionals (e.g. librarians) and information intermediaries (e.g. parliamentary researchers) are included as enabling actors. All of the actors are influenced by their individual knowledge, skills and attitudes and by the institutional and infrastructure environment in which they work.
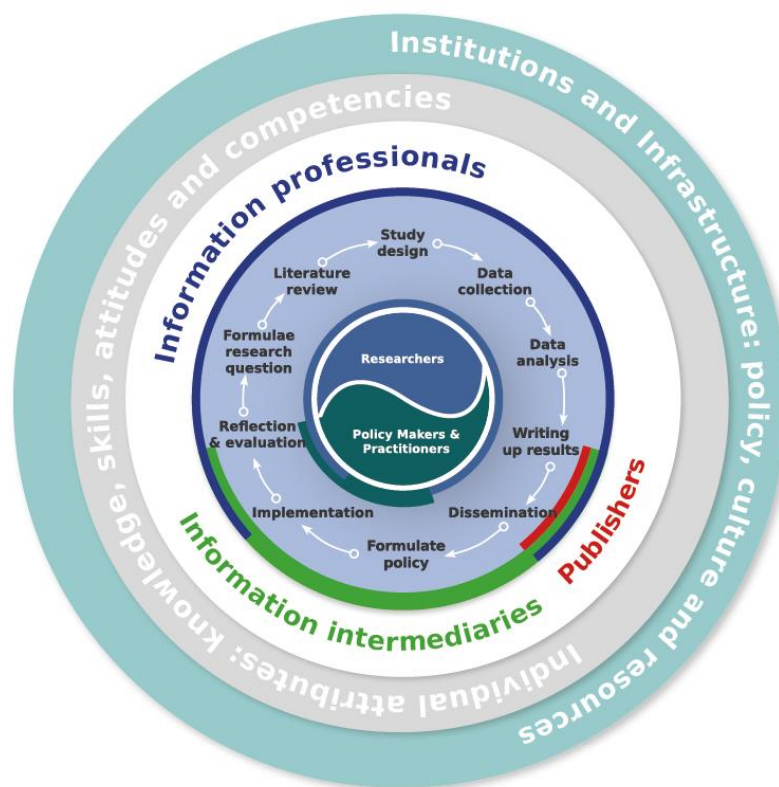

Figure 3 Diagram of research system (developed for INASP's Working Together to Support Research work[2]).

For the second reason to access, i.e. research uptake, there is no agreed theory of change or model. Rather than assuming the role of access to GNERs in these processes, this section considers the evidence from recent reviews of research systems, research uptake systems and research capacity strengthening (RCS) models.

As part of the Global Development Network's (GDN's) 'Doing Research' project, Buclet looks at the defining properties of an effective enabling research environment, with a focus on the quality, quantity and relevance of social science research. Following pilots in Indonesia, Cambodia, Niger, Peru, Bolivia, Paraguay, Cameroon, Cote d'Ivoire, India, Bangladesh and South Africa, it uses

> *"the concept of a system, understood as a set of heterogeneous actors, interacting with each other according to certain rules or principles, and responding to the various kinds of relationships: this reflects more accurately the interdependence of the components contributing to research quality" (Buclet 2017, p43).*

The study developed a set of criteria for understanding the research environment in the LLMICs studied, with seven categories: context and institutional framework, supply actors, demand actors,

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[2] www.inasp.info/publications/local-ideas-and-expertise-strengthen-research-systems

human resources, financial inputs, production processes, and output and social utility as summarized in their table:

Category	Components
Context and institutional framework	a. Type of political regime b. Degree of political stability c. Diversity of funding d. Clarity of national agendas / national research strategy e. Clarity and stability of rules (at all levels) f. Promotion of multidisciplinarity by authorities g. International exposure (a lack of which leads to inbreeding and/or insularity) h. Promotion of regional and international research i. Existence of an administrative structure dedicated to research j. Ability to research politically-sensitive issues k. Clarity of the legal and financial rules for consulting l. Level of disparities within the country m. Gender balance
Supply actors	a. Public and private universities b. Public and private research centres c. Public and private think-tanks (producing knowledge) d. Other knowledge producers (such as donors or non-academic public institutions) e. NGOs producing knowledge f. Availability and access to local networking and collaborations, particularly intersectoral g. Average age of researchers h. Average levels of education of researchers
Demand actors	a. Clarity of the role of the authorities b. Effective national funding agencies c. Channels of expression for civil society demand (indirect) d. International donor-driven demand e. Use of research by the private commercial sector f. Strength of relationship between supply and demand
Human resources	a. Dynamism of the employment research market b. The degree of 'inbreeding': the number of researchers holding a PhD obtained from the university where they work c. Management of life-long capacity building and career development plans d. Incentives for researchers (blame/reward systems) e. Salary levels f. Structural constraints g. Opportunities for hiring international students for teaching (related to international exposure) h. Incentives for research; publications included in performance measurement i. Flexibility to contract lecturers and researchers j. Correlation between salary and research productivity k. Incentives for internal publishing l. Gender balance m. Availability of student grants n. Research training in first year of graduation o. Workload p. Level of English language skills
Financial resources	a. Autonomy versus security b. Number of possible grant schemes c. Success rate for grant applications d. Flexibility of funding (bound to the fiscal year?) e. Management system following quality norms (International Standard Organisation norms) f. Existence of a quality assurance body g. Funding availability at national/regional/ international level
Production process	a. Quality of available data (statistics) b. Availability of research infrastructure and facilities c. Availability of administrative support for writing research and grant proposals d. Norms/rules for publication e. Access to current research resources f. Characteristics of projects (long-term, short-term, etc.) g. Access to academic journals h. Availability of support for management of financial resources, publications, etc. i. Share of published research on a country carried out by local researchers j. Opportunities for cross-sectoral knowledge production k. Quality of

Figure 4: Criteria relevant to understanding the research environment in the eleven LLMICs studied (Buclet 2017, p40).

These criteria were further honed to framework that could be used as a basis for analysis of research systems consisting of interacting:

- Context historical, cultural, political and economic conditions in which the research takes place and is used
- Inputs: people and resources needed to produce robust social science research
- Process: the set of rules, ethical principles, activities and interactions producing and promoting research
- Outputs: tangible products of research including publications, communications, and people trained in producing and using good research
- Outcome: policymakers, practitioners and the public actively support and use research-based evidence and knowledge in addressing societal problems.
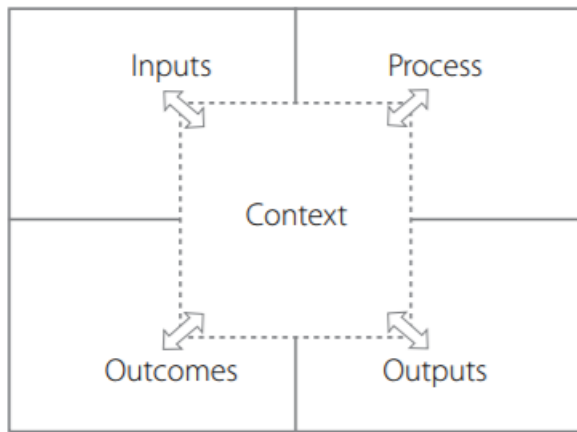
Figure 5: GDN's 'Doing Research' framework (Buclet 2017, p39).

Buclet's framework identifies:

- Actors: Public and private universities, public and private research centres, public and private think tanks producing knowledge, other knowledge producers such as donors or non-academic public institutions, NGOs producing knowledge (in 'Supply actors')
- Access to academic journals (in 'Production process' and 'Inputs')
- The interconnectedness of the system's context, inputs, processes, outputs and outcomes.

Datta (2018) summarizes conceptual frameworks for understanding and strengthening social science research systems in a LLMIC context (mainly Anglophone sub-Saharan Africa) and, as with other studies, finds that there are few frameworks that explicitly conceptualize a particular area and what studies there are focus mainly on health and agriculture.

The study finds three main existing modalities for strengthening research systems—centres of excellence North–South partnerships, and networks and consortia—and categorizes the actions currently taken to strengthen research systems as:

1. Generating and sharing knowledge about research systems and their evolution
2. Priority setting and financing
3. Governance and regulation
4. Managing and coordinating research
5. Research leaders and centres of excellence
6. Strengthening ties and connections between stakeholder groups
7. Support to female researchers and gender mainstreaming.

One of the most relevant frameworks for INASP's work included in Datta's review is part of GDN's 'Doing Research' project (also see Buclet, above):
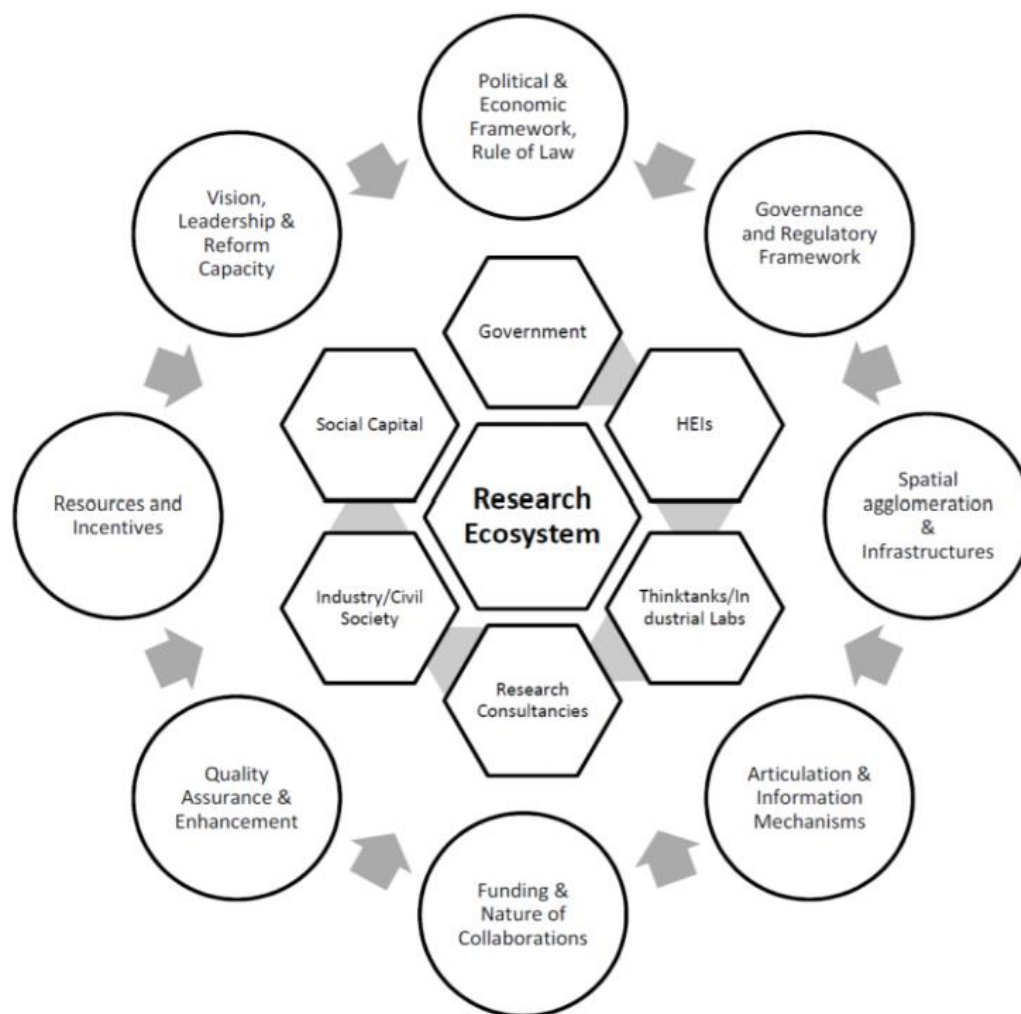
Figure 6: Research ecosystem (Gevaudan 2017[3], cited in Datta 2018).

Few of the studies reviewed explicitly mention formal academic knowledge. The ones that do talk about a role for: the 'available literature' (Kennedy and IJsselmuiden); journals as (one) source of knowledge in innovation systems (Spielman 2006); 'scientific/technical knowledge' (Spielman 2006); 'the knowledge created by research' (Kline and Rosenberg); access to current research resources/journals (Buclet 2017).

Datta (2018, p2)[4]. concludes that:

> *"the interaction between (knowledge) actors in a system is as important for processes and outcomes as the actors themselves; that development is driven, not by research scientific or technological change, but by the institutional (and political) context in which (social and natural) scientific and technological change occurs; and that formal research institutes only produce a fraction of the knowledge that society needs to grow and develop"*

Kim *et al* find that although many frameworks have been developed "none have been widely applied", and those that do exist are unrealistic, overly complicated. They present a new framework to efforts to apply evidence to policy and programmes. Although developed in the health sector, they see it as generalizable.

Fig. 1 FHI 360 Research Utilisation Framework
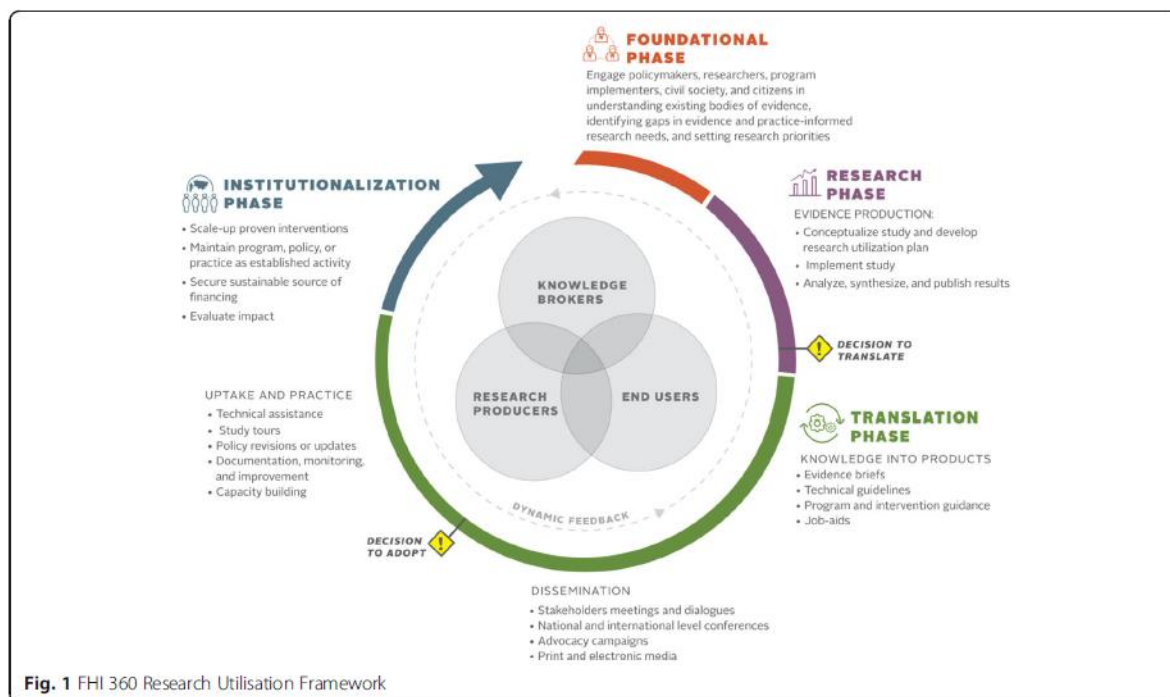
Figure 7 Research utilisation framework (Kim et al 2016, p2).

The process they outline includes:

- Foundation: all stakeholders are engaged in order to understand the knowledge needs and set research priorities
- Research: conceptualizing and doing the study including protocol development, data collection, data analysis and interpretation. Again, it should engage all stakeholders to help ensure its relevance and maximise eventual uptake
- Translation: longest part of the process, where knowledge products are created disseminated and advocacy activities are undertaken
- Institutionalization: where "*evidence use is established as an organisational norm and proven interventions are maintained, funded and scaled up*" (Kim 2016, p5).

Whilst this framework does not specifically mention access to journals, it is reasonable to assume the need for such access within the 'Research Phase'. This paper also emphasizes the need for a systems view of the process and the need to engage with a wide range of stakeholders at each phase.

Langer *et al* (2016) analyse the mechanisms used in interventions around use of research evidence in decision making and categorise them into six groups: awareness, agree, communication and access, interact, skills, and structure and process.

Evidence use mechanisms	
AWARENESS **(M1)**	Building awareness for, and positive attitudes toward, evidence-informed decision-making (EIDM). This mechanism emphasises the importance of decision-makers' valuing the concept of EIDM.
AGREE **(M2)**	Building mutual understanding and agreement on policy-relevant questions and the kind of evidence needed to answer them. This mechanism emphasises the importance of building mutual understanding and agreement on policy questions and what constitutes fit-for-purpose evidence.
COMMUNICATION **& ACCESS** **(M3)**	Providing communication of, and access to, evidence. This mechanism emphasises the importance of decision-makers receiving effective communication of evidence and convenient access to evidence.
INTERACT **(M4)**	Interaction between decision-makers and researchers.[4] This mechanism emphasises the importance of decision-makers interacting with researchers in order to build trusted relationships, collaborate, and gain exposure to a different type of social influence.
SKILLS **(M5)**	Supporting decision-makers to develop skills in accessing and making sense of evidence. This mechanism emphasises the importance of decision-makers having the necessary skills to locate, appraise, synthesise evidence, and integrate it with other information and political needs etc.
STRUCTURE & **PROCESS** **(M6)**	Influencing decision-making structures and processes. This mechanism emphasises the importance of decision-makers' psychological, social, and environmental structures and processes (for example, mental models, professional norms, habits, organisational and institutional rules) in providing means and barriers to action.

Figure 8: Mechanisms for use of evidence impacting on decision making (Langer 2016, p9).

Summarizing interventions related to access to and communication of evidence, they conclude that "*there is reliable[5] evidence (i.e. from high weight of evidence-rated reviews) indicating that interventions applying this mechanism can improve both decision makers motivation and opportunity to use evidence. There is also reliable evidence that interventions applying M3 [access to and communication of evidence] when providing both opportunity and motivation to use evidence, increase decision makers use of evidence*" (Langer 2016, p16). The review notes that a positive impact is only found if the intervention combines both the opportunity to use evidence and the motivation to do, with evidence showing no impact from interventions that provide only the opportunity for access.

Reliable evidence of no effect was found for "*interventions that take a passive approach to communicating evidence that only provide opportunities to use evidence (such a simple dissemination tools)*" (Langer 2016, p3), but that a combination of access to research information and building the opportunities, motivation and capacity of decision makers does increase the use of evidence in policy and practice (Langer 2016) and so can lead to important impact (Newman 2014).

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[5] Defined by the authors as evidence which is based on reviews rated with high trustworthiness and relevance in the weight of evidence assessment carried out in the systematic and scoping reviews.

Discussion

The frameworks reviewed here are based on research about research systems in Asia, Latin America and Africa and so it is reasonable to assume that they can be generalized.

They all highlight the need for a systems approach to be taken and they all, either implicitly (as part of the research process) or explicitly, include access to the literature as a component of the research system.

Author	Focus	Access	Actors/organizations
Newman	Impact of evidence on development	Implicit	Tertiary education, policy makers, decision makers, practitioners, firms
Oketch	Impact of TE on development	Implicit	Tertiary education, private and public firms
Buclet	Characteristics of an enabling research environment (social science)	Explicit	Public and private universities, public and private research centres, public and private think tanks producing knowledge, other knowledge producers such as donors or non-academic public institutions, NGOs producing knowledge, media
Datta	Frameworks for understanding and strengthening research systems concepts	Both	Researchers, research managers, funders, governments, policymakers, engagement and communications specialists, private sector, global companies
Kim	Research utilisation framework (health)	Implicit	Evidence producers and knowledge brokers typically in academic institutions, research or policy Institutes, think tanks, research units of governmental or non-governmental organizations, policymakers, Civil Society representatives, researchers, donors, health providers, private sector representatives, advocates
Langer	Efficacy of initiatives to increase use of evidence in policy	Explicit	Researchers, decision makers, policymakers and practitioners

Figure 9: Summary of the actors and inclusion of access in the frameworks reviewed.

Together the frameworks indicate that anyone who is producing research or knowledge for development (whether they are based in parliament, NGOs, CSOs, tertiary education institutions, research institutions or private companies) or directly using research for development (e.g. in clinical settings) needs access to relevant, credible evidence on which to base that knowledge.

Only Buclet's work explicitly includes libraries. Their framework includes them as an 'Input' of the research system: "*funding, infrastructure (workspaces, libraries, ICT, etc.), human capital (skills and time allocated to research), actors (types of organizations) and data (availability, quality, accessibility)*" (Buclet 2017, p41).

That work views libraries, along with the Internet, as source of access to documentation which is important in "*determining the quality of the research environment*" (p21) and notes that lack of access to libraries or the Internet hinders researchers' capacity to secure funding for their work and has a detrimental effect on the methodological rigour of knowledge production and use.

Is current access to research equitable?

Given that the frameworks all indicate that access to journals is a necessary (but not sufficient) part of the research process, this section will consider what conditions are needed for research to be accessed and the extent to which those conditions are in place in LLMICs, with particular focus on the e-resources from the Global North that are the subject of this study.

Before doing that, it is useful to consider the bigger arguments about the relevance and appropriateness of research from the Global North in LLMICs and development. The dominance of the Global North has an impact throughout the research process as:

> *"The researchers' perceptions of reality, what counts as knowledge and values, have an impact on the way research questions are conceived, research approaches, data gathering instruments, analysis, and interpretation and dissemination of research findings." (Chilisa 2012, Ch1, p2).*

Research and researchers from LLMICs are hugely underrepresented in the global research system with just 7.3% of the world's researchers coming from LLMICs in 2013 (UNESCO 2015) and just 0.8% coming from the least developed countries and gaps in other roles within the system. For example, there is a significant underrepresentation of LLMIC authors of Cochrane systematic reviews— although 10 upper-middle income countries had over 100 authors, only 13 low-income countries had any Cochrane review authors and no LLMICs had more than 10 Cochrane editors, with specialist roles such as statisticians, information scientists and librarians noted as particularly scarce (Oliver 2015).

The impact of this underrepresentation is that, for example, diseases that are relevant to high-income countries (HICs) are investigated seven to eight times more than diseases that are mainly experienced by LLMICs and the countries that carry nearly 90% of the global disease burden are largely excluded from participating in the "*research-led solutions that could bring the greatest impact to high rates of early mortality*" (Alemayehu 2018).

As well as this bias towards the North's research agenda, there is bias towards the Global North in the publishing of research where, for example, between 1966 and 2015 the United States was the highest contributor of the global scientific production on health inequalities, with 48.5%, whilst the top LMIC, India, contributed 1.2% and the top lower-income country Tanzania contributed 0.2%. The authors conclude that their systematic review "*clearly demonstrates the magnitude of asymmetric trends, inequitable systematic differences, and potential global dependencies that exist and persist within this research*" (Cash-Gibson 2018, p11).

This can have an impact on uptake of research. For example, a large survey of healthcare providers in China, Ghana, India, Iran, Kazakhstan, Laos, Mexico, Pakistan, Senegal and Tanzania found that 85% reported that research was likely to change their clinical practice if it was performed in their own country and 86% that it was likely to change their clinical practice if it was published in their own country. Those figures change to 66% and 63% for research and publications from their region, and 56% and 55% for research from HICs (Guidon 2010).

There are many valid arguments to be made about the chronic underrepresentation of LLMICs and the dominance of the North in the global research system (also see, for example, Court and Young 2004, Gooding 2017, Hall 2015, Oliver 2018) and in the structure and conceptualization of science and knowledge (for example, Chilisa 2012, Hall 2015, Piron 2018).

These papers do not make a case against enabling access to research from the Global North but rather that access needs to be balanced with work to strengthen research capacity in LLMICs— including the capacity of researchers, academics and librarians to be aware of and use the full range of resources available to them—and to improve the visibility of and access to research from LLMICs (Piron 2018).

> *"Access models that enhance accessibility of e-information resources from the North (developed countries) and that make local research outputs visible worldwide are necessary for [Higher Learning Institutions] to achieve their missions, namely, education, research and outreach services, in the 21st Century knowledge era" (Mammo and Ngulube 2018, p1).*

The relevance and use of GNERs is borne out in a recent study of access to and use of by postgraduate students in Tanzania (Katabalwa and Underwood 2017) that reports that the postgraduates found the 'PERii'[6] journals:

- Very useful 35%, Useful 50%, Somewhat useful 15.4%
- Most relevant 31%, Relevant 56%, Somewhat relevant 13.2%.

There are several routes for access to GNERs in LLMICS. They can be sourced via direct deals with publishers, (several forms of) Open Access (OA), donor-funded access schemes, individual publisher access schemes, negotiated access schemes, or via sources such as Research Gate or (the illegal) SciHub.

Whatever the source, accessing GNERs requires:

- Infrastructure: electricity, hardware, software, connectivity, bandwidth
- Knowledge: awareness of and motivation to use the resources
- Skills: to search, assess and use the e-resources
- Enabling environment: institutional and national valuing of research.

The recent literature (see, for example, Anhwere 2018, Boakye and Ndeogo 2017, Katabalwa and Underwood 2017, Mammo and Ngulube 2018, Nobes and Harris 2018, Park 2016, Turk 2018) evidences that these continue to be barriers in many LLMICs. These barriers affect different users or potential users of GNERs differently, and so bring further inequity to the research system.

Disadvantaged by location

Those working in less well-resourced institutions—often in rural rather than urban contexts or outside the high-profile, donor-supported institutions, for example clinicians working in field clinics (e.g. Park 2016)—will be disadvantaged.

In Zimbabwe, for example, there were significant differences in infrastructure such that:

- 79% of academics in one university and just 16% in another agreed that the infrastructure was adequate to support access to electronic resources
- 91% in one university but only 8.6% in another found lack of reliable internet connection was a major factor impacting the use of electronic journals
- 65% of academics from one university satisfied with the speed of the internet at they're institution but only 7% were satisfied at the other

The same survey also found differences between departments, with the medical department having access to generators that mitigate erratic electricity supply whilst other departments do not (Machimbidza and Mutula 2018).

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[6] INASP's PERI/PERii programme ran from 2001 to 2013 (www.inasp.info/project/programme-enhancement-research-information-peri). Together with the successor, SRKS (www.inasp.info/project/strengthening-research-and-knowledge-systems-srks), these programmes provided access to e-journals and e-books for institutions across Africa, Latin America and south Asia.

These less well-resourced institutions and departments are also likely to experienced greater lack of training, leading to low awareness of the resources that are available and a lack of skills to effectively access and use them (Harle 2010, Katabalwa and Underwood 2017, Malapela 2018).

Lack of awareness of or access to journals can also reduce the effectiveness of training as skills can't be practised and developed, and the effectiveness of research collaborations where individuals or teams working in different institutions have different access to databases (Oliver 2015).

Disadvantaged by subject area

Several studies[7] speak about inequities between subject areas with the bulk of support the scientific research, initiatives and capacity strengthening being around health and agriculture (Datta, 2018) and stigma attached to studying some areas, e.g. social sciences (Hall 2015).

Newman's theory of changes notes that:

"investment is needed in a variety of types of research covering a range of thematic areas. Public funding will be needed to fund research which will not be attractive to private funders. In some cases, public funding can be used to overcome 'market failures' and thereby enable private funding (for example in product-development partnerships)" (Newman 2014, p51).

In addition, some types of research may have particular needs. For example, Oliver *et al* (2015) consider capacity for conducting systematic reviews, noting their importance for informing policy decisions and setting research priorities, and highlighting that:

"Access to research reports, while important to research generally, is essential for systematic reviewing. Access to international journals from LLMIC institutions can be limited… and regional journals and national journals from LLMICs are not readily accessed by HICs" (Oliver 2015, p5).

Disadvantaged by type of organization

In addition to the infrastructure and skills shortages discussed already, organisations such as NGOs, CSOs, parliament, think tanks and health institutions who work outside the TE system might be further disadvantaged by lack of access to libraries who might enable access and a lack of valuing of research within their organisations (see, for example, Hall 2015, Hayman 2013, Park 2016) saying, for example that:

"Universities have long been seen as closed, 'members only' spaces, both physically and intellectually. Community–university partnerships require that both of these barriers be broken down. Partnerships are not collaborative and balanced if partners are not able to draw upon the physical resources of the university—faculty, meeting space, and knowledge tools such as the library, email, academic journal subscriptions" (Hall 2015).

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[7] There is clearly more research in this area that could be added here if useful.

It's also noted in the literature that many sources of useful information and data are often held in these institutions (e.g. policy briefs, evaluations, research) and not made accessible to those outside (or at times inside) that organization (Hayman 2013).

Disadvantaged by gender

The inequities in the research system caused by differing access to resources, infrastructure, knowledge, skills and the enabling environment are compounded by gender inequity. Women are underrepresented in research. In R&D women represent only 19% in South and East Asia, 31% in sub-Saharan Africa, 32% in Europe and North America, and 45% in Latin America and the Caribbean. Within these regions there is, of course, large variation such as Ethiopia having 13% and the Central African Republic 42% and Sri Lanka having 46% and Bangladesh 14% (UNESCO 2018).

Notes: -1 = 2015, -2 = 2014, -3 = 2013, -4 = 2012, -5 = 2011, -6 = 2010, -7 = 2009, -8 = 2008, -9 = 2007, -11 = 2005, -12 = 2004, -14= 2002, -15= 2001, -16 = 2000, -19 = 1997.
* = Based on FTE data.
Source: UNESCO Institute for Statistics, June 2018.

Figure 10: Breakdown of female researchers in Africa, Asia and the Pacific as a percentage of total researchers (HC), 2016 or latest year available (UNESCO 2018).

Globally, women account for less than 30% of authorship, there are fewer citations of papers where a woman is the first or last author, and a smaller percentage of women are involved in international collaborations There are only nine countries had more female authorship than male (Sugimoto 2013).

GENDER AND RESEARCH OUTPUT
The research output of most places is dominated by male authors (blue). Places where there is greatest gender parity in output (white) are often formerly communist states. Female dominance tends to occur in countries (orange) with lower research output. (See go.nature.com/8czxmy for an interactive version of these data.)

Vermont, Rhode Island, Maine, Manitoba, Nova Scotia and Quebec top the North American gender parity charts.

Women dominate science output in Macedonia, Sri Lanka, Latvia, Ukraine, and Bosnia and Herzegovina.

Turkmenistan had only 52 papers with gender assigned published in 2008–12.

Ratio of female to male authorships
No female authorship — Equal — Higher number of female authorships — No data or country had fewer than 20 publications
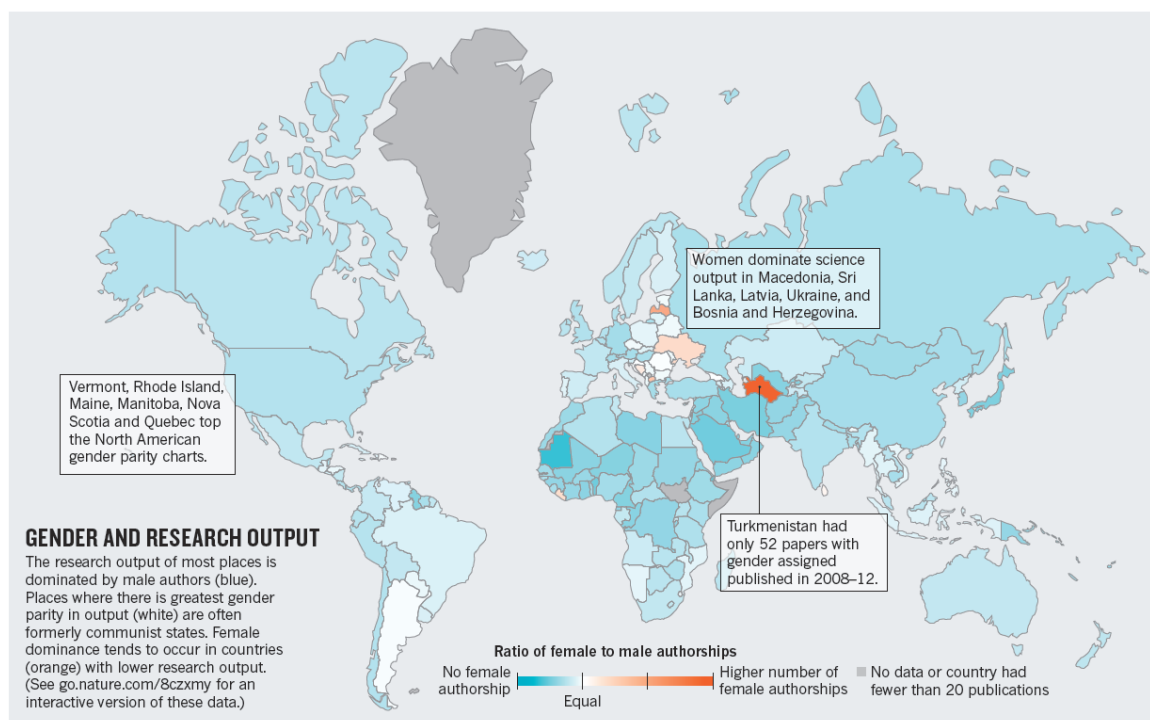
Figure 11: Gender and research output (Sugimoto 2013).

There are also gender biases by subject area with:

> *"specialities dominated by women include nursing, midwifery, speech, language and hearing, education, social work and librarianship. Male-dominated disciplines include military Sciences, engineering, robotics, aeronautics and astronautics, high energy physics, mathematics, computer science, philosophy and economics. Although disciplines from the social sciences show a larger proportion of female authors, the Humanities are still heavily dominated by men." (Sugimoto 2013, p213).*

Whilst there is evidence around the role of gender in technology use, it is beyond the scope of this study to analyse the extent to which those inequities might impact on access to GNERs.

So, as in other areas of access to tertiary education, participation in research and access and use of technologies, it is likely that women are disadvantaged in their access to the research literature.

Discussion

People experience inequities in: access to education, and particularly higher education; in the resources available to them at departmental, institutional or national level; in the profile or policy/financial support for their subject area; in the status, recognition and inclusion of their organisations they work in; and by their gender. There are, of course, very likely to be inequities related to, e.g., literacy, language, ethnicity, sexual orientation and disability but these are beyond the scope of this study.

All of these inequities obviously sit within complex contexts such that, for example, "*to a large extent, gender inequities in access to and usage of ICTs cannot be addressed through ICT policies per se. They require policy interventions in other areas that would allow women and girls to enjoy the benefits of ICTs equally. This would include policies and programmes that incentivise the education of girls– and particularly their participation in mathematics, science and engineering if they are to work in this sector in the same numbers as men… Many of the barriers for women, however, relate to cultural norms and practices that are difficult to legislate away*" (Gillward 2010).

Whilst there are institutions where some of these barriers are not reported as issues—for example, a recent study resource sharing in library consortia in Ghana (cited in Apronti Tetteh 2018) found that 82.4% of respondents were aware of the resources available and 98.4% of the library computers had internet connectivity—the literature indicates that they are still widespread.

Are LLMIC researchers disadvantaged by subscription journals?

In addition to the gender barriers and other barriers set out in previous sections that are common to any electronically accessed resources, the literature identifies costs of subscriptions as a significant barrier and:

> *"for many practitioners, these sources become inaccessible because they do not have the resources to pay for subscriptions to journals, do not have easy physical access to libraries, but do not have the institutional support to access subscription only databases" (Hayman 2013, p4).*

As well as the costs of the resources, the process of buying, managing and authenticating access to them raises further potential barriers.

So, are subscription-based e-resources still needed given the rise of open access (OA)?

Does Open Access solve the problem(s)?

A large-scale analysis of the prevalence of OA[8] (Piwowar 2018) finds that at least 28% of scholarly literature is OA, and rising year on year with about 45% of articles published in 2015 being OA. This includes articles classified as:

- Gold: published in an open-access journal that is indexed by the Directory of Open Access Journals (DOAJ)
- Green: paid-access on the publisher page but a free copy in an OA repository;
- Hybrid: free under an open licence in a paid-access journal;
- Bronze: free to read on the publisher page but without a clearly identifiable licence.

This does not include articles shared via academic social networks such as ResearchGate or via SciHub, and they also note that they use exclusive categories so an article cannot be double counted.

Piwowar *et al* estimate that the methods they used may underestimate the amount of OA by approximately a third, which would indicate that around 37% of the scholarly literature is free to read online (legally). They note that the majority of the OA articles they found were their new category of Bronze, which means they "*do not extend any reuse rights beyond reading*" (p16) and question how much of it is non-peer-reviewed, delayed OA or has transient free-to-use status.

The proportion of the literature available as OA varies by subject area with, for example, "*astronomy & astrophysics (87%), fertility (86%), tropical medicine (84%), and embryology (83%) were the specialties where access to literature was the most open. At the other end of the spectrum are pharmacy (7%), inorganic & nuclear chemistry (7%), and chemical engineering (9%), where publications were hidden behind a paywall for more than 90% of papers*" (Piwowar 2018, p13).

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[8] Defined by them as "*free to read online, either on the publisher website or in an OA repository*" with all other articles defined as '*closed*' (Piwowar 2018, p5).

The STM report (Johnson 2018) states that: DOAJ contained 11,811 journals in July 2018, i.e. around 27% of the report's estimated total number of journals; Scopus contains 16% OA; Web of Science 12% OA and its Emerging Sources Citation Index containing 28% OA (STM 2018, p133) [9].

Discussion

Taking the highest estimates of the amount of OA available, around two thirds of scholarly literature currently remains behind a paywall. This proportion will be higher for older papers, which are less likely to be OA. [10]

Conclusions

This review set out to find out whether work around access to research still relevant and needed. The evidence reviewed indicates that it is because:

- Research can contribute to achieving development goals and impact;
- Access to research is a core component of research, research uptake and research capacity building systems;
- Current access to research is not equitable, with those working in LLMICs often disadvantaged by lack of the knowledge, skills, infrastructure and enabling environment required for effective access to electronic resources;
- Around two thirds of global research literature remains behind a paywall.

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[9] The STM website shows that the report is currently being corrected so there may be changes to these figures.

[10] As this review was being written, Plan S (https://www.coalition-s.org/) was launched by "cOAlition S", a group of national research funding organizations, with the support of the European Commission and the European Research Council (ERC). This initiative is likely to increase the rate of growth of open access articles for research funded by European funders.

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