



Participation in the global knowledge commons

Global
knowledge
commons

Challenges and opportunities for research dissemination in developing countries

141

Leslie Chan

University of Toronto at Scarborough, Toronto, Canada, and

Sely Costa

Universidade de Brasília, Brasília, Brazil

Abstract

Purpose – This paper aims to provide a review of recent trends in the open access (OA) movement, as well as to discuss the significance of those trends for information access in developing countries.

Design/methodology/approach – An analysis of the recent literature was carried out, focusing on the benefits of a greater information access in developing countries. The paper also brings together the diverse experiences from the authors on OA publishing and archiving with institutions in a number of developing countries.

Findings – Knowledge workers in developing countries are now getting access to scholarly and scientific publications and electronic resources at a level that is unmatched historically. This is highly significant, if developing countries are to meet the millennium development goals. The OA movement and the growing number of Open Archive Initiative-compliant institutional repositories promise to provide even greater access to resources and publications that were previously inaccessible. These low cost technology and interoperability standards are providing great opportunities for libraries and publishers in developing countries to disseminate local research and to bridge the south-north knowledge gap.

Originality/value – This paper therefore provides recommendations for knowledge workers on how to actively participate in and contribute to the global knowledge commons. The results and recommendations contained in the paper should be of interest to authors, policy makers, funding agencies and information professionals in both developing and developed countries.

Keywords Libraries, Internet, Archives management, Electronic media, Electronic journals, Publishers

Paper type Literature review

Introduction

Information needs of developing countries

Developing nations today face many major problems, including widespread poverty, inadequate drinking water, high illiteracy rates, intense foreign debt, overpopulation, and a heavy disease burden. A common link underlying these problems is that science and technology could play a key role in their alleviation. At the same time, access to knowledge, primarily in agriculture, medicine, and technology, can help to create stronger social, economic, and technical infrastructures that are essential in the development process. Indeed it has long been recognized by international agencies



The authors would like to thank Barbara Kirsop, Peter Lor, Heather Morrison, Mary Waltham and the reviewers for their helpful suggestions.

such as Unesco (1982, p.157) that “assimilation of scientific and technological information is an essential precondition for progress in developing countries”.

However, the research infrastructure and the capacity to absorb scientific and technical knowledge are also weak in developing countries, leading to low levels of scientific output and further under-development. New knowledge is largely created in richer countries, where spending on research and development are highest. In a recent study of the comparative performance of the world’s major science producing countries, King (2004) found that researchers in eight countries – led by the USA, the UK, Germany and Japan – produce almost 85 per cent of the world’s most cited publications, while another 163 countries, mostly developing countries, account for less than 2.5 per cent.

An example of this highly uneven output is that only 10 per cent of the global health research is undertaken in the developing world (Global Forum for Health Research, 2003) and only 2 per cent of the 3,000 journals indexed on Medline are from developing countries (Smith, 2002). In addition, institutions and researchers in developing countries often have little or no access to the research literature published in the North due to the high cost of journal subscription and inadequate and expensive distribution mechanisms (Arunachalam, 2000; Arunachalam, 2003). According to a recent survey conducted by the World Health Organization (WHO), of the 75 countries with a GNP per capita per year of less than US\$1,000, 56 per cent of institutions have had no subscriptions to journals over the last five years; of countries with a GNP between US\$1-3,000, 34 per cent have had no subscriptions and a further 34 per cent have an average of two subscriptions per year (Aronson, 2004). Under these circumstances it is clear that progress in science and development in low-income countries will be made only with very great difficulty. As long as this asymmetry in research output and access to up-to-date information remains, research scientists in the developing world will remain isolated and their research will continue to have little impact.

Objectives of the paper

The advent of information and communications technologies (ICTs), and in particular the www, holds great promise for more equitable distribution of scientific knowledge and the ideal of a global knowledge commons is no longer seen as an unattainable utopia (Global Knowledge Partnership, 1997[1]). Important global initiatives such as the World Summit on the Information Society (WSIS) are looking to advances in ICT to bridge the knowledge divide and to achieve the millennium development goals[2]. At the same time, the declaration of the WSIS[3] calls for government, private business and non-government agencies to work together towards a more inclusive information society.

In recent years a chorus of initiatives has arisen in response to the growing recognition of the importance of improved access to knowledge in developing countries, as well as the growing importance of ICT in enabling this process. The purpose of this chapter is to: highlight recent initiatives that attempt to provide improved access to scientific knowledge for developing countries; assess the key players and the possible outcomes of these initiatives; discuss the importance of the open access (OA) movement for science in developing countries; and provide policy recommendations to government, research agencies, libraries and funding agencies

regarding support for improved access to international research and the sharing and dissemination of locally generated scientific knowledge.

Some qualifications

Defining developing countries. Before reviewing the various information access initiatives and their impact, it is necessary to qualify some of the terminology and limit the scope of this review. The term developing country has always been difficult to define because of its inherent connotation that the industrialized state enjoyed by rich countries is what other countries are striving towards. The World Bank's definition of developing countries based on a country's gross national product (GNP) is also overly simplistic as it overlooks the highly heterogeneous socio-political, cultural and economic diversity within and between developing countries.

Because of the inherent problems with defining developing countries, the terms low-income countries and The South are also used in this paper as a short hand to refer to the poorer, less technologically advanced nations of the world, as opposed to the north, which includes the richer, industrialized states. These are also common terms used to describe the disparities in information and knowledge flow.

Libraries. One of the key roles of a library is to provide structured access to information. With the increasing reliance on ICT, libraries are playing a significant role in implementing and moderating a country's information society agenda. From public to community to school libraries, librarians are playing diverse roles in knowledge organization, dissemination and access. This paper focuses on university and research libraries with the primary mission of supporting research and teaching in higher education.

Scientific journals. The peer-reviewed scientific journal, despite the advance of electronic publishing and new modes of scholarly communication, remains the primary vehicle for the dissemination of scientific results. Journal articles also remain the primary means for measuring research output of individual scientist, institution or country (King, 2004). This paper focuses primary on access to and the production of journals as a potential measure of a country's participation in global science. The OA movement is also primarily concerned with freeing the peer-reviewed literature from toll access. Given the scope of this paper, other forms of "local" or "indigenous" knowledge that are often highly important for developing countries (Kaniki and Mphahlele, 2002) will not be considered.

Developing countries' initiatives

Survey of initiatives

Providing free or reduced-rate journal access to developing countries is not a new phenomenon and many journals, particularly those published by scholarly or scientific societies, have in the past offered discretionary discount to subscribers or libraries from developing countries. What is new with recent journals-to-developing countries initiatives is the scale and the process by which journals in electronic format are being offered to developing countries. These new initiatives, some of which are discussed below, are largely based on models of consortial purchasing, national site licensing, and donors' subsidies and they often involve access to bundled journals rather than individual titles. The qualifying criteria also vary between initiatives so it is often difficult to know who qualifies for what and how access is gained.

HINARI. One of the best known and certainly most publicized developing country initiatives is the Health InterNetwork Access to Research Initiative (HINARI, www.healthinternetwork.org/). The program provides free or highly discounted subscription access to major journals in biomedical and related social sciences to non-profit institutions in developing countries. Demand for health information in developing countries is the most intense given the grave consequences from inaccessible potential life saving knowledge.

HINARI is developed and coordinated by the WHO, and it has been described by WHO director-general Dr Gro Harlem Brundtland as “perhaps the biggest step ever taken towards reducing the health information gap between rich and poor countries” (HINARI homepage).

First launched in January 2002, HINARI was comprised of 1,500 journal titles published by six major publishers: Blackwell, Elsevier Science, the Harcourt Worldwide STM Group, Wolters Kluwer International Health & Science, Springer Verlag and John Wiley. By May 2002, over 20 other publishers joined the program, bringing the total titles to over 2,000. The program is guaranteed through 2006.

Institutions in low-income countries with a GNP/capita of US\$1,000 or less are eligible for free access to HINARI. While countries with a GNP/capita of US\$1,000 to US\$3,000 pay an annual fee of US\$1,000 per institution. Institutions that wish to participate in the program need to submit an application to HINARI. As of May 2004, 1,100 institutions in 102 countries have registered with HINARI. Ethiopia, Nepal, Sudan, and Vietnam, which are all eligible for free access, have some of the highest number of registered institutions (Aronson, 2004).

Targeted institutions are national universities, research institutions, professional schools (medicine, nursing, pharmacy, public health, dentistry), teaching hospitals, government offices and national medical libraries. All staff members and students are entitled to access to the journals[4]. Each registered institution is given a password to HINARI by WHO staff, and individuals belonging to the eligible institutions obtain the password from their librarian (or equivalent). Access is restricted to institutional libraries only.

The HINARI portal allows users to access and download full text articles from participating publishers, search PubMed database through the National Library of Medicine in the USA, and search by subject.

It is too early to tell whether HINARI is having a real and significant impact on health care delivery and research in eligible countries. Formal evaluation of HINARI has not been conducted and one will start at the end of 2005 (Katikireddi, 2004). However, access to relevant health information in a timely fashion is already reducing the sense of professional isolation felt by many researchers in developing countries (Aronson, 2004). Early usage statistics indicate that at least document downloading has been steadily increasing (Aronson, 2004). However, whether download statistics translate into health care improvement or higher research productivity remains to be seen.

While the primary goal of HINARI is to provide high quality publications in public health and to bridge the digital divide in health, an associated goal of the program is to improve connectivity and networking and to train professionals in the access and management of health information resources. Some participating institutions are using their HINARI eligibility to leverage funding for equipment and Internet access from

their governments and from international donors (Aronson, 2004). Improved access to ICT will also improve access to other electronic resources. Thus access to HINARI may stimulate local improvement in infrastructure and may also lead to digital library development in the longer term.

AGORA. Global Online Research in Agriculture (AGORA, www.aginternetwork.org/), which is administered by the United Nations Food and Agriculture Organization, is a sister program to HINARI. The aim of AGORA is to improve food and nutritional security by providing free or low cost access to over 400 scientific journals in agriculture and related sciences to public institutions in developing countries.

AGORA is based on Cornell University's TEEAL (The Essential Electronic Agricultural Library) project, a collection of key agricultural journals distributed to developing countries on CD-ROM and made available to institutions without adequate Internet access. According to Anton Mangstl, director of FAO's library and documentation systems division, "by bringing together bilateral agencies, UN agencies, private foundations and international scientific publishers, AGORA demonstrates that the public and private sectors can work together to build greater momentum towards building a world without hunger"[5].

Launched in October 2003 and using the same eligibility criteria based on GNP, 200 institutions in 47 countries had registered for AGORA as of March 2004. AGORA operates on the same access and portal approach as HINARI, and "trains the trainer" on the use of electronic resources and digital library.

Again, due to the recent nature of the program and the long-term nature of possible impact, it is not clear at present how beneficial the program will become.

Electronic Information for Libraries.net (eIFL.net). Another large-scale project that provides multi-country access to commercially produced electronic journals and databases is the eIFL.net (www.eifl.net/), originally initiated by the Open Society Institute of the Soros Foundation. It is now an independent foundation with the mission "to lead, negotiate, support and advocate for the wide availability of electronic resources by library users in transition and developing countries". eIFL accomplishes this mission by "negotiating affordable subscriptions on a multi-country consortial basis, while supporting the enhancement of emerging national library consortia in member countries"[6].

Unlike HINARI and AGORA with a subject focus, the content of eIFL includes social sciences, humanities, business and economics as well as science and technology. The original targets of eIFL users were post socialist countries of Central and Eastern Europe, the former Soviet Union, and member countries of the Soros network. The initial focus on humanities and social sciences publications was based on the principle that knowledge from these fields are essential for the development of open and democratic societies. Since 2002 membership has been expanded to include developing countries that fit the eIFL profile[7], primarily countries with the right organizations that could provide the leadership in the development of local library consortia.

So eIFL is a program not only concerned with information access but with building local library capacity to manage increasingly complex demand of digital library as well as the development of skills in licensing negotiation with publishers.

As with HINARI and AGORA, evidence on the impact of improved and increased access to journal publications is not yet clear, again due to the recent nature of the program and the highly varied capacity of participating libraries.

Programme for the Enhancement of Research Information (PERI). The most comprehensive initiative of access to worldwide research is the Programme for the Enhancement of Research Information (PERI, www.inasp.info/peri/), coordinated by the International Network for the Availability of Scientific Publications (INASP). The main objective of PERI is to “support capacity building in the research sector in developing and transitional countries by strengthening the production, access and dissemination of information and knowledge” (PERI homepage).

PERI is a multi-dimensional approach to information access that includes several related objectives[8]:

- facilitate the acquisition of international information and knowledge;
- improve access to research through the promotion of national and regional journals;
- provide awareness or training in the use, evaluation and management of electronic information and communication technologies (ICTs); and
- enhance skills in the preparation, production and management of journals.

Like eIFL.net, PERI also acts as a negotiator with commercial publishers and information aggregators on behalf of developing countries by securing deeply discounted prices for access to online journals and databases. In addition to playing a key role in reducing cost barriers, INASP has also been instrumental in designing programs that assist local journals with improving their editorial and scientific quality.

Problems with differential pricing initiatives

While the various initiatives outlined above are important and welcome steps towards improving access to research in developing countries, there are problems associated with these programs that warrant attention, which are discussed below.

Information relevance. One of the main problems with research access initiatives like HINARI is the implicit assumption that research findings from the rich countries could be directly transferred to the poor countries, an assumption that has been seriously questioned in the past (Lor and Britz, 2004). Is it useful for doctors in Nigeria to read about the latest high-tech treatments for infertility published in a western journal when it is not economically feasible to implement these procedures in cash-strapped public hospital in Nigeria (Okonofua, 2003)?

In a recent paper on health information access, Godlee *et al.* (2004, p. 2) lamented that “despite growing understanding of the need for exchange of knowledge between countries and within regions, there is a continuing tendency to push information out to people rather than strengthening and responding to the pull of their information needs”.

Often what researchers or health workers in developing countries need is information generated in their own country or other developing countries with a similar socio-economic context and with similar problems that need to be solved (Kale, 1994; Smith, 2002). Further, locally generated research, such as that in traditional medicine and medicinal plants, may be highly relevant to treatment of diseases for local populations (Bosman and Marais, 1998).

It is not clear, however, what percentage of the information in the publishers packages are in fact relevant to the needs of developing countries. Nor is it clear whether journals published in developing countries are included in the packaged

databases. So the large databases being offered in some cases are not as comprehensive as they seem. An evaluation of what journals are consulted and how frequently eligible users consult them would be helpful in this regard.

While north-to-south flow of research is valuable to the South in terms of up-to-date scientific development, South-to-South flow of knowledge is equally important. As Lor and Britz (2004, p. 17) also noted “. . . the limited contribution that the south-generated information makes to the global knowledge society . . . not only inhibit creativity but also hampers sustainable development”. Unless efforts are made to include locally published journals into the international database, researchers in both the developed and the developing worlds will not get a true global picture of the phenomenon they study and researchers in the south will continue to be dependent on a North-biased approach to solving problems. Thus stronger efforts need to be made towards balancing the contents in the databases. The publishing initiatives program by INASP in strengthening local journal publishing and in particular the African Journal Online project are steps towards increasing the visibility and international presence of indigenous journals (Smart, 2004). This issue will be further discussed below.

Commercial interests. Related to the issue of relevant content is the marketing strategies employed by some large commercial publishers. As pointed out by Frazier (2001), the bundling of a large number of titles into a single package, commonly known as the “big deal”, give “the largest commercial publishers extraordinary power to control terms and conditions of the information market”. So while the cost of production and distribution of electronic resources continues to decline, the cost of subscription continues to increase. And while library consortia are able to negotiate better prices than individual libraries, access costs to the one price and one size fits all bundles remain exceedingly high (Scigliano, 2002).

In addition to a high price tag, the big deals often come with highly restrictive licensing terms, thus limiting libraries from resource sharing, collection development and long term archiving (Lougee, 1995; Lougee, 2002). These problems are causing a great deal of concern in research libraries in the North. And while the impact of these problems on developing countries’ libraries is not yet clear, it is likely that the effect will be even more severe.

Another important consequence of the “big deal” is that much of the library’s acquisition budget is tied up by these purchases, leaving little room for the library to subscribe to titles from small publishers, usually represented by university presses and scholarly society publishers. These publishers are most in need of research library support in terms of subscription revenue and their exclusion from library collections is leading to the loss of diversity in titles and publishing outlets available to authors (Landesman and van Reenen, 2000).

In developing countries, attention to the large bundles from large multinational commercial publishers also overshadows local publishers or new publishing initiatives that are in need of support. So small and non-commercial publishers, which are responsible for the majority of journals published in developing countries (Rosenberg, 1997; Rosenberg, 2002), are further marginalized and excluded from international as well as local readership (Cetto, 2000).

While libraries are given little flexibility in journal title selection in the bundled deals, publishers are at liberty to manipulate the bundles to suite their marketing needs. As Katikireddi (2004, p. 1192) pointed out, “some valuable journals of specific

relevance to the developing world (tropical medicine journals, for example) may not be available through HINARI as this may compromise publishers' commercial viability. Also, in a few countries, publishers withhold some journals because the sales of these journals are significant in these countries."

Indeed, this is the case for India, which is excluded from HINARI and AGORA even though India's per capita GDP is less than half of US\$1,000, the threshold accepted by the publishers for these programs, simply because there are many institutional subscribers in India for many journals included in HINARI and AGORA. University and research institute libraries in various regions of India also belong to different consortia who sign different licensing agreements with different publishers that allow them access to some titles that are also available through HINARI and AGORA. So offering these programs to India would substantially undercut the subscription revenue publishers currently enjoy. It appears that profit motive prevails over the principle of true equity.

Co-ordination. The lack of co-ordination by the various national site licensing programs and international initiatives is causing great confusion for many institutional libraries in terms of what is available to users. INASP recently conducted a survey of libraries' use of the various differential pricing programs and found that take-up of these initiatives is relatively low (Smart, 2004). Problems are due to the fact that some schemes overlap with others or are not communicated well to eligible users, while other schemes have not fully taken local needs into account. Clearly better communication between sponsoring organizations, publishers and users are needed, as are user training and awareness raising programs.

Long-term sustainability and capacity building. Finally, it is not at all clear what would happen to research access in developing countries when the publishers' agreements end and when donations and subsidies are no longer available. For poorly resourced research institutions that desperately need to build capacity and collections that are relevant to their research needs, termination of electronic access would mean the effective termination of local research because no back-files would be available from the local libraries. Thus, the differential pricing approach to access, while attractive in the short term, is indeed at odds with the needs of the developing countries. This is because instead of promoting sustainable development in science through local capacity building (Godlee *et al.*, 2004), differential fee programs promote dependency on foreign aid and charitable subsidies. Clearly, "the cycles of poverty and dependence will only be broken by capacity-building between nations of high and low science intensity" (King, 2004).

The remainder of this paper looks at the means by which long term sustainable access to local and international knowledge could be secured through complementary approaches of local capacity building and OA to scientific research.

OA and benefits for developing countries

Few topics in scholarly publishing and information access today are as hotly debated as the OA movement. Because this topic is also covered in other sections in this paper, the authors' discussion is restricted to areas of the OA debate that are often neglected, naming the rationales and benefits of OA for developing countries as well as for global science, and the means by which OA could be achieved by institutions in developing countries. It is also important to restate and amplify the principle underlying the OA

movement as it is often forgotten in debates regarding the economics of OA and who should pay.

The guiding principle of the OA movement to scientific literature is the conviction that scientific and technical information is quintessential global public good that should be freely available for the benefit of all (Alberts, 2002). The current system of scientific publishing is contrary to this ethos because some commercial publishers are placing excessive price and permission barriers on research publications that are largely funded by public tax dollars and other public funds (Suber, 2003). Effectively, the public goods have been turned into a high price commodity affordable only to those who have the financial resources.

The differential pricing schemes described above therefore mask the fundamental issue that publicly funded research should be accessible to the public without further barriers. So the “free” access to online journals given to the poorest of the poor countries is not true OA, as the cost is subsidized by sponsoring agencies, donors and other subscribers.

Remarkably, it is only in the last two years that government bodies and large research funding agencies in the developed world are starting to recognize the inefficiency of a system where results of publicly funded research are kept behind financial tollgates. The Budapest Open Access Initiatives[9], the Berlin Declaration[10], the Wellcome Trust statement[11], and IFLA’s statement[12] are now well known examples of calls for OA to publicly funded research.

OA journals

Essentially, there are two broad strategies for providing OA to scientific research. One is through OA archiving (OAA) of published research material and the other is through the development of OA journals (OAJ) in which the costs of publication are not met by the readers but by some other means, such as the authors’ institute or funding bodies.

OA publishing, and in particular the input-pay model where the author’s institute pays for the publication cost per article, is being pioneered by such organisations as the Public Library of Science (www.plos.org) and BioMedCentral (www.biomedcentral.com). Not surprisingly, there is on-going debate about economic viability of this model by authors from developing countries. Even though publishing fees for authors from developing countries are currently waived if requested, the long-term sustainability of this approach is not clear. There is little doubt, however, that the literature made available through OAJ is beneficial to all. Publishers in developing countries are also experimenting with various OAJ models.

SciELO. By far, the most successful and pioneering model of OA journal publishing is the Scientific Electronic Library Online (SciELO, www.scielo.org) project from Brazil. Through SciELO, users worldwide can access over 200 journals in health and other sciences published in Brazil and other Latin American countries. A collaboration between the Foundation for the Support of Science of São Paulo (FAPESP) and the Latin America and Caribbean Centre for Health Sciences Information BIREME (www.bireme.org), SciELO demonstrates how significant government funding and support can dramatically improve the visibility, accessibility and impact of science from Brazil and other regions of Latin America (Coura and Willcox, 2003).

BIREME also developed an index to journals from Latin America and the Caribbean known as LILACS (lilacs.bvsalud.org) to further improve the visibility of journals from

these regions. In collaboration with the Pan American Health Organization and a number of other agencies, BIREME also developed the Virtual Health Library (www.bvsalud.org) that provides free online access to a range of health journals that are highly relevant to health workers in the region. This collaborative approach is seen as the way forward for providing “health information for all by 2015” (Godlee *et al.*, 2004).

Bioline International. Another approach to OA publishing is to provide an online version of the journal articles for free while maintaining print subscription. An increasing number of journals from developing countries are practicing this approach, and, for the last ten years, Bioline International (www.bioline.org.br) has been providing free online hosting services to publishers who do not have the resources to provide their own online access. There are now just over thirty journals on the Bioline system, with publications from several African countries, as well as India, Brazil, Chile, Turkey and several other developing countries. The subject coverage of Bioline International is mainly in the health and biological sciences.

OAJ from India. Several scientific institutes in India are also practice OA publishing. The Indian Academy of Sciences publishes 11 journals and they are all freely accessible on the web (www.ias.ac.in/journals.html). The Indian National Science Academy has recently made available several of its publication online for free (www.insa.ac.in/html/home.asp). Medknow Publications (www.medknow.com), a small but fast growing publisher based in Mumbai, is providing electronic publishing services to a number of medical journals and partnering with Bioline International to make the full text of these journals available on an OA basis.

The Directory of Open Access Journals. The Open Society Institute funded the development of the Directory of Open Access Journals (DOAJ, www.doaj.org) to facilitate searching and library indexing of OA journals from around the world. A total of 1,150 journal titles are indexed in DOAJ as of the writing of this paper. It is not possible to determine the country of origin of the journals at the moment so the number of OA journals from developing countries is not clear.

However, it is noteworthy that the total number of journals listed in DOAJ constitutes only about 5 per cent of the world’s 23,000 peer-reviewed titles listed by Ulrich (www.ulrichsweb.com/ulrichsweb), a widely consulted and most authoritative source on periodical references. This means that close to 95 per cent of the literature is still only accessible through payment. It is for this reason that some advocates of OA, most notably Harnad (2001, 2003) and Harnad *et al.* (2003), have been championing the other complementary route of OA, namely OAA, as the most immediate road to freeing the entire corpus of the scholarly and scientific literature worldwide.

OAA

While open access publishing (OAP) is clearly beneficial to researchers from developing countries and is slowly improving the visibility and impact of high-quality publications (Sahu and Chan, 2004), OAA is a far more immediate and beneficial route for developing countries. But this approach to OA is not receiving sufficient attention and is often misunderstood (Chan and Kirsop, 2001).

There are various forms of OAAs. There are institutional archives based at university or research institute; there are discipline-based archives, such as the famous physics e-prints archive (www.arXiv.org), and other specialty archives such as PubMedCentral (www.pubmed.org). The term “self archiving” refers to the process

whereby individual authors submit their own published papers or preprints (collectively known as e-prints) to a publicly accessible archive of their choice. Many institutions also archive publications on behalf of their faculty (Chan, 2004). Ideally, the archive should be compliant with the Open Archive Initiative (OAI) Protocol for Metadata Harvesting so as to maximize interoperability with other OAI servers worldwide, thereby linking all servers into a worldwide and seamless virtual library.

Benefits of OAA. OAA is of particular importance to researchers and scientific organizations in developing countries for the following reasons:

- *Institutional access to research output.* Scientists in developing countries are under pressure to publish in foreign or “international” journals with a notable “impact factor” (as measured by ISI’s Science Citation Index) if they wish to be recognized within and outside their own countries (Adomi and Mordi, 2003). Because few “local” journals are indexed by Science Citation Index, and the ones that are indexed usually have relatively low impact factors (Coura and Willcox, 2003), scientists in developing countries often do not publish in journals from their own countries. This leads to a cycle of low visibility and low submission for indigenous journals (Alemna *et al.*, 2001).

Because articles published in overseas journals are often inaccessible to other scientists in developing countries due to high access cost, many publications by developing country scientists remain invisible to their home institutions or fellow scientists. The result is that it is difficult for institutions and granting agencies in developing countries to take stock of their research output (Arunachalam, 2004) and much essential research is “missing”. While this is very serious for the developing countries, it is often not recognised that international medical and environmental research programmes may be inappropriate, due to the lack of knowledge of research generated in the countries where the major health problems exist. A search for ‘malaria’ on the Bioline International web site illustrates the volume of relevant research available from the developing world.

By setting up institutional archives and asking staff scientists and faculty to submit their published papers, a corpus of published research would be instantly accessible to all. OAAs would be especially significant for transitional economies like Brazil, China and India, who have been investing substantially in scientific research in the last decade. These countries have seen a significant rise in the number of publications in recent years. For example, scientific publications from China (as indexed by ISI) has arisen from 69,000 to 115,000 articles between the two four-year periods 1993-1997 and 1997-2001 (King, 2004). Likewise, Brazil has increased its share of the world’s scientific publications from 0.84 to 1.21 per cent in the same period (King, 2004). If universities and science academies in these countries set up archives, they could be immediately populated with a great number of papers.

By showcasing their faculty’s research output, OAs will bring prestige to both the staff and the institution. Above all, such archives will reconnect local and international research and provide a better picture of a country’s research output and areas of specialization. This will have implications for future international collaboration, funding proposals, and even recruitment of new faculty.

- *Improved citation and research impact.* The most compelling reason for institutions, both in the developed and in the developing world, to set up

interoperable OAAs is the growing evidence that citation and the impact of papers that are openly accessible are far greater than non OA publications. In a highly cited study, Lawrence (2001) found an “average of 336 per cent more citations of online articles compared to offline articles published in the same venue”. However, this effect may have been specific to computer science literature, an area investigated by Lawrence.

A large-scale study is now under way to examine the “Lawrence effect” across all disciplines in a ten-year ISI sample of 14 million articles. The goal is to measure the citation effect of the articles from non-OA journals that have been made OA by their authors through self-archiving, and to compare this with articles that have not been made OA by their authors. Preliminary results suggest that there is a discernible difference in terms of the frequency with which the articles are cited, and that the difference is between 250 per cent and 550 per cent in favour of the articles that authors have made OA (Brody *et al.*, 2004). This offers a compelling reason for researchers from around the world to make their research openly accessible through their institutional archives and for institutions to begin implementing policies for setting up and filling their archives to maximize the impact of their collective research output. It should be noted that the use of OA archiving is still in its infancy so that these results are very encouraging.

- *Open source software and low infrastructure cost.* The technical infrastructure for setting up institutional archives is now in place and the costs are minor. This is because there are a number of free open source software applications for setting up institutional archives and the major cost involves the purchase of a server, if one doesn't already exist, and connectivity cost. The best-known and most widely used software are Eprints (www.eprints.org) made available by the University of Southampton and DSpace by MIT (www.dspace.org). Other applications with varying functionality are also freely available (see the Guide to Institutional Repository Software produced by the Open Society Institute[13]).

The software applications mentioned above are compliant with the Open Archive Initiative Protocol for Metadata Harvesting, which is now a widely adopted international standard for metadata sharing and resource discovery. Any publications residing in an OAI-compliant server will be discoverable by any OAI-aware search services such as OAIster.org, no matter where the server resides. This is a great boon for publications from developing countries and for developing country scientists, since institutions with OA servers become part of the international community and their published research part of the global library of science.

- *Improved access to primary data.* While the primary role of institutional archives is to make available published material, many institutions also use their archive to provide access to other materials, including theses and dissertation, datasets, technical reports, instructional materials, doctoral theses and other forms of electronic publications that may include multimedia objects. Many of these digital objects do not have regular publishing outlets but are nonetheless important for teaching and research purposes. Making these intellectual products openly available through institutional archives is vastly increasing the depth and diversity of raw material for research and development (Chan, 2004).

Such resources are not only available from institutions from the North, but many institutions in the South have accumulated a treasure house of primary sources in areas of health, demography, cultural heritage as well as environmental and biodiversity data. For example, the Tuberculosis Research Institutes in Bangalore houses over 100 years' worth of epidemiological and TB surveillance reports from various rural regions in South India and research staff at the Institutes also publish widely. Much of this data are scattered however, and available only to small number of researchers. If made available through an OAA, these data could be of tremendous value for TB research not only in India but also worldwide (Arunachalam, personal communications). Examples of this could be easily multiplied in all areas of science and medicine. The potential of OA to data is closely tied to OA publications and is mutually reinforcing. This is where the storehouse of knowledge in developing countries can also contribute significantly to the global knowledge commons[14].

Possible barriers to participation

After the initial inertia, the number of OAAs around the world is growing steadily. There are 214 OAI compliant archives that have registered with the institutional archive registry at Southampton[15]. Of these, 19, or nearly 9 per cent, are located in developing and transitional economies. Brazil, while leading in OAJ in developing countries, has three registered archives, and they appear to be experimental in nature.

India has four registered archives, with the library at the Indian Institute of Science[16] being the first to set up an e-prints archive in India and showing other institutions the way forward. However, with a faculty of about 500 members who collectively publish about 2000 papers per year, the IISc archive has only 160 papers as of May 2004, 14 months after the launch of the server. The uptake of self-archiving by faculty at IISc has been extremely sporadic, and (Rajashekar and Jayakanth, 2004) reasoned that concern with copyright violation, the lack of awareness of the benefits of OA, and the lack of support from senior administrators are key reasons for the low rate of participation.

These concerns and the near empty state of most archives once they are set up are by no means unique to IISc. Indeed a recent survey of 45 institutional archives reveals an average of only 290 records per institution (Ware, 2004). So while there appears to be great enthusiasm on the part of university libraries to set up OAA, the incentives for faculty to participate have not been well conveyed. Nor have university administrators been paying sufficient attention to the benefits OA will confer on institutional prestige and international exposure.

In developing countries, many researchers and administrators also express concern that the intellectual properties from poor countries will be exploited by the rich countries without proper compensation, further adding to the reluctance of developing countries to participate in the OA movement. This fear is perhaps justifiable given the history of exploitation of native knowledge by western science (Kaniki and Mphahlele, 2002). This apprehension also leads to a low participation in the culture of sharing, which is at the heart of the OA movement. There is a clear need for better understanding of the nature and benefits of OA for all researchers in order to raise the level of participation.

Copyright concerns. Commercial publishers in the west typically request authors to sign over exclusive rights of their publications to the publisher once their paper has been accepted. As a result, many authors fear that they no longer have the right to their own papers and therefore self-archiving them on their own or their institutional server would constitute violation to the publisher's copyright and they are then liable to prosecution. Likewise, librarians are reluctant to archive papers that are published in western journals on faculty's behalf for fear of putting their institution at copyright risk (Rajashekar, personal communication).

What authors and librarians often fail to realize, however, is that of over 8,000 journals that have been sampled, close to 85 per cent of them already permit authors to self-archive their own publications. This is a dramatic turn given that the percentage of journals giving permission for self-archiving was at best 50 per cent a year earlier (Harnad and Brody, 2004)[17]. As the momentum of the OA movement accelerates and the collective appetite for OA grows, publishers realize that there is no point or possibility in opposing OA itself. Opposition would indeed create a conflict of interest between themselves and their authors, given the growing empirical evidence for the dramatic benefits of OA for research and researchers (Harnad and Brody, 2004).

Lack of institutional policy. Harnad (2003) has pointed out that since copyright is not the real issue impeding the filling of institutional archives, the most likely reason why authors have been slow in self-archiving their publications is that their institutions do not have a clear policy on why and how their faculty members should participate. This is because senior administrators and policy makers themselves are often unaware of the benefits of OA for their institutions and for their faculty's research impact. Again, this is true for institutions in developing and developed countries.

Government bodies and funding agencies in rich countries are starting to question the efficiency of the current science publishing system dominated by commercial interests, and they are beginning to demand that the research they fund is made as widely accessible as possible. The Wellcome Trust, the largest private funding body in the UK, announced its support for OA last year[18]. After an eight month hearing on access to scientific publications, the UK House of Commons Committee on Science and Technology released a much-anticipated report on July 20, 2004[19]. The report contains a large number of recommendations for the government to improve science communications. Of special significance are the recommendations that:

- the government should provide funds for all UK universities to launch OA institutional repositories; and
- authors of articles based on government-funded research should deposit copies in their institutional repositories[20].

In a similar vein, a recent US House of Representatives Appropriations Committee report recommends that beginning in 2005, the National Institute of Health (the second largest funding body in the USA) develop a policy requiring NIH-funded scientists to deposit their articles, as accepted for journal publication, into PubMedCentral (www.pmc.org). PMC is a publicly accessible central archives managed by NIH's National Library of Medicine, with the mandate of managing publicly funded research in health and medicine. If such a policy were adopted, it would mean that thousands of new publications each year, many of which would have been only accessible through subscription before, would be available for free to all.

The two recommendations share the same objective of providing maximum access to publicly funded research through OAA, but differ slightly in approach. While the UK recommendation calls for a national network of distributed archives, the US recommendation calls for a centralized approach to providing OA to NIH funded research. However, since all OAI compliant archives are interoperable, it doesn't make a significant difference to authors where their publications reside.

As the two largest science producing bodies in the world, the UK and the US recommendations will have important international implications and these policy developments are being closely monitored by research agencies around the world. In addition, the UK House of Commons Committee also made recommendations regarding developing country initiatives. The Committee notes that since OA is becoming widespread, models such as HINARI, AGORA and PERI need to be "adapted" to compliment the OA movement. While the Committee did not suggest how the adaptation should occur, a likely route is to invest some of the money that is going to publishers into OAJ publishing or OAA instead.

It is perhaps too early to tell what impact these recommendations would have for policy making in developing countries, but it would be reasonable to think that they will provide confidence to science administrators in the developing world and be a welcome step. But to complete the global knowledge commons, research from developing countries, however small in relative terms, needs to be made available as well. Therefore governments in developing countries should enact similar policy.

OAA initiatives in developing countries

There are indeed signs that countries like India and Brazil are paying close attention to the benefits of OA. The Indian National Science Academy (INSA) is a signatory to the Berlin Declaration and INSA held a one-day seminar on OA at its annual meeting at the National Chemical Laboratory, Pune, in late December 2003. In May 2004, INSA held another one-day workshop at its head- quarters in New Delhi on institutional repositories to raise awareness about the institutional and policy issues surrounding provision to OA. INSA has set up an experimental archive (<http://drtc.isibang.ac.in:9080/insa/>) to begin archiving publications from scientific members.

The Indian Academy of Science, Bangalore, held two workshops on OAJs in March 2002, while the MS Swaminathan Foundation hosted two workshops on institutional e-print archives in May 2004[21]. The latter was to provide training on the technical setup of institutional archives as well as the policy and administrative needs at diverse institutions across India. The National Centre for Science Information (NCSI) of the Indian Institute of Science (IISc) is also active with training workshops and in the planning of a national level harvesting service which will further demonstrate the benefits of OA to research papers by Indian scientists. Indeed, MHRD (Ministry of Human Resources Development, Government of India) has advised all the consortium members of INDEST (Indian National digital Library in Engineering Sciences and Technology) to set up e-print archives using appropriate OAI-compliant software[22].

In Brazil, The Ibero-American Science & Technology Education Consortium (ISTEC) and its Digital Library Linkages (DLL) initiative released a public statement in May 2004 on OA to scholarship and research in Latin America. The statement urges "all Brazilian research funding agencies, IBICT, and university administrations to

study OA and implement policies that would encourage systems based on the principles of the Berlin Declaration on Open Access”.

IBICT, the Instituto Brasileiro de Informação em Ciência e Tecnologia, has just celebrated its 50th anniversary and it has been experimenting with both OAA and OAJ, the latter by implementing the Open Journal System (OJS), an open source journal management workflow and archiving system developed by the Public Knowledge Project[23], to manage publications by IBICT. The major journal in information science in Brazil, *Revista Ciência da Informação (Information Science Journal)* is now totally run under SEER, the OJS Portuguese version. A number of universities and other scholarly journal publishers in the country are training their staff to make use of SEER in order to make their journals more widely accessible.

In the area of OAA, IBICT has created a repository system known as Scientific Dialogue (Diálogo Científico). The project aims to create a central repository for technical reports, theses, pre-prints and post-prints. This project follows the establishment of the Brazilian Database of Theses and Dissertations (BDTD). According to H. Kuramoto:

IBICT has both established a new metadata standard, namely the Brazilian Standard for the Publication of Theses and Dissertations (MTD-Br), and developed a software package to publish theses and dissertations in electronic format (TEDE). This package has been distributed to a number of Brazilian universities that can now make their literature available worldwide. This, in turn, has been possible because the metadata contained in the BDTD have been harvested by the Networked Digital Library of Thesis and Dissertation (NDLTD). Since both initiatives, BDTD and NDLTD, use the same standards, NDLTD can now disseminate this literature, as a total demonstration of the conformity found in the BDTD (H. Kuramoto, personal communication via e-mail, June 27, 2004).

The BDTD is part of a major project of IBICT carried out for the establishment of digital libraries building standards required to build the Brazilian Digital Library (BDB). BDB is a national-wide project that aims to increase and facilitate access to electronic journals and to promote the integrated access to the scientific and technological information produced by Brazilian scientists.

In South Africa, the South African Site Licensing Initiative (SASLI) of the Coalition of South African Libraries Consortia held a workshop recently[24] in order to engage the library, higher education communities, research offices, as well as government funding bodies with implementing the dual strategy of OA as recommended by the Budapest Open Access Initiative. There is as yet no institutional repository set up at any African institution of higher education, although experimentations are going on at a number of universities. SASLI's effort in support of institutional repositories is noteworthy, as it is an indication that library consortia are recognizing that a national site licensing approach to information access is not sustainable in the long term and complementary approaches to information provision need to be supported and developed.

Policy recommendations

Based on the increasing understanding of the benefits of OA, all stakeholders in scholarly communication should take an active part in its continuing development.

Authors

Scientists and researchers from developing countries should continue to publish in international journals. But they should also self-archive their publications in their institutional archives in order to make them accessible to colleagues and other interested readers worldwide. If an institutional archive does not exist, they should find a suitable discipline-based archive or other centralized archive, recognizing that the interoperability of all OAA removes the significance of the location of the archive.

Authors and researchers should lobby their administration to set up institutional archives to facilitate knowledge dissemination and promote institutional output.

An increasing number of journals are now born OA or have converted from a traditional economic model to the OA model with alternative funding models. Authors should become familiar with such journals in their field by searching the Directory of Open Access Journals (www.doaj.org) and publish in them so as to maximize research access and impact.

Authors should also support local journals that have adopted an OA policy by serving on editorial boards, acting as reviewers, as well as also submitting papers for publications.

Journal publishers

As it has been demonstrated that on line access improves both readership and citation impact, we expect that the vast majority of the low impact journals would be well advised to make their journals OA. Increased readership and author's attention seems inevitable, given preliminary findings of increased impact quoted above, thus raising awareness of research in the developing world and strengthening the science base of countries.

Most journals in developing countries are published by scientific societies or non-profit organizations, and private foundations, aid agencies, and international bodies heavily subsidize these journals. But most of these agencies do not understand the power and benefits of OA and often insist on journals being self-sufficient through subscription. The reliance on the subscription model has led to repeated failures and short-lived journals. Instead, we would like to reshape thinking about the support for scientific publishing from a "subsidize until commercially viable" concept to one in which the support is seen as an ongoing contribution by donor agencies to the sustainability of science and society.

In other words, rather than trying to sustain print journals that will most likely never have an audience outside their home country or regions, we recommend using the same funds to bring the journal to a global audience through OA, thereby enlarging the readership base and potential contributors. The Open Society Institute has produced a business guide for publishers who wish to convert their subscription-based journal to an OA[25]. Publishers could also choose to work collaboratively with other organizations such as INASP, Bionline International, Open Knowledge Project, etc., which could assist with technical online publishing know-how.

Aid and development agencies

Development and aid agencies with the primary mission of local capacity building should pay closer attention to the OA movement as broader access to scientific knowledge will help strengthen local science and technology capacity.

Organizations such as the International Development Research Centre (IDRC, Canada) are promoting the use of ICT for development and knowledge sharing, but IDRC does not have a funding program for OA initiatives. However, IDRC supported both OA workshops in India mentioned earlier and the IDRC regional office in India is beginning to pay closer attention to the impact of OA on development programs.

Likewise, the British Council, which has regional offices in many parts of the developing world, is committed to broadening access to information and local professional development. The British Council in Chennai, India, has also supported the OA workshops in India and is interested in raising awareness of OA among library professionals in India.

It would be highly beneficial if agencies such as the IDRC and the British Council would begin programs in support of OAJ and OAA in the developing world by providing transitional funds for OAJ and for start-up and maintenance costs for OAA. This will ensure a strong foundation for more equitable distribution and access to knowledge worldwide.

Organizations such as the Open Society Institute have been playing a key role in the OA movement and other international agencies should follow suit.

Library and library consortia

In recent years, due to developments in electronic publishing and new business models, libraries are spending more time negotiating with publishers on access and licensing issues. Many libraries now belong to consortia as a means to negotiate a better price with publishers. However, as Landesman and van Reenen (2000) so forcefully put it:

As consortia become a major force in information delivery, they must take on a wider public-interest agenda. They need to focus on their obligation to further the common aspirations of libraries and librarianship to provide equitable and affordable information to all. They need to become real players in the creation and growth of wholly new systems for the creation and dissemination of scholarly communication. To ensure long-term changes in the affordability and availability of scholarly information, consortia need to be more than just buyers' clubs. They need to become partners in inventing new ways of information creation and discovery.

Library coalitions are indeed responding to new ways of knowledge creation and dissemination and the OA movement is proving to be an existing opportunity for libraries and librarians. The OAA movement received a big boost with the release of the Dspace software by the MIT library and with the formation of a development community in support of Dspace and institutional repositories. Research libraries are indeed the logical place where institutional repositories should be housed, given the intellectual partnership between researchers and librarians.

Library consortia in developing countries should actively participate in the growing OAA movement and take the initiative in helping institutions with a repository set up or help with the development of a centralized archive for partnering institutions in order to share cost and expertise. The workshop on OAs organized by the South African Site Licensing Initiative is a good example of how library consortia are taking a more active role in determining access, instead of only negotiating licenses, to scientific and scholarly information.

University administrators

To “publish or perish” is a modus operandi in most western universities and also in many universities in developing countries. Experience in the UK suggests that authors are more likely to self-archive their publications in their institutional repositories if their institutions require them to do so (Swan and Brown, 2004). With the recent UK Parliamentary Committee’s recommendation of institutional archiving of all publicly funded research, universities in the UK will likely begin to implement a policy requiring all faculty to archive their publications.

Whether such mandatory archiving policy will work in institutions in developing countries is not known. It is worth noting, however, that some universities in Africa, such as a number of universities in Nigeria, have explicit promotion policy requiring faculty to publish in “international” journals (Adomi and Mordi, 2003). If these university administrators understand the benefits of OAA, they would do well to implement a policy making sure that their faculty’s output are openly accessible in order to ensure global visibility, which is why the policy to publish overseas was implemented in the first place.

Government funding agencies

Government research funding bodies in low-income countries should become more aware of the opportunities provided by ICT and OA for the dissemination and application of research knowledge.

As the UK Parliamentary inquiry and the US Appropriations Committee reports clearly indicate, the existing system of science publishing and access is highly unsatisfactory because publicly funded research publications are largely inaccessible to the public and even to the funding agencies that commissioned the research.

Given the lower investment in research and development in developing countries, government may not place high priority on the research output of these investments. But unless past research output are made visible and accessible, there will be a continual loss of investment, lost of research impact and slow progress in infrastructure development. Thus it is in the best interests of funding bodies to ensure maximal dissemination of research through institutional archiving when the work is completed.

Conclusions

The recent information access programs to provide free or low cost journals to the poorest countries by publishers that make few sales in these areas is a welcome development, and can alleviate information poverty for some countries in the immediate term. However, these efforts are unlikely to be sustainable and exclude many developing countries, such as India, China and Brazil, where collaborating publishers may lose sale. In the longer term, the worldwide acceptance of OA is the most viable mechanism for creating a global knowledge commons.

OA is immediately available and it can provide equitable access as well as professional inclusion for developing country science. In particular, OAA enriches the global knowledge base by incorporating the “missing” research from the less developed world and improves the south-north and south-south knowledge flow. But for this to happen, researchers, publishers, librarians, funders, university administrators and government policy makers in developing countries have to work

in concert and promote a culture of sharing that is not yet pervasive in most parts of the developing countries. The past need for commercial sales of journals for survival encouraged competitiveness, but this is no longer an issue with the adoption of OA. The concept of thinking globally and acting locally is a principle that should be practiced by the same stakeholders if true equity of access to knowledge is to be achieved.

At the same time, researchers and institutions in developing countries should forge alliances with organizations that aim to strengthen local capacity building and democratization of knowledge, while international development and aid agencies should play a bigger part in developing funding models that takes into account local information needs as well as the capacity to absorb new knowledge. Ultimately, it is important to keep in mind Silver's (2002, p. 97) warning that "while any attempt to address the developing world's information problems should be welcomed, we may soon reach a point where anything other than collaboration is counterproductive". It is likely that only those initiatives that foster true collaboration between the stakeholders in the south and the north will succeed in making a sustainable and equitable access to knowledge.

Notes

1. See www.globalknowledge.org
2. Millennium Development Goals (2003), available from: www.developmentgoals.org/About_the_goals.htm
3. WSIS Declaration (2003), available from: www.itu.int/dms_pub/itu-s/md/03/wsis/doc/S03-WSIS-DOC-0004!!MSW-E.doc (English version of the declaration).
4. For eligibility criteria, see: www.healthinternetwork.org/src/eligibility.php
5. <http://www.fao.org/english/newsroom/news/2003/23019-en.html>
6. See: www.eifl.net/about/about.html
7. For a list of eligible countries, see: www.eifl.net/countries/countries.html
8. For further details, see: www.inasp.info/peri/intro.html
9. Available from: www.soros.org/openaccess/read.shtml
10. Available from: www.zim.mpg.de/openaccess-berlin/berlindeclaration.html
11. Available from: www.wellcome.ac.uk/en/1/awtvispolpub.html
12. Available from: www.ifla.org/V/cdoc/open-access04.html
13. Available from: www.soros.org/openaccess/software/
14. The Committee on Data for Science and Technology of the International Council of Science has sponsored several internal meetings to examine the implications and benefits of open access to scientific data. See: www.codata.org/
15. <http://archives.eprints.org/eprints.php> (accessed June 1, 2004).
16. <http://eprints.iisc.ernet.in>
17. See: <http://romeo.eprints.org/stats.php>
18. The Wellcome Trust (2003) statement on open access is available at: www.wellcome.ac.uk/en/1/awtvispolpub.html
19. The full report is available at: www.publications.parliament.uk/pa/cm200304/cmselect/cmsctech/399/39909.htm

-
20. Summary from Peter Suber: www.earlham.edu/~peters/fos/2004_07_18_fosblogarchive.html#a109028453862279542
 21. Summary of the workshop is available at: www.library.yale.edu/~llicense/ListArchives/0405/msg00059.htm
 22. See INDEST-NCST Training Workshop on Institutional Repositories: http://paniit.iitd.ac.in/indest/workshop/ncsi_index.html
 23. More information about the Public Knowledge Project can be found at: www.pkp.org/
 24. For a description and summary of the workshop, please see: <http://www.sasli.za/>
 25. The guide is available at: www.soros.org/openaccess/guides/

References

- Adomi, E.E. and Mordi, C. (2003), "Publication in foreign journals and promotion of academics in Nigeria", *Learned Publishing*, Vol. 16 No. 4, pp. 259-63.
- Alberts, B. (2002), "Engaging in a world-wide transformation: our responsibility as scientists for the provision of global public goods", President's address to the Fellows of the National Academy of Sciences, Washington DC, 29 April.
- Alemna, A.A. *et al.* (2001), "The role of libraries in the use of African-published journals in African universities", *International Information and Library Review*, Vol. 33, pp. 3-22.
- Aronson, B. (2004), "Improving online access to medical information for low-income countries", *New England Journal of Medicine*, Vol. 350 No. 10, pp. 966-8.
- Arunachalam, S. (2000), "International collaboration in science: the case of India and China", in Cronin, B. and Atkins, H.B. (Eds), *The Web of Knowledge: A Festschrift in Honor of Eugene Garfield*, Information Today, Inc., Medford, NJ.
- Arunachalam, S. (2003), "Information for research in developing countries – information technology: a friend or foe?", *International Information and Library Review*, Vol. 35 No. 2-4, pp. 133-47.
- Arunachalam, S. (2004), "India's march towards open access", *SciDev.Net*, available at: www.scidev.net/
- Bosman, M. and Marais, J.L. (1998), "Local knowledge – untapped resource in the development sage", *Focus Forum*, Vol. 6 No. 3, pp. 19-23.
- Brody, T. *et al.* (2004), "The effect of open access on citation impact", National Policies on Open Access (OA) Provision for University Research Output: An International Meeting, Southampton, 19 February.
- Cetto, A.M. (2000), "Sharing scientific knowledge through publications: what do developing countries have to offer?", *World Conference on Science: Science for the Twenty-first Century, a New Commitment*, Unesco, Paris, pp. 148-50.
- Chan, L. (2004), "Supporting and enhancing scholarship in the digital age: the role of open access institutional repositories", *Canadian Journal of Communications*, Vol. 29 No. 3, pp. 277-300.
- Chan, L. and Kirsop, B. (2001), "Open archiving opportunities for developing countries: towards equitable distribution of global knowledge", *Ariadne*, No. 30.
- Coura, J.R. and Willcox, L. (2003), "Impact factor, scientific production, and quality of Brazilian medical journals", *Mem. Inst. Oswaldo Cruz*, Vol. 98 No. 3, pp. 293-7.
- Frazier, K. (2001), "The librarians' dilemma: contemplating the cost of the 'big deal'", *D-Lib Magazine*, Vol. 7 No. 3.
- Global Forum for Health Research (2003), *10/90 Report on Health Research 2003-2004*, Global Forum for Health Research, Geneva.

- Godlee, F. *et al.* (2004), "Can we achieve health information for all by 2015?", *Lancet*, 9 July.
- Harnad, S. (2001), "The self-archiving initiative", *Nature*, Vol. 410, pp. 1024-5.
- Harnad, S. (2003), "Open access to peer-reviewed research through author/institution self-archiving: maximizing research impact by maximizing online access", in Law, D. and Andrew, J. (Eds), *Digital Libraries: Policy Planning and Practice*, Ashgate Publishing, Aldershot.
- Harnad, S. and Brody, T. (2004), "Comparing the impact of open access (OA) vs non-OA articles in the same journals", *DLib Magazine*, Vol. 10 No. 6.
- Harnad, S. *et al.* (2003), "Mandated online RAE CVs linked to university e-print archives", *Ariadne*, No. 35.
- Kale, R. (1994), "Health information for the developing world", *British Medical Journal*, Vol. 309, pp. 939-42.
- Kaniki, A. and Mphahlele, M.E.K. (2002), "Indigenous knowledge for the benefit of all: can knowledge management principles be used effectively?", *South African Journal of Libraries and Information Science*, Vol. 68 No. 1, pp. 1-15.
- Katikireddi, S.V. (2004), "HINARI: bridging the global information divide", *British Medical Journal*, Vol. 328, pp. 1190-3.
- King, D. (2004), "The scientific impact of nations", *Nature*, Vol. 430, pp. 311-16.
- Landesman, M. and van Reenen, J. (2000), "Consortia versus reform: creating congruence", *The Journal of Electronic Publishing*, Vol. 6.
- Lawrence, S. (2001), "Online or invisible?", *Nature*, Vol. 411 No. 6837, p. 521.
- Lor, P. and Britz, J.J. (2004), "Information imperialism: moral problems in information flow from south to north", in Mendoza, T. and Britz, J.J. (Eds), *Information Ethics in the Electronic Age: Current Issues in Africa and the World*, McFarland Publishing Company, Jefferson, NC, pp. 15-21.
- Lougee, W. (1995), "Beyond access: new concepts, new tensions for collection development in a digital environment", *Collection Building*, Vol. 14 No. 3, pp. 19-25.
- Lougee, W. (2002), *Diffuse Libraries: Emergent Roles for the Research Library in the Digital Age*, Council on Library and Information Resources, Washington, DC.
- Okonofua, F. (2003), "New reproductive technologies and infertility treatment in Africa", *African Journal of Reproductive Health*, Vol. 7 No. 1, pp. 7-8.
- Rajashekar, T.B. and Jayakanth, F. (2004), "Institutional repository at the Indian Institute of Science, India", *INASP Newsletter*, No. 26, p. 6.
- Rosenberg, D. (1997), *University Libraries in Africa: A Review of their Current Status and Future Potential*, International Africa Institute, London.
- Rosenberg, D. (2002), "African journals online: improving awareness and access", *Learned Publishing*, Vol. 15 No. 1, pp. 51-7.
- Sahu, D.K. and Chan, L. (2004), "Journal of Postgraduate Medicine and Bioline International: a collaborative approach to open access publishing", *Open Access and the Public Domain in Digital Data and Information for Science: Proceedings of an International Symposium*, The National Academy Press, Washington, DC, pp. 558-62.
- Scigliano, M. (2002), "Consortium purchases: case study for a cost-benefit analysis", *The Journal of Academic Librarianship*, Vol. 28 No. 6, pp. 393-9.
- Silver, K. (2002), "Pressing the 'send' key – preferential journal access in developing countries", *Learned Publishing*, Vol. 15, pp. 91-8.

- Smart, P. (2004), "Two-way traffic: information exchange between the developing and developed world", *Serials*, Vol. 17 No. 2, pp. 184-7.
- Smith, R. (2002), "Publishing research in developing countries", *Statistics in Medicine*, Vol. 21, pp. 2869-77.
- Suber, P. (2003), "Removing the barriers to research: an introduction to open access for librarians", *College & Research Libraries News*, Vol. 64, pp. 92-4.
- Swan, A. and Brown, S.N. (2004), "Authors and open access publishing", *Learned Publishing*, Vol. 17 No. 3, pp. 219-24.
- Unesco (1982), "Draft medium-term plan (1984-1989), Second part, VII, Information systems and access to knowledge", General Conference, 4th Extraordinary Session, Paris.
- Ware, M. (2004), "Institutional repositories and scholarly publishing", *Learned Publishing*, Vol. 17 No. 2, pp. 115-24.