CHAPTER 16

Africa's Science Diplomacy

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Introduction

The scope of science diplomacy in Africa is constrained by a lack of cooperation at state levels and collaboration among research institutions and low investment in research, science and innovation. On human capital contribution to Science and Technology, only 2.3 percent of the global research community comes from Africa, and the continent contributes just about 2 percent of the global scientific publications (Toure, 2018). Africa's contribution to the global scientific knowledge is, therefore, minimal. According to Pouris and Pouris (2008), Africa produced 68,945 publications over the 2000–2004 period or 1.8% of the global publications. Research in Africa is concentrated in two countries i.e., South Africa and Egypt (Pouris & Pouris, 2008). These two countries produce just above 50% of the continent's publications (ibid.). As far as investment on Science and Technology is concerned, most countries in Africa are struggling to reach 1% allocation of their Gross Domestic Product to science, research, and innovation. This is the case, despite that global spending on science and the number of scientists has been rising in the past several years. This situation has been further worsened by the impact of the COVID-19 pandemic, according to UNESCO (United Nations Educational, Scientific and Cultural Organization) (Kigotho, 2021).

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With this reality, diplomatic engagement on science, technology, and innovation (STI) among African countries is negligible. Only a handful of countries in Africa have active bilateral relationships on co-operation in Science and Technology with each other. South Africa, for instance, in its quest to improve its scientific cooperation with its counterparts in Africa, has through her Department of Science and Innovation, entered into bilateral agreements with various partner countries. Additional agreements and scientific co-operations that South Africa has with countries in Africa are nested in Science Councils such as the National Research Foundation (NRF), Council for Scientific and Industrial Research (CSIR), Human Sciences Research Council (HSRC), and Technology and Innovation Agency (TIA), which are funded by South Africa's Department of Science and Innovation. To reinforce its science diplomacy requirements, South Africa's Department of Science and Innovation has established a science and technology diplomacy program that aims at exploring different modes of engagement with countries and institutions in Africa.

Across the world, governments have realized the importance of science in advancing diplomatic relationships. With the increased role of science in diplomatic circles, the value of science diplomacy has been amplified. This coincides with the realization that science and technology underpin many of the challenges and opportunities that countries face. Global interconnectedness has heightened the incentive for science, and technology diplomacy as a vehicle for diplomatic engagement (Melchor, 2020). This indicates that although Africa is still lagging behind with its contribution to Science, Technology, and Innovation, it must increase its scope of science diplomacy through engagement with itself first and the world later.

This chapter presents science diplomacy as an emerging branch of international relations. It assesses the capacities of African countries to engage with one another through science diplomacy. It evaluates the institutional, strategic, and procedural aspects of science diplomacy using African experiences. It gives special attention on how Africa can catch up in Science, Technology, and Innovation through science diplomacy. It further examines ways of how science diplomacy can improve diplomatic relations among African countries. It outlines how science diplomacy can serve as a tool for addressing the challenges of poor infrastructure, limited funding, and inadequate logistical support for research in Africa, including, but not limited to, mechanisms by which the continent can mobilize resources for development of scientific knowledge through stronger diplomatic ties. Evidence provided derives from the dialogues that were held on science diplomacy in Mozambique, Kenya, Ethiopia, Uganda, Mali, and Cote d'Ivoire. Additional perspectives presented within the effort to analyze the role of science diplomacy in international relations come from secondary sources such as published articles and databases.

Review of Literature and Clarification of Terms

While the study of diplomacy has a long and honorable tradition that dates back to Machiavellian thought, it is only in recent years that diplomatic practice has started to receive detailed theoretical reflections it deserves (Berkman, 2019). Despite this progress, there is a notable absence of conscious theorizing in most scholarship on diplomacy (Fuller, 2000). The bulk of the scholarship offers detailed historical accounts of diplomatic events as well as elucidation of diplomatic practice (Hayes & Bruce, 2007). Scholars of diplomacy implicitly choose from a very narrow range of analytical frameworks, drawn almost exclusively from the realist tradition in international relations (Salomon, 2001).

Therefore, the orthodox study of diplomacy is marked by a remarkably unified theoretical approach, something quite unique in political science (Skolnikoff, 1994). There is a surprising ontological consensus about what diplomacy is and who the diplomats are (Skolnikoff, 1994). This consensus arises from the dominant influence of rationalist thinking (Skolnikoff, 2001). The consequence of this is that the range of scholarship in most studies of diplomacy tends to be limited to analyses of the international realm of sovereign states in the context of "high wire" politics (Stein, 2002). This situation begs the following questions: (a) where does science link up with international relations? and (b) is there a scope for infusing science diplomacy into international relations and transactions?

The origins and development of diplomacy are attributed to the European system of states (Lee & Kocking, 2011). As a discipline, diplomacy is defined as the art of obtaining agreement between countries who need to cooperate to produce results in which each country has some interest (Legrand & Stone, 2018). Lee and Kocking (2011) define diplomacy as the conduct of human affairs by peaceful means, employing techniques of persuasion and negotiation. Diplomacy can also be regarded as a system of structured communication between two or more parties (Melchor, 2020). It can be defined as a process between actors (diplomats, usually representing a state) who exist within a system (international relations) and engage in private and public dialogue (diplomacy) to pursue their objectives in a peaceful manner (Mcglinchey, 2017). With its techniques of negotiations to resolve conflicts, diplomacy is widely regarded as an alternative to war. War is considered a failure of diplomacy (Flink & Schreiterer, 2010). Diplomacy has always been in a state of evaluation, but the past century has had a particularly dramatic impact on the institutions, exponentially expanding its scope and means and the number of actors involved. Initially, diplomacy was formatted as intermittent communication between separate states. The institution of diplomacy is as old as international society itself, yet its enactment by organized agencies is of relatively recent origin.

Science diplomacy on the other hand has developed due to the need for countries to share technology through the instrumentality of negotiations that

may involve governments, academia, and other societal actors (Carlsson, 2006; Fähnrich, 2017). It is relatively new as a form of diplomacy and has become an umbrella term for description of several formal or informal technical, research-based, academic, or engineering exchanges, within the general field of international relations (Flink & Schreiterer, 2010). Science diplomacy is a means of pursuing national scientific agendas through diplomatic engagement, a component that falls within "soft power diplomacy" of international relations and diplomatic transactions (The Royal Society, 2010). Scientific and technological advances are critical for addressing major global challenges like diseases, climate change, nuclear technology, and so forth. The apolitical focus of science on evidence allows positive interactions even in the presence of differences (Glegg et al., 2012).

As a new branch of international relations, the American Association for the Advancement of Science founded the Centre for Science Diplomacy in 2008 (Pouris, 2018). This sought to infuse the use of science diplomacy in diplomatic transactions (Flink & Schreiterer, 2010). Its founding objective was advancement of the overarching goal of scientific cooperation in promoting international understanding of science by providing a forum for scientists, diplomats, policy analysts, and policymakers to share information and explore collaborative opportunities (Inglesi-Lotz & Pouris, 2018). Since then, several initiatives that seek to formalize science diplomacy as a branch of international relations have been implemented by organizations such as the Academy of Science of the Developing World, European Union, and others (Gluckman, 2016).

From an analytical point of view, an open question remains as to what exactly the term "science diplomacy" entails, how it is defined and conceptualized (Jasanoff, 1990). According to Kaltofen and Cuto science diplomacy is underpinned by a subtle dialectic which requires further study, despite all pragmatic intentions to address its meta-theoretical foundations. It is coming to the fore as a formidable dimension of interstate power relations (Salomon, 2001). As global challenges are increasingly starting to transcend borders, researchers and innovators have forged international coalitions to resolve global problems (Legrand & Stone, 2018), such that Science is neither inherently political nor ideological but represents a type of universal language, and a vector of transnational communication that poses fundamental questions about the nature of things.

The concept of science diplomacy has become one of the widely discussed subjects in the international relations and events of science and technology (Grimes et al., 2017). Various literature point to the fact that science diplomacy entails the use and application of science cooperation to help build bridges and enhance relationships between countries, with a particular interest in working in areas where there might not be other mechanisms for engagement at an official level (Ruffin, 2018; Aukes et al., 2020). Recognizing the role that science plays at national and international levels, identifying a state's national

diplomatic style helps to construct a national strategy for science diplomacy. Many countries now engage in science diplomacy to promote research and development and to nurture and attract the best scientists (Berkman, 2019). This ultimately strengthens the national system of innovation of the engaged countries.

Literature on science diplomacy is still thin, particularly on how countries can utilize it to bolster their systems of innovation (Beaver & Rosen, 1978). Contributors to the role of science diplomacy in diplomatic transactions are very few. This is the case despite the effectiveness of science diplomacy in strengthening bilateral relations among countries (Copeland, 2015). Meagre available literature on science diplomacy does not provide directives on the knowledge needed by diplomats to practice science diplomacy. Lohmann has proposed that the theory and practice of diplomacy in the twenty-first century must consider the evolution of diplomacy concepts and knowledge in the latter half of the twentieth Century and the plurality of analytical perspectives that it has created.

This chapter seeks to contribute to the developing body of knowledge on science diplomacy. With its focus being Africa, the chapter discusses: (a) the significance of science diplomacy in Africa's diplomatic transactions, (b) relevance of science diplomacy in international relations, (c) Africa's national systems of innovation and their contribution to science diplomacy, and (d) scope of collaboration through science diplomacy in Africa.

Significance of Science Diplomacy in Africa's Diplomatic Transactions

Recent developments in technology and innovation have highlighted the need for scientific collaboration among countries (Georghiou, 1998). The globalization process has driven countries to assimilate and transfer technologies at a much higher speed than ever before (Ngwenya, 2015). The critical roles played by science and technology in the determination of the fates of countries have enhanced the need to infuse science and technology into diplomatic transactions. The target is improvement of knowledge about science among diplomats so that they can grasp the art of negotiating the exchange of knowledge, its development and transfer of technology between countries.

Developed countries are increasingly exploiting their technological capacities to their advantage while developing countries, especially those of Africa, are left on the margins of scientific breakthroughs (Soler, 2021). This has been witnessed in the exploration of Mars, which holds the future for space science and has been reinforced by experience with the development of SARS-CoV-2 vaccines, the devastating pandemic of the twenty-first century. Only few countries are collaborating in the exploration of Mars. For SARS-CoV-2, developing countries waited for industrialized countries to develop vaccines with the hope that they will receive vaccines through diplomatic engagements and negotiations.

The pandemic demonstrated how countries initially responded to SARS-CoV-2 in isolation, instead of relying on multilateral science diplomacy (Melchor, 2020). That experience on response begs the question on how countries with weak national systems of innovation and limited scientific resources can participate and collaborate meaningfully in the development of global scientific knowledge and solutions. As witnessed in SARS-CoV-2, science diplomacy is the mechanism through which countries with limited resources and weak national systems of innovation can forge partnerships. This requires the infusion of science, technology, and innovation into diplomatic transactions (Pouris, 2018).

The modalities for the infusion of science, technology, and innovation into diplomatic transactions in Africa are numerous. As listed during the Science Diplomacy dialogues held in six African countries, key areas include transboundary water resource management, natural resource exploitation as exemplified by mining, the development of human capital for science and innovation, technical aspects of indigenous knowledge systems, mobilization of resources for research and development, pharmaceuticals, medicine, and many others. What further emerged during the science diplomacy dialogues is the significance of institutional collaborations across the continent, with the dire need to conduct research that supports planning and informs government policies. The general perception was that there is little or no uptake of research results by policy makers in many countries in Africa. Institutions for higher learning are not equipped to conduct research as a result they place much emphasis on teaching. The inadequacy of research infrastructure is not encouraging for lecturers to dedicate their time in research.

To address some of these issues, African countries need to capitalize on science diplomacy if they want to increase their participation in the development of global scientific knowledge. This will enable them to advance in science through strong collaborations, firstly, among themselves to strengthen their systems of innovation and secondly, to tap into the international system of innovation. A united Africa in science, technology, and innovation has many benefits. The critical one is the strengthening of knowledge base for enhancement of competences in science, by generating scientific knowledge that can be shared and assimilated by the global system of innovation (Archibugi & Michie, 1997). This can help Africa to solve problems that are endemic to the continent while contributing to the international knowledge system. In return, through cooperation and contributing to the global system of innovation, Africa could attain most of the targets of her Agenda 2063. The African Union has recognized the importance of science, technology, and innovation development through collaboration in STISA-2024. In this strategy, it emphasizes the role of science, technology, and innovation in Africa's socio-economic development. The main focus areas are presented in Table 16.1.

International cooperation in science, technology, and innovation is guided by two fundamental considerations, that is, advancing knowledge and acquisition of scientific capabilities to strengthen systems of innovation of partner

Table 16.1 Priority areas of the Science, Technology, and Innovation Strategy for Africa (STISA) 2024

Priority areas	*Details*
Eradicate hunger and ensure food and nutrition security	• Agriculture/agronomy in terms of cultivation technique, seeds, soil and climate • Industrial chain in terms of conservation and/or transformation and distribution infrastructure and techniques
Prevent and control diseases and ensure well-being	• Better understanding of endemic diseases—HIV/AIDS, malaria hemoglobinopathies • Material and child health • Traditional medicine
Communication (physical & intellectual mobility)	• Physical communication in terms of land, air, river and maritime routes equipment and infrastructure and energy • Promoting local materials • Intellectual communications in terms of ICT
Protect our space	• Environmental protection including climate change studies • Biodiversity and atmospheric physics • Space technologies, maritime and sub-maritime exploration • Knowledge of the water cycle and river systems as well as river basin management
Live together-build the society	• Citizenship, history and shared values • Pan Africanism and regional integration • Governance and democracy, city management, mobility • Urban hydrology and hydraulics • Urban waste management
Create wealth	• Education and human resource development • Exploitation and management of mineral resources, forests, aquatics, marines etc. • Management of water resources

countries, thereby, advancing broader national interests (Gluckman et al., 2017). In this respect, science diplomacy leverages on science engagements, collaborations, and knowledge exchange to support broader objectives beyond scientific discovery (Turekian, 2018). This can involve sharing equipment and research infrastructure, international exchange of personnel and exchange of ideas. Breakthroughs in science have long been attained through international collaboration and exchange of personnel through cooperation (The Royal Society, 2010).

In this world of science-driven development, knowledge is built through collaboration and sharing of ideas and resources through research (Balzat, 2002). This means that science diplomacy is not limited to office and laboratory-based analyses and engagements but entails movement and interactions among people (Lee et al., 2012). It serves as a way of engaging with people from

different countries, cultures, and backgrounds. Through this, it provides a common language, lenses, and approach for addressing major societal problems (Carlsson et al., 2002).

Africa has a multitude of obstacles that constrain its ability to harness the power of science diplomacy. One of them is international movement constraints. The infusion of science into diplomatic transactions in Africa requires the attention of politicians and the development of programs that will enhance the movement of researchers across countries. In addition, existing infrastructure for research and development is inadequate. It does not encourage collaboration among researchers. Allowing institutions of higher learning to come together and develop collaborative centers of excellence as opposed to universities working in isolation is needed for Africa to immerse itself into global knowledge production in key areas of scientific breakthroughs. A key opportunity is the unfolding Fourth Industrial Revolution (Industry 4.0).

This requires a well-defined road map and strategy with clearly articulated objectives and a plan of action that takes into consideration the strengths and weaknesses of each country in Africa. Of great concern is that most countries in Africa lack adequate systems for uptake of research output by planners and policy makers. This was well articulated during the science diplomacy dialogues. While countries that participated in the dialogues are Mozambique that represented the Lusophone sector; Kenya, Ethiopia, Uganda that represented Anglophone sector; and Mali and Cote d'Ivoire that represented the Francophone sector of the continent, the challenges discussed in these dialogues highlighted problems that are endemic to Africa. What the dialogues emphasized is that for Africa to be at par with the technologically advanced world on knowledge production, industrialization, and science, technology, and innovation, it must infuse science, technology, and innovation into its diplomatic transactions.

Relevance of Science Diplomacy in International Relations[1]

The link between international relations and science diplomacy is an area that is still being explored (Carlsson, 2006; Fähnrich, 2017). Perspectives on science and technology are primarily dominated by views and ideas of natural scientists. This suggests that for science, technology, and innovation to be infused into international relations and diplomacy, diplomats must grasp the understanding of science, technology, and innovation (Hayes & Bruce, 2007).

There is a realization that for science and technology to have impact, there need to be balanced collaboration and partnerships between diplomats, social and natural scientists (Chalecki, 2008). This should manifest itself in various ways, for instance, in the consensus on challenges such as pandemics, climate

[1] For more on science diplomacy in general, see the chapter on Public Diplomacy by Maunder & Stivachtis in this volume.

change, peace, and security, nuclear disarmament have brought together diplomats, natural and social scientists, with active participation of civil society to reach agreement on these issues. This requires that diplomats assigned to lead negotiations in science and technology, be specialists in one or two fields of science (Fuller, 2000).

Most often, countries assign the task of science diplomacy to diplomatic attachés. As stated by Adler, there is a need to analyze science diplomacy concepts from different international relations theories, especially, the mainstream ones. Lack of analyses, particularly, of how science diplomacy fits into mainstream international relations, impedes the full infusion of science diplomacy into international relations (Krishna-Hensel, 2010). Krasnyak has noted that from the academic perspective, most authors hold the opinion that sharing of technology for the benefit of humanity requires the infusion of science diplomacy into international relations (Flink & Schreiterer, 2010). As a result, science diplomacy is regarded as an enabler of international cooperation in science and technology (Huddle, 1980).

What science diplomacy entails is still contested by some scholars. Those who study diplomacy remain divided over whether it is essentially a state-based set of political processes or a set of networked-based political processes. Those who maintain that diplomacy is primarily the pursuit of the foreign policy interests of the state in the international system of states, argue that diplomacy is confined to quite a narrow set of bilateral and multilateral processes of communication, representation and mediation that are administered by each country's Foreign Ministry and its Overseas Missions (Fan, 2008).

Diplomatic processes continue to exhibit some irregularity such that functions, institutions, codes, conventions, and cultures of diplomacy are marked by continuity and marginal change, and that diplomatic rules and norms will continue to hold in the future (Sharp, 1999). In contrast, those who conceptualize diplomacy outside state-centric frameworks tend to emphasize continual change in the conduct and context of diplomacy (Tennis, 2008). The principal objective of network-based approaches is to highlight and analyze the challenges posed to diplomacy by contemporary changes in the international system (Krishna-Hensel, 2010).

Africa's National Systems of Innovation and Their Contribution to Science Diplomacy

The National system of innovation provides a solid foundation for organizing each country's collective efforts in science and technology (Manzini, 2012). This is strengthened through collaboration with other countries using science diplomacy. It can be argued that science diplomacy as a specialized branch of diplomacy is effective in strengthening the national system of innovation of a country (Copeland, 2015). This comes through cooperation in the development of scientific knowledge, processes and techniques. With the evolving political and economic tensions all over the world, diplomacy has become a

single effective mode for cooperation in science and technology as well as creating cohesion within and among nations.

For Africa, there exist reliable claims about historical contributions of Africa to science and technology. These claims are based on ancient history, which indicates, for instance, that Africa is the origin of mathematics. As such many ancient philosophers came to Africa to study various subjects in fields ranging from the humanities to mathematics. Despite this rich history of Africa's past contribution to science, the current reality is that Africa's contribution to the global knowledge bank is marginal. The primary responsible factor is weak national systems of innovation of many African countries, which translates to weak Africa's system of innovation.

Only a handful of countries in Africa are investing adequately in Science Technology and Innovation. The science diplomacy dialogues held in six African countries (i.e., Mozambique, Kenya, Ethiopia, Mali, Uganda, and Cote d'lvoire) revealed existing gaps between countries, which can be narrowed through science diplomacy. In attempts to do this, obstacles such as lack of free movement of researchers across the continent and tough visa requirements imposed by some countries to researchers serve as impediment to the implementation of science diplomacy in Africa. This hampers the exchange of ideas and the development of technologies gravely needed by Africa.

If countries in Africa can collaborate in developing technologies, the ripple effect of this will benefit the entire continent. Deriving from science diplomacy dialogues each country in Africa has its needs, priorities, capabilities and short comings. For instance, for Mozambique, the greater concern is the inability to access data from government institutions. Due to economic hardship, there is no allocated budget and resources for research. The institutions rely on foreign funding, which is difficult to access. Policy makers rarely use findings from research institutions or institutions of higher learning who felt less appreciated by the government. Cote d'Ivoire require technological inputs in three areas, which are agriculture, natural resource management and Information Communication Technology. The country considers that for Africa to benefit from these areas, value chains, both backward and forward, must be developed. The health and social security sectors are additional areas that need attention. For Ethiopia, lack of institutional strength and capacity for research and development serves as a drawback for country's system of innovation. Kenya has a well-structured system of innovation and the government recognizes the role played by Science, Technology, and Innovation (STI) in wealth creation and building human capital required for the transition to a knowledge driven economy. Kenya's Vision 2030 proposes to intensify the application of STI to raise productivity and efficiency levels across the three pillars of national development. As a result, the Government is implementing STI policy framework through the identification, acquisition, transfer, diffusion, and application of relevant STI knowledge in all sectors of the economy. In Kenya, the structural problems of social sciences are a basic challenge. The social sciences are less developed than natural sciences in terms of theory, data, methods and

tradition. This makes it difficult for social scientists to be given same recognition as natural scientists. This normally leads to:

(i) internal conflicts because of hyper-criticism within the social sciences. Social scientists are more critical and negative in peer reviews than natural scientists.
(ii) lack of data and resources in the social sciences (more data is available in the physical and natural sciences). Social science data base is weak and sometimes researchers have to start from the scratch.
(iii) poorly written/crafted social science proposals due to theoretical diversity and weakness/absence of data make it difficult to write a water-tight proposal that is theoretically strong and empirically grounded on research.
(iv) lack of tangible products for social science research i.e., much research in natural sciences is product oriented and has tangible outcomes while social science research often lack tangible objectives or objectives are not clearly linked to research outcomes.

Mali is facing major challenges related to issues of state fragility, insecurity, pervasive poverty, and weak institutions of the state. Through collaboration with countries like South Africa, some of these challenges can be better understood through research and development. Thus, collaboration with countries like South Africa is prudent. Some of the challenges Mali faces are endemic to Mali, this means that solutions for these have to come from the country itself. In Uganda, policies in government are not based in research, even some of the members of parliament do not have capacity to make policies. There is thus a need for policy makers to talk from an informed point of view that is supported by research. In addition, there is an underutilization of research in the country, with a lot of information being stacked away in libraries, so recommendations from evidence-based research are not being used. In the budget of the country, education, which is very strategic in the development of the country, is not well placed. Generally, funding limits research activities in the country. From Mali's perceptions following focal points of Science Diplomacy were proposed:

(a) creation of a network of researchers and academics that would continue to debate and propose solutions to the pressing challenges facing the two countries. The networking platform should focus on training of doctoral students, organization of conferences and seminars, funding proposal writing workshops and researcher exchange programs.
(b) creation of a publication and dissemination platform for Malian researchers in order to expose their work to South African researchers and academics.
(c) revitalize the Timbuktu digitization project which the government of South Africa have spent consideration amount of money on already.
(d) creation of a conflict mediation forum whereby Malian academics and researchers could benefit from the expertise of South Africa in resolving the security and secessionist tendencies in the country.

Despite endemic challenges in each country, most countries on the continent opine that continental challenges require stronger collaborations. For these, collective efforts should be developed in order to ensure that most of them are overcome. While there are efforts to unite the continent politically, very little is done to conjugate African efforts within the domain of Science, Technology, and Innovation (STI). The work of institution like CODESRIA in providing a platform for African researchers to share their expertise and disseminate their research findings worth to be noted. Institutions like these must ensure that their work cut across disciplines, languages, ethnicities, and religions. From Uganda's point of view, South Africa is well poised to pull up other African states. African countries need to rise above military, politics, and wars and turn to knowledge because knowledge is an essential pillar of development.

It is universally accepted that technological change and other kinds of innovations are the most important drivers of economic growth, productivity and increase utilization of available resources and material welfare. For Africa to pull itself out of the doldrums, it needs to develop regional innovation systems that are based on local and indigenous knowledge. Furthermore, it needs to develop integrated value chains that seek to add value to raw material available in the continent. This will eventually help the continent to implement the Africa Continental Free Trade Area. This implies that the infusion of science diplomacy in the diplomatic transaction in Africa is urgent more than before.

Scope of Collaboration Through Science Diplomacy in Africa

Exploring opportunities for collaboration, which could be Interdisciplinary collaboration or Regional and Global collaboration United Nation's Sustainable Development Goals provide a mechanism for generation of collaborative research. Think tanks need to start enhancing collaboration amongst themselves as opposed to each operating in isolation.

Organizations like the Council for the Development of Social Science Research in Africa (CODESRIA) need to be popularized. Most scholars, especially young researchers, may not be aware of organizations that promote collaborative research. Researchers need to be challenged at individual level to collaborate with others nationally, regionally, and globally. Going transnational is key in development research. Research needs to embrace cross-disciplinarity, trans-disciplinarity, trans-nationality, and so on.

There is a great need to endeavor to engage in impactful research. Steps to be taken should be those that take the continent and the society forward. This approach can advance research significantly above past practices. The International Social Science Council has now transformed into the International Science Council where the humanities and social science have merged. This is an indication of the narrowing divide between the two knowledge sectors.

There is a lot that Africa can tap from through collaborative research and just allowing different sectors to work together toward development. There is need for institutions to be ready to capitalize on the available opportunities/funding to steer forward their agenda.

Exchange programs need to be enhanced. This could point toward institutional readiness to implement policies that are adapted from diverse sources. Enhancing existing proven and resourced approaches, and upscaling them through reformed initiatives can be robust. Allowing universities to come together and develop collaborative centers of excellence as opposed to each neighboring university working in isolation with its limited resources can improve the creation and deployment of knowledge.

Policy Recommendations

For Africa to participate in the global knowledge through science diplomacy, following points must be considered:

(i) A strong focus on capacity building and skills development in multidisciplinary research.
(ii) High-quality educational and research institutions equipped with adequate facilities for multidisciplinary research.
(iii) A strong need to develop and support a coherent strategic approach to policy making on multidisciplinary research infrastructure in Africa.
(iv) Establishing continental research infrastructure that allows several researchers/partners to undertake common research in multiple locations and countries.
(v) Facilitating multi-country initiatives to a better use, development and sharing of research infrastructures.
(vi) Establishing a continental roadmap for multidisciplinary research infrastructure development including developing new ones and upgrading existing ones as need arises. This will hopefully stimulate the implementation of an interdisciplinary research agenda.
(vii) Ensuring follow-up of implementation of ongoing interdisciplinary research projects.
(viii) Fostering networking and improvement in the efficient use of national and continental research infrastructures.

To realize the benefits of science diplomacy, Africa must improve the uptake of research findings by:

(a) enhancing the application of knowledge gained in research through data collection and storage systems as illustrated in Fig. 16.1.
(b) moving into the knowledge-based economy, this will require that knowledge be placed at the center of development.

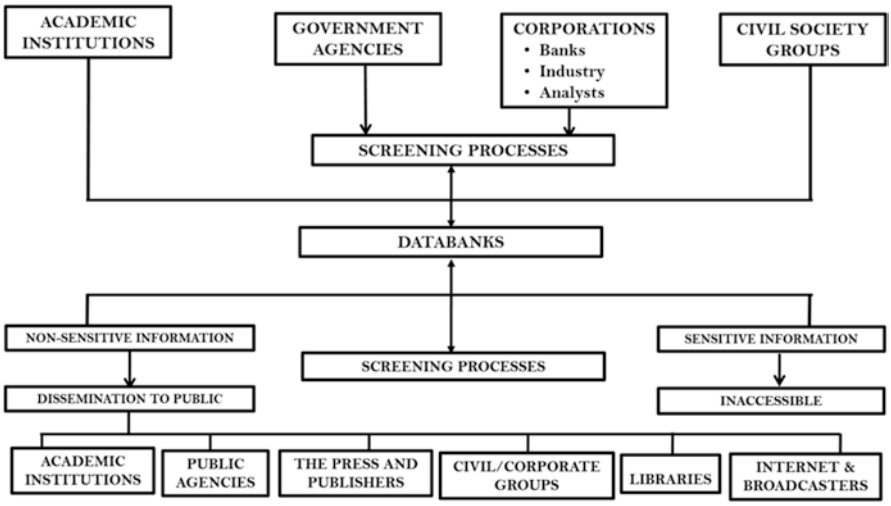

Fig. 16.1 Data storage and management systems that can support diplomacy (Inyang, 2011)

(c) enhancing research funding by assisting universities to generate their own funding while developing indigenous knowledge, that is, home-based knowledge. They must balance between being knowledge-based institutions and being production of public goods. In essence, universities must be encouraged to begin making money out of their research. For this, collaboration of universities across the continent is key.

In view of this, universities must change:

(a) to well-informed decisions about policies, programs, and projects by putting forward the best available evidence from research,
(b) policy makers make hierarchical judgments on what evidence to use, when, and how,
(c) different forms of evidence do not share equal importance, relevance, or weighting; hard evidence/empirical data that is often used,
(d) tacit knowledge, practice/experiential knowledge, and voices of ordinary citizens are equally valid forms of evidence.

Science diplomacy will not succeed in strengthening the infusion of science into diplomatic transaction in Africa if:

(i) there is generally low investment in research.
(ii) taxation of research equipment which tends to generally affect the level of research activities in Africa.

(iii) funding is tied to administrative bureaucracies. Most universities in Africa are faced by slow procurement systems.
(iv) most researchers are faced with the problem of competing priorities i.e., teaching and research.
(v) institutions of higher learning in Africa rely on funding from outside/foreign funding. Where this fails, researchers fail to receive the required funding for their work.
(vi) lack of trust among institutions resulting from accumulated debts.
(vii) universities in Africa lack state of the Art facilities for research and innovation
(viii) most institutions being unable to honor their part in maintaining centers of excellence for research and innovation.
(ix) there are restrictive Immigration laws such as visa requirements that prohibit the mobility of researchers within the continent.
(x) Africa still experience Brain drain: more people trained in Africa leaving the continent. This reduces the pool of human resources to tap from during critical moments.
(xi) the need for National STI Roadmaps across Africa.

Broader relations among countries depend on their diplomatic relations. Such relations are strengthened by the geo-politics and strategic interests of nations, in which soft power plays a limited role (Fan, 2008). Science diplomacy is not restricted to one specific aspect of science and technology but covers a range of different activities that includes support for academic exchange, international cooperation, and provision of scientific advice. Lately, there has been a growing trend of infusing science into the diplomatic scientific transactions in such areas such as water, biodiversity, health, and medicine diplomacy. It is a fast-growing field of research, education, and practice that is dedicated to better understanding of the connections among science, technology, and international affairs (Mauduit & Soler, 2020). The clear fit is still elusive. Thus, the practice of science diplomacy encompasses a spectrum of roles, organizational configurations and professional profiles needed to align science with a traditional career patch of diplomats (ibid.). It reflects the existence of two distinct career paths, that is, scientists and diplomats with different values, knowledge, and skills needed to be integrated to produce diplomats that can apply science diplomacy (ibid.). According to Mauduit and Soler (2020), education personnel in science diplomacy requires a further exploration of the knowledge and skills scientists and diplomats should learn from and about each other to work closer together.

Conclusion

Science diplomacy has been successfully utilized by many countries to strengthen their systems of innovation. For instance, in response to domestic needs for technology and science, apartheid South Africa pursued science and

technology solutions that focused on mitigating the impact of sanctions. It paid special attention to technologies that could strengthen the state's security. Examples are those for iron processing and steel production, energy, nuclear technology, and bio-warfare technologies (Simelane et al., 2015).

This means that prior to the 1994 transition to democracy, the government of South Africa was selective in its science diplomacy transactions. It focused specifically on areas that were important to the state needs such as strengthening the military expertise of the country through steel producing industries, nuclear capabilities, and associated industries. This approach enabled South Africa to sustain economic activities amidst international sanctions (Masters, 2016). It forged relationships with countries that had advanced technologies such as Israel, Germany, United States of America, Britain, and others (Simelane et al., 2015). This approach can be replicated by other countries in Africa, especially those that have weak national systems of innovation.

Across the world, science and technology have been utilized by many countries to enhance their productivity and economic and socio-economic development (Lord & Turekian, 2007). A good example is China that positioned itself as a producing capital of the world. This subsequently improved China's national system of innovation such that today China is one of the top countries in the world that has advanced system on innovation. For Africa science diplomacy is the only mechanism through which the continent can acquire various forms of technologies for its development (Ruffin, 2018). For the continent to achieve this, it needs to present a united front, just as it did with the acquisition of COVID 19 vaccines. To sustain the momentum, the African Union must develop and empower its diplomats through training on diplomacy and science, technology, and innovation. The core group can be people with backgrounds in science such as scientists, engineers, medical doctors, and others who can be coopted into diplomacy through special training in international relations. This will infuse science into diplomacy and help Africa to gain strength in addressing global issues. Africa's science diplomatic potency was witnessed during the climate change negotiations, where African diplomats presented a united position for developing countries to have a more say on climate change matters and how the world can share technologies for mitigating the impacts of climate change.

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