



Centre for Research on
Science and Technology

Reviewing national research systems: A new mapping template

Johann Mouton, CREST, Stellenbosch

NACI Indicators Workshop at STIAS
22 October 2009





At its workshop held on the 6th of 7th of April 2006 at UNESCO the objectives of a proposed study on national research systems were formulated as follows:

....to learn more about research systems in developing countries, and to help strengthen research and research capacity. Thus, the project supports research on and for development so that these countries may articulate and have ownership of their systems which are key assets for their socio-economic progress.



- Mapping and stock-taking exercise
- A meta-review of studies published between 1990 and 2005
- Three scenario's anticipated
 - A reasonably complete country study is available
 - Elements of a country study are available
 - No information on the country's research system available



The review should focus on countries that meet the following criteria:

- Developing and poor countries of the world
- Non-OECD countries and also not including the newly industrialized countries
- Countries that have not already been well researched even if they fall into the two categories above
- Countries with at least some minimal R&D capacity



Africa (18): BOTSWANA, BURKINA FASO, CAMEROON, ETHIOPIA, GHANA, IVORY COAST, KENYA, LESOTHO, MALAWI, MALI, NAMIBIA, RWANDA, SENEGAL, SUDAN, TANZANIA, UGANDA, ZAMBIA, ZIMBABWE

Latin America and Caribbean (14): ARGENTINA, BOLIVIA, CHILE, COLOMBIA, COSTA RICA, CUBA, ECUADOR, JAMAICA, MEXICO, PANAMA, PERU, TRINIDAD & TOBAGO, URUGUAY, VENEZUELA

Asia (10): BANGLADESH, INDONESIA, MALAYSIA, NEPAL, PAKISTAN, PHILIPPINES, SINGAPORE, SRI LANKA, THAILAND, VIETNAM

Arab Region (12): ALGERIA, BAHRAIN, JORDAN, KUWAIT, LEBANON, MOROCCO, OMAN, QATAR, SAUDI ARABIA, SYRIA, TUNISIA, U ARAB EMIRATES



- Four regional compilations on country reviews:
 - Africa compilation (18 countries)
 - Arab compilation (12 countries)
 - Latin American compilation (14 countries)
 - Asia compilation (10 countries)
- Four regional reports
 - African regional report
 - Arab regional report
 - Latin American regional report
 - Asia regional report
- Four regional bibliographies
- A final synthesis report
- **A mapping template**



FINDINGS



- Our study has found overwhelming evidence that points to the continued weakening of scientific institutions (universities, institutes, journals, scientific societies) in SSA
- This is manifested in various interrelated dynamics:
 - Shifts to modes of knowledge production which are individualistic, non-cumulative and consultancy mode. Such research is often disconnected from national, strategic research goals which translate into fragile research institutes and the continuing decline in (institutionalized) knowledge production.
 - Continuing dependence on external (donor) sources of research funding coupled with general lack of commitment by national governments to fund and support science adequately
 - The growing lack of the the reproductive capacity of many universities (which is both cause and effect of the brain drain)

“Building blocks” of well-functioning research systems (I)



- Social inscription of science: In functional and sustainable science systems science is well-inscribed in the social and political system with high degree of legitimacy, consistent support by the national government, healthy and critical public interest in matters of science and so on. In SSA we have had different “legitimizing discourses” that underpinned some support for and investment in science. After independence it was mainly a symbolic narrative and arguments based on national pride and nationalism. Later followed a discourse informed by developmental goals (research for development), and more recently the legitimizing discourse of systems of national innovation. Whether the latter is the most appropriate needs to be interrogated of course.
- A “national” mode of knowledge production; Research that is recognized as essential in building and developing the nation. This means that the science system works to a similar goal: to contribute individually and collaboratively to building a national knowledgebase, a highly-skilled human resource base and autonomous and robust scientific institutions.

“Building blocks” for well-functioning research systems (2)

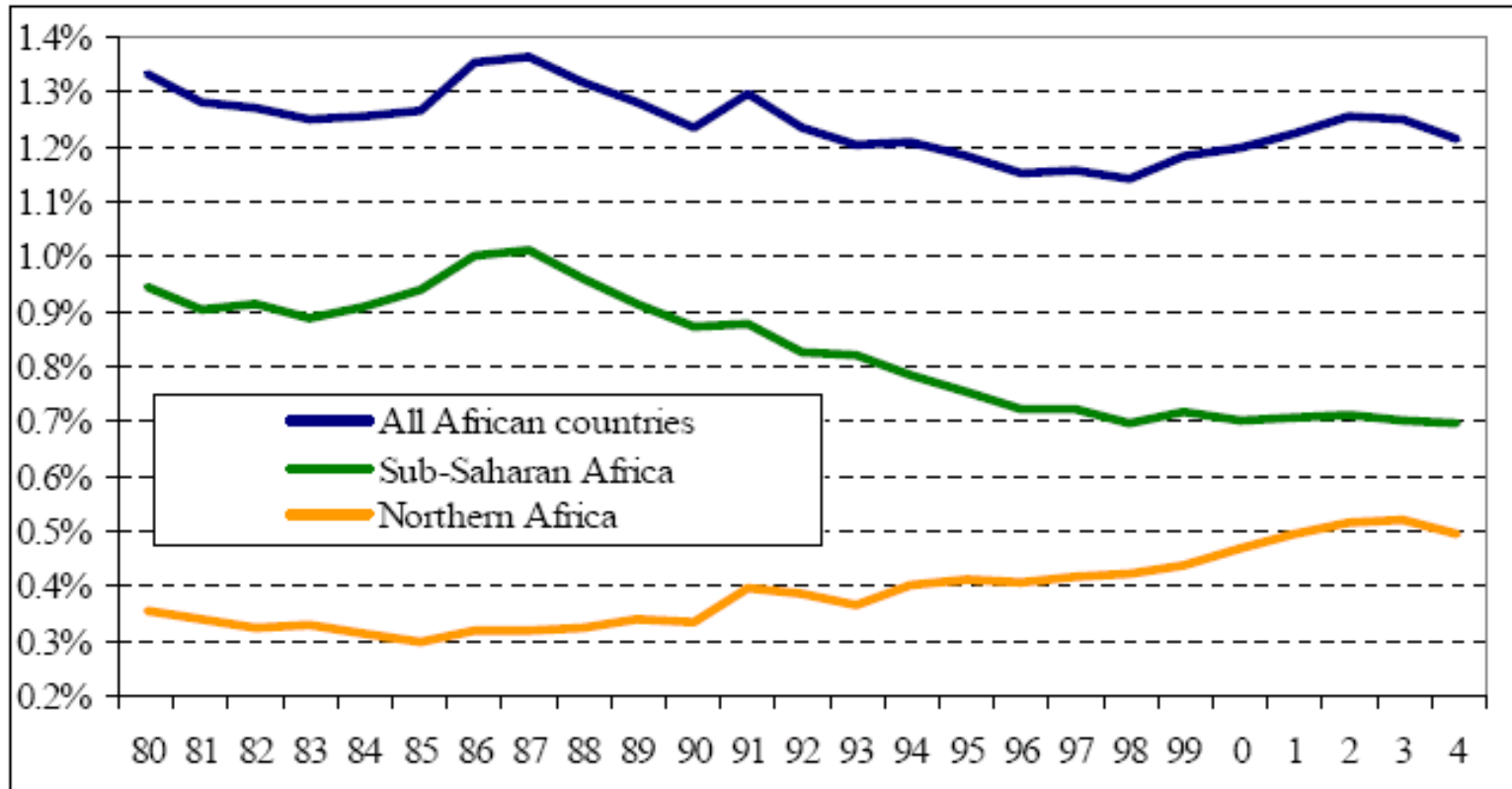


- Density of diverse institutions: Functional research systems are well-populated with a diversity of scientific institutions. “Scientific institutions” are any formal organization or entity which is dedicated to the pursuit of scientific knowledge production, dissemination and utilization. This includes bodies that perform R&D such as university centers, laboratories and institutes as well as knowledge production 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.
- Articulation of function: In a modern science system there are typically a multitude of institutions that perform clearly articulated functions and roles and together constitute the national system of science and innovation. In addition to the institutions listed above, there are bodies tasked with governance and oversight (A Ministry of S&T), with policy advice, with a national funding agency role and other lobbying and advocacy bodies.



- Decline in world-share of science
- Weakened (and weakening research institutions
- Continued dependency on foreign sources of funding
- Shifts in modes of knowledge production
- Secondary brain drain

SSA: Decline in share of world science - ISI (1980 – 2004)



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

Tijssen, R. (2007)



Numerous studies have been conducted over the past 10 – 15 years that demonstrate quite convincingly that research at former well-resourced and supported institutions in sub-Saharan Africa (such as Makerere University in Uganda, Ibadan in Nigeria and University of Zimbabwe) have deteriorated; that research infrastructure and the general state of laboratories at many institutions have 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 only recently having converted to computerised library management systems; the demand for sufficient research funding for ongoing research and scholarship continues as does the need for proper research management and support at many of these institutions.

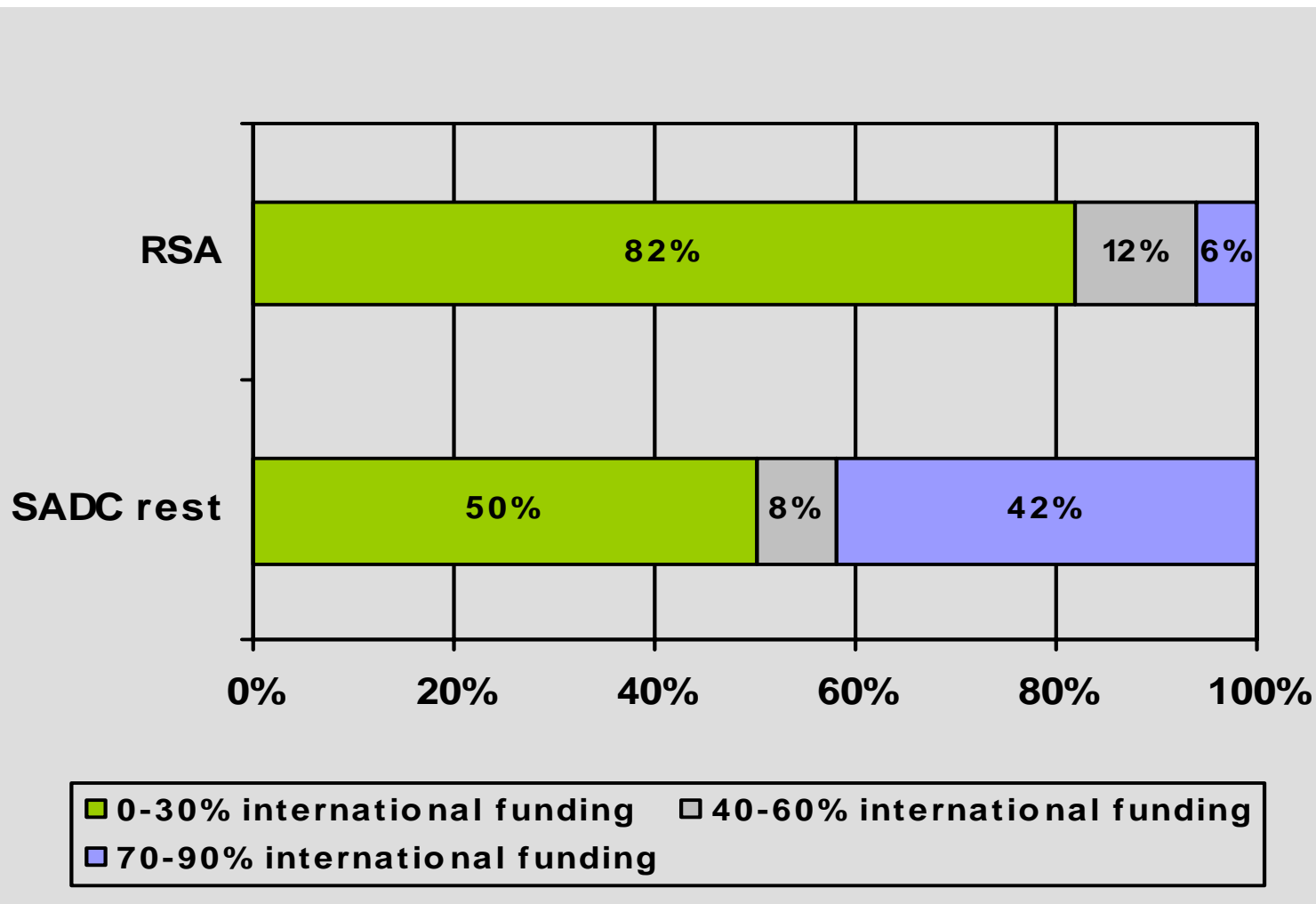
The cumulative effect of the funding policies of the last two decades of the previous millennium – especially of the World Bank, the huge growth in student enrolments in higher education institutions, continuing brain drain, combined with continuing political instability in many African countries have created a state of affairs which is best described as the “de-nstitutionalisation” of science.

Number of social science institutes by country and recency (excluding South Africa)



COUNTRY	NR OF RESEARCH INSTITUTES	ACTIVE WEBSITE	CURRENT
KENYA	18	13	12
NIGERIA	13	11	6
GHANA	18	9	7
BURKINO FASO	9	6	3
NAMIBIA	6	6	4
ZIMBABWE	10	6	2
COTE D'IVOIRE	5	5	4
SENEGAL	8	5	5
MALAWI	6	5	1
BOTSWANA	4	4	3
ETHIOPIA	8	4	4
TANZANIA	6	3	3
UGANDA	7	3	3
BENIN	4	2	1
MALI	4	2	2
LESOTHO	2	2	0
MADAGASCAR	2	2	1
CAMEROON	7	2	1
GAMBIA	3	1	0
NIGER	1	1	1
SIERRA LEONE	1	1	1
RWANDA	1	1	0
SOMALIA	1	1	0
CHAD	4	1	0
GABON	1	1	1
	149	97 (53%)	65 (43%)

Continued dependency on foreign funding: Total research funding sourced from international funding agencies



The shift towards “individualistic” and “consultancy” modes of research



- A shift towards three forms of research: individualistic (academic research), mission-driven research for government, international agencies and regional networks and consultancy research
- Given the lack of research infrastructure (strong research centres with a critical mass, sustained funding and institutional continuity) scholars end up engaging in projects that do not convert into building institutional capacity. This has been referred to as “individualistic research” (Zezeza). It is very rarely linked to the work of other scholars or doctoral students (of which there are few anyway). It tends not to be accumulative over time and does not culminate in the building of a programme or centre of excellence that can act as a node for future research and post-graduate training.



- Recent survey of nearly 800 academics in 12 SADC countries show that the majority of our survey respondents (62%) indicated that they are involved in some form of consultancy work or the other. The proportions of respondents by country that indicated that they engage in consultancy range from 50% (Lesotho) to 72% (Malawi and Zimbabwe).
- What types of consultancy are the respondents involved in?
 - 36% consult for their governments
 - 30% consult for the industry sector in their country
 - 21% indicated that they do consultancy for academics in their country
 - 8% said that they consult for academics in other African countries
 - 8% consult for governments of other African governments
 - 7% do consultancy for academics in non-African countries
 - 4% consult for industry in other African countries

Wight, Daniel (2008) "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" in *Social Science and Medicine*, Vol. 66: 110 – 116.

Extent of consultancy by scientific field



Scientific field	Yes		No	
	Count	Row N %	Count	Row N %
Engineering sciences	48	84%	9	16%
Material sciences	18	82%	4	18%
Economic and management sciences	31	78%	9	23%
Earth sciences	42	76%	13	24%
Social sciences	98	76%	31	24%
Environmental sciences	102	73%	37	27%
Agricultural sciences	91	70%	40	31%
Applied sciences and technologies	76	69%	35	32%
Health sciences	77	68%	37	33%
Arts and humanities	43	63%	25	37%
Information and communication technologies	30	61%	19	39%
Biological sciences	88	57%	66	43%
Medical sciences: clinical	24	57%	18	43%
Marine sciences	11	55%	9	45%
Physical sciences	21	54%	18	46%
Medical sciences: basic	27	53%	24	47%
Chemical sciences	33	52%	31	48%
Mathematical sciences	14	37%	24	64%
		65%		35%

Weakening of human resource base: Secondary brain drain



- In addition to the well-documented flight of high-level human capital (academics and scholars) from the African continent over the past four decades, there has been another equally devastating “secondary brain drain” - not at the level of scholars and scientists but at the level of post-graduate student. Many students in the region do not study in their home country because of the lack of adequate endogenous facilities, expertise and very often simply (in the case of post-graduate students) because there are no master’s or doctoral programme for them to enrol in. The extent of this problem is clearly illustrated by the increasing numbers of students from African countries who do not study in their home country any more (next slide).
- The countries with the highest outbound mobility rates in sub-Saharan Africa are: Botswana (87%), Namibia (65%), Lesotho (53%), Swaziland (50%), Mauritius (41%), and Zimbabwe (31%). Students from Mozambique tend to go and study in Portugal; students from Mauritius prefer studying in France as first choice. In both cases, South Africa is the second preferred destination. For the other countries on this list, South Africa is one of the top three preferred educational destinations (together with the USA and UK). Conversely, South Africa has the highest inbound mobility rate with nearly 50 000 foreign students studying in the country in 2005.

International flow of university students (2006)



Country	Students from a given country studying abroad			Top five destinations for outbound mobile students
	Total	Outbound mobility rate (%)	Gross outbound enrolment ratio	
Botswana	9246	87.3	4.3	South Africa(6889) ⁻¹ , Australia (765), UK (688)
Ghana	8336	7.4	0.4	USA (3252), UK (3035), Germany (621)
Kenya	13913	13.4	0.4	USA (7027), UK (2977), Australia (1233)
Lesotho	3995	52.6	1.7	South Africa (3826), USA (43), UK (30)
Malawi	1635	30.7	0.1	South Africa (559), UK (440), USA (392)
Mauritius	7331	40.8	7.3	France (1940), UK (1660), South Africa (1553)
Mozambique	2884	10.7	0.2	Portugal (1345) ¹ , South Africa (906), USA (111)
Namibia	6369	64.9	3.1	South Africa (6061), USA (69), UK (71)
Nigeria	18210	1.2	0.1	UK (8147), USA (6617), Germany (562)
Tanzania	3913	8.1	0.1	USA(1391), UK(986), South Africa (385)
Uganda	2373	2.8	0.1	UK (890), USA (660), Germany (12)
Zambia	3680	14.7**	0.3**	South Africa (1311), USA (829), UK (547)
Zimbabwe	15667	30.6	1.1**	South Africa (9507), UK(2658), USA (1770)



- The trend towards de-institutionalised research in SSA (with the exception of the RSA) will continue unless
 - Governments commit to more funding of R&D and sustained and adequate support of universities
 - Universities are able to invest more in research and doctoral programmes in the sciences in order to build a new indigenous generation of researchers
- Amidst all of this SSA countries will continue to
 - Depend on donor funding for research projects, networks, regional agencies, journal production
- But greater connectivity and use of web resources will undoubtedly
 - Increase the visibility of African scholarship and
 - Improve research networking and scientific collaboration in the region



Centre for Research on
Science and Technology

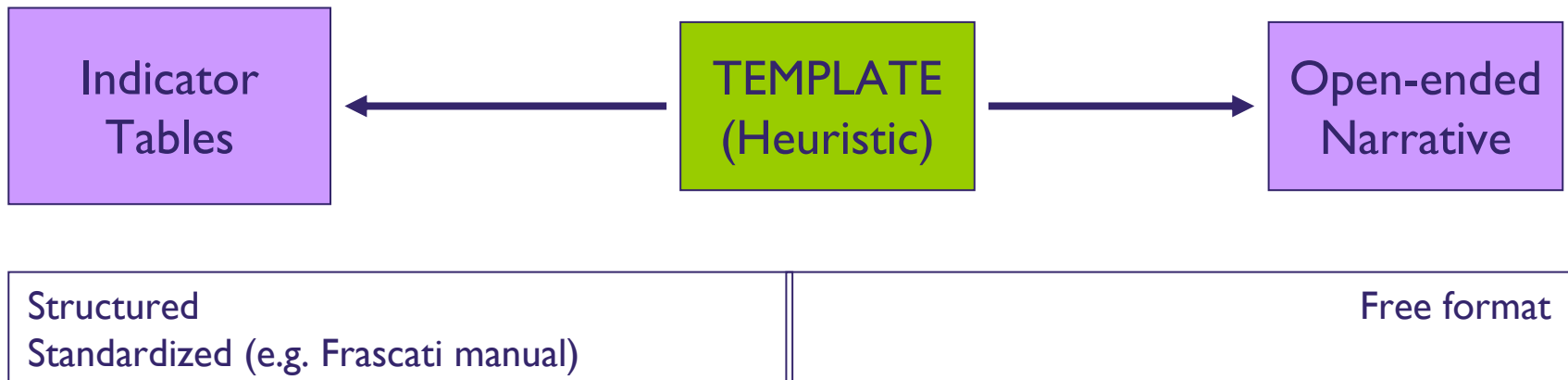
The mapping template



UNIVERSITEIT•STELLENBOSCH•UNIVERSITY
jou kennisvenoot • your knowledge partner



- Templates are heuristic devices: i. e. they are frameworks (neither completely closed or open-ended) that guide data-collection, analysis and reporting
- They can be used slavishly and mechanistically OR reflexively and critically





- **Research and knowledge indicators**

[These are standard quantitative measures that allow for statistical manipulation (e.g. construction of indices) and comparison across units of analysis]

- **Descriptors**

[These are nominal measures (not standardized) that provide basic information of quantities of units of analysis – listings of these (also chronological) allow for trend and comparative analysis]

- Chronological descriptors (establishment of institutions, societies and journals, release of policies and plans)
- Listing descriptors (lists of institutions, journals, societies, associations)
- Visual descriptors (organogram of governance of science, flow of knowledge products)

- **Narratives**

Sections of "thicker" textual descriptions and analyses that attempt to capture (historical, social, cultural) context and meaning of phenomena and are organized around themes, issues and topics



- **CONTEXT**
 - General country context
 - History of science in the country
 - Governance of science in the country
 - Informal S&T structures
- **COMPONENTS**
 - R&D Performers
 - Human resources
 - Funding
 - Research Output
 - Co-operation agreements
- **DYNAMICS**
 - Tensions, dynamics and challenges.

The template: **CONTEXT**



Category	Description	Nature of data
1. Contextualization of the science system within broader political, economic, educational and social systems	This section contains a brief narrative description of the political and socio-economic “status” or “climate” of the country highlighting significant strengths, weaknesses and major events and developments.	<i>Historical narrative</i>
	In addition a set of uniform tables listing demographic (6), social (8), economic (4) and technological indicators (8).	<i>Statistical indicators</i>
2. Some considerations about the History of science in the (country, region) under review and especially the development trajectory	Date (decade) of establishment of first research institute (s), of first public university, Scientific journals, Academy of science and/or first professional societies, Ministry for science, research and/or higher education, Science policy documents	Descriptors (listing)
	Description of specific models of scientific organization and governance as influenced by colonial and other powers historically Major periods in the institutionalization of science in country Major events shaping the development of HE and science in country	Narrative



3. The governance of science in the country and available policies (especially S&T, R&D and HE)	List of science policy, research strategy and HE documents as well as formal reviews and commissions into HE and research in the country	Descriptors (listing in chronological order)
	Research and science priorities as identified in science policy documents	Narrative
	Diagrammatic representation of science governance	Visual descriptor
4. Informal S&T structures (Academies, Associations, Journals) = Scientific Community)	National scientific journals Scientific societies and associations Academies of science	Descriptor (Listing)
	Status of main journals (still being published or not) (Historical) description of information structures	Narrative



5. Knowledge and R&D performers (Establishments/ Institutions/ Universities/NGO's)	Names of public universities, Names of private universities, Key university/college research centres, Key government funded research institutes/ centres, Key internationally funded research institutes/ centres Key private sector research facilities	Descriptor (listing)
	Description of strengths and weaknesses of the university system Modes of knowledge production undertaken in various sectors of the system	Narrative
6. S&T Human Resources (Description/s Statistics + The Profession of researcher: status, salaries, etc)	Number of researchers/ scientists in country * gender Number of academics in HE institutions * gender Nr of academics by scientific field (6) * gender Nr of Graduate enrolments * field * gender Nr of M and D graduates by field of study (Natural/ Agric/ Engineering/ Health/Social/Humanities)	Indicators
	Profession and status of academics and knowledge workers Remuneration compared to other public professions Scientific mobility and brain drain challenges	Narrative

Template: COMPONENTS



7. Research Funding (Public or private; National and international; Trends)	R&D intensity (GERD/GDP) Expenditure on R&D per researcher Expenditure by sector Source of funding (incl. overseas agencies) – actual values and proportions Expenditure by scientific field (6)	Indicators
	Role of government and other domestic agencies in funding research Role of international donor and funding agencies in funding and steering research in the country	Narrative
8. Research Output (post-graduates/ publications/ papers/ patents)	Total output in ISI-journals (by scientific field) Total output in local journals (by field) Nr of PG theses/dissertations Nr of patents Citation impact statistics	Indicators
	Description of specific policies (funding, incentive) and initiatives to encourage participation in innovation, technological learning, and research publications locally and internationally	Narrative



9. Scientific co-operation and agreements	Nr of bilateral scientific agreements Nr of multilateral and regional agreements Nr of international agencies operating in country Degree of scientific collaboration as measured through share of foreign co-authors of papers	Descriptors (Listing) Bibliometric Indicators
	Main international and regional scientific partners	Narratives
	Main institutional collaborators	Bibliometric indicators
	Domains and topics of scientific research	

Template: DYNAMICS



<p>10. Tensions, dynamics & challenges</p>	<p>Social inscription of science The ethos's of science (values) Science and the state/ contract Legitimacy/ credibility/trust/ accountability Controversies in science Science and its publics Usefulness of science?</p>	<p>Narratives</p>
---	--	-------------------



Centre for Research on
Science and Technology

Thank you

jm6@sun.ac.za



UNIVERSITEIT • STELLENBOSCH • UNIVERSITY
jou kennisvennoot • your knowledge partner