Scientific mobility and institution building in science in developing countries

Thematic Paper

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1. Introduction

This paper develops further a thesis on the "de-institutionalisation of science" in developing countries (Waast and Gaillard, Waast and Mouton, 2008) as it pertains to scientific migration. One of the prevailing arguments about scientific migration, and specifically about so-called "brain circulation", is that the movement of scientists and academics between institutions and countries is in fact a positive feature of the modern global world. The argument is that in addition to the benefits that accrue to the individual in terms of new experiences, competencies and networks gained, there are also obvious benefits to the returning country. Once a scientist returns to his or her country, the local institution (university or research institute) also benefits in a multitude of ways. The recently acquired academic capital translates into new networks and future exchanges, new knowledge and skills are applied to solve local problems, new insights and understandings of a scientific field are incorporated into curricula which are of immediate value to students and so on.

The conceptual lineage of the brain circulation approach can be traced to elements of the sociology of science, in particular the (Mertonian) notion that scientific nomadism is an inherent feature of the development and advancement of science (Meyer et al., 2001). Much of the literature on brain circulation focuses on the dynamics and the potential of the Diaspora knowledge networks in contributing to development in their home countries (Meyer & Brown, 1999; Meyer, 2003; Song, 2003; Teferra, 2004; Tettey, 2003). Meyer and Brown (1999) offer the most comprehensive analysis of the nature of the Diaspora knowledge networks, identifying 41 expatriate knowledge networks that have been established in some 30 countries since the early 1980s.

The brain drain paradigm, according to these authors, is premised on human capital theory, which treats labour or human capital as a fixed asset that is manipulable. As a consequence, the policies that have been devised to address it assume that governments can intervene to reverse the brain drain itself, if not its effects, by determining or shaping their national labour markets. In contrast, the starting point of the brain circulation framework is that the international mobility of human capital is governed by (global) market considerations, over which individual governments have no control (Cao, 1996). Further, the international mobility of highly skilled personnel (HSP) is seen as a contributor to, and also a consequence of, globalisation and, as such, should be seen as one of the indicators of the interdependence and convergence of the world economy. As one of the earliest proponents of this thesis, Cao (1996) has argued that what is usually regarded as 'brain drain' should rather be seen as an ongoing and global phenomenon that is neither permanent nor irreversible.

Therefore, instead of devising policies and strategies that seek block or hinder the mobility of HSP, Cao's advice to developing countries is that they ought to manage it by creating a favourable domestic (political and economic) climate that will make it possible not only for their skilled émigrés to return, but for these countries to attract other (developed) countries' HSP as well – hence his notion of a brain 'exchange'.

The problem, however, is that not only does this advice sound very much like that which used to be dispensed by the IMF to struggling economies in the South *via* its Structural Adjustment Programmes: if only the developing countries could embrace the free market principle of liberalising their economies by lowering or breaking down their tariff barriers and introducing flexible labour markets, all will be fine. And, as we know, this remedy didn't work for the developing countries. As Meyer et al. (2001) have noted, the international mobility of HSP is not simply a consequence of a neutral and/or market co-ordinated operation of the global supply and

demand of labour. These knowledge flows are also, and perhaps pre-eminently, influenced by the highly selective nature of the immigration policies of most OECD countries.

What is usually cited as evidence of this paradigm shift are the experiences of countries such as Australia, New Zealand, Canada and some countries in Western Europe (including the UK) who have lost skilled workers (mostly scientists and engineers) to the United States and have, in turn, been able to replenish this loss through their ability to recruit and attract skilled workers from other countries, especially developing countries. This then means that the notion of a 'circulation', or the multi-directional mobility of skilled personnel, is largely to found only within the developed countries, especially within the OECD, rather than between the North and the South. Further, the claim that the mobility is no longer unilateral (from poor to rich countries) but is now multi-directional and global is also not borne by the evidence, since most of the émigrés in the diaspora not only do not return to their home country, but they seldom move to third or fourth countries (Meyer et al., 2001). Thirdly, although the existence of transnational professional networks is seen as crucial in facilitating return, there is no evidence that these diasporal networks – which are usually cited as evidence of this 'paradigm shift' – have had any effect on the brain circulation itself.

So with the exception of the OECD countries mentioned above, there is very little evidence of a reverse flow of skilled personnel – and thus a circulation – taking place from developed to developing countries; in other words, most of the brain circulation is highly asymmetric (Parthasarathi, 2006). Although there is certainly some counter-movement in the form of short-term visits back to their home country by many émigrés', these periodic visits do not by any means constitute an indication of a sustainable and long-term trend. Indeed, many developing countries, especially those in Africa and Latin America, continue to experience a unidirectional and permanent outflow of their skilled personnel to the industrialized North (Kapur, 2005; Lowell, 2004; Parthasarathi, 2006).

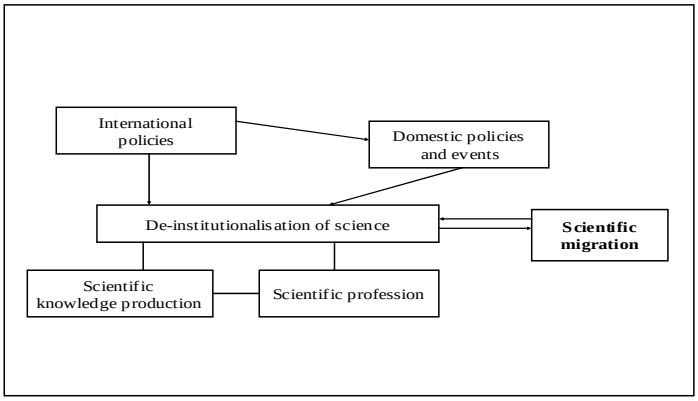
Thus, our argument in this paper is that the "brain circulation" thesis, as it has been referred to, is premised on (incorrect) assumptions about equal and symmetrical flows of highly skilled personnel (HSP) between countries and that the circulation and mobility of scientists across different countries and institutions occurs where there are reasonably strong and well-resourced institutions. Scientists returning to a country where there is a science system that is well-funded, properly governed and where research institutions are properly managed as well as adequately resourced are in fact able to "give something back" (cf. Thematic Paper 1). This is why many South African scientists on return, are able to invest their newly acquired knowledge and experiences in their institutions. The South African science system is in most respects a modern and self-sustaining research system with many strong and internationally acclaimed universities. But this is not the case for many countries in the rest of Africa. Our argument, therefore, is that the effects of scientific mobility on weak and dysfunctional institutions are quite different and the worst effects of "brain drain" are apparent in these systems.

We argue that the institutions of science in many sub-Saharan countries have been systematically eroded and broken down over the past three decades through various international economic policies as well as the devastating effects of domestic policies and events. The cumulative effect of these policies over time has had various impacts – a decline (at least in relative terms) in scientific output, changes in modes of scientific work, the devaluing and degrading of the profession of science and, of course, the brain drain.

But the relationship between the state of the institutions of sciences and the brain drain is a reciprocal one – the continuing decline of human capital in science and technology through the brain drain has become itself a major cause of the de-institutionalisation of science. We are indeed witnessing a spiralling of effects (a true "vicious circle") where the continuing drain of high level human resources in many developing countries continue to weaken the institutions of science which

in turn cause more scientists to turn away from "normal" scientific practices and increasingly to seek employment elsewhere. Our research interest, then, can be represented in the following diagram:

Figure 1



Our discussion in the next section is devoted to the recent history of university research in sub-Saharan Africa and specifically the impact that the decline of these institutions have had on scientific knowledge production.

2. The decline of university research in Africa

The central role of the modern research university within the knowledge economy is now generally appreciated. Although it is recognized that knowledge is also produced outside the university, there is – if anything – greater appreciation today of the critical role and function of the university in the production of scientific knowledge. There is every indication that the central role of the university in modern day knowledge economies will only increase as the economy and society become even more reliant on knowledge.

However, it is not self-evident that this trend necessarily applies to universities in many poor and developing countries and specifically not to many sub-Saharan African countries. In many of these countries the university is often the main, if not only, site of scientific knowledge production. Unlike many of the developed countries in the North, these countries do not have an abundance of private research laboratories or well-resourced government institutes. Such countries rely heavily on these universities for the production both of basic research as well as being a reservoir of applied and problem-solving research and the production of highly skilled knowledge workers. Unfortunately, as we will argue, the research capacity at many of these institutions has over the past thirty years gradually been eroded to the extent that one could not refer to these universities as vibrant and sustainable scientific institutions in the normal sense of the word. In fact, one could claim that science in many African countries has, in the recent past, been systematically de-institutionalized!

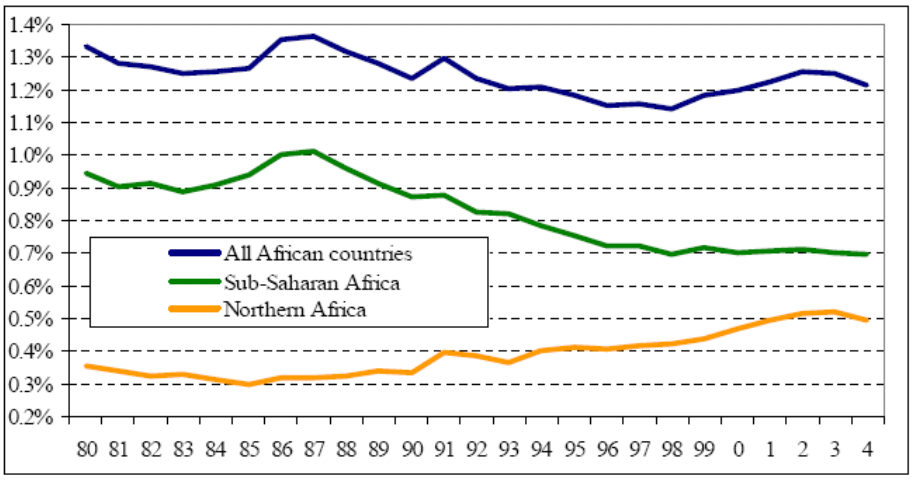
Various international forces associated with globalization and internationalization of trade in the 1980s and 1990s have had a devastating effect on the economies of many African countries: the decline in export volumes as well as the relative decline in the price of primary products in world trade in the 1980s and 1990s, combined with the mishandling of exchange rates and of external reserves, and the huge external debt overhang together created major resource gaps for the countries of Africa. This put serious pressure on their import capacity and the availability of resources for essential economic and social investment. The result was an increased dependence of the typical sub-Saharan Africa country on aid from the developed countries.

At the same time international agencies, most notably the World Bank, decided to privilege expenditure on basic education at the expense of support for higher education. This policy position was based on two premises: The first was the belief that the returns to investments in primary and secondary education are higher than those to higher education. The second reason related to concerns with equity and access to basic education which would naturally lead to an emphasis on primary education to the exclusion of tertiary education. The result was quite predictable with many universities thrown into financial crisis, laboratories and libraries not receiving any maintenance, overcrowded lecture rooms and huge flight of the top academics from these institutions. A very good example is the case of Makerere University as described in Mamdani's recent book (2007) *Scholars in the marketplace*.

Research and scholarship would be one of the main losers during these years. Africa's share of world science, as measured in papers published in the citation indexes of the Institute for Scientific Information, has been declining steadily over the past two decades. Various earlier studies by Gaillard, Waast and other have looked at this issue, but arguably the most comprehensive and up to date bibliometric analysis of these trends is captured in Robert Tijssen 2007 article in *Scientometrics* (*Africa's contribution to the worldwide research literature: new analytical perspectives, trends, and performance indicators.).*

In his analysis, Tijssen shows how sub-Saharan Africa has fallen behind quite dramatically from a world share of 1% in 1980 to 0.7% in 2004 with no sign of recovery (Figure 2). The diminishing shares of African science overall do not reflect a decrease in absolute sense, but rather an increase in publication output less than the worldwide growth rate. Africa has lost 11% of its share in global science since its peak in 1987; Sub-Saharan science has lost almost a third (31%). The countries in Northern Africa; Egypt and the Maghreb countries (Algeria, Mauritania, Libya, Morocco and Tunisia) accounted for the modest growth of the African share of the worldwide output during the years 1998-2002. Part of this decline of Sub-Saharan science can be attributed to discarding African journals from the *Citation Indexes*. Notably, the number of South African journals dropped from 35 to 19 during the years 1993-2004.

Figure 2. Trends in African research article output in the international journal literature (1980-2004): % of worldwide publication output in the international peer-reviewed journal literature.



Source: CWTS/Thomson Science Citation Index database (excluding the Arts and Humanities Citation Index).

In a detailed analysis of the individual citation profiles of a selection of countries, Tijssen clearly demonstrates that there are huge inequalities in knowledge production across the continent. For example, within the group of the seven largest countries, South Africa and Kenya are out-performing the other five in terms of average citation rates, the share of publications cited, and the

field-normalized citation scores. As Tijssen argues, it seems reasonable to assume that this performance is partly a cultural heritage from their English-language science systems that help to sustain or enhance their visibility in English-language dominated international research literature. The Northern African countries, traditionally more focused on the Arab world and the French-speaking scientific world, are at a disadvantage.

Bibliometric analysis of research output is only one measure of the relative decline of research and scholarship at many African universities. Numerous studies have been conducted over the past 10-15 years that demonstrate quite convincingly that research at former well-resourced and supported institutions such as Makerere University in Uganda (cf. Mamdani, 2007), Ibadan in Nigeria and University of Dar es Salaam in Tanzania have deteriorated; that research infrastructure and the general state of laboratories at many institutions has suffered from a lack of maintenance and timely replacement of old equipment. In addition the generally poor quality of library resources has not improved significantly with many university libraries not even using automated management systems; the demand for sufficient research funding for ongoing research and scholarship continued as does the need for proper research management and support at most of these institutions.

The cumulative effect of the funding policies of the last two decades of the previous millennium, the huge growth in student enrolments in higher education institutions, combined with continuing political instability in many African countries have created a state of affairs which is best described as the "de-institutionalization" of science. We elaborate more on what we mean by this in the next section.

3. The de-institutionalisation thesis

Science systems in developed and highly industrialized countries have a certain number of clear and evident features. Such systems are dense (well-populated) with highly articulated scientific institutions. We use the term "scientific institution" in a rather broad sense as referring to any formal organization or entity which is dedicated to the pursuit of scientific knowledge production, dissemination and utilization. This definition includes bodies that perform R&D such as university centres, laboratories and institutes as well as R&D performing entities outside the higher education sector. But it also includes scientific publishing houses, journals, conferences, workshops and seminars which are "organizations" for the dissemination of scientific knowledge. And it also includes bodies such as technology incubators, technology transfer offices, patenting offices and so on that promote the utilization and commercialization of scientific knowledge.

In a modern science system there are typically a multitude of these scientific institutions that perform clearly articulated functions and roles and together constitute what could be termed the "national mode of scientific production". The "national mode" means that science is conducted for the public good and that the direction of science is shaped and steered by a nation's most pressing socio-economic needs. It also implies that the state assumes a major responsibility for financing research and development activities.

Many of the scientific institutions in Africa are fragile and susceptible to the vagaries of political and military events and are severely under-resourced and suffer because of a lack of clarity and articulation of science governance issues (demonstrated by constant shifts in ministerial responsibility for science). In fact, one could even refer to some of these science systems and the associated institutions as operating in a "subsistence" mode where they struggle to even reproduce themselves. A "subsistence mode" in this context would refer to a system that basically produces knowledge for its own use only and does not export knowledge. In fact it does not make a significant contribution in the global game of knowledge production. It is even debatable whether one can talk of a science "system" in many of these countries as they do not exhibit typical

"systemic" characteristics. Institutions are not typically aligned through input, process and output flows and there is no typical systemic behaviour in response to external changes and demands. Rather, the image of an "assemblage" of fragile, somewhat disconnected and constantly under-resourced institutions is perhaps a more apt metaphor to describe the science arrangements in some of these countries. These conditions apply particularly to many of the countries in sub-Saharan Africa (with the exceptions of South Africa and possibly Kenya, Malawi and Tanzania).

However, one should at the same time be cautious of over-generalization and over-simplification, as there are also some instances of small but robust institutions (some universities and research centres) that have survived the ruptures of political changes and economic fluctuations and where pockets of significant science are still found. In these isolated cases (for example in Burkina Faso, Botswana and more recently Rwanda), science is publicly supported by the government, there is reasonable political stability and good governance of the science system. In many of these cases, there are also well-established links and collaborative networks with strong research establishments elsewhere in the world.

But what are the factors that have in the past and still continue to shape and affect the (de) institutionalization of science in these countries? Four major historical influences on the nature of scientific institutions in sub-Saharan Africa are briefly discussed below: (1) The continuing legacy of colonial science in many countries, (2) The destabilizing influence of political events and civil wars, (3) The role of international agencies in shaping African sciences, and (4) The gradual erosion of human capital through the brain drain.

Colonial science legacy

Many of the research institutes that were established during colonial rule in Africa still exist in African countries. It is now well documented that the role of different colonial powers in the formation of scientific institutions varied greatly across continents. This is both a function of the nature of the institutions that were established as well as the "model" of "colonial" science pursued.

The British model of colonial science privileged the establishment of botanical gardens in many of the colonies as sites to conduct plant and other related research. This model was shaped by the influence exerted by the Royal Botanical Garden at Kew in London. At Lagos (Nigeria) a botanical garden was established in 1887; the Royal Niger Company also founded a garden for the distribution of plants at Asaba in 1888 and established four other agricultural stations at various locations between 1889 and 1890 for experiments with coffee, cocoa and other crops. Ghana (then Gold Coast) also had a government botanical garden in 1890 at Aburi. Interestingly enough the British did over the years attempt to give more responsibility to the colonies in steering their own research agenda's. To accomplish this regional approach to colonial S&T, research councils were created in British Africa (following the British model of a Council for Scientific and Industrial Research) which formulated regional research policies and priorities and then made recommendations on the allocation of research funds, as well as on projects assigned to institutes.

The French approach to colonial science was very different. Research done in the colonies had to be done through the mediation of institutions based in Paris such as the *Musée National d'Histoire Naturelle,* which had a section devoted to tropical agriculture and the *Ecole Supérieur d'Application d'Agriculture Tropicale,* which provided the training for Colonial Agricultural Officers. It was only the advent of the Pasteur Institute which pioneered the organisation of research activities in the region when it established local branches. The major translocation of French science in Francophone Africa occurred from the late nineteenth century onwards until the 1950s with the establishment of six local Pasteur institutes in Saigon (1890), Algiers (1894), Nhatrang (1895), Madagascar (1902), Tunis (1903), Brazzaville (1910) and Dakar (1913). Unlike the British case, only modest effort was accorded by French colonial or metropolitan authorities to the development of research activities in African colonies. Hence, the S&T activities of each institute or

territory were explicitly and implicitly assimilated and undertaken by research institutions in metropolitan France that had African branches. Moreover, the regional centres thus established were controlled by the French in terms of central management and staffing, as these centres were dominated by expatriates and no concrete efforts were made to develop the local capacity for independent research in the colonies.

It is perhaps fair to say – and somewhat ironically so – that the legacy of the French model has been more permanent and eventually more beneficial to the science systems in those countries where it became embedded. Precisely because of the strong link to the centre in France (which in many cases is still maintained today), these institutions (such as the Pasteur institutes) perform a major role within the local science systems and are examples of pockets of research excellence in the midst of a generally fragile science landscape.

However, the fact of the matter is that this situation does not of course build local scientific institutions. In fact, too great reliance on such foreign institutes may even be used as an excuse not to develop one's own institutions.

Political instability and civil wars

The destabilizing influence of many regional and local political events have led to the closing of scientific institutions (universities) in many countries and effectively put science back many decades. Events such as the civil war in Rwanda/Burundi, the Mengistu regime in Ethiopia, Amin's dictatorship in Uganda, the civil wars in Mozambique and Angola, and more recently the repressive regime of Robert Mugabe in Zimbabwe are examples. These events have had different negative impacts on institution building in these countries. In many cases it led to the suspension of overseas research funding (e.g. Sida/SAREC suspending its support to Ethiopia in the late 1990's), the closing of institutions because of lack of government funding and perhaps most notably the huge flight of top academics and scientists to other parts of the world. A good example of the devastating impact on a single institution is that of the University of Makerere in Uganda. Once a major site for internationally recognized good research in the 1950s and 1960s, it suffered because of civil war and lack of government funding in the 1980s and beyond. This has forced the University in the 1990s to take in many more students than it could support (in order to raise some fees) with the result that by the beginning of this millennium it had more than 30 000 students for a campus built for less than 15 000. It is only in recent years that student growth has been capped and a decline in student numbers has materialized.

International research and funding agencies

The role of international agencies in shaping and steering science on the African continent cannot be underestimated. In this regard we include the role of international development and aid organizations such as the Swedish International Development Agency (SIDA), the Carnegie Corporation of New York, the Ford Foundation, Rockefeller, International Development Research Centre (Canada) and many others as well as the presence of international research bodies such as the CGIAR institutes, World Health Organization research institutes and so on. On the positive side, these institutions and agencies have, to a large extent, managed to sustain a minimal scientific production in many countries where the formal S&T structures (universities and government research laboratories) have failed or seriously declined. So, for example, it is clear that the continuing support of SIDA to Addis Ababa University in Ethiopia since 1976, has sustained a minimal scientific output in the natural and health sciences. On the negative side, it could be argued that some organizations and agencies have been more interested in pursuing their own (international) research agenda's and have not done enough to ensure the long-term sustainability of a local science base in Africa. In fact, some commentators may argue that international funding for

doctoral students through sandwich programmes (which entail spending time at a northern university), has in fact been one of the contributing factors to brain drain. Students on doctoral scholarship from developing countries who spend time at well-resourced northern universities are subsequently better qualified and certainly more networked and hence able to leave their country of origin and seek employment elsewhere.

The gradual erosion of human capital through the brain drain

General concerns in the human resource area include poor pay and conditions which have resulted in extensive and persistent brain drain. Studies sponsored by the Research and Development Forum for Science-Led Development in Africa (RANDFORUM) reveal that up to 30% of African scientists – i.e. excluding other professionals – are lost due to the brain drain (see Adeboye, 1998). According to the United Nations Economic Commission for Africa (UNECA-ECA) and the International Organisation for Migration (IOM), an estimated number of 27,000 skilled Africans left the continent for industrialised countries between 1960 and 1975. During the period from 1975-1984, the figures increased to 40,000. Since 1990, at least 20,000 qualified people have left Africa every year (*Education Today*, 2006:4).

A recent World Bank report on census and population, titled 'International Migration, Remittances and Brain Drain', indicated that 47 percent of Ghana's college-educated citizens live abroad. In fact it has been estimated that about 90% of all Ghanaian graduates have attempted at one point or the other to travel overseas. Although remittances are growing, in the words of Kwesi Andam, "nations are built with brains, not with absentee dollar remittance" (quoted by *Adomako, Appiah Kusi 2006 Ghanaweb Feature, 29 August 2006)*. The report notes that about 50% per cent of the 'highly-educated' Ghanaians have migrated – mainly to more developed countries such as the United States, Britain and others within the OECD. Although brain drain cuts across sectors of the Ghanaian economy the health sector has received much attention in recent times. For example, Samuel Owusu-Agyei, Ghana's Deputy Minister of Health, expressed regret that out of the over 73 members of the Class of 1986 medical graduates, only 23 were currently working in Ghana with the rest working abroad.

Another recent United Nations report on International Migration presented before the 61st UN General Assembly in August 2006 points out that "Between 33 and 55 per cent of the highly-educated people of Angola, Burundi, Kenya, Mauritius, Mozambique, Sierra Leone, Uganda and the United Republic of Tanzania live in the countries of the Organisation for Economic Co-operation and Development (OECD).

In a 2007 survey of the state of public science in the fourteen countries of the SADC region, the results showed that about 20% of scientists and scholars seriously have given some consideration to leaving their universities and countries to look for employment elsewhere. When the results were disaggregated and South African respondents compared to the other thirteen SADC countries (Angola, Botswana, DRC, Lesotho Madagascar, Malawi, Mauritius, Mozambique, Namibia, Swaziland, Tanzania, Zambia and Zimbabwe), it revealed that nearly 25% of respondents from other SADC countries responded in the affirmative to the question: Do you plan on moving to another country in the near future?

Table 1 Do you plan on moving to another country in the near future?

RSA versus rest			Frequency	Column %
South Africa	Valid	Yes	33	14.0
		No	202	86.0
		Total	235	100.0
Other SADC	Valid	Yes	93	24.8
		No	282	75.2
		Total	375	100.0

The costs of migration of professionals from African countries have been huge. The United Nations Commission for Trade and Development study reported in 1996 estimated that each migrating African professional represented a loss of US$184000 to Africa. The overall estimate is that Africa spends about US$4 billion on expatriates' salaries and other emoluments every year. In 2000, Bundred and Levitt reported that there were about 600 South African doctors registered to practice in New Zealand alone. The cost to the South African taxpayer was estimated at US$37 million.42 However, these figures today are underestimates because the original studies had been done 5-10 years ago.

In summary: We have argued that scientific institutions in many developing countries in sub-Saharan African have declined significantly over the past three years in terms of basic research capacity and production. This decline has eroded the capacities of these institutions not only to do research, but also to teach advanced programmes (such as doctoral programmes). We have focused on four main factors causing this decline: the colonial legacy, international economic and funding policies, the role of civil war and political instability and the devastating effects of the flight of human capital. As we indicated in the first section, we need to see the brain drain now only as one of the negative consequences or effects of the systematic decline of these institutions, but also increasingly as one of its enduring causes. What are the effects of the de-institutionalization trend on the modes of knowledge production? We turn to this topic in the next section.

4. "De-institutionalisation" and modes of knowledge production

Much of current scientific inquiry at many institutions in developing countries is under-funded, is often driven by the individual scientist's priorities and interests and is ultimately aimed at advancing the career of the individual academic. We elaborate on these points.

Investment in Research and Development in the majority of African countries is low. Despite commitments by ministers of science and technology to strive towards investing at least 1 percent of Gross Domestic Product on R&D annually the reality is that most countries spend less than 0.2%. As a result very few governments support public research through a national system of research grants and scholarships. This also explains the high reliance of many African scientists on foreign funding. The solution is straightforward. The symbolic commitment to increased investment in R&D by African governments needs to be put into practice. It seems as if, despite the rhetoric, governments still view research and knowledge production as a luxury given the huge pressures on addressing socio-economic challenges such as poverty, infectious diseases, food security and so on.

Since funding for research is not channelled through a properly articulated and monitored system of public funding (e.g. through a national funding agency), the individual scientist and academic at a university receives his or her funding directly from foreign funders (or through the mediation of a

local representative). Those who are privileged to receive such funding use it to pursue their own research interests (not surprisingly) and also to advance their own careers. This allows them to travel overseas, attend international conferences and in general have the required resources to build their own individual research capital. . This focus on building one's own curriculum vitae must be understood within the context of poor academic salaries and working conditions and a general lack of sufficient research and library resources. But, this kind of scientific endeavour rarely converts into building institutional research capacity. It is not linked, for example, to training doctoral or even post-doctoral students. In fact, the fact that there are so few doctoral programs at many of these universities means that "reproducing" existing scientific work through doctoral students is not even possible.

The focus on the individual's own research interests and advancing his or her own career, also means that such scientific endeavours are is not cumulative over time and does not culminate in the building of a program or centre of excellence that can act as a platform for future research and post-graduate training at an institution. Again, there are exceptions such as the highly successful Ethiopian Flora project that has been supported by SIDA/Sarec since 1975. But this program is an exception precisely because the support was lengthy (nearly three decades), focused (it prioritized on domain of science) and was augmented with post-graduate student training.

Many of the constraints and poor working conditions continue to persist in many low-income countries forcing many academics increasingly to revert to consultancy work – oftentimes for international agencies and governments rather than for local agencies. In a recent study of public science in the SADC region[1], we collected data (one of the first studies of its kind) on the extent and nature of consultancy activities in these countries. A major finding of our research is that two thirds of all academics in the region regularly engage in consultancy.

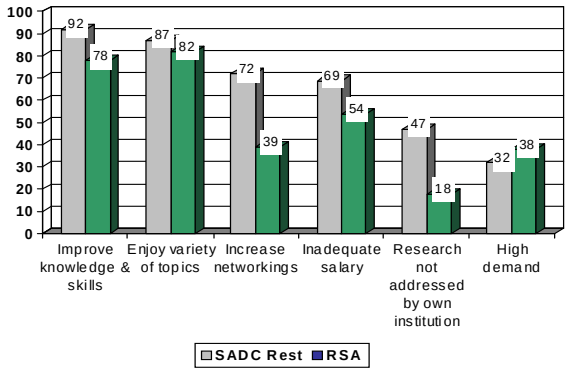
What are the main reasons respondents provided for engaging in consultancy? Figure 1 below presents a comparison of the South African and other SADC responses. There are some noticeable (and statistically significant) differences. In two areas we notice very little difference: first, the fact that consultancy is undertaken because the respondent enjoys the variety of topics that this brings (87% vs. 82%); second, that consultancy is done because of the demand in the market (32% vs. 38%).

But the other reasons provided demonstrate large differences between the South African and other respondents:

- Inadequate salary is cited as a reason by significantly more SADC respondents: SA (54%)/ SADC Rest (69%);
- Consultancy advance my networks and my career: RSA (39%)/ SADC (72%);
- My research interests are not addressed by my own institution: RSA (18%)/ SADC (47%);
- Consultancy improves my knowledge and skills: RSA (78%)/SADC (92%).

[1] Study conducted by the Centre for Research on Science and Technology at Stellenbosch University under commission for the Southern African Regional Universities Association (SARUA). Final report to be released by the end of 2008.

Figure 1: Reasons for consultancy



A further breakdown by scientific field revealed significant field differences but mostly in the expected direction. Respondents in very applied fields (where there are close links with industry and also government) such as applied sciences and technologies, earth sciences, engineering, material sciences and also social sciences (with policy work) reported high percentages of consultancy engagement. In other fields such as Mathematical sciences little consultancy opportunities exist.

In a recent article (entitled "*Most of our social scientists are not institution based: they are there for hire – Research consultancies and social science capacity for health research in East Africa*") Daniel Wright (2008) focused in some depth on the lack of social science capacity as it pertains to Aids/HIV-related research in Africa and especially on the ethical and political roots of this. According to him "the main explanations for limited research capacity have been identified in the literature as: inadequate resources for education at every level; the drain of expertise to the North; dependence on Northern research funding; inequitable access to the literature; unbalanced North-South research collaborations and poor support from government. Some see the perpetuation of inadequate research capacity as replicating the imbalance in global trade relationships and essentially semi-colonial. Others assume the good intentions of funders and research partners, but identify the perverse consequences of North-South collaborations, such as poaching senior researchers from local institutions. Either way, limited research capacity in Africa should be an ethical issue for Northern researchers working there (2008: 111).

Wright conducted an exploratory study (interviewing 29 scientists) in three African countries: Kenya, Uganda and Tanzania. His findings are consistent with our finding (reported above) and provide further support to the de-institutionalisation thesis. Wright found that most of the research work conducted by social scientists in East Africa is in the form of consultancies. The proportion of academics' time spent on them is unclear, but most estimates were around 50% of working time. Teaching takes up much of the rest, with very little for academic research.

According to Wright (idem: 113): "Extremely low university salaries create a powerful incentive for consultancies. A research associate's salary might be $250/month, while consultancies can pay $100-$250/day. In one research institute consultancies augment salaries from around $400/month to about $5000. Furthermore, in contrast to regular salaries, most researchers can avoid declaring consultancy fees for tax (30%). Research commissioners, predominantly government departments or NGOs, usually seek a contract with individuals, or sometimes consultancy firms, but rarely with university departments. Private consultancy firms, often constituted for a particular brief, usually employ university staff to help with the bid and subsequent research".

Wright also comments on the impact that the consultancy culture as on "normal research practice" and the effects on the development of future research capacity. As he observes: "Financial insecurity leads researchers to take on any work available, and consequently: There are no research traditions being developed" (ibidem). Not surprisingly, "the CVs of highly experienced researchers often list numerous consultancy reports but very few journal publications, jeopardising their applications for senior jobs. The conflict between consultancies and academic publications reportedly generates a professional culture in which: 'the point is to try and chase the quick money, and not take advantage of the chance of academic growth" (ibidem).

Consultancy research invariably leads to an "individualised" (Wright's term) form of research. In our terminology – it is essentially anti-collaborative and does not in the whole contribute to any form of institutional-building. It simply further reinforces the trend towards de-institutionalization and overall weakening of universities in these countries.

5. Restoring scientific institutions

The argument presented in this paper has aimed to emphasize the link between brain drain (the unequal movement of scientists between countries) and the state of scientific institutions. Where there is an asymmetrical flow of scientists from developing to developed countries (as is well-documented), it is difficult to make the case for any positive gains from scientific mobility. On the contrary, the outflow of highly skilled scientists and academics from the developing countries in sub-Saharan Africa has had two significant consequences: first, it has severely eroded the remaining research and advanced teaching capacity at many universities (thereby adding to the de-institutionalisation trend), but second, has also meant that academics who remain in these (mostly dysfunctional and under-resourced) institutions have had very little recourse but to turn to other forms of generating income and hence turning to consultancy work. The "knock-on" effects of the brain drain on the institutions and institutional research culture have not been adequately researched nor emphasized. The loss of significant (and often the best) scientific capacity does not mean that the remaining faculty can conduct "business" as usual. On the contrary, they are often burdened by additional teaching loads (again as a means of survival) and minimal support to undertake research. The poor state of laboratories, scientific equipment, library holdings and weak ICT infrastructure are all impediments to a healthy and robust research culture. The shift towards consultancy work is logical: it is financially rewarding, does not require institutional support and helps to build individual careers and curricula vitae that make future mobility more possible.

At the policy and practical levels, it means that this trend will not be reversed simply by looking at interventions that target individual scientists (such as home coming initiatives or diaspora networks or exchange programmes). Our argument in this paper points to the key role of the institution and how the brain drain continues to erode institutional capacity and institutional research culture. Any attempt to reverse the brain drain will fail if it does not also consider interventions and initiatives that restore and eventual make these institutions sustainable research institutions.

A focus on institution-building interventions and support should be based on the following key tenets: Scientific institutions need to be understood broadly as including the R&D performing centres and institutes at universities, but also including graduate programs (especially Doctoral programs) that produce the scientists of the future and, as we have indicated above, also including the broad scientific infrastructure (publishing houses, journals, research management offices, technology transfer offices, and so on). Interventions aimed at (re-)building scientific institutions are of necessity in the long-term and must take into account the "eco-system" of science: the governance and regulatory frameworks of science in a particular country, the role of international donors and funding agencies, the social inscription of science in a society (Is science valued by the political leadership?) and the general socio-educational fabric of that society.

We conclude this paper with some practical suggestions in this regard:

Focused niche area support: Governments and international funders should be encouraged to shift their support from individual scientists to supporting research centres and institutes which either have already achieved some critical mass or have the potential to do so. Such centres should be sufficiently resourced to enable them to undertake both basic and fundamental research in critical areas of national interest and not to become completely dependent on commissioned contract research. In order for the sustainability of such centres, it is essential that one or more doctoral programs and post-doctoral fellowship schemes be linked to the activities of the centre. The establishment and support of more doctoral programs is therefore equally important. The statistics show that large proportions of graduate students in many African countries are forced to study outside of their native country (increasingly in South Africa but mostly in Europe) as there are not sufficient doctoral programs at their home institutions. The notion of a research centre which is advocated here must thus include a combination of research work as well as post-graduate training as well as a proper integration between these two components.

Training and technical advice in research management and graduate studies. Very few African universities (outside of South Africa) have well-established research management offices. Although some effort has been made in recent years to strengthen the local expertise in this field (most notably Carnegie's support of the Society of Research Administrators in Africa), this is simply not enough Our experience shows that many research managers at these universities are recently appointed, have very little knowledge how to manage the institutional research profile and how to access funding and support to do so. . In addition research directors and managers of doctoral programs require much more training and support across a wide range of skills and competencies in such areas as the supervision of graduate students, development research plans and strategies, codes of conduct on integrity in research and so on.

Continuing investment in the essential Information and Communication Technologies. Research centres and programs are in a sense the "superstructure" of science. But it depends for proper functioning and effectives on an extensive ICT infrastructure (fibre optic networks, information systems development, sufficient bandwidth, automated library management systems). Much effort and funding has over the past 5-10 years been invested in this area. However, it is clear that many challenges remain. In fact experience has shown that many universities have outdated administrative systems with archaic procurement policies that make the simple acquisition of computer equipment extremely difficult. And when they manage to acquire such equipment, the absence of a local support system (in the form of local vendors and maintenance companies) means that broken equipment often do not get repaired or replaced.

Support and funding for local scientific publishing in African countries. The dissemination and uptake of scientific research is a process which requires its own dedicated scientific institutions: journals, publishing houses, electronic repositories and data archives. One practical proposal would be to support some of the already operational University Presses (of which there are a number). These publishing houses, which are linked to universities, perform multiple functions in that they often publish local academic journals, the best doctoral dissertations that are produced at the universities and of course also worthwhile monographs and other academic books. One of the success stories in this regard is SIDA/Sarec's support of more than 20 scientific journals in Ethiopia in recent times. Through their support, Ethiopian scholars have had access to high-quality journals and managed to disseminate their research findings to both academic and non-academic audiences. However, it is equally important that such support be accompanied by proper training and technical advice in such matters as scientific publishing, editorial practices, peer review procedures and so on to ensure high quality publishing.

In conclusion: It is important to emphasize that the interventions listed above all aim to build a system of interconnected scientific institutions rather than focusing on advancing the careers of either emerging or well-established scientists. African universities need support programs that will

build and rebuild their institutions of science. There will always be a place for individual grants and scholarships that advance the career of individuals. However, in many cases the advancement of a personal scientific career occurs at the expense of building sustainable scientific institutions. In well-articulated and well-resourced science systems, one finds a "co-production" of individual and institutional scientific endeavours. In such systems, the creative scientific effort of the individual occurs within sustainable institutions and knowledge networks and in fact serves to reproduce these. Because of the fragility of African science systems after years of neglect and poor management, such mutual reinforcement and co-production between the individual and the institutional does not exist.

In the final analysis, the restoration of research institutions and their development into centres of scientific excellence will only take place if future interventions focus on re-establishing them as proper scientific institutions, i.e. institutions that are dedicated to the pursuit of science for the common good and the attainment of national goals and priorities.

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