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The Future of Knowledge Sharing in a Digital Age: Exploring Impacts and Policy Implications for Development

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The IDS programme on Strengthening Evidence-based Policy works across seven key themes. Each theme works with partner institutions to co-construct policy-relevant knowledge and engage in policy-influencing processes. This material has been developed under the Policy Anticipation, Response and Evaluation theme.

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Abbreviations

AJOL	African Journals Online
ALIN	Arid Lands Information Network
AOARI	African Open Access Repository Initiative
BCP	Bio-cultural community protocol
CBO	Community-based organisation
CEDIA	National Research and Education Network of Ecuador
CGIAR	Consortium of International Agricultural Research Centres
CIA	Central Intelligence Agency
COAR	Confederation of Open Access Repositories
CSR	Corporate social responsibility
DFID	Department for International Development (UK)
DOI	Digital object identifiers
EDS	EBSCO Discovery Service
FOI	Freedom of information
GIS	Geographical information system
GSMA	Groupe Speciale Mobile Association
HDI	Human Development Index
ICT	Information and communications technology
ICT4D	Information and Communication Technologies for Development
IDI	ICT Development Index
IDRC	International Development Research Centre (Canada)
IDS	Institute of Development Studies
ITOCA	Information Training and Outreach Centre for Africa
ITU	International Telecommunication Union
M2M	Machine to Machine
MDG	Millennium Development Goal
MOOC	Massive Open Online Course
NEPAD	New Partnership for Africa's Development
NGO	Non-governmental organisation
NREN	National Research and Education Network
OA	Open Access
OAI-PMH	Open Access Initiative's Protocol for Metadata Harvesting
OCLC	Online Computer Library Center
OCR	Optical character recognition
OCS	Open and Collaborative Science
OCSDNet	Open and Collaborative Science in Development Network
ODDC	Open Data for Developing Countries
OGD	Open Government Data
Open A.I.R.	The Open African Innovation Research and Training
OpenDOAR	Open Directory of Open Access Repositories
ORCID	Open researcher and contributor identifier
SDG	Sustainable Development Goal
STEEP	Social, Technological, Environmental, Economic and Political
TEEAL	The Essential Electronic Agricultural Library
TISC	Technology and Innovation Support Center
UI	User interface
UK	United Kingdom
UN	United Nations
UNDP	United Nations Development Programme
UNECA	United Nations Economic Commission for Africa
USA	United States of America
WEF	World Economic Forum
WIPO	World Intellectual Property Organization
ZB	Zettabyte

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Executive summary

We live in a Digital Age that gives us instant access to information at greater and greater volumes. The rapid growth of digital content and tools is already changing how we create, consume and distribute knowledge. Even though globally participation in the Digital Age remains uneven, more and more people are accessing and contributing digital content every day. Over the next 15 years, developing countries are likely to experience sweeping changes in how states and societies engage with knowledge. These changes hold the potential to improve people's lives by making information more available, increasing avenues for political and economic engagement, and making government more transparent and responsive. But they also carry dangers of a growing knowledge divide influenced by technology access, threats to privacy, and the potential loss of diversity of knowledge.

Our research sets out with a 15-year horizon to look at the possible ways in which digital technologies might contribute to or damage development agendas, and how development practitioners and policymakers might best respond. We draw on secondary materials, but the bulk of this report draws on discussions, insights and opinions of a range of experts, which we gathered through a set of Foresight tools and processes. This included two workshops – one in London and one in Centurion, South Africa – and interviews. Workshop participants and interviewees were selected due to their familiarity with issues around different areas of digital technology, representing non-governmental organisations (NGOs), bilateral and multilateral development agencies, government bodies, universities, libraries, knowledge intermediaries, and businesses. The recommendations we arrived at were largely a result of analysis of the contributions from the workshops and interviews, though grounded in the secondary research.

Key recommendations

We recommend policies and strategies in four major areas, as follows.

Cross-cutting principles:

- For technological change to benefit the poor and to close digital divides, there is a need for strategies that will deliver the principles of ***universal access*** and ***inclusive knowledge***.
- The poor should ***participate*** in developing knowledge infrastructure and systems that benefit them.
- Research institutions, governments and development organisations should pursue strategies toward ***open knowledge*** through better incentives, capacity development and advocacy.
- Openness needs to be balanced with ***ownership, privacy and security*** considerations, but currently tilts far to the 'closed' side.

Enabling environment:

- Governments, regional bodies and international development agencies need strong ***cooperation*** on improving information and communications technology (ICT) infrastructure and ***incentivising knowledge sharing*** across borders and institutions.
- A ***common set of goals and meaningful metrics*** are needed that capture not just basic access, but also levels of access and behaviours.
- This cooperation could be framed by ***Sustainable Development Goals (SDGs)***, which should more explicitly address digital opportunities and threats related to knowledge sharing.

Human capacity:

- Governments and development agencies should invest in the capacity of ***knowledge intermediaries***, ***librarians*** and ***information and data scientists*** working at the intersection of development, information science and governance.
- Universities and governments should ***incentivise African research*** and ***encourage publishing*** through cooperative, peer-reviewed open access platforms.
- School ***curricula*** from primary school upwards should emphasise digital literacy and skills.

Infrastructure and tools:

- Most of the above recommendations hinge on coordinated ***investment in ICT infrastructure*** at local, national and regional levels by governments and development agencies.
- This includes investment in developing more effective ***knowledge sharing systems*** and ***digital repositories***.
- Ongoing improvements for ***search and discovery tools*** are needed to make them more powerful and intuitive.
- ***Crowdsourcing tools*** should be developed to help improve participation in public discourse and development research, and to improve government service delivery and accountability.

These policy recommendations are broad, and suggest general strategies that a range of actors can act on according to their mandates and strengths:

- *International development organisations*, including bilateral aid agencies and multilaterals can prioritise these recommendations in their development agendas, including drafting and implementing the SDGs. They should lead on coordination and Digital Age advocacy efforts.
- *Government bodies* at local, national and regional levels can help to integrate digital technologies and infrastructure into their development agendas in ways that fit with local priorities and context. Governments should put a greater focus on the role of knowledge in the kind of society they are trying to create, including education curricula and policies for innovation.
- *Civil society* can help spread a stronger understanding of, and advocate for, policies for openness and privacy, and for knowledge and infrastructure that meet the needs of people who are poor and marginalised.
- *Researchers and research organisations* can also take forward the agenda of openness, changing incentive structures. Universities and research organisations, especially in developing countries, can encourage federated systems for vetting the quality of local research and making it more widely available.
- *Libraries and knowledge intermediaries* should lead and inform advocacy efforts for openness, and collaborate in developing coordinated systems, platforms and approaches to more effective, inclusive and open knowledge sharing and discoverability.

1 Introduction

1.1 Background

Digital technologies are changing our relationship with information and how we understand and interpret the world. New tools that are already so common we barely notice them—ranging from social media to big data and online resources—are changing how we create, distribute and consume knowledge. Many of these changes have profound, far-reaching implications not only in terms of scale, access and availability of knowledge, but also for our relationship to that knowledge: our notions of what knowledge matters the most, where it comes from, how we know what to trust, and our own roles in creating and engaging with it.

Access to the internet continues to reach more and more people, spreading to increasingly remote areas. While many basic necessities such as clean water remain out of reach for large swathes of the world's population, internet connectivity is growing at such a rate that some commentators predict most of the world will be online by 2025 (Schmidt and Cohen 2013: 4). Mobile banking is already being used widely in Kenya and Tanzania, reaching wealthy and poor communities alike. And it is becoming increasingly common for even traditional and remote farmers, fisherfolk and others to link to international markets directly, online. Growing connectivity is bringing information and new opportunities to many of the world's poorer and marginalised people, and there is much cause for optimism that this trend will continue into the future.

The media is abuzz with the latest on new technologies and the various ways they stand to transform society, and nor is there a shortage of popular and academic literature on the subject. Our aim in this report is to focus the discussion onto a context of sustainable development, looking in particular at how digital technologies stand to change knowledge production and use in developing countries.

We have chosen to focus on Africa, and in particular sub-Saharan Africa, to contextualise our research. This is not, however, a report about the future of Africa or specific African countries. We chose this geographical framing because of our familiarity with and contacts in the region, and to help focus our discussions by keeping a specific context in mind, to avoid excessive flights of fancy about what is possible.

Thus we are homing in on a set of technologies and tools that are most likely to affect poor people, or will influence the work of researchers, practitioners and policymakers in an African development setting. Social media and crowdsourcing, for example, hold the potential for more participatory methods of creating knowledge and for setting research agendas. Likewise, digital repositories or similar platforms for knowledge sharing hold the potential to disrupt the current flow of development knowledge that is overwhelmingly from the 'developed' to the 'developing'. On the user side, digital discovery tools, for example, can enable practitioners, policymakers and citizens to more easily discover the information and evidence that is most relevant to their needs. We are aware that the subject 'digital technologies and development' can be defined much more broadly – big data, internet of things, drones, wearable tech – but we have tried to limit our scope to roles and affordances of technologies that are most relevant to the knowledge economy. Thus our focus is on knowledge sharing and digital infrastructure, and how knowledge is discovered and sourced, which has led us also to think about the roles of social media and crowdsourcing.

How will digital technology affect those roles of curation, intermediation, gatekeeping and guiding, which have until recently been the preserve of librarians, knowledge managers, publishers and universities, and what will this mean for development actors?

1.2 Research question

This research, carried out between August and December 2014, was designed as a horizon-scanning exercise to anticipate the possible directions that digital technologies might take us in the next 15 years. While this is a standard time frame for such a project, it also coincides nicely with the bookends of the Sustainable Development Goals (SDGs), which run to 2030. In addition to researching secondary sources, we have followed Foresight methodology (see Annex 1) to systematically gather thoughts and analysis from leading researchers, practitioners and policymakers. This is not to make predictions, but to explore a range of possible future outcomes and the potential role of digital technologies in them.

> **Over the next 15 years, what are the implications of digital technologies for sustainable development? What kinds of decisions and actions are needed now from policymakers and practitioners to create a positive digital landscape for development?**

1.3 Methodology

Foresight

Our evidence comes from secondary literature, interviews and two workshops with academics, practitioners and decision-makers. Throughout, and especially in the workshops, we used a set of 'Foresight' methods and facilitation tools. A Foresight approach is widely used by industries, governments and NGOs to think about longer-term changes that may not be immediately apparent from simply observing current trends. In our case, we used this approach to help us look at the different ways that digital technologies might affect developing countries and development efforts over the next 15 years. Core to the Foresight approach is the development of a set of scenarios that develop different futures, depending on differences in key variables.

Scenario development is particularly relevant to our research question on the future of digital technologies and sustainable development. The approach forces its users away from the habit of focusing solely on what future they think is most *probable*, toward a wider range of what futures are *possible*. History never unfolds linearly or according to expectations, and is full of 'black swans' (unpredictable and rare events which have a major effect). Although looking at wider swathes of possibilities does not help us identify where the black swans will be, it does make it more likely that they will be less surprising. Second, scenarios can be useful tools to help groups of people visualise and discuss possible developments in a way that many would otherwise find too vague and abstract. This, in turn, gives people concrete scenarios in which they can imagine relevant implications for policy and practice.

Our inputs for this report come mainly from the following.

Literature review: A survey of the relevant literature, focusing on trends and possible future developments across a number of themes:

- digital technologies and media
- the Digital Age and the African and development contexts
- curating knowledge, information and library science
- digital repositories and discovery tools
- knowledge sharing and development goals.

The literature surveyed included academic literature, reports commissioned by governments and development organisations, and popular literature from industry leaders in digital technology.

Interviews: We held interviews with 12 actors in the fields of ICTs, library science, digital technologies and development, selected because of their background and expertise in digital technologies and development, and representative of the range of stakeholders that changes in the digital landscape would affect. The interviews were inspired by a Foresight tool, '7 questions', and were organised so as to elicit responses on the social, technological, environmental, economic and political (STEEP) aspects of respondents' visions of the future, focusing on digital repositories, access, search and discovery.

Workshops: We held two workshops – one in London, the other in Centurion, South Africa – to develop scenarios and related policy implications. Participants came from a range of backgrounds, including researchers, ICT and development practitioners, and policymakers, representing different sectors that stand to be affected by a changing digital landscape. In Centurion, we especially tried to ensure a group of participants that could help contextualise our discussions in an African development setting.

1.4 Structure of this report

In **Section 2** we look at the context of the Digital Age and the implications of new technologies and ways of sharing knowledge for development goals in an African context. Drawing on insights from the literature, interviews and workshops, we look at where current trends in digital technology are leading. What areas of knowledge production, sharing and use are likely to be most affected by new digital technologies and levels of access? We then look at these trends and impacts in the context of development, with a focus on Africa. How do digital technologies support, inform or threaten a post-2015 development agenda and the SDGs? This section concludes with a discussion of where digital technologies present either new opportunities or threats.

In **Section 3** we present four possible scenarios of how the world might look in 2030. These scenarios were developed through the workshops and consultations, and envision the role that digital knowledge might play in different versions of the future. Out of these, we then develop a fifth, preferred scenario.

In **Section 4** we look at strategic approaches and policy implications for trying to move toward that preferred scenario, drawing on workshop discussions and the materials for Section 2. We frame our recommendations into those that relate to cross-cutting principles, the enabling environment, human capacity, and infrastructure and tools.

Section 5 presents our conclusions.

2 Knowledge sharing and development in the Digital Age

2.1 Introduction

This section explores the trends for knowledge sharing in development in the Digital Age. It draws on insights from a review of the literature, supplemented by perspectives gained from interviewing a diverse range of experts and from workshop participants, who have insights into both knowledge sharing and the African context.

We start by considering some of the opportunities and challenges of the Digital Age, and then consider trends and impacts of digital knowledge, relating these to the African context for the SDGs and post-2015 development agenda. The section concludes by considering the positive and negative ways in which development impacts may be manifested. A particular focus is on distributional aspects, and who benefits or loses from the different ways in which knowledge is created, shared and distributed in the Digital Age.

2.2 The Digital Age

2.2.1 A period of rapid change

More than 45 years ago, Kenneth Goldstein (1969: 8) wrote about the world of tomorrow, and looking 100 years into the future, he speculated that:

> No one will use real money any more.
>
> … through special electronic walls of their houses, which are huge television sets, the people are 'plugged in' to all the world and other parts of the solar system.
>
> … the television sets, as you might guess, are three dimensional and colour. The electronic wall also connects the set to libraries, museums, and the houses of friends.

Far-fetched as some of these ideas must have seemed at the time, in some ways they are already evident in many of our lives. The pace of change is getting ever faster as we come to terms with sensor technology, 3D printing, big data, voice recognition, automatic translation and human augmentation – all of which have huge implications for how knowledge is created and shared. However, Goldstein rightly cautioned that predictions will always be limited by our imagination, and that 'the future will be shaped by many inventions that have not been thought of yet' (Goldstein 1969: 7).

As we look towards a horizon of 2030, which coincides with the period of the SDGs, it is clear that many think we are on the threshold of a new and hugely significant era. This project does not make significant reference to the major social and geopolitical trends or the growing humanitarian and security concerns, but limits its scope primarily to the domains of digital technologies that enhance knowledge creation and sharing. It is, however, important to note the global implications of the internet and ICT infrastructure:

> The United States, a relatively cloistered, isolated nation has gone from having two borders to having two hundred. These borders are unexplored, are un-demarcated, and have few effective treaties… For good and for ill, the wired networked nations of the world all share common borders. We now have two hundred reasons to care about the information revolution in developing countries. The internet has brought more borders not fewer.
> (Wilson 2004: 10)

Focusing on the technology, we can anticipate a period of major transformation. Brynjolfsson and McAfee (2014: 37) describe this as follows:

> The digital progress we've seen recently is certainly impressive, but it's just an indication of what's to come. It's the dawn of the second machine age. To understand why it's unfolding now, we need to understand the nature of technological progress in the era of digital hardware, software and networks. In particular we need to understand its three key characteristics: this is exponential, digital and combinatorial.

At the heart of this exponential growth lies Moore's Law, which is one of the most famous forecasts, and has held true for the past 50 years since 1965, when Gordon Moore wrote:

> The complexity for minimum component costs has increased at a rate of roughly a factor of two per year… certainly over the short term this rate can be expected to continue. Over the longer term, the rate of increase is a bit more uncertain, although there is no reason to believe it will not remain constant for at least ten years. (Brynjolfsson and McAfee 2014: 40)

The essence of Moore's Law is that digital computing power doubles every year for the price that is paid. Clearly, the original ten-year estimate has been vastly exceeded, and Brynjolfsson and McAfee (2014: 39–56) illuminate Moore's Law by reference to the story of a clever man who invented chess and, in reward for this, requested the emperor for a reward of a quantity of rice. One piece was to be placed on the corner of the first square of the chessboard, two pieces on the second, four on the third and so on, doubling on each square. By the time the second half of the board is reached, the numbers of grains has grown exponentially into millions, and into the billions by the end of the board. Needless to say, the emperor, who too readily agreed, felt tricked!

In terms of digital capacity, we are now well onto the second half of the board, and in terms of cost and power, our digital capacity is now enormous, and growing ever faster and extending onto an ever greater range of digital devices.

In short, this illustration makes it clear why ICT infrastructure is becoming so powerful and access to it becomes ever more important, as it provides the platform on which many of our future services will run, and different digital technologies are merging together to create powerful combinatorial effects. The smartphone, with its multimedia features, is a perfect example of this.

Access and connectivity is also spreading rapidly, with mobile technologies in particular making internet access more widely available within developing countries. Schmidt and Cohen (2013: 4) write that:

> By 2025, the majority of the world's population will, in one generation, have gone from having virtually no access to unfiltered information, to accessing all of the world's information through a device that fits in the palm of the hand. If the current pace of technological innovation is maintained, most of the projected eight billion people on Earth will be online.

Some may view this claim as exaggerated and debatable, but what will our knowledge infrastructure and lives be like if, indeed, we are all online by 2025? Will we really have access to all the world's information? Will the so called 'digital divide' have been addressed, or will the reality be that there are many more 'last' or 'first mile' development problems to be addressed? It is clear that today, some countries and people are already experiencing life on the second half of the chessboard, while many others have barely left square one. Schmidt and Cohen (2013: 253) acknowledge the uncertainties that widening access brings, while also seeing the huge potential good:

> How many new ideas, new perspectives and new creations will truly global technological inclusion produce, and how much more quickly will their impact be felt? The arrival of more people in the virtual world is good for them, and it's good for us.

Another view comes from Manuel Castells, who argued in a recent lecture at Stellenbosch University[1] that advances in ICT are making it easier for people to organise themselves and press for change. However, he also believes that 'the notion that we are in an information and knowledge economy is absolutely misleading'. Despite the fact that 98 per cent of the information on the planet is now digital, the human mind remains more important than technology per se. Technology gives us new possibilities for effectively processing information: 'That's what the technological revolution means. Not just that there is information, but that information can be recombined, developed, accessed and utilised on a global scale.'

2.2.2 Emerging trends in technologies, ICTs and digital applications

In future, the majority of digital-based communication is likely to be a mix of people-to-people, people-to-device, and device-to-device (e.g. driverless cars talking to each other), perhaps with most communication falling into the latter category. This increasingly complex web of 'interconnectivity' has been termed the 'internet of things'.

> By 2020 it is thought that 50 billion to 100 billion devices will be connected to the internet. So, connections that run on different frequency bands will be established to cope with demand.[2]

However, participants from our Centurion Foresight workshop cautioned that while many people in developing countries will have access to internet-capable devices, securing access to the information is still a problem due to prohibitive tariffs. Unless this is addressed – i.e. via competition to try and lower tariffs – access will remain low. It is therefore important to note the difference between having a device and making it useful in terms of accessing information. Stork, Calandro and Gillwald (2012) emphasise this difference by saying '... making a distinction between access and use of the Internet clarifies the goal of policies aimed at closing the digital divide'.

We now briefly identify and explore some of the technology trends that are likely to have an impact in the coming years. Not all are directly relevant to this study, and the potential they have for positive and negative impacts in a developing country context is open to debate; but these lists provide a useful point of reference when thinking about the future and policy options.

The big drivers for connectivity and quality of access are bandwidth and harmonisation of the radio spectrum. The greater the bandwidth, the faster our connections can potentially become, although this is always offset by increase in user 'traffic' (i.e. the growing amount of data passing across the networks). The way mobile phone infrastructure has been developing, through four generations and with a fifth on the horizon (1G–5G outlined in Table 2.1), illustrates how the nature and use of connectivity develops significantly as bandwidth increases.

A recent report on the 'mobile economy' by the Groupe Speciale Mobile Association (GSMA) indicates that by 2020, more than half of all mobile connections will be 3G or 4G (GSMA 2014). Computer-based connectivity has also followed a similar trajectory, as fast optical cables and satellite links, alongside increased computer hardware performance, have improved the speed and quality of communications networks and infrastructure, and consequently the types of multimedia applications that can be designed and used. It is also

[1] See www.sun.ac.za/english/Lists/news/DispForm.aspx?ID=2111.
[2] See www.bbc.co.uk/news/technology-30224853.

likely that physical broadband connections demonstrate a mix of slower and faster capabilities, with some users in locations with better, faster infrastructure able to access far greater performance benefits when using the internet.

Table 2.1 Mobile phone generations

Generation	Introduced	Attributes
1G	1980s Operational 1990s	Allowed for voice phone calls within a country
2G 2.5G	Launched 1991	Uses digital signals and supports text and multimedia text messaging. 2.5G for the first time provided scope for web browsing and email using a mobile phone. Mobile phones start to incorporate basic camera features
3G	2000s	Improved bandwidth and data transfer rates based on a new infrastructure. Provides better web access, with scope to support audio, video streaming and mobile TV. Phones take the form of multi-functional devices and become referred to as smartphones
4G	Late 2000s	Higher data rates with a greater range of multimedia services, aimed at providing an extensive range of anytime, anywhere services via the mobile device
5G	Projected for availability from 2020	Dramatic overhaul and harmonisation of the radio spectrum provides the scope for huge improvements in data transfer speeds. Increased scope for devices to communicate

A report by the United States (US) National Intelligence Council, *Global Trends 2030: Alternative Worlds* (2012: 83–97), provides an interesting reference point, identifying 'impact of new technologies' as one of six global game-changers. It identifies three technology developments that are seen as having a particular significance for the way 'we live, do business and protect ourselves' in the period to 2030. They are 'solutions for storage and processing large quantities of data', 'social networking technologies', and 'smart cities' encompassing a host of urban technologies enabled by enhanced and secure information technology (IT) systems.

Hoorens *et al*. (2013) identify six possible disruptive technologies, including social networks, the internet of things, big data, automation of knowledge work, and cloud computing. All these will have significant implications for knowledge creation and sharing.

At a more detailed level, the Government Office for Science report (2012) identifies 53 individual technologies (divided into 28 clusters) as particularly important for the 2020s. The following stand out as directly or indirectly relevant to knowledge sharing:

- ambient intelligence in the built environment
- desirable sustainability and user-centric design
- display technologies
- managing and processing of real-time social data
- multisensory input and sensing
- new computer technologies
- robotics
- sensor networks and speckled computing.

It is beyond the scope of this project to explore these areas in terms of the innovation possibilities and the ways in which they might impact development; clearly, though, it will be important for developing countries to assess their potential impacts more fully, and the scope for developing national human resource capabilities to engage in related scientific innovation and development work.

Interestingly, the National Intelligence Council (2012: 83) does envisage 'a shift in the technological center of gravity… as the flows of companies, ideas, entrepreneurs, and capital from the developed to the developing markets increase'. The BRICS (Brazil, Russia, India, China and South Africa) are also highlighted, and the speed at which this will happen is viewed as depending on '… the availability of risk capital in the developing countries, rules of law to protect intellectual property rights, and the desire of developing-economy companies to grow and be globally competitive' (*ibid*.).

Looking at the more immediate future, experts commenting in *The Guardian*[3] highlight the increasing development of mobile applications designed to improve social outcomes and related gender dimensions as girls and women begin to use them effectively to benefit their families and communities. We can also expect applications that make governments more accountable:

> Early ICT successes that relied on service delivery and civic mapping are creating an appetite among developers and civil society organisations (who are increasingly networked internationally through communities such as OpeningParliament.org) to confront power through public information, and practitioners are becoming more sophisticated in their approaches to these questions.
> (John Wonderlich, Policy Director, Sunlight Foundation, Guardian Media Network, blog, 4 December 2013)

Opening of government data, as discussed in Section 2.3.2, is another area that would enhance accountability.

In the other direction, we are likely to see governments increasing their use of data collected from mobile phone usage:

> … to focus their efforts to provide better services to the most vulnerable citizens. We will see improved food security and increased agricultural yields, rural education transformed, disease outbreaks detected, mothers sent vital information, and all of this done by sophisticated systems that take advantage of a basic mobile phone (Chris Vein, Chief Innovation Officer for Global Information and Communications Technology Development, World Bank, Guardian Media Network, blog, 4 December 2013)

The emergence of the 'internet of things'[4] also brings with it the rise of Machine to Machine (M2M) technology and more data being generated, which will require new and innovative business models. All of these trends are of clear relevance to the developing country and African context, where mobile technologies are rapidly increasing (although, as discussed later in the report, this is not necessarily occurring in an equitable manner).

Metrics and appropriate measurement tools are becoming increasingly important, both to the digital marketing experts and to those who wish to measure impact of knowledge services, behaviours of information consumers and the way data is being used:

> Simple web metrics won't do. This is not about looking for 'last click'. This will be about using all the research resources at our disposal including new ways to analyse digital and social data and understand what our customers actually do over time…
> (John Bell, Vice President of Enterprise Digital Marketing, Travelers, Guardian Media Network, blog, 10 December 2013)

[3] See www.theguardian.com/media-network/media-network-blog/2013/dec/04/ict-for-development-trends-2014.
[4] See http://en.wikipedia.org/wiki/Internet_of_Things.

2.2.3 Information proliferation

Turning to knowledge, much has been written about knowledge societies and their links to globalisation and economic growth. A major factor in this is the huge proliferation of information – including documents, data, government records, multimedia, and more tacit communication pieces (such as blogs) – that can be codified and made widely available in digital formats. Pepper and Garrity (2014: 35) note that: 'Data growth is skyrocketing. Over 2.5 quintillion bytes of data are created each day; 90 percent of the world's stored data was created in the last two years alone.'

In his book *Information 2.0*, De Saulles (2012: 4) refers to a once-in-a-generation 'technological shift' and notes that changing behaviours are also driving change: 'not only is access to information making the notion of an information society real, but the ability of individuals to create and share information is changing the structures of many industries, in particular the publishing sector'. In the Digital Age, De Saulles notes that the 'born digital' production model is now having a major influence as information 'suffers little from rivalry' and the concept is that the 'first copy costs' and then there are little costs involved in producing additional copies.

So data and information are increasingly available in vast quantities, potentially at little cost after initial production. Distribution is becoming much easier, and this promotes access to those who can access the internet. However, one of our workshop participants expressed a major concern: 'Knowledge is going to be the new inequality – where does it fit in the SDGs?' This is a critically important observation and poses a question which is at the heart of our study. The other issue that arises is discovering and accessing 'suitable information'.

2.2.4 Knowledge and open development

The potential implications of more data, information and knowledge for development are huge, and start with issues around who owns knowledge and how it is shared. Smith and Reilly (2013: 5) argue for a new paradigm of open development, which is primarily focused on development goals but with openness, providing: 'an opportunity to achieve those goals in a manner that has never been done before. That is, openness contributes its own logic – a value added to solving problems'.

Openness is described as layered, disruptive, never perfect (i.e. never completely open), requiring some form of closed structure around it to enable it to function, and requiring a critical perspective. The landscape in which openness takes place is essentially a networked society, where knowledge – including the tools to use it – is openly licensed and therefore freely shareable. In order for this to be most effective, a strong ICT infrastructure and digitally literate users and experts are needed. A range of projects[5] are starting up that explore the ways in which open development approaches in knowledge creation and sharing can flourish. These include:

- Open Data for Developing Countries (ODDC)[6]
- Open and Collaborative Science in Development Network (OSCDNet)[7]
- IDS's Open Knowledge Hub.[8]

[5] For a good overview of many other projects emerging related to open data see Boyera (2014).
[6] The ODDC project, led by the Worldwide Web Foundation, seeks to learn about open models particularly in relation to data, and has focussed on capacity development, (www.od4d.net/).
[7] OCSDNet is led by iHub in Kenya and supported by Canada's International Development Research Centre (IDRC) and the UK Department for International Development (DFID). It is building communities of practice on open approaches and exploring the question of when open scientific research is appropriate (http://ocsdnet.org/).
[8] The Open Knowledge Hub project, led by IDS and supported by DFID, seeks to build an architecture and commons for sharing research knowledge, with a particular focus on promoting engagement of Southern knowledge producers and users (www.okhub.org).

These projects are all, to an extent, exploratory and experimental, recognising that there is still much to learn about openness, who it benefits and under what circumstances, and how it can be sustained. In a show of honesty, the OCS 'About us' webpage acknowledges that:

> OCS outcomes may also turn out to be negative in nature, and could further exacerbate problems of inequitable participation, gender disparity, and further exclusion of researchers who do not have the capacity to take advantage of the network tools and resources.

Lessons are starting to emerge and, in relation to the ODDC project, are summarised by Tim Davies (2014), who makes an interesting point about the need for collaborative research processes which themselves develop the capacity of the intended beneficiaries. From points expressed during our project interviews, it is clear that for open development approaches to be effective there needs to be a strong focus on the context; solutions cannot be simply transferred.

> *In the open data space there is a tendency to move very quickly to discussion of best practice instead of good practice, and there is a real lack of innovation. All the research we have says context matters, but so few applications of technology start from a position of contextualising what they are doing. Every implementation of technology should, to some extent, be an innovation project because it is in a new setting…*
>
> *There is a tendency towards seeing the tool and trying to export it, rather than understanding the process and trying to learn from it in the transfer of ideas*. (Interviewee)

Summarising these insights, it is clear that we are at a stage where **connectivity** – via internet and, increasingly, using mobile technology – gives rapidly increasing numbers of people the potential to **access** a wealth of information, and engage in services supporting knowledge sharing and **innovation** that are often built on new and disruptive business models. **Openness** is a key factor in terms of breaking down barriers to content, whatever form that takes, and **digital literacy** is a key skill both for working online and navigating the knowledge landscape, which is increasingly information and **data** rich.

2.2.5 A darker side to knowledge sharing in the Digital Age

Despite the exciting potential of the open development approach and the growing momentum of the related 'open access movement', much information, data and knowledge remains controlled and subject to a model of private ownership and commercial exploitation. The power of the **network** is becoming ever more important, and as one interviewee puts it:

> *What we have learned in the past 20–30 years of information networks, is that network effects kick in and the rich get richer, first movers have a big advantage, not only in dissemination of knowledge but in the production of knowledge – you've got much more scope for a privatisation or private control of the digital knowledge ecology*.

There are big questions related to who our knowledge networks serve, whose knowledge is shared and valued, and how knowledge can be truly open and inclusive of poor people, who often lack the means or 'know-how' to engage in the systems created for them. Yet, if significant efforts are not made to address this, it is hard to see how such systems and related research processes will produce knowledge that is relevant to the real needs and interests of people living in poverty. As one interviewee noted, this is a major challenge:

> *Researchers need to live with the poor and understand what they really want. Novel solutions are not often in the interests of the poor and marginalised. It is challenging*

> *and not in academics' interests to do this – they are incentivised to get research grants and write lots of research papers. It is not compatible with academics' situations when they are trying to get and implement large research grants. What the poor want and what we say they need is different. We need to design relevant solutions, in terms of language, format and accessibility for what the poor really want. Much collectively produced knowledge isn't presented to subsequent users in a format that is most likely to have a big impact*.

In the preface to his book, *The Rise of the Network Society*, Castells (2010: xvii) describes a darker side of the Digital Age, including 'the social and cultural exclusion of large segments of the population of the planet from the global networks that accumulate knowledge, wealth and power'.

In this context, Schmidt and Cohen (2013: 83), discussing the future of states, see the likelihood of what they term 'balkanisation of the internet':

> Every society in the world has its own laws, cultural norms and accepted behaviours. As billions of people come online in the next decade, many will discover a new found independence – in ideas, speech and conversation – that will test these boundaries. Their governments, by contrast would largely prefer that these users encounter a virtual world that allows the powers that be to mirror their physical control, an understandable if fundamentally naïve notion.

Such a scenario would have a hugely influential effect on how our knowledge sharing systems and use of ICT tools develop. Our interviews have identified a range of major concerns (listed below) related to the Digital Age and our lives online. Unless addressed, many of these will inhibit free and open knowledge sharing:

- Online fraud and cybercrime
- Identity theft
- No respect for privacy
- Slander and online bullying
- Stigmatisation
- Loss of money, goods, etc.
- Monetisation of free services resulting in exclusion or getting locked in to particular systems
- Terrorism and security concerns
- Monopolistic practice and commercial exploitation of open data
- Combinations of these factors, which can lead to affected persons taking their lives, suffering depression, etc.

A major concern globally, and particularly for developing countries, derives from increasingly divided societies. Interviewees, commentators and participants from our project expressed fears of a 'two-tier society' in different ways as future scenarios were discussed and developed.

> *Such a society would trend toward global homogeneity. It would need policies to preserve and promote diversity*.
> (Scenario 4 commentator)

One interviewee also warned that chip implants, leading to cyborgs, could become a reality,[9] with a potential scenario that reinforces economic division (the following summarises the interviewee's words):

[9] see also http://unwin.wordpress.com/2014/12/07/the-future-of-communication/.

> *The rich will have these and they can be switched off. Global corporations will chip labour – in the brain with neural connections – this is possible in next 25 years. Knowledge for a task will simply be downloaded when needed. Poor people will just be seen as labour or a market and not as sentient human beings. There will be a central repository with universal access, regularly updated, but where you can get what you need to perform your life's tasks. This is being seen already with privatisation of education systems, the power of social media, and the big search engines wanting all the world's knowledge at their fingertips. As everything is accessible, so we don't now need to remember anything – we just need to know how to search. What is this doing to the human brain? Google searches are not delivering innovative things, but what it thinks you need to know. This takes away your freedom of will*.

2.2.6 Responding to the threats

What some may see as an apocalyptic vision, others may see as wonderful, so there are important and informed debates that need to take place. The massive growth and widespread diffusion anticipated in IT and connectivity will, according to the National Intelligence Council '… present significant challenges for governments and societies, which must find ways to capture the benefits of new IT technologies while dealing with the new threats that those technologies present' (2012: 83).

The response needed is for regulation and governance that relates very clearly to ICT and knowledge system infrastructures. In the words of one of our interviewees:

> *Here, regulation becomes important – a simple model to enable the private sector to do what it can do best – shared infrastructure requirements, but the state needs to also be involved and invest in the interests of the poor and marginalised*.

> *I think establishing much better norms in the global system – so even if we are thinking about knowledge sharing systems in Africa, we have to deal on a global level with issues of internet governance and governance of shared knowledge systems and recognising that things like Wikipedia are becoming part of a global knowledge infrastructure. We need to work on the diversity of those spaces and platforms and find ways to increase their inclusiveness in terms of who's running them*.

Governments, civil society, the media and other knowledge intermediaries have a key role to play in ensuring that the knowledge needed for development is freely shared, and knowledge infrastructures shape our societies in ways that are open and transparent. The range of ways in which governments are interacting with their citizens through e-government applications is increasing, though there is more focus on transactions than participation (ITU 2014a: 20).

Civil society will also have a key role to play in guarding people's access to knowledge and their privacy in the Digital Age, and in helping to build consultative and inclusive regulation. The mainstream media, for example, supported by citizen journalists, will be important. It is significantly influenced by changes in use of ICTs, mirroring many of the attributes of a knowledge intermediary taking on the role of aggregator, custodian and verifier, and providing the credibility filter that is vital for trust.

> Mainstream media outlets will have to find ways to integrate all of the new global voices they can now reach, a challenging but necessary task. Ideally, the business of journalism will become less extractive and more collaborative.
> (Schmidt and Cohen 2013: 49)

2.3 Digital knowledge: trends and impacts

> The Internet has no curriculum, no moral values, and no philosophy. It just brings on the data, railroad cars of it, data by the ton. The Internet is scholarship that is electronically supercharged, decentralized, disorganized, multicultural, and out of control.
> (Sterling 2002: 51)

Against the backdrop of the rapid changes taking place in the Digital Age, we now focus specifically on the trends and impacts related to digital knowledge, and explore new ways of (1) producing knowledge, (2) curation and communication, and (3) searching and discovering. In the following sub-section we then link this discussion to the emerging post-2015 development agenda, with particular reference to the African context.

2.3.1 New ways of producing knowledge

Social knowledge

The internet has profoundly shaped the dynamics of knowledge creation and dissemination. Fast and easy online publication means that a new scholarly paper is now published roughly every 20 seconds. Over 50 per cent of these papers are made freely available.[10] Gradually, the internet has begun to affect not just the amount and the availability of research and knowledge, but its very nature.

The first trend to examine in this context is the blurring of 'the age-old distinction between information producers and information consumers' (Rowlands *et al*. 2008: 297–8). The proliferation of interactive websites and tools known collectively as 'web 2.0' or the 'social web' has allowed individuals to create, manage and publish their own micro-content. We are now firmly in the age of the 'prosumer' – a term first coined by Alvin Toffler in his 1980 book *The Third Wave*.

Another new development is that researchers now have a range of social platforms and networks available to them beyond the traditional academic journal. Joint projects can be developed and updated using wiki platforms, and blog comments can provide instant feedback on research in progress. Papers can be shared, annotated and discussed on services such as Research Gate, Mendeley and Academia.edu.

A recent example of the social web being used in iterative scientific review and communication was the #Bicep2 discussion on the discovery of gravitational waves claimed to be an 'echo' of the Big Bang. Unusually, a press conference was held before the actual research was published (and crucially, before peer review). Scientists on social media (via a 1,200-member Facebook group, blogs, and 3,000 tweets) were able to live-critique the claim, accelerating its review and ultimate revision.[11]

In an essay on 'tomorrow's library', Joseph Janes (2013: 154) wrote that:

> This opening hand [of new media] seems to be providing the opportunity for developing new forms and genres, including, for example, new modes of scholarly communication… And as scholarship begins to inhabit those forms and scholars get used to them, those forms will no doubt begin to influence how the scholarship is written and composed and critiqued and conceived; new questions will be asked, new methods of investigation will be developed, and scholarship itself will evolve.

[10] See www.sciencemag.org/site/special/scicomm/infographic.jpg.
[11] See, for example, www.theguardian.com/science/2014/jun/04/gravitational-wave-discovery-dust-big-bang-inflation.

More specifically, Jain (2014: 26) discusses how digital scholarship incorporates new tools and processes such as 'data visualization, network analysis, text-analytic techniques, GIS/mapping, and data mining'. Our interviewees and commentators hope that this evolution of scholarship will include more voices from Africa and the global South, supported by growing access to social web technologies and open platforms. One scenario reviewer points to the potential for more experiential knowledge sharing across communities of practice, and platforms such as Eldis Communities[12] are already hosting and supporting such initiatives. Participatory research with poor people, using a range of multimedia, can also be seen in action at www.participate2015.org.

Crowdsourced knowledge

Crowdsourcing as a concept comes from the business sector, where it was developed as an innovative and efficient way to outsource work to 'ordinary people' rather than using employees or contractors (Calhoun 2014: 252). As such, it is 'a model capable of aggregating talent, leveraging ingenuity while reducing the costs and time formally needed to solve problems' (Brabham 2008: 87).

Many cultural and scientific endeavours have since used the model successfully, especially in projects involving large-scale digitisation, where manual correction of text prepared with OCR is required. These include Project Gutenberg's 'Distributed Proofreaders' initiative, newspaper archive digitisation projects in California, Massachusetts and elsewhere, and Amazon's Mechanical Turk. However, transcription and OCR correction tasks are arguably not transformative in terms of the creation of new knowledge; the Mechanical Turk in particular has an echo in our Scenario 3, where data tasks are fragmented partly as a means of preventing the general population having access to 'big picture' knowledge while still leveraging their labour.

Crowdsourced knowledge in a more participatory sense could be said to have its roots in the UK's Mass Observation Archive, founded in 1937. The original Mass Observation social research organisation aimed to create an 'anthropology of ourselves', recruiting a team of observers and a panel of volunteer writers to study the everyday lives of ordinary people in Britain. The continuing Mass Observation project is based on the same principle that 'everyone can participate in creating their own history or social science'. There is potential for Mass Observation methods to be updated for use in the age of social media – for example, in a global call for observations on development policy issues as they affect 'ordinary people'.

The Map Kibera citizen mapping project created the first free and open digital map of the Kibera slum area in Nairobi, Kenya, empowering marginalised youth as well as creating brand new knowledge resources.[13] Significant contributions to science have also been made through crowdsourcing, most notably through the Galaxy Zoo project,[14] which allows members of the public to classify galaxies. A rare astronomical object was discovered by a Galaxy Zoo volunteer in 2007. Another important role for crowdsourcing is in the area of translation, where volunteers provide multi-language versions of popular sites and resources, including most notably Facebook.

Globally, the 'epitome of crowdsourcing' is Wikipedia (Calhoun 2014: 253). As of December 2014, the English version of Wikipedia includes 4,663,522 articles and more than 800 new articles are added daily. But the Wikipedia model raises an issue with crowdsourced knowledge: who is the crowd? As pointed out in our interviews and workshops, Wikipedia editors are a relatively homogeneous group – overwhelmingly white, male and middle class. In addition, the editorial criteria may not currently be hospitable to certain types of content, especially from developing countries. However, the global influence of Wikipedia and its

[12] See http://community.eldis.org/.
[13] See http://mapkibera.org/.
[14] See www.galaxyzoo.org/.

associated projects means that it could transform the online knowledge landscape if its community of editors grows and its projects diversify.

New knowledge can also be what we might call 'involuntarily crowdsourced' through analysing the vast amounts of data shared on public social media. This kind of deep analysis of social media 'big data' is resource-intensive and so far has been mainly carried out by the private sector and security services. Our workshop participants highlighted the implications for privacy that this activity is already having and will continue to have in some of our future scenarios if regulation is not put in place.

Local knowledge

One consequence of increasing levels of internet access and the development of open platforms for sharing knowledge is the greater exposure and credibility of local and indigenous forms of knowledge. One of our scenario reviewers describes the potential for social networking technology to provide community-specific products for sharing local knowledge of specific data such as rainfall patterns. Another reviewer noted that there has been donor, philanthropic and publisher investment in initiatives to increase access to indigenous research, especially from Africa.

At the same time, the open digital landscape has led to an awareness that traditional knowledge needs to be protected from capture by commercial and/or Northern actors, whether by expanding intellectual property regimes or with whole new instruments. The Open African Innovation Research and Training (Open A.I.R.) Project is one example of efforts to reconcile open development with intellectual property protection.[15] A number of communities have also adopted new forms of self-governance and knowledge management in relation to their traditional heritage. The Kukula Healers in Bushbuckridge, South Africa, have created a common pool of members' individually held traditional knowledge through a bio-cultural community protocol (BCP). The BCP has assisted the healers to protect their knowledge of medicinal plants against bio-piracy, and to provide for sustainable use of natural plant resources.

One of our interviewees suggests a 'glocal' future for knowledge sharing, where local village communities can virtually connect to other local communities who have similar interests and information requirements. Relevance becomes an extremely important factor in a world of information abundance.

The example of the Maarifa (Swahili for 'knowledge') centres supported across East Africa by the Arid Lands Information Network (ALIN)[16] illustrates a community-based knowledge sharing approach which has reach to farmers. The community-managed centres use solar-powered technology and equipment linked to the internet via the cell phone networks, to make knowledge available as part of wider strategies of face-to-face and digital knowledge sharing with and among the community. The Maarifa centres act as local knowledge intermediary hubs, providing access to books, internet and knowledge and research evidence that is translated and repackaged to be made accessible to local people. Through ICT training and local expert support, users are helped to engage with relevant knowledge, and also share their experience through blogs and citizen journalism (e.g. http://ngaruamaarifa.blogspot.co.uk/).

There are still many barriers to the international acceptance of knowledge produced in Africa and the global South, chiefly around the issue of quality and how this is measured. Related to this is the persistent brain drain that, as one of our interviewees suggests, prevents local standards of research being raised sufficiently. Greater investment in local research capacity is needed.

[15] See www.openair.org.za/.
[16] See www.alin.net/introduction.

2.3.2 New ways of curating and communicating knowledge

Social digital libraries

The Digital Age and the evolving online information ecosystem have had an inevitable impact on the nature of libraries and librarians. The first all-digital public library was launched in 2013,[17] and the 'invisible library' has become a key concept in the literature (Borgman 2003; Kennan and Wilson 2006; Brophy 2007).

> In the paper paradigm, the library was a building holding tangible items such as books and journals. In the new paradigm libraries provide an invisible infrastructure to enable the provision of information to inform research.
> (Kennan and Wilson 2006: 237)

As Brown and Duguid (2002: 5–6) caution, this invisibility (or disintermediation), whereby users perceive their access to information as more direct, has the effect of 'screening out' all the people and tasks involved in providing the information. One challenge for libraries and librarians is how to become visible and valued without disrupting the easy access to resources now expected by their users. What is the role of the library 'in a world where so many information sources are place-independent, dynamic and transitory'? (Brophy 2007: 16)

One key lesson for libraries is to build services around the user and the user's workflow. Providing digital content is only one aspect of this. As Rowlands *et al*. (2008) point out, 'there is a big difference between "being where our users are" and "being useful to our users where they are"'.

Libraries need to manage the shifts, not just from print to digital, but from pre-designed to personalised collections, from owning to renting, from desktop to mobile, from archiving to publishing, and from the hard drive to the cloud. Further shifts towards social digital libraries are expressed in Figure 2.1.

Figure 2.1 Transitions to social digital libraries

Focus on collections	→	Focus on online communities and networks
Repositories	→	Social platforms
Vertical (top-down) communications	→	Horizontal communications
Content consumers	→	Content creators and contributors
Read-only sites	→	Active connections for discovery and interaction
Authority and authenticity valued	→	Engagement and participation valued

Source: Adapted from Calhoun (2014).

Calhoun (2014: 212) defines the digital library as:

> … a tool at the centre of intellectual activity having no logical, conceptual, physical, temporal, or personal borders or barriers to information. Generally accepted conceptions have shifted from a content-centric system that merely supports the organisation and provision of access to particular collections of data and information, to a person-centric system.

[17] See www.cilip.org.uk/cilip/blog/bibliotech-library-without-books.

Library users now bring with them expectations formed through using e-commerce and social networking sites; they want to access information anytime and anywhere, to be able to discover new content through their connections on the social web, and to have content pushed to them based on past behaviour or preset criteria. Despite these expectations, however, some research has found that users of library resources are not interested in libraries moving into the social media space (Rowlands *et al*. 2011).

There are also risks attached to borrowing digital strategies from the consumer web. As Rikowski (2011) suggests in the context of digitisation, we 'need to exercise some caution, not just jump on every digital bandwagon'. A crucial point explored in our scenario workshops was the fact that there are still those who are absent from the digital landscape, either by choice or through lack of capacity and resources. Rural populations are particularly ill-served by internet access globally, and as one of our interviewees noted, are glossed over in the hype surrounding mobile and smartphone penetration rates. In fact, only 19 per cent of the total population of Africa was using the internet in 2014, compared with 75 per cent in Europe (ITU 2014b). Low literacy rates and preference for oral culture are additional factors in some areas, as highlighted by our scenario reviewers.

Being 'useful to users where they are' in this case may mean developing inclusive non-digital services as well as making sure digital services are audience-appropriate and keeping pace with commercial products.

It should be noted that even BiblioTech, the all-digital public library, maintains a physical space:

> The social function of library as the 'third space' for the community needed to be addressed… A digital library is of no use to those without technology access. Our physical location provides technology access where consumer buying power and internet access are severely limited.
> (Cole 2014)

Rikowski (2011) remains hopeful for digital libraries in Africa, believing that they could ultimately, more than any other means before, aid literacy development in Africa and in higher education, and foster more quality academic output and research.

Digitisation and preservation

Related to digital libraries is the question of digitisation of print materials, and how these are managed and preserved in a dynamic online environment. Although the technical infrastructure is well advanced, the legal, policy and ethical framework is relatively unclear, especially in an African context. The questions posed by Britz and Lor (2004: 218) are still largely unanswered today:

- Who has access to this information? For example, will African scholars be able to access this information free of charge?
- What control will the originating community have over their information once others have digitised it?
- Will originating communities be identified as the original creators of their cultural heritage and will they have the right to control access and non-disclosure of certain categories of their cultural heritage, for example sacred knowledge artifacts?
- To what extent will the global rules on intellectual property be able to protect this common heritage of Africa and prevent it from becoming exclusive, private property? Will the international intellectual property regimes be able to maintain the balance between private ownership and common heritage of the people of Africa?
- Will the people of Africa be fairly compensated for the use of their knowledge by others and what incentives will there be for them to make their body of knowledge available to the rest of the world?

If local capacity for African-owned digitisation initiatives increases, some of these questions could become less troubling. But despite a proliferation of projects, one of our interviewees bemoaned the lack of 'synergy with what happened before and what is to come'.

Intermediary roles and skills

> Information has never been more abundant and accessible so those who know how to manage it for the benefit of others in the digital age will be in great demand. (De Saulles 2012: x)

There is wide agreement that navigating the enormous amount of information on the web requires skilled intermediaries, and that managing emerging forms of data and knowledge may even require a whole new kind of information professional. For example, the Central Intelligence Agency (CIA)'s social media analysts, who tracked and predicted developments in the 2011 Arab uprisings, describe themselves as 'ninja librarians' (De Saulles 2012: 114). Thinking on intermediaries who support evidence-based development policy (or 'the power of in-between') has also emerged in recent years (Fisher and Vogel 2008).

Scenario exercises in the United States of America (USA) and the United Kingdom (UK) identified the need for future professionals with skills in data curation, researcher support, project management, deep subject knowledge and networking (Association of Research Libraries 2010). An additional major area where librarians' voices are needed in Africa, as identified by our interviewees, is in advocating and lobbying for coordinated open knowledge infrastructure and standards. In the wider context of economic and political development, it has been suggested that libraries, through extracting and delivering reliable, authoritative and up-to-date information, can stimulate growth and contribute to social justice (Tise 2012).

Table 2.2 summarises some of the roles and skills that could or should be important for libraries, librarians and information intermediaries in the Digital Age.

Table 2.2 Library roles in the Digital Age

Libraries	Librarians and information intermediaries
● Providing space – study, social, convening ● Providing technology access (local terminals) ● Selection and curation – material relevant for users ● Metadata – developing and applying standards ● Outreach – going into remote or digitally marginalised communities ● Training and capacity building services – in information seeking, evaluation, use ● Consortia agenda-setting and leadership	● Advocacy for knowledge sharing – at institutional and national levels ● Research data management ● Project management ● Increasing uptake and demand for research – training ● Social media monitoring and analysis ● Advising on copyright, licensing, privacy and data protection ● Subject knowledge and synthesis skills ● Constructing platforms and infrastructure for knowledge creation, publishing and sharing

Open platforms and repositories

One area where libraries have evolved and added to the services they manage is in the development of open access digital repositories. There have been many definitions of a repository (and the different types of repository), but one of the most comprehensive is Pinfield's (2009: 165):

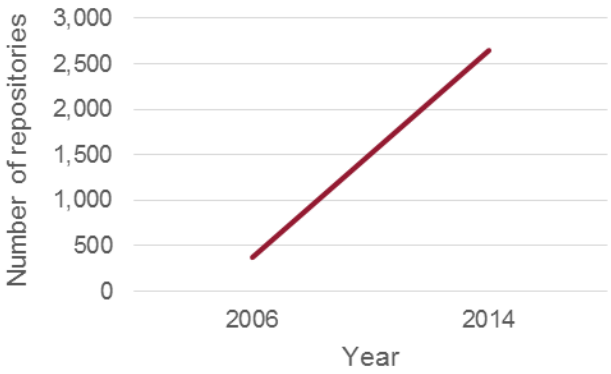
> A repository may be defined as a set of systems and services which facilitates the ingest, storage, management, retrieval, display, and reuse of digital objects. Repositories may be set up by institutions, subject communities, research funders, or other groups. They may provide access to a variety of digital objects, including peer-

reviewed journal articles, book chapters, theses, datasets, learning objects, or rich media files.

This is a helpful definition because it emphasises the dynamic and flexible qualities of a repository, whereas the word itself is understood by most non-specialists as something static, possibly a physical archive, and more to do with storage than sharing.

The enormous growth in the number of repositories worldwide (see Figure 2.2) over the past decade is inseparable from the rise of the open access movement. Of the 50 per cent of scholarly papers that are now freely available online, a large number are being made accessible through repositories.

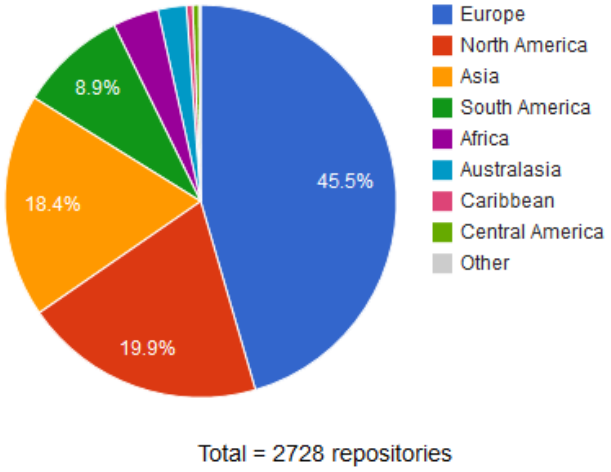
Figure 2.2 Growth of repositories



Source: OpenDOAR (2014).

However, the fact that there are now more than 2,700 repositories in the world[18] does not tell us very much about their success as knowledge sharing systems or the institutional picture in different parts of the world. Even in terms of raw numbers, the take-up of these platforms in Africa has been comparatively low (Pinfield *et al*. 2014), with just 3.8 per cent of the total repositories recorded in the Directory of Open Access Repositories (OpenDOAR).

Figure 2.3 Worldwide proportion of repositories by continent



Source: Based on data from OpenDOAR (2014).

A lack of ICT infrastructure is the main reason for this, although issues of language and culture also come into play (Jain 2011; Xia 2012; Pinfield *et al*. 2014).

[18] Data from http://opendoar.org (4 December 2014).

Chisenga (2006: 10) identifies the key issues as being related to:

- acceptance of electronic information
- absence of information management strategies/policies
- copyright and Intellectual Property Rights (IPR) concerns
- inadequate technical infrastructure
- lack of awareness and understanding of the concepts
- lack of funds.

Nwagwu (2013) emphasises the need for Africa to have ownership of its knowledge stock and the technology to disseminate it, and to move from a consumer (or 'downloader') of knowledge to a producer (or 'uploader'). Despite new access mechanisms, real knowledge sharing is lagging behind in terms of South-North and South-South access and usage. As one of our interviewees remarked, 'access to knowledge created elsewhere, e.g. Europe and USA, is easier than accessing knowledge created by neighbours within the African continent'. Xia (2012: 87) identifies the resulting asymmetry in the global research landscape:

> Many countries in Africa and Central Asia are lacking essential technological structures for their researchers to make OA [open access] contributions and share intellectual results freely. Consequently, scientific publications from these countries have low visibility and little impact on the international scholarly community.

Although 'current OA practice focuses on knowledge transfer from the developed to the developing world' (Nwagwu 2013: 5), there are examples of African innovation and ownership in this area. These include the African Open Access Repository Initiative (AOARI) at Stellenbosch University (Raju, Smith and Gibson 2013), African Journals Online (AJOL)[19] and the Scholarly Communication in Africa Programme.[20] As Xia (2012: 94) concludes, 'OA can only be effectively established after it meets local standards'.

The global picture is slowly changing. From 1996 to 2012, the number of research papers published in scientific journals with at least one African author more than quadrupled (from about 12,500 to over 52,000). During the same time, the share of the world's articles with African authors almost doubled from 1.2 per cent to around 2.3 per cent (Schemm 2013).

We have found that even where African repositories exist, there are major barriers to their effective usage as knowledge sharing tools, especially at the national, regional or federated level. This is in contrast to Latin America, where such efforts are being taken seriously – for example, the National Research and Education Network of Ecuador (CEDIA)[21] and REDALYC (Network of Scientific Journals from Latin America, Caribbean, Spain and Portugal).[22] Our interviewees highlighted areas such as sustainability/continuity, differences in regional and disciplinary priorities, perverse incentives, ownership issues, usability, technical capacity and advocacy. These are discussed in more detail below.

Sustainability/continuity

One interviewee noted that 'libraries often get funding, and at the end of the project, that is the end of that'. There is no investment in continuity or efforts to avoid duplication or learn from previous projects. Our own knowledge of repository initiatives suggests that there is a 'front loading' problem, with funding available to set up repositories but little to ensure continued staffing for content recruitment or technical maintenance, much less long-term preservation strategies.

[19] See www.ajol.info/.
[20] See www.scaprogramme.org.za/.
[21] See http://rraae.org.ec/.
[22] See http://redalyc.org/home.oa.

Regional and disciplinary priorities
Several of our sources have noted that agricultural research platforms dominate in the African repository context, due to the interest in funding agricultural innovation and supporting knowledge sharing in this area. Recently, platforms which share knowledge on Ebola have inevitably attracted funding as well. This suggests a scenario of disciplinary 'poor relations' where knowledge – even where there is a will to make it open – can only be effectively shared if it can attract funding. There are also parts of Africa where ongoing instability/insecurity means that creating an enabling environment and infrastructure for national/regional-level repositories and participating in regional knowledge sharing platforms may not be a priority. North African regimes also make open knowledge sharing less likely in that region.

Perverse incentives
Even where institutions and funders have open access policies, there are forces militating against their implementation. Many African universities, for example, receive government funding that is dependent on the number of peer-reviewed journal articles their faculty publish. Faculty, in turn, are incentivised through promotion/tenure conditions attached to journal publication. Few of these peer-reviewed journals are (currently) open access. There are also drivers for repositories to compete rather than collaborate or federate. A university repository may be its shop window for its own research, and ranking services such as the Ranking Web of Repositories[23] encourage institutions to focus on their own 'impact' in terms of downloads rather than other measures of success.

Ownership
Although there is some appetite for national and regional-level federated repositories, the need for information to have 'ownership and origins' (as one reviewer put it), and the uncertainty around responsibility for archiving and sharing, may lead to the continued primacy of institutional-level systems that compete with each other.

Usability
Questions persist over the usability of repository systems from the point of view both of those contributing content and the end user trying to access that content. Systems for adding new content need to be made more intuitive, and collections should be structured to support access and discovery rather than serve institutional goals.

Technical capacity
Although 'out-of-the-box' open source platforms promise easy set-up of repositories for institutions, the continued maintenance of these platforms is not trivial and few African institutions have the requisite skills embedded in their permanent staff. This is also related to sustainability as above.

Advocacy
Advocacy is needed at every level, but may be more successful at some levels than others. Lessons from our interviews would suggest that repository managers and librarians should go directly to policymakers and top-level institutional leaders. There is also still a need for awareness-raising, myth-busting and incentives at the individual researcher level.

A recent report from the Confederation of Open Access Repositories (COAR 2013) acknowledged that despite the great potential of repositories as an essential infrastructure for scholarship in the Digital Age, there have been challenges in recruiting content in sustainable and scalable ways. The report goes on to describe a number of profiles that can be adopted to mitigate these challenges, which broadly fall into three categories, as follows.

[23] See http://repositories.webometrics.info/.

- Incentives: promoting the benefits of repositories through advocacy and metrics, as well as the adoption of policies/mandates that require deposit.
- Integration: amalgamating repository services with other institutional services like research information systems and research biographies.
- Mediation: implementing tools, workflows and agreements that ease and simplify the deposit process.

Content recruitment may also be addressed by more federation, and by open 'hubs' that provide one-stop shops for related content from various sources. Examples include the Oriel Open Knowledge Hub[24] and the various agricultural portals managed by the Consortium of International Agricultural Research Centres (CGIAR).[25]

Aside from the institutional, national and international digital libraries and repository approaches, there are interesting examples of digital initiatives that have been designed to be responsive to the knowledge and information needs of local communities. The Essential Electronic Agricultural Library (TEEAL) is a well-established programme, founded in the early 1990s. The programme is designed by Mann Library, Cornell University, in conjunction with the Information Training and Outreach Centre for Africa (ITOCA), and is funded by the Bill & Melinda Gates Foundation. In its latest phase, a digital library makes available thousands of documents from highly ranked international journals as well local scientific literature. This is supplied on a hard disk drive to universities, agriculture ministries and extension organisations, making content accessible offline, though there is scope for regular updating via the internet.[26]

Open data

Effective hubs and knowledge sharing systems rely just as much on open data as open access. Open data is defined as data which anyone is free to use, reuse, and redistribute – subject only, at most, to the requirement to attribute and/or share-alike. It is now widely acknowledged that no one organisation will hold all the data; neither are data silos appropriate in this day and age. The ability to make connections with other data thereby augmenting your own data to create new information and knowledge is a very powerful proposition. The explosion of data in this Digital Age has provided organisations and individuals alike with a new resource on which to capitalise. Of course, to take full advantage of this new resource, the resource needs to be standard based, open and with a favourable licensing regime – hence the *movement towards open data*.

Tim Davies (2013), in the *Open Data Barometer* report for the Open Data Institute, found that one area of growth is the number of Open Government Data (OGD) portals (see above in Section 2.2.4 on open development). In the past five years, OGD policies have seen rapid diffusion. However, the report also found regional and country differences in take-up; for example, leading countries are investing in the creation of 'National Data Infrastructures' while mid-ranking countries have put in place some of the components of an OGD initiative, such as an open data portal and competitions or events to catalyse re-use of data, but have often failed to make key data sets available, and are lacking in important foundations for effective open data re-use. This can be attributed to the absence of strong 'right to information' laws as well as limited training and support for intermediaries. Low-ranking countries have not yet started to engage with open data, and many developing countries lack basic foundations such as well-managed and digitised government data sets. The potentials for OGD listed by Davies (2013) include the following.

- More efficient and effective government – both through government using its own data better, and through innovators outside of government identifying improved ways

[24] See http://okhub.org/.
[25] See www.cgiar.org/.
[26] See www.news.cornell.edu/stories/2013/12/gates-grant-share-knowledge-developing-world.

to provide public services, meeting the diverse needs of citizens through digital technologies.

- Innovation and economic growth – acting as a twenty-first century infrastructure, and a raw material, for activity in the information economy. Start-ups and established businesses can use open data to generate new products and services, and secure efficiencies, generating a net gain for country economies.
- Transparency and accountability – allowing citizens and civil society to more effectively see, understand and monitor what their governments and the private sector are doing, challenging corruption or unaccountable activity, and finding opportunities to influence policy and practice.
- Inclusion and empowerment – enabling marginalised groups to get involved in the political process, and removing imbalances of power created through information asymmetry.

Global standards and interoperability

The real value of repositories lies in their potential to become an interconnected repository network – a network that can provide unified access to an aggregated set of scholarly and related outputs that machines and researchers can work with in new ways (COAR 2012). However, this potential to create a unified body of scholarly materials is entirely reliant on interoperability. By that, we mean the ability of systems to communicate with each other and transfer information back and forth in a usable format. It allows us to exploit today's computational power so that we can aggregate repository content, data mine content from repositories, create new tools and services on top of repositories, and generate new knowledge from them. Interoperability is the technical 'glue' that makes it possible to virtually connect repositories to each other and to other systems and transfer information, metadata, and digital objects between each other.

The Open Access Initiative's Protocol for Metadata Harvesting (OAI-PMH)[27] has been the cornerstone of interoperability, but emerging standards and technologies such as linked data,[28] digital object identifiers (DOI)[29] and open researcher and contributor identifiers (ORCID)[30] are also being incorporated as core components within repository software platforms. COAR (2012) succinctly lists the issues that are being addressed in this area: metadata harvesting; repository networks; usage statistics; cross-system transfer; author identification; persistent identifiers; and managing compound objects.

The development of these international standards for machine-readable information has been vital in enabling global information sharing. As one of our interviewees pointed out, knowledge sharing systems require collaboration across countries, because many major issues such as climate change and epidemics are not framed within a single country. As Wilson (2004: 10) writes: 'For good and for ill, the wired networked nations of the world all share common borders. We now have two hundred reasons to care about the information revolution in developing countries.' However, due precisely to this proliferation of borders and connections, linking enormously different contexts, standards are not always applied consistently.

Open repository software (for example, DSpace, Fedora and EPrints) comes with interoperability features such as OAI-PMH compliance as standard 'out of the box', but these capabilities are not always enabled in African implementations. According to Khan (2013), there were just 50 OAI-PMH compliant repositories on the African continent by 2011, compared to 995 in Europe. The lack of take-up could indicate a need to raise awareness when planning repository and open access projects, and there is also a lack of sophisticated

[27] See www.openarchives.org/pmh/.
[28] See http://linkeddata.org/.
[29] See www.doi.org/.
[30] See http://orcid.org/.

use cases. Knowing how others are taking advantage of interoperability capabilities is an important part of joining up the open landscape across borders and building consistent capacity.

Social media

The internet has altered not only the way knowledge is produced and curated, but also the way it is communicated. In terms of traditional scholarly output, we have started to see researchers sharing their papers through a range of outlets. Moriano *et al*. (2014) studied the diffusion of scholarly content on Twitter, finding that the proportion of scholarly tweets rose by 42.6 per cent between 2012 and 2013, and that some of these tweets spread across multiple communities to become 'viral'. Meanwhile, Adie and Roe (2013) have identified a 5–10 per cent increase every month in social media activity around scholarly articles.

In terms of development information and political participation, one scenario reviewer commented that:

> *Social networks will play an important role in the development sector, especially in building relationships among development organisations and target populations, and disseminating and sharing information and dialogue on a range of development strategies.*
>
> *Another area in which social networks will play an important role is in enhancing political participation among Africans. As more and more people (including politicians and high-profile citizens) adopt social networks, the public will use more of social networks to express their political views, engage in civil protests, sign petitions, and join and participate in lobby groups or political advocacy. Elements of this aspect have already been seen in Egypt, Kenya, Nigeria and Tunisia.*

Another scenario reviewer noted that freely available services (for example, LinkedIn, Instagram, Twitter, Flickr, Tumblr and Facebook) have increased people's willingness to share personal and professional information. However, there is a 'dark side' to social media usage, one which was explored in our scenarios and picked up by all our scenario reviewers. This encompasses government surveillance and general invasion of privacy, as well as the prospect of identity theft, fraud, blackmail and other cybercrimes.

Social media may well evolve in ways that are more difficult for governments to monitor, as suggested by the US National Intelligence Council's report (2012: 86). Future social networks may well not be formal organisations 'but rather anarchic collectives built on sophisticated variants of peer-to-peer file-sharing technologies, against which developed- and many developing-world governments might have no meaningful negotiating leverage'.

Mobile knowledge sharing

Our workshop participants agreed that the future of knowledge sharing is mobile, especially in the African context. While most African countries cannot generate enough power for their needs, mobile penetration is high. If mobile devices can continue to perform better and charge more quickly, their dominance seems assured. As one reviewer stated:

> *Mobile devices will offer facilities and functionalities to instantly capture knowledge generated by individuals (whether at home, at work, on holiday, on the bus, on the plane, etc.) and transmit it to distributed servers for processing/categorization and immediate access by all those who want it.*

The huge uptake of the Kenyan M-PESA mobile banking system suggests a strong model for future services facilitating all forms of social and commercial activity – and possibly education and information services too. E-government and e-learning are already becoming more established and could transfer to mobile platforms in future.

According to one of the scenario reviewers:

> *A few positive ways in which mobile phones will be used for knowledge sharing, include knowledge on market prices, availability of products, advisory services, access to weather data, sharing of ideas and knowledge through online communities of practice especially through relevant social media, questions and answer services, access to relevant literature, weather/climate information, online learning and skills development and not forgetting entertainment and leisure.*

However, as seen above, there are privacy implications for such universal mobile services. Mobile devices are easily monitored and hacked, and the power that service owners (whether government or commercial) have over data gathered by those devices leads to concerns over how people's personal data will be used.

2.3.3 New ways of searching and discovering

Search behaviour at web scale

Despite a young population (especially in Africa), which is often termed 'digital natives', Rowlands *et al*. (2008: 308) found that 'the ubiquitous presence of technology in their lives has not resulted in improved information retrieval, information seeking or evaluation skills'.

Search behaviour has changed across the board, however. 'In general terms, this new form of information seeking behaviour can be characterised as being horizontal, bouncing, checking and viewing in nature' (*ibid*.: 294). As previously discussed, digital platforms would be advised to respond to user behaviour and expectations, largely formed by Google.

> Library users demand 24/7 access, instant gratification at a click, and are increasingly looking for 'the answer' rather than for a particular format: a research monograph or a journal article for instance. So they scan, flick and 'power browse' their way through digital content.
> (*ibid*.: 293)

If a digital library provides its own user interface (UI), it should be designed in such a way that it caters for all types of users. For example, Caffo, in Verheul, Tammaro and Witt (2010), talks about how the Culturaltalia[31] is designed to work for the expert public (students and researchers) and non-specialised users such as citizens and tourists. The World Bank's Open Knowledge Repository has developed a powerful mobile interface to keep up with users' preferences without sacrificing functionality.[32]

Discovery tools

Google and other internet search engines can be termed the biggest discovery tools, but a search engine's results are only as good as the content it indexes – i.e. it is important that designers, digital libraries and other information sources provide good metadata so their content can be found and correctly indexed.

Alongside Google, academic libraries are increasingly adopting resource discovery tools or 'next generation catalogues' that aim to go beyond the traditional database of library holdings and offer the user a more 'Google-like' search experience across multiple online resources (Stone 2009). These resources might include institutional repositories and other open access collections as well as proprietary databases (Shapiro 2013). Hofmann and Yang (2012) noted that discovery tool use had almost doubled since 2010 (from 16 per cent of US and Canadian libraries to 29 per cent).

[31] See www.culturaitalia.it.
[32] See www.doria.fi/handle/10024/97654.

Commercial products Summon, Primo and EBSCO Discovery Service (EDS) are the most frequently used tools (Spezi *et al*. 2013), with key features being the provision of a single search interface and the ability to connect directly to full-text resources. Open source offerings are also available, for example VuFind, which can be seen in use at IDS,[33] and CEDIA.[34] Most of these products offer intuitive features such as search suggestions and a 'did you mean?' prompt to correct for spelling and typing errors. Social and interactive features include user-contributed reviews, ratings and tagging.

However, there is evidence that the majority of researchers/information-seekers begin their search with Google itself (OCLC 2010; Rowlands *et al*. 2011), and some commentators have cast doubt on the value of installing expensive systems that emulate it (Kortekaas 2012; Harris 2014). The University of Utrecht started to phase out its library catalogue in 2012 and is not replacing it. The rationale is summarised by Kortekaas (in Harris, 2014) as: 'with discovery, libraries need to accept that others can do it better'.

In terms of what users want from their library search, delivery is more important than discovery. In other words, they want to see where the item is, whether it is available, how to access it, and how soon they can get it. (This applies more to print materials, but it is also important for discovery systems and catalogues to provide clear guidance on how to access the digital resources they supposedly connect to.)

There was some scepticism among our interviewees around the value of Google results: 'Google searches are not delivering innovative things, but what it thinks you need to know'. Meanwhile, Fister (2014) raises the concern that discovery tools are 'putting too high a value on volume of information and too little on curation'. Perhaps this goes back to the added value that libraries and information intermediaries can provide in the Digital Age: selection and curation of what is truly relevant for their users among the 1.2 zettabytes (ZB) of data on the internet.

2.4 Digital knowledge, Africa and development goals

A Foresight report on Africa 2060 prepared by Gatune and Najam (2011) concluded that: 'Innovation, entrepreneurship, technology, knowledge, and globalization are among the areas that have generated significant "good news" to record from Africa'.

Within our study, we look more specifically at development and the global agendas around development goals, and explore the roles of digital knowledge and related ICTs, as we move from the period of the Millennium Development Goals (MDGs) to the post-2015 development agenda and the SDGs. We continue to focus our discussion on data and insights relevant to the African context, and it is interesting to note that Africa is currently working on a 2063 agenda vision,[35] to coincide with the centenary of the African Union.

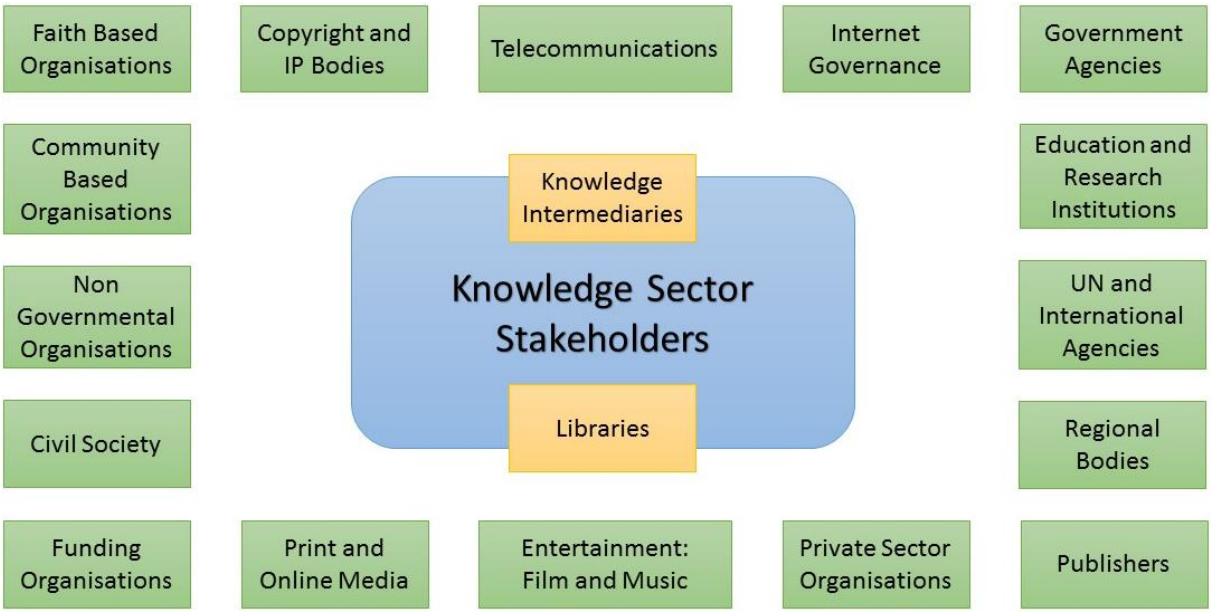
In the context of the post-2015 development agenda, we now briefly discuss the following major areas for attention in relation to digital knowledge and Africa:

- an inclusive and accessible ICT infrastructure
- development of skills for the Digital Age
- approaches to address growing digital divides
- deeper understanding of the relationship between ICTs, digital knowledge sharing and achievement of development goals
- metrics and measurement that support the wider integration of knowledge in the SDGs
- innovation in use of ICTs for knowledge sharing across and within African countries.

[33] See http://resourcefinder.ids.ac.uk/vufind/.
[34] See http://rraae.org.ec/.
[35] See http://agenda2063.au.int/en/vision.

One of the interviewees from our study commented that there are 'many policies but poor implementation' and this is a challenge for many actors to pick up on. It is important to recognise that in any context, there is a wide range of potential national and international actors and stakeholders when it comes to knowledge creation, sharing and discovery in the Digital Age. Figure 2.4 illustrates this by mapping out some of the main actors, and Annex 3 identifies some specific actors relevant to the African context who were mentioned by participants in our study.

Figure 2.4 Key stakeholders



Policymakers and funders will need to consider the sorts of configurations and partnerships that will work best and provide knowledge sector outcomes that are in Africa's interests and the interests of its poorest citizens.

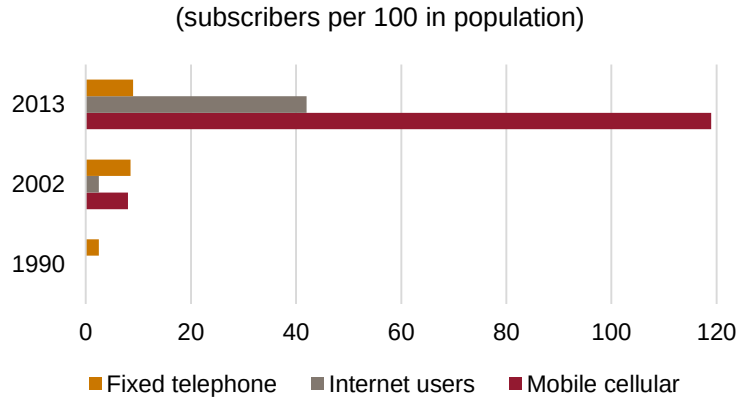
An inclusive and accessible ICT infrastructure

The MDGs made specific reference to ICTs as an enabler (MDG 8, target F), and provided access indicators in relation to fixed telephone, mobile cellular and internet subscriptions. The figures below (adapted from ITU 2013) show the rapid progress in the spread of mobile cellular subscriptions during the period of the MDGs. An analysis of the ITU 2013 data shows that northern Africa is generally ahead of the average for developing regions, while sub-Saharan Africa is generally ahead of the average for less developed countries.

According to Schmidt and Cohen (2013), there are now 650 million phone users in Africa, but with only one in three people (on average) in Africa and Southern Asia having their own unique subscription to a mobile service, there is still significant growth to come.

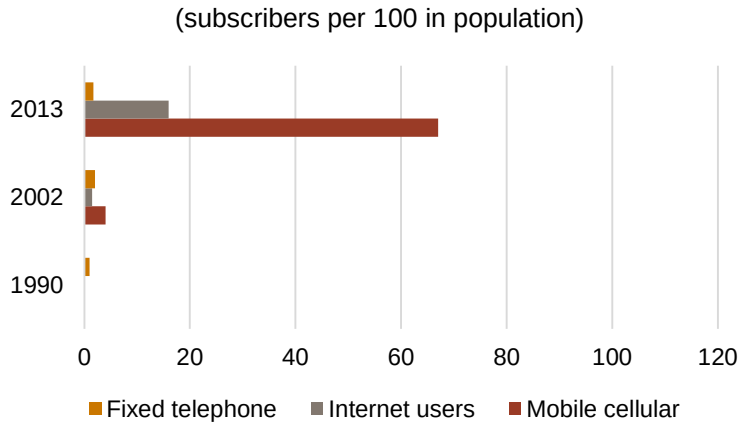
While trends (particularly for mobile subscriptions) are impressive, these graphs do not illustrate who has access in terms of gender and diversity, nor do they provide insights in relation to urban/rural divides, which are very evident in many parts of Africa and globally. Simple access measures also typically fail to highlight the nature of that access – e.g. whether 2G, 3G or 4G; nor do they tell us whether sufficient capacity and skills exist within a country to make effective use of the connectivity to support knowledge-based economic and livelihood-relevant activities.

Figure 2.5 Telephone, internet and cellular subscribers, northern Africa



Source: Adapted from ITU (2013).

Figure 2.6 Telephone, internet and cellular subscribers, sub-Saharan Africa



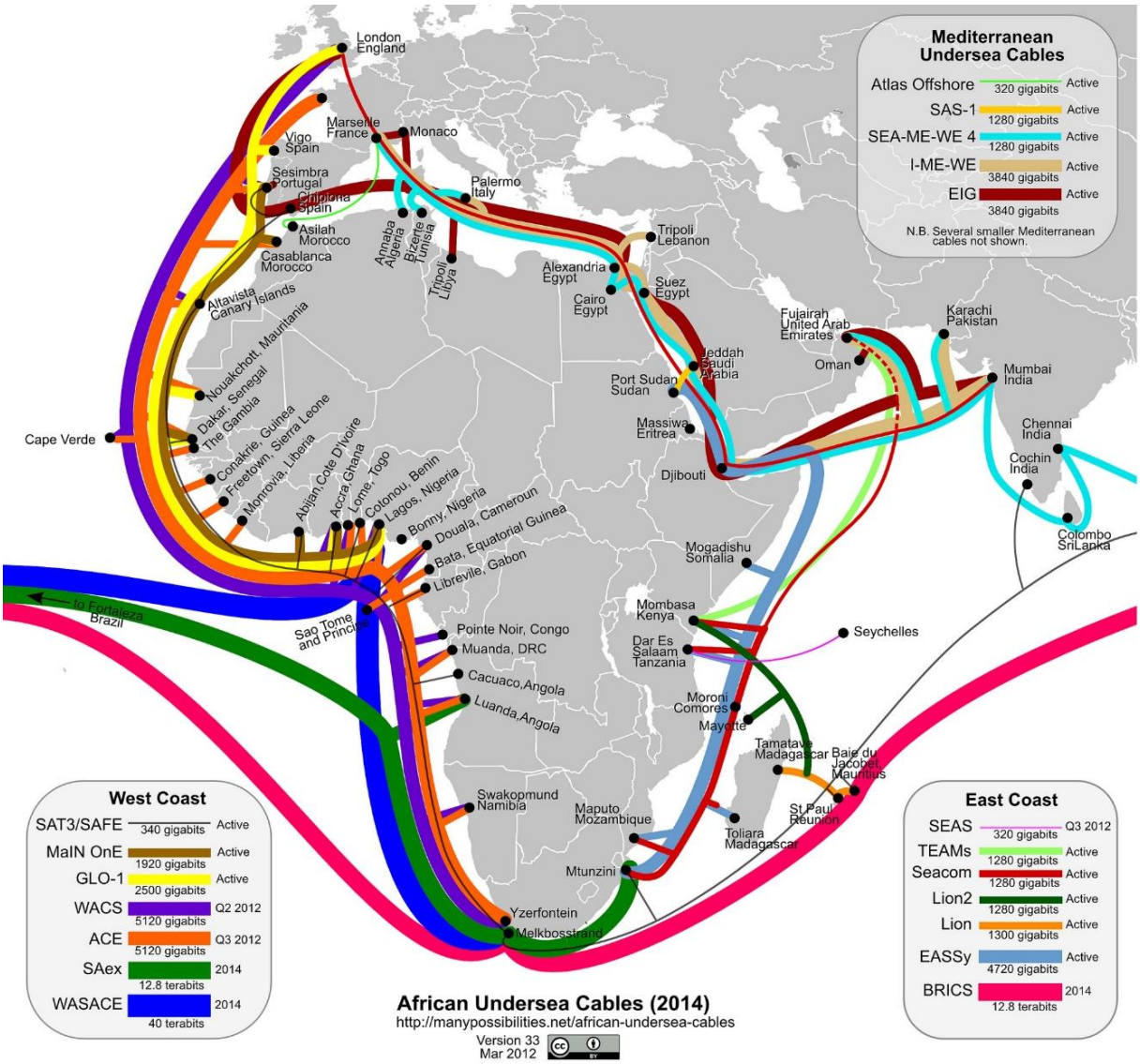
Source: Adapted from ITU (2013).

Internet access is clearly lagging behind mobile, and in the coming years there is likely to be a closer correspondence as users with 3G- and 4G-based data services increasingly access the internet via their mobile phones.

Developing the ICT infrastructure to enable effective digital knowledge sharing is a critical issue that was identified by many participants in our study. As the map in Figure 2.7 shows, undersea cables are increasingly connecting Africa internationally, but internally, connectivity remains a problem. However, as one of our interviewees observed:

> *One issue today which can become worse if not solved is that while bandwidth infrastructure is getting better, international bandwidth connectivity is alarmingly low – for the African continent as a whole it is similar to the total in Norway. This limits the development of repositories and streaming applications.*
>
> *The rest of the world is getting more cloud based, but lack of data centres for cloud-based services in Africa means it will lag behind, compared to if it had 'close proximity' infrastructures. It will be a missed opportunity if African institutions just invest in local infrastructure rather than taking on cloud-based approaches. But there is a lack of skills.*

Figure 2.7 African undersea cables

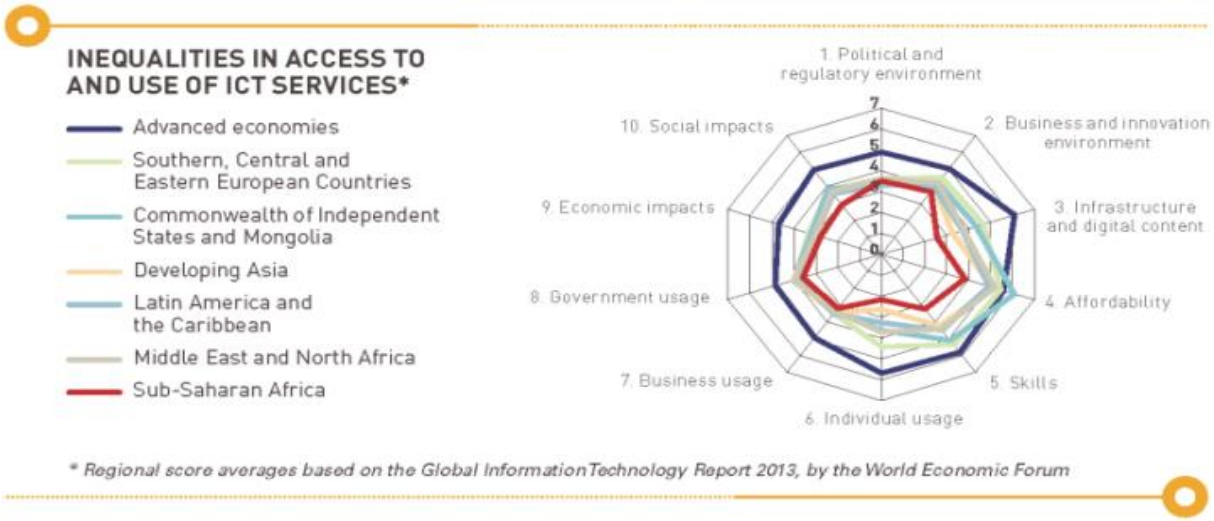


Source: Song (2014), *https://manypossibilities.net/african-undersea-cables/*

Development of skills for the Digital Age

The benefits of digital knowledge content becoming available and an open development paradigm are clearly going to be constrained in the African context while the ICT infrastructure lags behind that of developed countries, limiting access and stifling the development of relevant skills for the Digital Age. Jahan (2014), in an article entitled 'The Data Revolution for Human Development', illustrates data from the World Economic Forum (WEF) Global Information Technology Report (2013), which shows that sub-Saharan Africa lags behind the rest of the world on a range of relevant indicators including skills, infrastructure and digital content.

Figure 2.8 Inequalities in access to and use of ICT services



Source: Independent Expert Advisory Group Secretariat (2014).
Note: Image reproduced with permission from the Expert Advisory Group on a Data Revolution for Sustainable Development, http://hdr.undp.org/en/content/data-revolution-human-development.

Evidence from the ITU (2013) ICT Development Index (IDI) also highlights the need not only for improved infrastructure and investment in broadband, but also for skills. Commenting on this report, Essoungou (2013) notes a growing divide: '30 of the continent's 55 countries surveyed are part of the 39 least connected countries, (home to 2.4 billion people) with particularly low levels of ICT development'. This skill divide is across the continent and also between urban and rural locations. Brahima Sanou, ITU Director, in the foreword to the ITU (2014a: iii) report, notes that:

> ICT performance is better in countries with higher shares of the population living in urban areas, where access to ICT infrastructure, usage and skills is more favourable. Yet it is precisely in poor and rural areas where ICTs can make a particularly significant impact.

ICTs are stressed as important for achieving development goals across a wide range of sectors. It is not technology alone, however, that makes this possible, but the knowledge-related applications that are made available and the skills of the people who use them.

Approaches to address growing digital divides

Divides we have noted in the African context relate to access and the type of digital content being made available (as well as its relevance to Africa's development challenges and skills). Additionally, ResearchICTafrica.net[36] highlights the price differences for access, with broadband prices varying widely across the continent, from US$2.1 in Cameroon to US$25.9 in Namibia for a 1GB package.[37]

There is a lot to be addressed in relation to regulation policy. As Mayaki (2014), Chief Executive Officer (CEO) of the New Partnership for Africa's Development (NEPAD), points out, unless development policies (including those related to ICT infrastructure) are inclusive, big problems can arise. By 'inclusive', Mayaki means 'creating jobs for the youth and

[36] ResearchICTafrica.net (www.researchictafrica.net/home.php) is a network of ICT researchers in 20 African countries that has produced a wide range of policy briefs and publications relevant to ICT trends and challenges across the continent. Their publication, 'How Ordinary People get Connected', www.researchictafrica.net/publications/Other_publications/How_Ordinary_People_Got_Connected.pdf, provides a helpful overview of their evidence-based approach and work.
[37] See www.researchictafrica.net/publications/Research_ICT_Africa_Policy_Briefs/RIA_Policy_Brief_August_2014_No_6_Broadband.pdf.

facilitating access to public services' and warns that the equation of the most unequal yet youngest continent is one that could explode. He points to Tunisia as an example of a country where high penetration of ICTs was evident, but where there was an implosion due to youth not feeling sufficiently included in policies.

Inclusion and relevance to people's needs are of great importance when it comes to development, and a big part of the challenge is also to respond to demand. As Unwin (2009: 363) states:

> One of the main reasons why many ICT4D initiatives have failed is that they have been excessively top-down, externally driven and supply led, with insufficient attention being paid to real development needs, however these are defined.

But he also notes that:

> Approaches that are purely demand driven are also often doomed to fail, because local advocates have incomplete knowledge about the optimal ICT-based solutions that could support their needs.

Helpfully, ICTs themselves can now enable better communications between different actors to support this process of discovering needs and giving voice to users of knowledge sharing systems.

The rural landscape could change dramatically in Africa, narrowing the digital and knowledge divides, if plans by Google and Facebook to make internet accessible via drones[38] and balloons[39] prove to be effective. Likewise, as more rural users gain access to mobile payment systems such as M-PESA in Kenya, EcoCash in Zimbabwe and Tigo Pesa in Tanzania, the range of mobile services they can access will also increase. These are likely to include extension information services, m-government, rural insurance, agriculture support services, money transfer and other financial services. New mobile developments will also provide governments with tools to approach security and surveillance in new ways.

The urban landscape is also changing and it is interesting to see the emerging roles of technology companies like IBM and Safaricom[40] (which runs the M-PESA system, and is partly owned by Vodafone) playing a major role in the development of smart cities and security and surveillance systems in parts of Africa. Once access to services and knowledge improves, it becomes ever more important for users to have digital literacy skills from an early age, and for educational curricula to be designed to respond to this need.

ICTs, digital knowledge sharing, and achievement of development goals

By contrast with the MDGs, which focused targets on developing countries, the SDGs are inclusive of all countries, and allow for a more complete global vision to be shaped around sustainable development. An online and face-to-face participatory process, using a globally accessible voting system based on the 'My World' website (http://vote.myworld2015.org/), has engaged civil society in identifying priorities for future development goals. The data[41] indicate a strong demand for good education, with African countries and those with a low Human Development Index (HDI) score ranking it highest. Many respondents also highlight the importance of phone and internet access. Interestingly, this was rated higher among the Africa votes, where it polled 12th highest (above concerns for some of the planet's resources and some rights issues), than for the world as a whole or for countries ranked low on HDI

[38] See www.bbc.co.uk/news/technology-26784438.
[39] See www.slate.com/articles/technology/future_tense/2014/12/project_loon_how_google_s_internet_balloons_are_actually_working.html.
[40] See www.businessdailyafrica.com/Corporate-News/Safaricom-gets-go-ahead-on-Sh15bn-security-contract/-/539550/2534280/-/13msm5iz/-/index.html.
[41] See http://data.myworld2015.org/.

scores. One may assume that knowledge and communication are at the heart of these two expressed priorities for a good education and phone and internet access.

The Open Working Group of the UN General Assembly, in its proposal for the SDGs, identifies 169 measurable targets (126 identified as major, and 43 as supporting). There is, however, no explicit focus on creating an enabling ICT-based knowledge infrastructure for the Digital Age, and in a manner that would promote equitable access and be beneficial to developing countries. There is a strong focus in the report on resource access (including phone and internet access in Goal 9c) but little attention given to knowledge per se – the word appears just seven times in the draft statements. Goal 17 does, however, give some prominence to data monitoring and accountability, perhaps reflecting the new emphasis on a 'data revolution' (see below). Neither this report nor the MDG report on Africa, which contains a draft of the Common African Position for the post-2015 development goals, makes mention of digital; it is also telling that there is no reference either to 'information science' or libraries, but there is one reference to information systems in relation to education management.

If, as Sanou states in the foreword of the ITU report, *Measuring the Information Society* (ITU 2014a), ICT is an enabler to achieving development goals, it is very important to understand in the African context what the evidence shows, and how ICTs and the knowledge infrastructure are helping. This would then need to be translated into meaningful strategies and measures for future development goals, ensuring that they play a role in delivering on Africa's ambitions and vision for the future.

The danger of ICTs and knowledge systems being seen simply as a cross-cutting issue is that in achieving the SDGs, we may inadvertently be creating unnecessarily negative outcomes and impacts through the knowledge systems we create. Prevailing inequities and divisions around resource distribution are reflected and exacerbated. As one interviewee stressed, knowledge itself also has to be seen as a resource. It is therefore very important to recognise that knowledge systems and technology can never be seen as simply neutral, and there is a need to target investment in ICT infrastructure and related aspects of regulation and governance to negate potential negative impacts.

The post-2015 development agenda needs to be looked at holistically, and the role of digital knowledge needs to be fully integrated into this agenda and the SDGs. This means ensuring that each SDG target is supported by a strategy to provide a suitably diverse pool of knowledge that is carefully curated, and that knowledge sharing systems are designed to be inclusive and strategically managed. This process needs to involve digitally literate knowledge intermediaries who understand the key issues around ICTs and knowledge management, and design processes that engage with and protect the rights of the poorest and most vulnerable people.

Supporting innovation

A recurrent theme in the literature is the need for innovation. The Common African Position expressed by the United Nations Economic Commission for Africa (UNECA) in *The Millennium Development Goals Report 2014* (United Nations 2014: 103–21) stresses the needs for funding Africa-grown technological innovation, and its development, transfer and diffusion, and for enhancing technological capacities for Africa's transformative agenda (*ibid*.: 111–12). It also puts strong emphasis on people-centred development and the need for entrepreneurship and life skills, as well as vocational and technical training to respond to labour market demands, which includes reference to the need for information and technology skills (*ibid*.: 114).

Despite the gloomy overall picture for innovation in sub-Saharan Africa presented by the ESPAS RAND Europe Trend Report (Hoorens *et al*. 2013), the picture on the ground can appear more positive for development:

> With technology innovation hubs springing up across the continent, technology communities within many African countries are gaining access to state of the art facilities, events, mentorship and training; making it more likely that they'll devise impactful solutions. These hubs also provide the opportunity for collaboration with civil society and each other, which maximises the chance of success for new projects. (Dr Loren Treisman, Executive, The Indigo Trust, Guardian Media Network, blog, 4 December 2013)

It is good to see the emergence of innovation hubs such as iHub in Kenya (ihub.org.ke) providing research and incubation for start-up companies, with a particular focus on mobile applications that address local problems. Founded by Ushahidi,[42] iHub's mission is to 'change the way information flows in the world and empower people to make an impact with open source technologies, cross-sector partnerships, and ground-breaking ventures'.

Through its involvement with the Making All Voices Count[43] programme, Ushahidi has gone a step further through the set-up of the South to South lab,[44] which focuses on fostering learning and dialogue between citizens and government. Its strategy involves creating technology hubs across southern Africa and designing local solutions to African development challenges.

Another interesting example is the World Intellectual Property Organization (WIPO)'s Technology and Innovation Support Center (TISC) programme,[45] which focuses on providing 'innovators in developing countries with access to locally based, high quality technology information and related services, helping them to exploit their innovative potential and to create, protect, and manage their intellectual property (IP) rights'.

The challenge is to innovate in ways that benefit the poorest citizens and engage them in the digitally based knowledge societies. A recent study by Deen-Swarray, Moyo and Stork (2013) of the informal business sector and its use of ICTs (especially mobile phones) is particularly illuminating. It shows there is '… clearly a strong link between informal sector activities and reach with the poorest in communities and to those most marginalised'.

The frugal approaches described by Bound and Thornton (2012), albeit in the Indian context, as well as social innovation examples provided by Banks (2013), would appear to offer good ways forward to support innovation in the knowledge sector that would benefit those working in rural areas and in the informal sector, where primary access to digital knowledge is likely to be via mobile phone.

Measuring the relationship between SDGs and the Digital Age

Back in 2004, Ernest Wilson noted that:

> Conceptually we still don't have adequate definitions of critical terms like information revolution or digital divide that capture all the richness and variability of developing countries.
> (Wilson 2004: 36)

[42] See www.ushahidi.com/mission/.
[43] See www.makingallvoicescount.org/.
[44] See www.makingallvoicescount.org/news/making-all-voices-count-south-to-south-lab/.
[45] See www.wipo.int/tisc/en/.

It is critical that our definitions and measures for the Digital Age recognise this richness and variability. It will be crucial to build the right framework for measuring and bridging divides that continue to evolve in nature as the Digital Age unfolds, with a greater focus on the infrastructure that supports knowledge creation and sharing, and who is benefiting from the ways in which knowledge is distributed. The web index[46] goes further than most measures in this regard, with the internet currently being seen as becoming 'less free and more unequal'.[47]

It is good to see that the latest ITU report (2014a: 8), *Measuring the Information Society*, incorporates 'rural society covered by at least a 3G network', though many African countries rank very low on this measure or do not appear at all. The ITU data illustrate significant time lags and 'divide' in terms of take-up of new infrastructure.

The ITU's IDI index and UNDP's HDI index are (when combined) actively monitoring access by different actors, including skills and access to infrastructure and digital content. But what is really needed is a measure that focuses on the role of knowledge and knowledge intermediaries and their contributions (positive and negative) to development in the Digital Age.

In the past few years, the role of data in particular has been given a lot more prominence, and use of data for development is the major focus of the WEF report (Bilbao-Osorio, Dutta and Lanvin 2014), subtitled the *Rewards and Risks of Big Data*. While big and open data are not the focus of this study, it is important to note this trend; the UN MDG report (2014: 6–7) is particularly relevant to metrics, highlighting the need for 'sustainable data for sustainable development' and noting that:

> Reliable and robust data are critical for devising appropriate policies and interventions for the achievement of the MDGs and for holding Governments and the international community accountable.

Reliable statistics for monitoring development are regarded as currently inadequate and patchy, and continue to present major challenges for measuring indicators relevant to the post-2015 development agenda. Looking to the future, the UN (2014) report states that:

> The Report of the High Level Panel of Eminent Persons on the Post-2015 Development Agenda called for a 'Data Revolution', which reflects the growing demand for better, faster, more accessible, and more disaggregated data for bringing poverty down and achieving sustainable development.

2.5 Value creation in a development context

The context and trends outlined above carry with them opportunities for greater inclusiveness, wider access to information, and better knowledge sharing in development efforts. They also hold a darker potential to create new disparities, exacerbate existing ones, and lead to a homogenisation of knowledge that stifles discussions that stray from the norm and mainstream. The scenarios presented and discussed in Section 3 will look more holistically at what different futures may look like.

In this sub-section we explore some of the positive and negative implications for development in relation to where value may be added or lost, and who wins or loses as a result of distributional outcomes of different knowledge infrastructures and policy approaches. Inevitably, this analysis involves making value judgements, and we take the view that the development outcomes we aspire to are ones that:

[46] See http://thewebindex.org/.
[47] See www.bbc.co.uk/news/technology-30432487.

- promote equitable access to relevant knowledge for all
- widen availability of knowledge to support the livelihood development of all, with a particular focus on poor people living and working in rural areas and in the informal sector
- support the creation of a diverse knowledge pool
- provide uncensored and free access to knowledge made openly available wherever possible by governments, civil society and the private sector
- support an appropriate level of regulation to enable the private sector and innovation to flourish while avoiding the creation of unduly powerful elites or hugely influential monopolies.

2.5.1 Positive implications and opportunities

The positive opportunities presented by the Digital Age to achieve the stated outcomes in relation to development are as follows.

Access and availability: If the accelerating range of digital materials is made widely open and available through good policies and incentives, a wealth of opportunities will present themselves, including for groups who are marginalised. These include: (a) improved transactional information drawing on better connections that overcome distance and support innovative practice and a range of improved and context-relevant financial and business services; and (b) transformative changes that eliminate barriers to market entry and enable a much wider cross-section of the population to acquire knowledge skills and credentials through online learning.

Digital repositories or other knowledge sharing systems will enable research to be more available and accessible, and local research will be more visible. Methods such as crowdsourcing will, moreover, help ensure that research agendas are more aligned with needs on the ground.

Governance and service delivery: Digital changes can lead to positive changes in how government works, how it interacts with its citizenry, and how it delivers services. Digital tools and crowdsourcing approaches can increase and improve citizen voice and government transparency, allowing citizens to be more informed about budgets, issues and upcoming decisions. Digital technologies will also offer technocratic improvements to service delivery. Data on health, education, infrastructure, social protection and other government sectors will be more abundant and more tools will be available to analyse it.

Quality and relevance of knowledge: Digital technologies have the potential for a transformative impact, disrupting current regimes of knowledge production and publication, and enabling poor regions to become producers rather than net recipients of relevant development knowledge about themselves. This can happen if networks and incentive systems and structures are established that support local knowledge production, validation and distribution. New technologies will not, overnight, unhinge existing systems held in place by strong historical, political and cultural forces; but technologies do hold the potential to create new structures of knowledge production and sharing that can grow and start to compete with publishing regimes. Given the right circumstances for cooperation, federated groups of digital repositories could introduce systems for aggregating their resources, developing user-friendly discovery tools, and implementing structures for peer review.

Wisdom of the crowd: Crowdsourcing methods are becoming a powerful tool to help development initiatives become better targeted, informed and researched. They can aid research into identifying needs and problems, ranging from wide-scale regional issues down to those at the community level. Crowdsourcing can also help generate new, innovative solutions by bringing together sectoral experts from around the world with community members. In the process, it can help to gather relevant information and identify problems, as

Ushahidi maps have done. It can then help to source funding using Kickstarter approaches. And finally, crowdsourcing is a valuable monitoring tool because of its ability to amass real-time data on impacts down to the individual level.

2.5.2 Negative implications and threats

The Digital Age also presents some major threats to achieving the stated outcomes in relation to development, which include the following.

Infrastructure and governance: Many governments, even though they recognise the importance of ICTs and knowledge sharing as enablers, find it difficult to prioritise the well-coordinated and long-term investment needed when other major issues (health, education and poverty) demand more immediate attention. Furthermore, many governments may lack the political will for free and open knowledge flows even if they had the capacity to deliver it.

Privacy, censorship and control: In the wrong hands, digital technologies can bolster authoritarianism by providing ever more effective methods of surveillance, censorship and control. Privacy issues arise not only through invasive spying regimes but also if information is 'too' open. Public records and data on individuals' health or spending habits can provide valuable information for the public good, but could also be used maliciously.

Homogenisation of knowledge: There is a danger that digital trends will result in a global homogenisation of knowledge toward the mainstream – a 'Coca-colonisation' of knowledge. Rather than giving local knowledge a greater chance to flourish, a free flow of knowledge could just as easily edge out voices that do not fit within dominant discourses and epistemes that are largely products of Western cultures. New ideas will be incubated in one global discussion. This could, in many ways, be a new pinnacle in participation and efficiency. But as with all discussions, some voices will always dominate, and there could potentially be far less room for separate discussions to follow different courses, emphasising different priorities and perspectives.

Fracturing: The converse threat is that knowledge and worldviews fracture into smaller and smaller groups. Smart platforms know what people want, direct them to it, and keep them away from serendipitous discovery or confronting knowledge that they do not like. People could get sucked into whirlpools of self-reinforcing worldviews in smaller and smaller online communities. Rather than resolving or otherwise accommodating disagreement, it could become easier to just disengage and splinter off with those who do agree.

Meritocracy of the motivated: In a world where opportunities to learn, gain credentials and do business abound, rewards will go to the highly motivated self-starters. Despite ongoing disparities, the Digital Age will be trumpeted as a meritocracy, making inequalities appear more justifiable. Experts, teachers and motivators will remain important for their expertise and ability to guide and encourage learners, but will come at a cost, and only elites will be able to afford the best personalised services.

Unsustainable models: Open knowledge is not free. The systems, infrastructure and human resources needed for it require considerable, ongoing investment. There is currently no business model that will allow knowledge to be open and free at the point of use that does not need support from governments and funding organisations. Without some form of reliable, ongoing support and investment from African governments and the international community, open knowledge will remain a patchy, unfulfilled promise, often benefiting only those with the access and skills to use it.

Information overload: Efficiencies in making knowledge available and accessible have, in the minds of the public, reduced the need for information intermediaries and professionals. When most information needs can be fulfilled online, the skills that go into curating materials,

making them visible, and helping to guide people to what they need become largely invisible. In a world where knowledge is free, open and abundant, there is a danger of a lack of knowledge professionals and institutions just when they are most needed to help guide those who lack digital literacy through it all.

Growing disparities: Perhaps the biggest threat posed by the Digital Age is that rather than leading to greater equality of opportunities and outcomes, it instead creates new disparities or exacerbates existing ones. There are many types of disparities that the Digital Age could exacerbate.

- *Digital skills and literacy*: Increased access and availability do not, by themselves, result in greater equality of use, and groups that are already poor and marginalised are most likely to get left behind. Current digital divides along gender and ethnic lines would be reinforced. Without policies and strategies to develop capacities and skills among vulnerable groups, it is likely that those at the bottom of the socioeconomic ladder will remain there even if everyone gains greater opportunities to climb. Digital metrics in the workplace could drive the value of labour down further, with greater mechanisms for control.
- *Digital capital*: At the other end of the spectrum, we are already seeing the way that the internet's winner-take-all effect is creating a small group with extreme wealth and power. The ability to invest vast sums to own and accumulate data has a self-reinforcing effect. Below this group at the very top, there will likely be a somewhat larger, but still elite group that stands to benefit disproportionately, consisting of individuals who are highly skilled at working with information. As these elites will rise largely due to their own efforts and abilities, a neoliberal discourse will have trouble locating the implications of this phenomenon and identifying that there is a problem.
- *Rural/urban*: There are likely to be huge differences in infrastructure and skills between rural and urban areas in developing countries.

In this section we have presented insights from relevant literature and drawn on the perspectives of those we have interviewed and met during the course of this project, incorporating a diverse range of expert knowledge and experience around digital knowledge and the African context. We have concluded by assessing some of the considerations that we believe to be most important when thinking about the future and formulating policy. We believe these are also important aspects to describe and measure when setting development goals.

Section 3 draws on this material to inform wider discussion about future scenarios. The analysis leads us to a preferred scenario, and we present specific recommendations for strategic approaches and policies that could render this preferred scenario more likely and deliver more positive and equitable impacts of the Digital Age for developing countries.

3 Scenarios and policy implications

In Section 2 we looked at trends in digital knowledge, examining their impact on development and the potential for these changes to bring about new opportunities and threats in the future. In this section we present four scenarios of different futures to help think about the specific ways in which knowledge creation, sharing and use might change. We then present a fifth, preferred scenario that visualises a future of positive outcomes, and discuss policy strategies that would lead us towards that scenario.

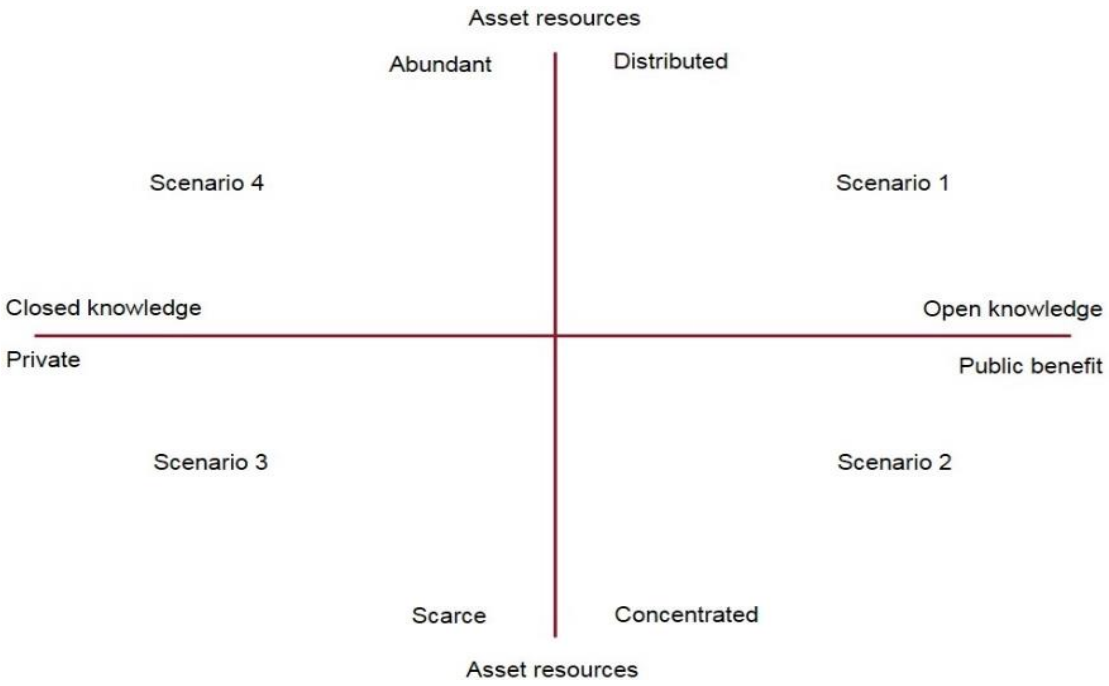
3.1 Introduction to scenarios

We held two workshops to develop the scenarios and discuss related policy implications. Participants in both workshops included a range of stakeholders representing different groups that will be affected by technological changes: researchers and ICT and development practitioners, and policymakers. The first workshop in London was held in conjunction with another complementary horizon-scanning research project focusing on 'Big Data and Development'. Participants first discussed drivers of change identified in the STEEP framework, narrowing them down to ten that were most important for defining how the world would look in future.[48] From these ten, participants defined two broad drivers that they felt would most determine how the future would look. These were:

1. *Access to knowledge and data*: Capturing whether knowledge of all kinds is openly accessible or closed and controlled.
2. *Asset scarcity and distribution*: Capturing whether resources are abundant and widely distributed, or scarce and concentrated in terms of ownership. 'Assets' are defined broadly, including wealth, energy and environmental resources, as well as human assets such as health and education.

The two drivers were then used as axes to form the basis of four distinct scenarios, as shown in Figure 3.1.

Figure 3.1 The four scenarios



[48] See Annex 2 for a full list of the drivers of change.

- **Scenario 1** is a world of abundant assets and relatively dispersed ownership, where knowledge is openly available but regulation and surveillance are pervasive.
- **Scenario 2** is also a world of freely available knowledge but in a context where many important assets are scarce and ownership of these assets is relatively concentrated.
- **Scenario 3** is also a world of resource scarcity and concentrated ownership but where access to knowledge is tightly managed and controlled.
- **Scenario 4** combines tight management and control of knowledge with abundant assets, with ownership distributed relatively widely.

Participants were then asked to develop scenarios in each of the quadrants formed by the axes, taking into account the drivers of change previously identified, and to create a narrative for the scenario to bring it alive. These scenarios were then reviewed and edited by four other experts with a strong knowledge of the African development context, to further refine them and ensure their relevance.

3.2 The scenarios

3.2.1 Scenario 1: Distributed and abundant resources + open knowledge

Scenario 1: Regulated abundance

Scenario 1: A world of abundant assets and relatively dispersed ownership, where knowledge is openly available but regulation and surveillance are pervasive.

Key characteristics:

- Data are produced about everything through sophisticated tracking devices.
- Information is open and available to all.
- Society and economics are centralised and highly regulated. Machines guide regulation and policies.
- An explosion of innovation is produced from available data and tools.

It is 23 October 2030. Amaka is on the cusp of another breakthrough, but she can't quite put her finger on it. She steps away from her computer and gazes out the window across the rolling scrublands. The cerulean sky is turning dull orange at the day's end. Funny how the sunsets aren't nearly as vivid in today's pristine clean air, ever since the big changes happened, what everyone now just refers to as '2019'.

That was the year the economies of the world cracked from the strain of free-for-all financial markets. Some say it all just collapsed, but truth be told it had a bit of help from a well-organised group of digital rebels – call them 'cyberterrorists' if you like, but to us, looking back, they are legends. It's a long story, but the gist is that these rebels saw how the world's resources were concentrating in smaller and smaller pockets of population, driving the environment to ruin for everyone else, all driven by an oligarchy in the financial sector that was always two steps ahead of the regulators. When the rebels broke through the systems, everyone could see that we were in a bubble almost exactly the size of the economy. In '2019', nothing was too big to fail.

And fail it did. Every piece, everywhere. And since then we've been building it back, all of us, better and fairer. Today, pretty much everyone has what they need to live a decent life. We created a global government. Yes, the apocalypse of 2019 helped us forget what we thought we knew about peace, justice, collaboration: that they are nice stories for little children. We invested what resources we had – yes, scarce government money – into a green well, and now we all enjoy abundant clean energy. They said that the government couldn't fix it, only business interests could. They said the open market would create the right *incentives*. But

they were wrong, and the rest of us – what they once called the 99 per cent – were right. Our notions about the kind of place we want to live in proved to be incentive enough; we just needed the power to make it happen.

Without this transformation, Amaka would probably not be so close to her idea for a new business. She had always lived here, in these West African rural scrublands which, in 2018, were a grim place, and only getting worse. But now, she was thinking about the business plan for her third online business. It was just a matter of digging deeper and deeper into the data that was freely available everywhere for anyone to use. Focusing on it, contemplating it, meditating on it. Finding the patterns, finding the opportunities.

For in 2030, we have abundant and distributed resources. With a left-of-liberal agenda, we've made nuclear energy safe, and we've developed renewable energy resources. We even have nuclear batteries for our bots and the free digital devices that we're all provided by the government. All our basic needs are met, even if most of us live fairly simply. Most important is that we also have all the information. Yes, *all* the information. Full stop. Information and knowledge are truly available and accessible to everyone. Today it seems almost inevitable. We had already taken on the publishing regimes pre-2019, but in the post-2019 world there were no longer mega corporations like Plex and Nile and MeBook hoarding vast troves of data that created their profits.

You could say all this has come at a cost. Yes, we have central planning. Yes, we have regulation in spades. Never in history had central planning worked, why would it work now? The answer: availability of and accessibility to data. In the past, the economists were mostly right about the market: the invisible hand was smarter than government because information was too dispersed, the data were too 'big' for any centralised planner to grasp it, much less harness it. But now we have so much data on everything under the sun, it boggles the mind. To un-boggle, we have computing power you wouldn't have dreamt of in the 2010s. And our algorithms are so good that they get together and make their own new algorithms without us. Yes, maybe you could say we are not far away from being governed by a benevolent machine. As abhorrent as that may sound to you, dear reader in 2014, we have only to look around at the abundance of knowledge and resources at our disposal to remind us how lucky we are to live in the new times.

But still, a lot of things are different in a way that still feels strange. Without the gatekeepers and hoarders of information we used to have – the publishers, knowledge managers, mega corporations – these days it seems like *everyone's* an entrepreneur. The major characteristic of our economy is free sharing of information and knowledge. The gatekeepers themselves led the entrepreneurial race at first, because they had the sharpest skills to start. But now anyone with a strong will can make it as an entrepreneur just as well as anyone else. And so what does that even mean anymore? To be an 'entrepreneur'? Why, even Amaka's older brother has just come up with a way to turn household plumbing data into a business, and if you ask Amaka she'll tell you that he's not exactly an entrepreneurial genius.

What he does have is patience and perseverance. And a lot of self-confidence, however delusional its basis may be. Anyway, these days we have a new meritocracy. It rewards those who have the grit and attention to keep at the data sets until they come up with something. The new times are for Amaka, and those like her, with the motivation to learn the skills, understand the data, figure out things to do with it. But that has also given rise to a whole new class of professionals to replace the information gatekeepers. Even Amaka gets personal coaching and mentoring from Chiluba, a Motivator from EntreMentor, the government-owned mega branch on motivation and incentives. Motivators have become the second largest profession next to entrepreneurship in the new world, with a whole government industry of attention-enhancing pharmaceuticals, or 'smart pills' following close behind.

And there is now a sense that other things are also changing. Now that we have state-of-the-art infrastructure for transport, ICT and communication, and everyone has adequate skills, they can have all the information they want, and can do so much with it., That kind of work, although so valuable to maintaining our current way of living, is becoming less valued, less sexy. The real work, these days, seems to be doing those things – singing, composing, painting, writing – that the machines still don't know how to do (although they are, in some cases, getting better and better at them).

There are also more and more people who don't think *everyone* should know *everything* about everything. Especially about them. Those people who feel that the world being able to know their toilet habits is a little degrading. Who feel that having your health, your habits, your skills, your social 'worth', quantified and made public is an affront to human dignity. Who question how everyone's 'Merit Points' are determined, categorised, and used to 'help' plan people's lives. For them, the costs of efficiency to liberty and privacy are too great and they dream of getting out somehow. They whisper mysteriously about 'pre-digital knowledge' and impossible tales of 'going off the grid'. Their nostalgia for an idealised past that never happened would seem dangerous to the rest of us if it weren't so naïve and impossible. And yet their numbers grow…

3.2.2 Scenario 2: Scarce resources + open knowledge

Scenario 2: The good, the bad and the ugly[49]

Scenario 2: A world of freely available knowledge but in a context where many important assets are scarce and ownership of these assets is relatively concentrated.

Key characteristics:

- High levels of inequality, with resources monopolised by a small elite.
- Knowledge is widely available, but difficult for most people to put to use.
- Political instability results from people knowing the ways in which they are excluded.
- Open information systems allows for organising and networking.

One day, while getting ready to go to work, Judy Malekani's wearable device, which has all sorts of sensors and also connects to a 'smart' system in the cloud, sounds an alert. She checks what the alert is about and discovers that it is informing her that a lump has been detected that is developing somewhere in her body. Not knowing exactly what it is, she logs into her medical records where the findings from the sensors/imaging device and diagnostics from the 'smart' system have been logged. Once in the system, she navigates to her personal medical records where she finds her personalised medicine that has been arranged by the 'smart' system. Unfortunately, the medicine comes from a rare tree that grows in only one country along the equator in a special forest. The forest is owned by a multinational corporation that charges a lot of money to get the ingredients for the medicine from this tree, making the cost of the resultant medicine unaffordable to people like Judy.

Judy Malekani lives in a developing country in 2030. A lot of trends from the early 2000s have continued into the present, and Judy's world is now one in which resources are scarce and unevenly distributed, but knowledge has become increasingly open and available to all. Still, not everyone is able to use information to the same advantage, as the global corporations generally have the technology, algorithms and resources to make best use of that information. Furthermore, having abundant information does not necessarily mean empowerment in this resource-scarce world. Rather, it leads to growing feelings of

[49] The title used here is borrowed from the Clint Eastwood movie, see http://en.wikipedia.org/wiki/The_Good,_the_Bad_and_the_Ugly.

resentment, as those who are poor and marginalised are all too aware of the inequalities that contribute to their situation.

Checking closely on the system, Judy discovers that actually there is a generic version of the medicine available that has been created by scientists who came together with funding from a wealthy philanthropist. Once they know about the existence of the generic medicine, Judy's children start a campaign on a crowdfunding site so that they can try to raise the money for the generic medicine, which, although cheaper than the expensive one, is still beyond the means of Judy and her family. At the same time as starting a funding campaign, they also start an online petition to lobby their government to stockpile the generic ingredients so that the country can start manufacturing the medicine domestically.

People's ability to identify what they need and conduct crowdfunding exercises to try to get it is a positive side of the open knowledge that is available. But these efforts are rarely successful as so many people are always attempting to crowdfund so many needs all at the same time, and there are few with the resources to meet the high demand. Political tensions, therefore, are nearly always high. The wealthy have increasingly shut themselves off behind thick security blankets as the rest of society threatens to revolt and take back what they believe to be theirs. A digital surveillance state has grown to giant proportions, gathering detailed information on all aspects of people's lives in an attempt to maintain law and order. Drones are everywhere.

Meanwhile, Judy's own privacy is affected too. By sharing her medical records for crowdfunding and petitioning the government, anyone could have access to them. Due to the publicity surrounding the crowdfunding and online petition, a lot of people and organisations that she depends on for her livelihood and other things also know about her illness. Her life suddenly changes in that her existence becomes expensive and stressful. For example, she cannot get a loan at a decent interest rate, her job prospects are not looking good and her medical insurance becomes very expensive.

The worst part of her situation is that she has become stigmatised because of her condition, which is contagious in certain circumstances and/or if precautions are not taken. In order for the government to prevent the spread of the illness, an emergency law is passed that mandates individuals in such a position to be tagged so that their movements are tracked, which causes panic to people who happen to be in an area close to Judy. Fortunately, the government now has the capacity to use advanced robotics to manage patients who may need isolation in order to minimise the risk of medical personal contracting the illness. This is a frightening situation for Judy and other people in a similar situation, due to the thought that 'machines' will be taking care of them should they be isolated. The tracker used and the resultant databases are open access just like any other information generated by systems, therefore anyone could access this system and its data. This situation leads to Judy becoming an outcast.

But she quickly comes to learn that she is not so alone. So many people have become outcasts in this world that they have started to band together in larger and more effective groups. While some of these groups foment violence and rebellion, most use their numbers as a means to persuade the public and the government that extreme inequalities are damaging to all, not just to those people who are marginalised.

Judy's situation attracts the attention of one of these groups, a global consortium of health experts who seek effective alternatives to those medicines monopolised by Big Pharma. It remains to be seen if groups like this will be able to change the 'rules of the game' anytime in the near future, but this is the growing hope for Judy and many others like her. They strive to promote the idea of a new, effective form of governance, building up from the local with the dream of someday creating a 'global commons'.

3.2.3 Scenario 3: Scarce resources + closed knowledge

Scenario 3: Ignorance is bliss?

Scenario 3: A world of resource scarcity and concentrated ownership but where access to knowledge is tightly managed and controlled.

Key characteristics:

- Society is stratified between a small elite and everyone else.
- Only government-approved information and knowledge are available.
- There are high levels of government surveillance and social control.
- Non-elites are pacified with mass-produced entertainment and cheap but bland food.

In 2030, resources have gradually become scarcer. The price of everything, including information and knowledge, has increased. A small political and economic elite controls the few remaining resources, and also owns everyone's data, the media, and the means of producing and disseminating knowledge.

Betty is a community health worker in an African country. Like almost everyone else, she works for a branch of MegaCorp. Her journey to work takes her along poorly maintained roads where street lighting flickers on and off, but large MegaScreens on every corner use the more reliable electricity grid owned by the elite to broadcast a popular TV show. Although viewers can no longer choose what to watch, the production values and scripts of the available offerings are generally good due to MegaMedia employing almost all the creative talent.

Betty collects data on her ageing patient's response to his proprietary MegaPharm medication, which is then encrypted and scanned to a teenager on another continent (Xiao Li) for transcription into the MegaPharm regenerative medicine repository. Millions of other workers across the globe are all transcribing discrete chunks of data in the same way. Although Xiao Li is intelligent and curious, his parents can't afford to send him to university. He tries to educate himself online, but since only the largest companies (all subsidiaries of MegaCorp) can pay to transmit their services through the internet, his search results only show him what the elite wants him to see.

The fragmented big data from Xiao Li and the other transcribers will be collated and analysed by scientists at MegaPharm, where it will eventually be used to perfect life-prolonging medication for the elite. Meanwhile, a hacker activist (Shruti) is trying to break into the MegaPharm network. A trained computer programmer, Shruti worked on designing the universal social network OurBook before becoming disillusioned. She now dreams of releasing MegaPharm's data and making its medical advances available to all. Not all hackers are altruistic though – some people who have the technical skills to break into closed systems are trying to use them for personal gain, as a means of blackmailing members of the elite or gaining access to restricted/expensive services. And many don't blame them.

Meanwhile, members of some poor communities have managed to become self-sufficient. Instead of consuming the replicated food delivered by MegaStore drones (which contains balanced nutrition combined with mood-controlling pharmaceuticals), Patrick and Bibi grow their own vegetables. Ivana Jones, CEO of MegaPharm, also eats real vegetables of course, as well as all the meat, spices and artisan-baked goods she wants. These products are just a distant memory to most people, and the few remaining farms and suppliers have exclusive contracts with elite households and businesses. Poets, film-makers and painters also work under contract, paid handsomely to create their best work for the elite while also obliged to create inferior products to a strict formula for mass consumption.

By avoiding the large urban centres, independent spirits like Patrick and Bibi can avoid seeing prescribed broadcast content via the MegaScreens, although they still have compulsory OurBook profiles, created for them from population data. Bibi prefers to get her information from an underground knowledge network; these are informal and uncontrolled, although some are assisted by librarians who try to curate and preserve community knowledge without collecting any personal data. Some of these local networks have even developed into small self-governing enclaves, usually where somebody in the community has the knowledge to bypass the various forms of government and MegaCorp surveillance. Living in these enclaves can sometimes feel difficult and isolated, but on good days it feels like this is where a real life will finally emerge for the 99 per cent again.

3.2.4 Scenario 4: Distributed and abundant resources + closed knowledge

Scenario 4: The digital dambusters

Scenario 4: A world that combines tight management and control of knowledge with abundant assets, with ownership distributed relatively widely.

Key characteristics:

- Despite abundant resources, society is stratified, with a few states and corporations holding power.
- Data are abundant, but only elites have the tools to analyse and use data.
- There are high levels of government surveillance through sensors and social media.
- Innovation is largely crowdsourced and automated.

The world we live in today (2030) is, at first sight, overflowing with wealth, riches and gadgets. The global system as we call it on the surface looks fairly stable, and everyone seems to have some form of employment and entertainment. You can't argue that some things have changed for the better. As a result of partnerships and global agreements between governments, big country state-scale companies, and international NGOs, the Sustainable Development Goals (SDGs) have been met and comfortably exceeded in many countries; diseases that were once rampant are now controlled and no longer threaten us; and we have such good threat detection systems with sensors embedded everywhere (in people and our environment) that any new risks can be quickly assessed and monitored. The Massive Open Online Courses (MOOCs) have turned into Global Online Education Delivery and Tracking Environments (GOEDTEs), which all but the elite must subscribe to. Our educational achievements are analysed from an early age, and the educational modules are adapted to ensure that we perform at the right level for our pre-selected career options. Nutrition has improved, we have green energy access, good food, healthy lifestyles, increased life expectancy and a tightly controlled yet 'democratic' public global governance system, which most of Africa has signed up to. The strength of the private sector has resulted in a good range of efficient service provision.

Yet, not all is as it seems. Some things we remember from 20 years ago that used to be free have to be paid for now, and it seems that the superpower countries in tandem with a small super wealthy elite which owns mega companies are running everything and the result is not at all equitable. Let's see how this plays out in a few different lives:

Clooney Jnr went to the Chinese-owned Google University as part of the 2027 cohort, selected for entry via carefully developed search algorithms to identify the top one million achieving teenagers from around the world. Those who run the global systems have lots of knowledge about each of us (exam scores, health, etc), which is gathered and managed by the new 'NGOs' which the government contracts to use their reach and M&E skills to gather personal data and interesting stories. Clooney Jnr studied the whole course from his

bedroom, but unusually (there is no accounting for parental influence), he took issue with the way corporations know everything about people. He became a data dissident, one of the 'digital dambusters', annoyed at the way the US government is pandering to China, which now controls finance and goods in the way the USA used to.

Despite the irony of being a Google Uni dropout, Clooney Jnr still gets information online, but has found ways to hide data and parts of his online identity. He knows to be careful in what he searches for, and these days it is quite hard to find information on international development that is reporting on failure or lessons learned. There is more and more data on results, achievements and successful processes. But Clooney Jnr is part of a counter-movement driven by small net-savvy community-based organisations and information archaeologists who search the archives for hidden realities and truths, and look for ways to innovate and overturn the Google empire by developing 'communities of like-minded individuals' found in difficult-to-track online spaces.

Sheena lives in what they used to call a 'developing economy' in Africa. She owns a smartphone, has solar panels on the roof, and enough food but not loads. These days every child gets a basic MFMGD (multi-function mobile global device) with a unique biometric control pad. This connects her to a local university that links through to the GOEDTE, which accredits all global degrees and delivers on the fly Google-translated lectures and learning activities. You can either study in English or Chinese.

Her full records are also on an international database and she has her own virtual profile and web passport, which controls her access to relevant sites and knowledge bases. There used to be a concept of net neutrality, but things have changed a lot and the web is full of different spaces and worlds where access is privileged and knowledge tightly managed.

Sheena never gets lost – well, sometimes she does, but then she is never entirely off the map, so she is never lost to others. Drones are everywhere, dropping off goods, transferring messages and delivering personalised entertainment. Sheena can travel but rarely needs to and it is not encouraged. She works mainly from home, and although there is only one currency now, she is not at all wealthy, and has to meet regular targets in terms of her local organic farm production and distribution. She gets approached sometimes by a strange organisation calling themselves 'digital dambusters', and although she is not happy with her life, she can't afford to take risks. She doesn't exactly feel disempowered, but she does feel strangely contained – not exactly free.

Saraswathi has been a professional librarian all her life. Well, at least that's the way she sees it, though the reality is that she developed her successful career from information and library management skills, and then on to computer science, data science and mining, social network analysis, and now things have, in one way, gone full circle. She remembers the days of providing valuable services to individuals guiding them through the maze of books and research, and then everyone thought they could do it for themselves with a simple Google search. And now, she is back to personalised added value services – the walled gardens are there everywhere on the web, and the new librarian holds the key to the many different private and culture- and faith-based repositories. Data banks are huge labyrinths of research evidence, if totally unintelligible to most people. But with the right skills and knowledge keys, those with rights can join up data sets instantaneously, and be handsomely rewarded by the customer.

The crowd concept that used to exist as a way of taking society's pulse on certain issues is now almost invisibly powerful. Facial recognition of expressions, data on movements, health and spending patterns is all pervasive, and Saraswathi's team are able to rapidly analyse data by voice-generated commands using the new vLib artificial language. They can also use vLib to find and delete huge dissident data sets which don't conform to the vStore international standard.

Sheena, of course, could not dream of using Saraswathi's team's services and can't speak vLib, and while Clooney Jnr might want to (for his own subversive reasons), his digital identity trail denies him access to people like Saraswathi, although he knows they exist.

Shakti is what one might call an alternative infomediary (a bit like in the old days when we had alternative medicine practitioners). She knows so much, has learned and stored so much as the new systems developed, and she can find out more, mainly because she knows someone who knows someone in the virtual world. There are, of course, the official social videobook applications that stream endless information on what people are doing right now (it's like everyone has their own channel, but whose life are they watching? Yes, the media is dumbed down to almost zero!). But the encrypted alternative social knowledge2video networks are where Shakti comes into her own. If you know where to find them, the alternative databanks exist, and are actually open (in a hidden kind of way!). They reveal the huge inequalities in wealth and resource distribution, and the places where communities live very different lives, reprogramming and changing algorithms and driven to create a more equitable and social society. Shakti is a key person for the digital dambusters.

So, how did we arrive at this point? It has a lot to do with the way knowledge-based economies took shape. What was open was steadily captured, and publishers and university repositories became more regulated by government or bought-out by big companies. As these major players joined forces, telecoms, entertainment and education gradually merged their data and processes. Honestly, it all looked pretty good. Data are cheap, like water – you could say there is a glut, and poor people and developing countries seemed to progress and achieve new goals, and the heads of international development have smiles on their faces. The real value of the data, though, lies with those who have the power and the right skills to determine how it is used, and how to make big money from it, in areas such as security. The knowledge that really counts is more and more in the hands of powerful groups, and accessible only to the wealthy or extremely talented. They put the really useful stuff in walled systems, which are often incompatible with each other as the major powers seek to compete.

The data dissident group are active in working on ways to disrupt the domination of the current corporate superpowers and have a particular interest in the disruptive potential of artificial intelligence (AI) systems. They are quietly working on the next big innovation, to transform society and challenge the current inequitable power structures, but war these days is ever more dependent on data, knowledge and use of technology, so you have to have the right skills to access up-to-date information and knowledge.

3.3 Preferred scenario

The preferred scenario

Key characteristics:

- Internet access is universal, and considered a right.
- Information is abundant and available.
- Better tools and cooperation have resulted in more African research.
- Crowdsourcing helps with service delivery and government accountability.
- There is a balance between openness and privacy.

The four scenarios we have just described became the basis for discussion and analysis at the research study's second workshop, held in Centurion, South Africa. This workshop included representatives from academia, civil society, the private sector, and government, all with an understanding of ICT issues in the African context. Participants analysed the scenarios to further contextualise them, particularly with regard to regional differences. This exercise sought to identify positive and negative potential impacts that each scenario would

hold for developing countries in Africa. Through a 'windtunnelling' exercise,[50] participants analysed the effectiveness of potential policies across the different scenarios, leading to a preferred scenario that encompassed desirable outcomes from across all four scenarios.

Who would have thought it possible, back in 2015 when they were drafting the Sustainable Development Goals, how much could have changed for the better in 15 years? So many things that seemed naïve and unrealistic back then have now been achieved, helping to realise a more prosperous and just society. This was accomplished largely through the pursuit of prudent policies based on a few principles that were agreed on globally and implemented by national governments, with crowdsourced feedback mechanisms enabling citizens to hold the international community to account for delivering an open and fair digital society.

One of the key principles of today is that internet access is a basic right. In a world where so much information is available online, being denied internet access is almost like being denied a livelihood. So even those of us in lower-income brackets have a minimum allocation of internet access, accessible through multi-function ubiquitous mobile devices much in the same way as we have access to subsidised electricity and water.

For this to happen, agreements to build a global ICT infrastructure were drafted and set into motion through the mechanics of the SDGs. This included direct funding from governments, but also good policies to incentivise private investment in the infrastructure. Although global leaders held different views on the cost-benefit of extending ICT infrastructures to more remote regions, most nations have now extended internet access to over 90 per cent of their populations, with active involvement of government bodies down to the village level. This means that nearly everyone has access to good information on nearly everything: market prices for goods they wish to buy or sell; health advice and monitoring; short- and long-term climate modelling; government initiatives and their impact; and almost anything else they might need.

For researchers, government policy and implementing bodies, and development practitioners, openness also includes access to research documentation, data sets and government records. Processes of research and innovation are supported by strong information science and data management, together with widespread curation and preservation capacity. The way we used to research and develop new ideas has changed dramatically. Breakthroughs by lone geniuses like we saw in the past are now a rarity. Research and innovation are now community or crowdsourced efforts, and tools for online collaboration are common and being used by students from an early age.

Global knowledge has become more truly global. By that, we mean that knowledge about developing countries and research on development is produced and shared much more within developing countries themselves. An Africa-wide repository of locally produced research automatically harvests documents from universities and research institutes throughout Africa, making them easily available and searchable. A pan-African research body administers the system, and has set up a peer-review system that ensures the quality of materials in the repository. In addition, under this research scheme, African governments have implemented policies to incentivise publishing in the repository. No longer do researchers need to be published in European or American journals to prove the quality of their research. The result has been a marked rise in local contributions to literature on local development, which has improved the quantity and relevance of development-to-development efforts, and helped to set new agendas for both research and development.

Information and data scientists, librarians and knowledge intermediaries play a vital role in this pan-African research council and its repository system. New digital documents and data

[50] See Annex 1 on Foresight methods.

sets are being produced in heaps, and information professionals are needed at all levels to make sure that it is all easily searchable and discoverable. They are also a much-used resource at libraries, whether university or public ones, to help guide people to the information they need.

Technology has also made education more widely available. MOOCs didn't totally disrupt the education business model, but they have become one of a number of important tools in helping to increase access to quality education. The availability of information and knowledge has also made it easier for students to find what they need, even in remote areas. Most importantly, new models of knowledge sharing have enabled more African researchers to contribute to global online education systems, joining the ranks of globally famous online lecturers that previously came exclusively from Western universities.

With so much information available to all, privacy is an ongoing public debate. Everyone seems to have a different comfort threshold in terms of how much information should be collected about them, how much made available, and to whom. There are variations country by country on, for example, how much of your health information can be made available to government and to the public for medical research purposes. But in every case, the general principle of the right to privacy stands, and debates about specific spheres of privacy are open and transparent.

Some people talk about the right to 'opt out' of the 'information racket', but they mean different things. Some just think the levels of privacy should be much higher, but they're still happy with the better health care, better education, better infrastructure, and greener environment that everyone's accumulated data help bring about. Others mean going off the grid altogether, though that's probably just nostalgia, and anyway it's practically impossible nowadays without becoming some kind of mountain hermit.

Still others worry on a philosophical level about how life and society is too much about data: 'if data aren't the answer, there can't be a problem'. True, citizens insist that the algorithms that determine so much of our lives must remain transparent, so that civil society groups can monitor the thoughts and values that go into crafting them. But as they get more and more sophisticated, sometimes it feels we're being asked to trust that the computers have our best interests in mind. Mostly, though, the 'opt out' talk is about a discomfort with the amount of data we each produce and the potential for our data to someday fall into the wrong hands. Even though most people believe that government policies toward privacy, transparency and data use are working well for now, it is good that these worries can be freely aired and discussed.

Government services have also improved from e-government and m-government systems that support regional, national and local services. Through crowdsourcing and large amounts of data, the government is able to get a much more granular view of citizens' needs and thus target policies and programmes more accurately. We're also able to hold the government to account much better. Budgets and procurement are all transparent for watchdog organisations to scrutinise, and through crowdsourcing we're able to participate in policy discussions. This has, at times, caused problems, especially when groups of people were quick to hold strong opinions on things before learning about them, but as a community we're all getting better at spotting and correcting this. Civil society has grown stronger and more effective through the abundance of information it can access to guide its strategies and advocacy work, and the networked approaches linking different groups together.

The Digital Age has ushered in new opportunities, reaching all the way into remote villages, and this has resulted in a stronger global economy with a lot less inequality and poverty. Social entrepreneurship, corporate social responsibility (CSR) and profit-sharing with workers has become widespread and, nationally and internationally, incentives serve to increase competition and break monopolies.

4 Policy implications and recommendations

The work we have done has developed a preferred future scenario for knowledge sharing, drawing on insights from the African context. Throughout the process, we have focused on identifying the potential positive impacts for developing countries and the policies and strategic approaches that would make these more likely to happen. Due to the approach we have taken, they are likely to be most relevant to the African context, while also significant for consideration in the wider contexts of developing countries globally. They all contribute in different ways to the 'preferred 2030 scenario', which was designed and informed by interaction with a diverse range of stakeholders with interests in international development and the role of knowledge in the Digital Age.

In this section we discuss a range of strategic areas and approaches relevant to policy, and highlight the main policy recommendations. We consider these in relation to four key aspects:

- cross-cutting principles
- an enabling environment
- human capacity
- infrastructure and tools.

4.1 Cross-cutting principles

Ownership, privacy and security
Digital technologies can threaten the privacy and security of poor and marginalised groups, whether that threat is from global powers, corporations or oppressive national regimes. Regulation is needed to ensure that knowledge-based digital initiatives are open, transparent and secure. There is no single correct level of privacy, but having a participatory way of setting those levels, and transparency about how data gets used, will be important. Global pressure should be exerted on states that violate basic principles of privacy and security. Safeguards must be in place to ensure that knowledge is not hijacked by corporations and used at the expense of the public good or the knowledge creators.

Universal access
Without universal access, open access through digital media only reaches those with digital technologies, so investment in ICT infrastructure and inclusive services remains critical. This must go beyond simple tick-box criteria such as free or affordable access to a mobile phone or PC, as using these alone may paint a picture of steady improvement that belies a growing divide. Factors like telecommunications speed (2G, 3G, etc), phone functionality, and issues of 'net neutrality' (i.e. differences in bandwidth availability and cost of higher performance and quality of access) are also an important part of the quality and experience of available information. There is a need for indicators and metrics that are relevant to universal access and what users can do with their access, which reflect these dimensions. The concept of universal access will need to be regularly reviewed and redefined to promote equity and inclusiveness in an ever-changing Digital Age.

Open knowledge
Open knowledge helps to close the digital divide and spur innovation. Current incentive structures discourage researchers from publishing in open access platforms, and the costs of accessing research through mainstream publishers is often prohibitive for people in developing countries. Knowledge, data sets and records from public bodies, government and the private sector need to be made openly available wherever possible. This will support

inclusive work and innovation at regional, national and local levels. Open access should address all development goals and not just be considered relevant to academia.

This requires open access (OA) and freedom of information (FOI) legislation and should be balanced with an individual's freedom and privacy, and increased understanding of copyright and intellectual property, including patents. Furthermore, this requires a revolution in publishing and distribution, investing in digitisation and distribution (which has been one of the major costs and bottlenecks for developing country knowledge sharing).

Many argue for investment in regional interoperable knowledge systems, where open linked data sets can be built to support a wide range of services in key thematic areas. Others advocate for a continental agreement for open reusable transparent platform-agnostic and device-agnostic ICT infrastructures. Both of these should be given serious consideration, with a strategy for knowledge sharing central to this cross-border strategy.

Inclusive knowledge

Subjects of development knowledge need to be more central to how that knowledge is produced, distributed and used. Digital technologies are increasingly making it possible to disrupt current research and publishing regimes that privilege knowledge produced and packaged in developed countries. For example, by combining participatory processes with crowdsourcing technologies, research agendas can become more relevant and focused, while research outputs can have a stronger evidence base and more appropriate dissemination methods as they reflect voices from the communities they study. National and regional repositories with quality assurance mechanisms can also help increase participation and create demand for research from developing countries. These approaches should align with greater investment and incentives for African research within curricula of national universities.

Another important aspect of inclusive knowledge is including poor people in developing knowledge infrastructures and knowledge intermediary systems so that knowledge efforts better respond to their needs.

Key recommendations

- Pursue strategies to increase openness in knowledge sharing through better incentives, capacity development and advocacy.
- Build capacity and understanding of privacy risks in online information sharing. Develop and enforce data protection regulation.
- Design policies that balance openness and protection of traditional/local knowledge resources and intellectual property.
- Involve poor and marginalised groups in the design of the knowledge systems they use, and the ownership and use of data.
- Promote good governance and effective light-touch regulation of private sector activities in the knowledge sector.

4.2 Enabling environment

Inclusive and equitable goals for the Digital Age
The SDGs currently mention access to ICTs (Target 17) and the assumption is that knowledge creation, sharing, research capacity and ICT infrastructure are seen as cross-cutting themes. It is also acknowledged that there are many relevant indicators monitored – for example, the ITU's ICT Development Index (IDI), UNDP's Human Development Index (HDI) and the Web Foundations Index. However, we recommend a more explicit focus on 'Digital Society Development' goals that provide the basis for a coordinated agenda on the different ways in which knowledge is created, used and shared.

A common set of meaningful metrics and indicators
These goals should relate not only to universal ICT access, but also cover metrics for digital literacy, infrastructure, standards, public service access, costs, openness and capacity to inclusively create and share knowledge, and to monitor how the benefits of digital development are distributed. They should:

- include metrics to measure behaviour change and the impact of policies designed to support development in the Digital Age
- include metrics that inform our understanding of the opportunities presented by the 'internet of things', and the ways in which 'machine-to-machine' communication and links between humans and computers can provide positive outcomes for development
- regularly review and update concepts such as 'digital divide' and 'universal access', and their related measures, to ensure targeted investment in more equitable and universally beneficial Digital Age outcomes in terms of access to and usage of high-quality knowledge services supported by digital technologies.

Strengthening knowledge-mobilising institutions
The library and information science sector as a whole needs stronger institutions and regional knowledge intermediary groups that can clearly advocate for and explain the benefits of investment in development of national and regional open knowledge infrastructures and related skills. Without this, the investment needed by governments and institutions in the research and knowledge systems and processes to support effective delivery of the SDGs and the post-2015 development agenda will, in all likelihood, be segmented. That would represent a missed opportunity to deliver truly transformative results for Africa and other developing countries.

Developing a sustainable business model
Strategies are needed to define how open knowledge systems can operate sustainably, and this will require knowledge-mobilising institutions to develop business models that are less dependent on government or donor subsidies. This probably means developing closer links with private sector actors, and following similar models. But it will also need committed, long-term strategies from governments for investing in infrastructure, and from international development agencies for establishing priorities within the SDG framework and making financial resources available accordingly.

Incentives and policies
Repositories will never become appealing as a place to publish or find information without better policies and incentives. Policies must change from the university level up through the national and regional levels to encourage the use of repositories and to develop and implement coordinated systems to combine resources and ensure quality standards. In the shorter term, the national level is perhaps most feasible for such policies to be implemented. Government policies can encourage university repositories to cooperate, rather than

compete as they now often do, in federated repository systems that make all the repositories searchable through one platform. Such a system would allow for mechanisms to carry out peer review, and materials that have successfully passed review would be tagged for users' benefit. This would, in turn, make it easier for university promotion, rewards and tenure systems to reward documents peer-reviewed through this system, and distinguish them from low-quality works that are currently perhaps over-represented in many repositories.

Key recommendations

- Develop focused ICT and knowledge sharing objectives, approaches, mechanisms, and metrics within the SDGs.
- Governments, regional bodies, international development agencies and donors need to coordinate across physical and disciplinary boundaries to create knowledge sharing infrastructures that are compatible and inclusive.
- Universities and national governments need to incentivise repository collaboration, publishing in repositories, and developing peer-review systems.
- Provide sustainable funding for repositories and open platforms. Think longer term and build in preservation policies.

4.3 Human capacity

The Digital Age needs people with new skills and competencies in a range of areas, in order to develop relevant knowledge systems that can respond well to the challenge of delivering development goals. These include the following.

Library and information skillsets

Physical library spaces that support interaction and learning related to information literacy and research skills remain relevant and valuable, but information systems are becoming more distributed and content is becoming increasingly digital. To build an effective open knowledge society in the Digital Age requires a strong cadre of information and data scientists, who can support the development from traditional to digital libraries and online information and knowledge sharing systems. Such experts are critical not just in libraries but in government, civil society and the private sector, and play a key role in supporting the research process. In knowledge intermediary roles they also help shape policy debates and can play a key role in bringing together issues related to information, development and governance, and knowledge sets that are increasingly complex and driven by different power interests.

There is a particular need for significant investment in developing skills to manage digital repositories and knowledge sharing systems. A lack of technical expertise and awareness of good practices currently holds many OA repositories back from becoming more than merely confidential secondary libraries for institutions, and from sharing in ways that aggregate resources, impact and benefits.

Knowledge intermediaries

Knowledge intermediaries – media, civil society organisations, knowledge managers – will continue to play an important role in connecting and translating knowledge among different groups in society, and in helping set the agenda for public discourses around relevant issues. It is important to continue to develop skills that make use of local capacity and contextual knowledge to support the needs of researchers, policymakers, practitioners, private sector entrepreneurs and the public. This means investing in the capacity of knowledge intermediaries, information and data scientists, and skilled experts who can work at the intersection of development, information science and governance.

Research and digital scholarship

More investment is needed in African research. Many African countries have poor incentives for research, focusing instead on teaching, and consequently lose many of their best researchers due to a brain drain. Investment needs to be targeted – e.g. National Research and Education Networks (NRENs) need more investment so researchers have more access, and an enabling environment. It will also be important to develop strong regional data sets on digital library content and use, providing valuable information on supply and demand side trends. This should inform development of research and strategic development of online content and digitisation programmes.

Education curricula

Education systems need to produce students who, from an early age, are digitally literate and fully aware of the tools for knowledge navigation and the opportunities that can be found online. This includes ICT training, but goes beyond this, to equip students with awareness of the pitfalls and challenges of the virtual world. Curricula need to be relevant to the national and local context and labour market, but also imbue students with lifelong skills for seeking and critically assessing knowledge.

Key recommendations

- National governments and development agencies should invest in training a new generation of information professionals, with an emphasis on skills in curating and tailoring open content, data management, and communication for high-level advocacy and networking.
- There should be more investment in building skills of knowledge intermediaries, information and data scientists, and skilled experts who can work at the intersection of development, information science and governance.
- Educational curricula should promote the development of digital capacities throughout society.
- There should be greater investment in African research.

4.4 Infrastructure and tools

Regional, national and local systems

Investment and coordination are needed in regional, national and localised repositories or knowledge sharing systems. The latter require collaboration across countries as climate change and epidemics (for example) are not framed within a single country. In particular, support needs to be given to digitisation programmes that are demand driven and targeted at making local and global thematic research relevant to the SDGs and post-2015 development agenda in Africa available on relevant and accessible repositories and knowledge sharing systems. There is a need for user-friendly platforms to communicate scientific discoveries to nurses, farmers and the public more widely.

Improving search and discovery tools

The ability for people to find the information they need depends on how open and available relevant content is, the design and functionality of the search and discovery tools, and the skills of the information seeker. Academic researchers often need specialised search engines to help discover relevant materials that Google searches alone fail to render, in many cases also providing quality assurance.

Social media have also started playing an important role in the way information and knowledge is discovered, be it via direct marketing, discussions or debates that can take advantage of the social graph that some social media sites have built to help spread the message within a group. Having material in different places can also enable information to be more easily discovered. Aggregators (which can be thematic, regional or country-specific)

can also help. Better approaches are also needed to customise the way information and knowledge is discovered. By combining users' data on behaviour, interests, location, and demographic, discovery tools can become more powerful and specific to individuals' information needs.

Knowledge sharing systems and digital repositories

Participants were divided on whether digital repositories were the best way forward to support open knowledge sharing. This was due to the mixed performance of existing repositories in Africa, the current disincentives to use them, and some of the technical and funding challenges in supporting them. However, it is also evident that there has been significant growth, particularly in DSpace repositories in Africa, in recent years. There is also a nascent but growing enthusiasm for the possibilities that repositories hold for aggregating online resources, making them available, and implementing review mechanisms for quality assurance.

Crowdsourcing tools for voice and accountability

Crowdsourcing methods will increasingly become a tool for gathering data, ideas and perspectives in useful ways. They can help to identify development priorities down to the community level, set relevant agendas, and resource talent and funding to innovative solutions that are feasible and appropriate to the context. Similarly, crowdsourcing tools should be developed to help governments determine needs, research appropriate solutions, and monitor the impact of their projects. Civil society can also hold government to account through crowdsourced information.

Crowdsourcing methods should also be used to more effectively monitor goals around issues such as digital competencies, free and open access to information, privacy rights, right to be forgotten, and level of service, with indicators to rank country commitment to achieving these goals (which could themselves be refined and updated via crowdsourcing). Over time, the data associated with this would itself provide an interesting picture of trends, and with links to social media data it would also catch the zeitgeist of what is happening, and tap into what communities are saying.

Key recommendations

- Research leverage crowdsourcing to capture views on development issues (e.g. around the SDGs) and global voices. Ensure that the crowd is representative, or source at community level.
- Serve rural and non-digital communities with library outreach. Use appropriate technology in the right spaces for your users.
- Support the development of innovative knowledge-based services that use mobile technologies to benefit the rural poor and those working in the informal sector.
- Design policies and programmes to produce knowledge sharing systems (making use of mobiles and ICTs as appropriate) that focus on understanding the context and needs of users.
- Make big data sets and government records openly available wherever possible, and develop skills and capacity within knowledge intermediaries to make effective use of these data to support development outcomes.

4.5 Conclusions

Our study enabled us to interact with a diverse range of stakeholders and hear their views on the critical issues for knowledge sharing in the future. We also scanned relevant literature and used Foresight methodologies to structure our analysis of drivers of change and potential future scenarios, and put forward a range of important recommendations relating to policy and strategic approaches.

It is clear from everyone we have talked to that we are at an important and formative moment in relation to how we shape development in the Digital Age. Some see rapid changes ahead as technology propels us to find new solutions, while others are more sceptical and see little likelihood of the poorest benefiting in ways that address their needs. It is, however, clear to us that the kind of knowledge infrastructure, knowledge intermediary skills and capacities, and related governance systems that we create in Africa and developing countries will be hugely significant in shaping the lives of citizens and addressing development challenges in an inclusive and equitable manner.

The implementation of the SDGs and post-2015 development agenda needs to be supported by significant and well-coordinated investment in the knowledge sector. It should have its own clear targets and engage citizens in monitoring activities to ensure that knowledge is openly shared wherever possible, and that goals for the type of digital development we are seeking are also identified and achieved at local, national and global levels. In this way, we stand the best chance of delivering the outcomes that mirror the preferred scenario articulated by the participants in our study.

Annex 1 Foresight methodology

The three principal methods used in this project were:

- drivers of change analysis ('STEEP')
- scenario building, using the 'two-axes' method
- options testing ('windtunnelling').

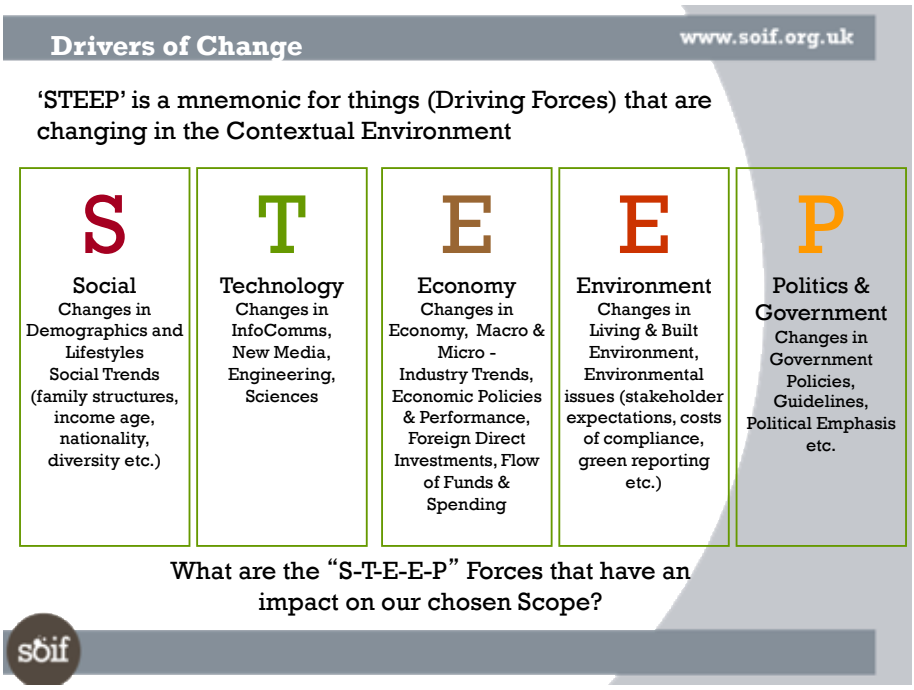
Below is a brief overview of these methods. For more in-depth explanation, and alternative or complementary approaches, see the *Foresight Scenario Planning Guidance note*.[51]

1. Drivers of change analysis ('STEEP')

A group of participants identifies major trends and drivers of change, usually in a workshop. In doing this, participants draw on their knowledge and awareness of different kinds of information, including research and horizon scanning data, economic and demographic models, political and legislative trends, and cross-country analysis. They also apply their judgement and intuition to assess which drivers of change will play an important role in shaping future trends and outcomes relevant to the topic they are looking at.

We use the **STEEP** framework to ensure that there is coverage of **S**ocial, **T**echnological, **E**nvironmental, **E**conomic and **P**olitical factors. In discussion, participants identify 10–15 of the most important and most uncertain drivers for the period under consideration.

Figure A1 STEEP drivers of change



Source: Foresight Horizon Planning Centre, Government Office for Science, pers. comm. 2009.

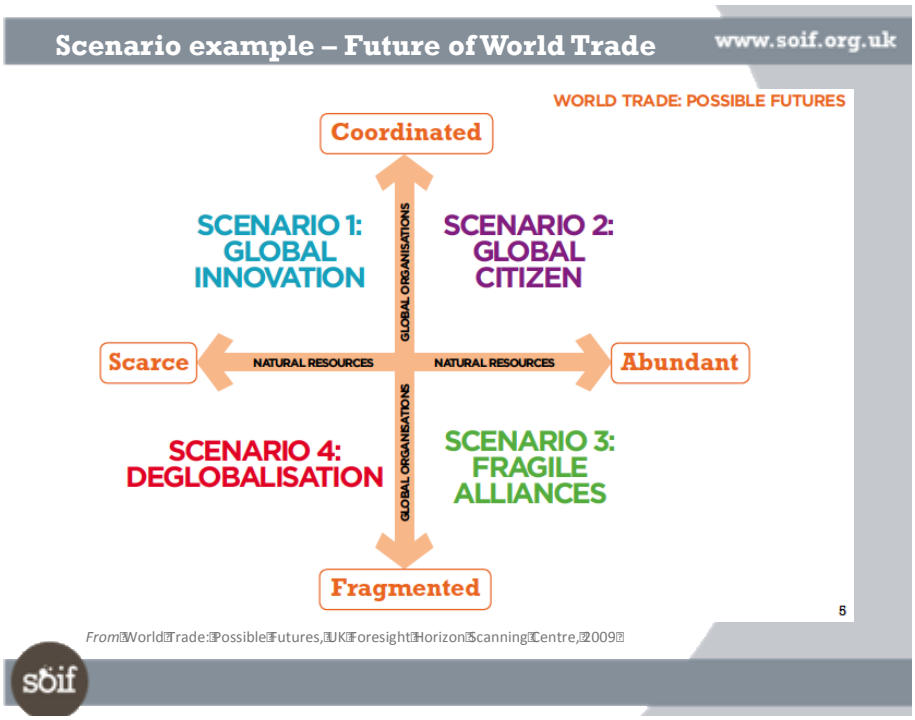
[51] See www.soif.org.uk/wp-content/uploads/2014/12/Foresight-Scenario-Planning-Guidance-2009.pdf.

2. Scenario building

We use one of the most common approaches to build scenarios: the 'two-axes' method (also known as 'axes of uncertainty').

Four scenario 'spaces' are constructed, based on the two most uncertain and highest-impact drivers identified in the STEEP exercise. Each scenario is written up as a narrative of what the world in each of the quadrants is like for the people living in it. An example of this from a different project is shown in Figure A2.

Figure A2 Scenario example



Source: Foresight Horizon Planning Centre, Government Office for Science, pers. comm. 2009.

The scenarios provide alternative versions of the future, relevant to the policy or plan being developed. They are not predictions of the future, but plausible versions of what *could* happen in discrete and contrasting futures.

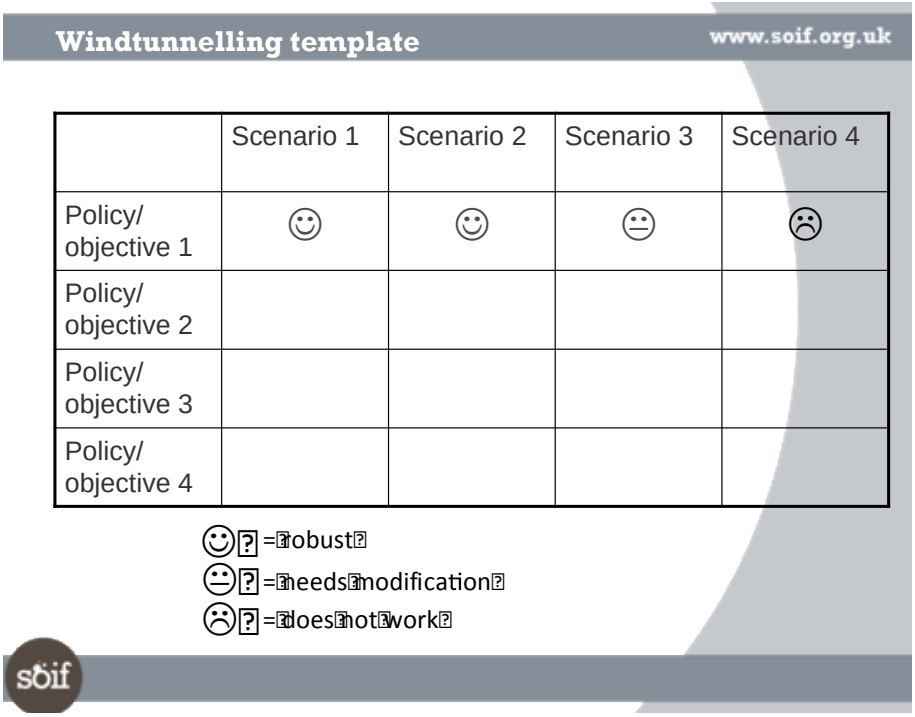
3. Options testing ('windtunnelling')

Having broadened our perspective on the future through the drivers of change and scenarios exercises, we focus on the implications of the different scenarios (possible futures) for policy choices.

Windtunnelling is used to assess how a set of policies or objectives would perform in different scenarios. We first identify the policies or objectives to be 'tested'. This can be done by reference to an existing (or draft) strategy; alternatively, candidate policies can be formulated by groups in a workshop exercise.

Once policies have been identified, we examine how effective those policies are likely to be in each scenario. Policies that perform well in several scenarios are considered to be more 'robust' than those that are well adapted to only one or two scenarios.

Figure A3 Windtunnelling template



Source: Foresight Horizon Planning Centre, Government Office for Science, pers. comm. 2009.

For examples of windtunnelling, see the annex to the *Foresight Scenario Planning Guidance note*.[52]

[52] See www.soif.org.uk/wp-content/uploads/2014/12/Foresight-Scenario-Planning-Guidance-2009.pdf.

Annex 2 Drivers of change

At the initial Foresight workshop in London, participants were first asked to identify key drivers of change to consider in our scenarios. The categorisation of these driving forces followed the STEEP framework.

Within each driver we proposed a binary/spectrum along which these factors may evolve in the future. These binaries were then used for the construction of the scenario matrix.

Social

S1) Privacy and digital identities: The prevalence of social media and their impact on societies was a common theme identified by the participants. The main concern was related to the intrusion on privacy, information ethics and the construction of (public) digital identities, as well as the reaction to these phenomena, which may entail a mass exodus from social media. Spectrum: privacy and ethics → surveillance and identity theft.

S2) Population dynamics: Participants shared ideas around the global population and population increase, migration patterns, and especially ageing populations. Spectrum: current population dynamics (with young poor population in developing countries and old rich population in developed countries) → the construction of a global population or another sort of shift in population dynamics.

S3) Education: Another range of driving forces considered that people (especially women) are expected to be more educated in the next 20 years, especially through new forms of education (digital/online). Spectrum: current education rates → universal education.

S4) Knowledge creation: How will the changes in education and access to information influence knowledge generation? The excess of information may reduce the perceived value of research and evidence, or maybe the new technological advances can promote a stronger involvement of citizens in data generation and knowledge creation. Spectrum: open, accessible and participatory knowledge → closed and commercialised knowledge.

S5) Health: Lifestyle diseases overtaking infectious diseases, diseases induced by technology as well as antibiotic resistance were some of the health concerns shared by the participants. Spectrum: increase of health solutions → increase of disease/pandemics.

S6) Socioeconomic dynamics: A change in the characteristics and dynamics present in societies was also discussed from diverse perspectives. On the one hand, new forms of employment (no workplace/working remotely) may drive changes and shifts in peer networks and lead to (even) more individualistic societies. The further growth of the 'top 1 per cent' and the consequent increase in inequality was also considered. On the other hand, some participants proposed more utopian views where poverty did not exist and gender equality increased. Spectrum: unequal and individualistic societies → more equal societies (in terms of gender and income).

S7) Religion: Several participants shared thoughts regarding the future of religion, faith and spirituality in its diverse forms. 'God is dead' and 'God is real' are two good examples of the wide range of ideas. The reversal of enlightenment and the rise of religious fundamentalism was confronted by other hypotheses around the rise of new religions or new forms of organising (or not organising) religion. Spectrum: religion → faith, or fundamentalism → common spirituality.

S8) Culture: The impact of new economic and technological powers in culture and behaviour was another subcategory of drivers of change envisioned by the participants. Spectrum: cultural diversity → homogeneity.

Technology

T1) Data: The data deluge and 'datafication' of everything will have implications for data infrastructure, storage and transport. However, ideas around data being not only stored but also processed by technology were also shared, building on the concepts of the 'internet of things' and the rise of sensors. Spectrum: data collected and stored through technology → data analysed and processed by technology.

T2) Information and communications technology: In this subcategory, the participants envisioned two directions in which the world may evolve: a world of increasing connectivity through mobile and internet technology, in opposition to a breakdown of the one 'global internet' as we know it and the privatisation of the World Wide Web (www). Spectrum: an open interconnected world where communication and information flow freely → closed and privatised access to ICT.

T3) Cybercrime/terrorism: The increase in data collection and the value associated with it triggered the inclusion of factors related to cybercrime in its different forms (cyberterrorism, cybercrime tailored to individuals, etc). Spectrum: use → misuse of data, or potential associated with data access → risks associated with data dependency.

T4) Innovation: The evolution of technological innovation in its several forms was another subcategory of factors and drivers shared by participants. From new applications of already developed technologies (such as 3D printing and its impact in decentralisation of manufacturing, further applications of Biotech and Nanotech, and the changes in ownership of satellites and space programmes) to more 'infant' technologies that, if further developed, have a strong transformative potential: teleportation, cryogenics, genetic engineering, robotics and artificial intelligence, etc. Spectrum: stagnation of technological innovation → full development.

Economy

E1) New economic models: A wide variety of drivers of change regarding obsolete economic models and the rise of new economic models were shared in the workshop. In the sphere of traditional models, participants envisioned the end of employment, the death of the physical economy, capitalist dystopia and the collapse of social security systems. On the other hand, 're-imagined' economic systems included the rise of digital money and the shared economy, as well as business models that incorporate environmental sustainability concerns, and/or personalised pricing. Spectrum: crisis of traditional economic systems → innovative economic models.

E2) Globalisation: Participants proposed ideas around de-globalisation and return to regional or even local markets. Others considered a reshaping of the global order by new powerful actors such as the BRICS or multinational corporations. Spectrum: global (including the possibility of a new global landscape) → local.

E3) Inequality: Concerns about rising income inequality (global and national) were also included in this section. Spectrum: rise of inequality → rise of middle class.

E4) Finance: Several participants envisioned the possibility of a new global financial crash and the consequences it may have, in terms of crippling development and altering the current monetary system. Spectrum: financial system stability → instability.

Environment

V1) Climate change: The range of factors and drivers of change in this subcategory goes from participants considering the possibility of climate change not being true/being controllable, to a catastrophic event with regards to climate, which may trigger a shift in public behaviour towards the environment or the rise of full environmental cost accounting (i.e. by incorporating a valorisation of carbon emission in pricing mechanisms). Spectrum: climate chaos/crisis → increase of mitigation/adaptation techniques.

V2) Resources: Given the growing population, resource scarcity (food, water and minerals, among others) was a recurrent theme. There was a special emphasis on energy. Participants considered hypotheses that ranged from new forms of energy (wireless, fusion, etc), free energy, to even the end of energy. Spectrum: scarcity/constraints → availability/new solutions.

V3) Health: Public health concerns were also present in relation to environment, forecasting the rise of new pests and diseases, or the health consequences of intensifying urbanisation and pollution. Spectrum: solutions to environmental health problems → rise of environmental diseases/threats.

Politics and government

P1) Global order/geopolitics: This subcategory of drivers of change considers a shift in geopolitics and global governance, which ranges from the abolition of the distinction between developed and developing countries and the irrelevance of multilaterals, to the formation of a new global order where the rising powers (especially China) have a growing influence. Spectrum: old global order → new global order.

P2) Political regimes: The crisis of political systems and democratic models is another subcategory of factors that will affect politics and government in the next 20 years. Spectrum: democratic regimes (with new models of democracy and fight against corruption) → authoritarian regimes.

P3) Public sector/private sector: Another sub-category of factors considered a shift of real power from governments (end of nation states) to businesses (controlling data, information, content, etc). This subcategory links back to some drivers included in 'Economy', where the change in ownership models and the concentration of power in business were also discussed. Spectrum: power and relevance resides in public sector → power and relevance resides in private sector.

P4) Data/ICT: Another sub-category of drivers of change is related to the control of data, information and communication by governments. From perverse forms of control (colonialism 3.0, manipulation and cybertactics for mass social control) to a more open approach to data and ICT that encompasses freedom of information and intellectual property reform to promote openness. Spectrum: Closed access/perverse use of data and information → open access and constructive implementation of the potential of ICT technologies.

P5) Conflict: Participants envisioned several forms of conflict and war: World War III (which can take the form of a virtual/data war), global ethnic and ideological cleansing and terrorism. Spectrum: war → peace.

Annex 3 Stakeholders

Indicative list of African and Africa-relevant stakeholders in the ICT and knowledge sector

A very wide range of organisations and networks represent stakeholders when it comes to digital knowledge creation and sharing. These include: research and educational institutions, libraries, government agencies, private sector, media, faith-based organisations, publishers, film and music companies and many other categories, some of which are covered below.

This annex lists some of the stakeholders and actors identified and mentioned during the course of our study. (NB: many of these relate particularly to the agriculture sector and to the sub-Saharan Africa region). They represent an indicative list, but clearly a much more detailed and comprehensive stakeholder mapping would be needed to inform coordination activities at a strategic and operational level.

(1) NGOs, CBOs and associations

African Capacity Building Foundation (ACBF) www.acbf-pact.org/
African Economic Research Consortium (AERC) http://aercafrica.org/
Arid Lands Information Network (ALIN) http://alin.net
Association for Strengthening Agricultural Research in Eastern and Central Africa (ASARECA) www.asareca.org/
Association for Water and Rural Development (AWARD) www.award.org.za/
Centre for Coordination of Agricultural Research and Development for Southern Africa (CCARDESA) www.ccardesa.org/
CORAF/WECARD www.coraf.org/ag2014/?lang=en
Food Agriculture and Natural Resources Policy Analysis Network (FANRPAN) www.namc.co.za/pages/about-us/index.php?q=con,82,%20FANRPAN
Healthcare Information for All (HIFA2015) www.hifa2015.org/
ICTs for Rural Africa www.ictruralafrica.net/site/index.php
Open Educational Resources for Africa (OER Africa) www.oerafrica.org/
Regional Universities Forum for Capacity Building in Agriculture (RUFORUM) www.ruforum.org/
SAfAIDS www.safaids.net/
SANGOKO, the umbrella body for NGOs in southern Africa www.sangoco.org.za/
South African NGO Network (SangoNET) www.ngopulse.org/about

(2) Sectoral initiatives (agriculture sector example)

African Association of Universities (AAU) www.aau.org/
CIARD, Open Agricultural Knowledge for Development www.ciard.net/
Forum for Agricultural Research in Africa (FARA) http://faraafrica.org/
Global Forum for Agricultural Research (GFAR) www.egfar.org/
Global Open Data for Agriculture and Nutrition (GODAN) www.godan.info/
International Association of Agricultural Information Specialists (IAALD) www.iaald.org/
Research4Life www.research4life.org/

(3) International and continent-wide bodies

African Union (AU) www.au.int/
African Development Bank (AfDB) www.afdb.org/en/
CGIAR www.cgiar.org/
Food and Agriculture Organization of the United Nations (FAO) www.fao.org
United Nations Development Programme (UNDP) www.undp.org

United Nations Educational, Scientific and Cultural Organization (UNESCO) http://en.unesco.org/
United Nations Economic Commission for Africa (UNECA) www.uneca.org/
United Nations Environment Programme (UNEP) www.unep.org
World Health Organization (WHO) www.who.int

(4) Libraries, networks, knowledge service and intermediary organisations

African Digital Library Support Network (ADLSN) http://adlsn.org/
African Library Associations and Institutions (AFLIA), http://aflia.net/
Beyond Access http://beyondaccess.net/
Directory of Open Access Repositories (OpenDOAR) www.opendoar.org
Google http://google.org/
Electronic Information for Libraries (EIFL) www.eifl.net
iHub www.ihub.co.ke/
INASP www.inasp.info
International Federation of Library Associations and Institutions (IFLA) www.ifla.org/
International Research & Exchanges Board (IREX) www.irex.org/
Information Training and Outreach Centre for Africa (ITOCA) www.itoca.org
Library and Information Association of South Africa (LIASA) www.liasa.org.za
Open Knowledge https://okfn.org/
Sabinet Online www.sabinet.co.za
Ushahidi www.ushahidi.com/
Wikipedia www.wikipedia.org
Wikipedia's Africa portal http://en.wikipedia.org/wiki/Portal:Africa

(5) Internet-related governance

Alliance for affordable internet http://a4ai.org/
Internet Governance Forum (IGF), Creative Commons
UbuntuNet Alliance www.ubuntunet.net

(6) Intellectual property: copyright, patents, etc

Creative Commons http://creativecommons.org/
Open African Innovation Research and Training (Open AIR) www.openair.org.za
Technology and Innovation Support Centres www.wipo.int/tisc/en/
World Intellectual Property Organization (WIPO) www.wipo.int/portal/en/index.html

(7) Communications

Association of Progressive Communication (APC) www.apc.org
Commonwealth Telecommunications Organisation (CTO) www.cto.int
International Telecommunication Union (ITU) www.itu.int

(8) Regional bodies

Association of African Universities (AAU) www.aau.org/
East African Community www.eac.int/
Economic Community of West African States (ECOWAS) www.ecowas.int/
Economic and Monetary Community of Central Africa (CEMAC) www.cemac.int/
Southern Africa Development Community (SADC) www.sadc.int

(9) University related

National Research and Education Networks (NRENs), see http://ei4africa.eu/about-e-infrastructures/nren/ for links
Southern African Regional Universities Association (SARUA) www.sarua.org

(10) International funders

Bill & Melinda Gates Foundation www.gatesfoundation.org
CTA-Netherlands www.ct.int
Department for International Development (DFID) www.gov.uk/government/organisations/department-for-international-development
Elsevier Foundation www.elsevierfoundation.org
German Academic Exchange Service (DAAD) www.daad.de/en/
International Development Research Centre (IDRC) www.idrc.ca
Open Society Foundations www.opensocietyfoundations.org

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