A Caribbean Approach to S&T Indicators

Report on the CCST Workshop on S&T Indicators
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Introduction

The formulation of Science and Technology (S&T) policy and the development of S&T plans and programmes for the promotion of sustainable development and innovation require up-to-date, reliable and comprehensive data on a country's scientific and technological potential as well as its resource base.

Over the past two years there has been a growing need in Caribbean countries for an information system and database on S&T statistics (popularly known as "Science Statistics"). Policy makers, particularly those concerned about planning, implementation and management of technology issues, felt the need for comprehensive information, not only on the use of input resources which comprises mainly the financial and human resources deployed and infrastructure available for S&T, but also the output of such activities measured in terms of increased productivity and increased economic growth and the use of new technologies and their impact on society. Such information is considered useful for undertaking cost benefit analysis and other economic studies as well as for efficient programming, planning and budgeting. It will also help in comparing the national S&T efforts with other developing/developed countries.

Background

S&T indicators fulfil several functions:

- signalling or monitoring: giving insight and calling attention to developments and trends in the S&T system and its environment;
- accountability, evaluation and allocation: setting and justifying S&T budgets and giving insight into the performance of the S&T system against the goals established by policy-makers and planners;
- legitimisation; support for existing policies; and,
- awareness: providing information to set aside prejudices and incorrect perceptions of the performance of the S&T system

In the public sector, statistics on S&T inputs and outputs, and the consequent S&T budget, should support the following activities:

- formulation of S&T policy, in support of economic and social objectives including analysis of the national system of innovation;
- provision of advice to ministers and other senior officials;
- support for and justification of S&T program expenditures; and,
- information on scientific activities for elected officials, journalists and other stakeholders.

Most nations have one or more governmental or not-for-profit agencies charged with collecting and analysing S&T data. These are sometimes referred to as S&T observatories. Hernan Jaramillo, in writing about S&T observatories has noted that an observatory, as an agency for collecting and processing S&T indicators:

"helps society to understand S&T development and the integration of S&T variables with other measures of economic and social development. The resulting information becomes a public good and a necessary input for the development of society."

The mandate of S&T ministers, ministries and institutions everywhere is to harness S&T to support social and economic development of the nation. In practice this means that the over-riding question to be addressed by quantitative studies of S&T activities is "What is the state of S&T in the nation?" In the case of Caribbean nations this becomes a two-fold question - "What is the state of S&T in the nation?" and "What is the state of S&T in the Caribbean".

In practice this means looking at changes in the levels of human and financial resources devoted to S&T (as inputs) and the change in the level of national development (as the desired output). Human resources for S&T are the common denominator among all nations - S&T programs are, by definition, carried out by skilled S&T professionals. In the Caribbean context, the allocation of human resources is more indicative of the distribution of S&T assets than actual expenditures. Thus it is possible to define what is, and is not, an S&T program by asking whether or not S&T professionals are a component of the program.

There are two universes which intersect: that of all people trained in S&T fields of study, and that of all people who are working as S&T professionals, regardless of their formal training. The sum of both universes is the area that is of interest to policy makers, although the policies may differ for the two. Indeed, it is important to know the relative magnitudes of the two universes and the degree of overlap between them.

The CCST has sponsored a series of workshops on S&T indicators. At the most recent workshop, participants agreed on some basic indicators of S&T performance. These indicators were felt to be consistent with S&T policy interests that most CCST members would have in common. The CCST recommended S&T data collection process is at two levels:

- data collected and reduced from a specific, common, questionnaire outlined below.
- national economic and social data

National S&T Performance Data

National S&T performance data is keyed to the identification of S&T activities, as defined by S&T-related occupations, and the activities, whether S&T or not, of individuals trained in S&T-related fields of study. It was felt that the national responses should include both an S&T policy statement, as well as specific quantitative measures of performance.

The proposed common Caribbean S&T questionnaire is based on the collection of data from all projects, institutions, establishments, etc. which employ S&T professionals. If a program has S&T professionals working in it (as defined in the OECD Canberra manual) then it is included in the survey.

HRST, as defined by the Canberra manual includes individuals trained in both the natural and social sciences, and individuals working in occupations that are contained within the definitions of natural and social sciences. The test as which should be included and which should be excluded is whether the particular field of study or occupation falls within the mandate of a nation's S&T policy or programme. If there is any doubt, then the test is whether the field of study or occupation would contribute to the development of a new product or process within the establishment in question. Some draft definitions are attached.

<u>Economic and Social Data Relevant to S&T activities</u>

1. Population
2. Labour force
3. % of population with post-secondary education
4. GDP (US$)
5. GDP/capita (US$, ppp)
6. Exports as % of GDP
7. Imports as % of GDP
8. Foreign Direct Investment
9. KwH/capita
10. Telephone lines per 1000 population
11. Internet hosts/ 1000 population
12. Computers/ 1000 population

An excellent source for national economic and social data are the figures published by the UNDP in the annual Human Development Report.

Specific CCST S&T indicators

13. Public sector personnel performing S&T (including R&D) as a percent of total public sector employment - *Public sector as defined in the Frascati Manual; use either full-time equivalents or total employed for both HRST and all employees.*
14. Public sector S&T expenditures (including R&D) as a percent of government budgetary allocations – *Government budgetary allocations are the forecast current and capital expenditures, including funds from international development agencies, but excluding debt repayments.*
15. HRST workers as a percent of employed labour force – *Employed labour force is all individuals active in the formal economy.*
16. HRST-trained workers as a percent of total labour force – *Total labour force is the employed labour force plus all individuals 15 years and older available for work*
17. Percent of total labour force with post-secondary education.
18. GERD as a percent of GDP
19. Distribution of HRST by sector:

Sector	HRST (number)	% females	%< 35 yrs.old	HRST %employed labour force	Expatriate HRST % of total	Expatriate HRST % CARICOM
Non-renewable resources, plus associated primary mfg.						
Renewable resources plus associated primary mfg.						
Secondary manufacturing						
Private sector services (except tourism)						
Tourism						
Public sector services (except tourism – related)						

Notes:

1. HRST is defined as all individuals who have tertiary level post-secondary education in at least one of the fields of study as defined in the Canberra Manual, Annex 3, Table 6, sections 1, 2, 3, 4, 5.1, 5.2, 5.3, and 6.1, or are employed in an HRST occupation as defined in Annex 4 of the Canberra Manual.

2. An expatriate is an individual who is working in the nation who is normally resident elsewhere regardless of citizenship or place of birth.

3. Primary manufacturing is any sector of industry where the major inputs are raw natural resources, whether renewable or non-renewable.

4. Tourism activities are those as defined by the local tourist board.

20. Distribution of S&T Spending by Sector (National Currency)

Sector	S&T Expend.	R&D Expend.	S&T % Extramural	S&T % Capital	S&T % Salaries
Non-renewable resources, plus Associated primary mfg.					
Renewable resources plus Associated primary mfg.					
Secondary mfg.					
Private sector services (except tourism)					
Tourism					
Public sector services					

Note: S&T expenditures are those expenditures resulting from the activities of all individuals in HRST occupations.

21. Each national contribution would also include an S&T policy statement, as outlined above.

Future Studies

As a result of focussing on human resources for S&T rather than S&T related expenditures, the workshop identified areas where there is need for additional coordinated studies within the CARICOM region. Specific studies could include:

- the magnitude and sources of remittances to CARICOM nations from CARICOM nationals with HRST training or who are in HRST occupations resident in other countries.
- The potential for repatriating CARICOM nationals from other nations, whether into HRST occupations or as retirees.

CCST Draft Questionnaire

Survey frame (establishment level):

- All government S&T agencies
- All government-supported institutions (hospitals, libraries, etc.), excluding education
- All post-secondary educational institutions (UWI faculties will fill out separate questionnaires)
- All S&T NGOs and private-non-profit institutions
- All S&T professional associations – doctors, engineers, etc. (private practice members only)
- All business enterprises with any S&T employees as defined as HRST in Annex 4 of the Canberra Manual
- CCST will send questionnaires to international S&T organisations operating in the Caribbean

1. **HRST**	# Males	# Females	% Expats	% Expats from CARICOM	%<35 yrs. old
STA professionals (level 6&7)					
STA technicians (level 5)					
STA support staff					
R&D professionals (level 6&7)					
R&D technicians (level 5)					
R&D support staff					
Other employees with level 6&7					
Other employees with level 5					
Total all employees, all levels of education					

2. **Expenditures** (National Currency)	Salaries	Operating	Capital	Total
STA expenditures				
R&D expenditures				
Total				
	Internal	External Public sector	External Private. sector	Total
STA expenditures				
R&D expenditures				
Total				

Concordance with RICYT indicators (1999 edition, pp 13 - 18) :

RICYT Ind.#	Description	CCST Indicator #
1	Population	1
2	Labour force	2
3	GDP	4
4	Total S&T* expenditures	Available from CCST quest.
5	Total S&T* expenditures/GDP	Data available from CCST quest.
6	Total S&T* expenditures/capita	Data available from CCST quest.
7	R&D expenditures/researcher	Data available from CCST quest.
8	S&T* expenditures by funder	Data available from CCST quest.
9	S&T* expenditures by performer	Data available from CCST quest.
10	S&T* expend. By socio-ec. Object	Data available from CCST quest.
11	S&T* personnel	Data available from CCST quest.
12	S&T* personnel/1000 labour force	Data available from CCST quest.
13	S&T* personnel by gender	Data available from CCST quest.
14	R&D personnel by sector	Data available from CCST quest.
15 - 17	University graduates by level	Approx. data may be available from Min. of Education
16 - 20	Patent data	Numbers may be too small and variable for valid comparisons
23 - 28	Bibliometric data	Numbers may be too small and variable for valid comparisons

*R&D data may also be available from the CCST questionnaire

REGIONAL SCIENCE & TECHNOLOGY INDICATORS QUESTIONNAIRE CONCEPTS AND DEFINITIONS

1. Scientific and Technological Activities (STA)

These are systematic activities which are closely concerned with the generation, advancement, dissemination and application of scientific and technical knowledge in all fields of science and technology These include such activities as R&D, scientific and technical education and training (STET), and the scientific and technological services (STS)

2. Research and Experimental Development (R&D)

Research and experimental development (R&D) comprises creative work undertaken on a systematic basis in order to increase the stock of knowledge of man, culture and society and the use of this stock of knowledge to devise new applications.

3. Scientific and Technological Services (STS)

STS are defined as activities concerned with R&D and its contributing to the generation, dissemination and application of scientific and technical knowledge;

(i) S&T services provided by libraries, archives, information and documentation centres, reference departments, data banks and information-processing departments.

(ii) S&T services provided by museums of science and/or technology, botanical and zoological gardens and other S&T collections.

(iii) Systematic works on the translation and editing of S&T books and periodicals

(iv) Topographical, geological and hydrological surveying; routine astronomical, meteorological and seismological observations; surveying of soils and of plants, fish and wildlife resources; routine soil, atmosphere and water testing; the routine checking and monitoring of radioactivity levels.

(v) Prospecting and related activities designed to locate and identify oil and mineral resources

(vi) The gathering of information on human, social, economic and cultural phenomena, usually for the purpose of compiling routine statistics, e.g.

population census; production, distribution and consumption statistics, social and cultural statistics.

(vii) Testing, standardization, metrology and quality control; regular routine work on analysis, checking and testing, by recognized methods, of materials, products, devices and processes, together with the setting up and maintenance of standards of measurement

(viii) Regular routine work on the training of clients and other sections of an organization of independent users which is designed to help them to make use of scientific, technological and management information

(ix) Activities relating to patents and licenses; systematic work of a scientific, legal and administrative nature on patents and licenses carried out by public bodies.

4. Human Resources in S&T (HRST) Basic Definition

In order to obtain a complete picture of both supply and demand for HRST, the definition is based on two dimensions, qualification and occupation. The qualification aspect tells about the supply of HRST i.e. the number of people who are currently or potentially available to work at a certain level. The demand of HRST i.e. the number of people who are actually required in S&T activities at a certain level, is related to the occupation dimension. Because demand does not always match supply and because skills can be obtained outside the formal education system, the following combined definition is proposed.

HRST are people who fulfil one or other of the following conditions:

a) successfully completed education at the third level in an S &T field of study

b) not formally qualified as above, but employed in a S &T occupation where the above qualifications are normally required.

5. Education

Education at the "tertiary level" comprises successfully completed studies which result in a first or higher university degree and other post-secondary level studies which lead to awards or certificates not fully equivalent to a first degree. Successfully completed education at a given level leads to a formal qualification. The tertiary level corresponds to ISCED levels 5, 6 and 7, as defined by UNESCO**.**

Professionals are individuals engaged in the conception or creation of new knowledge, products, processes, methods, and systems, and in the management of the projects concerned. They are typically trained to ISCED levels 6 or 7

Technicians are persons whose main tasks require technical knowledge and experience in one or more fields of engineering, lie and physical sciences, or the social sciences and humanities. They participate in S&T projects by performing scientific and technical tasks involving the application of concepts and operational methods , normally under the supervision of professionals

Supporting staff includes skilled and unskilled craftsmen, secretarial and clerical staff participating in S&T projects or directly associated with such projects.

6. Expenditures

a) Salaries: This comprises salaries and all associated costs or fringe benefits such as bonus payments, holiday pay, contributions to pension funds, NIS and health surcharge contributions, payroll taxes, etc.

b) Operating Costs: These comprise non-capital purchases of material supplies to support STA performed by the statistical unit in a given year. All expenditures on indirect services should be included here, whether carried out within the organization concerned or hired or purchased from external suppliers.

c) Capital: These are gross expenditures on fixed assets used in STA or R&D programmes. They are composed of expenditures on major and minor instruments and equipment.