International scientific cooperation in Latin America and the Caribbean

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As a consequence of the general trend towards globalization, scientific activity is currently experiencing unprecedented dynamism and interactivity. At the international level, scientific cooperation has expanded and diversified in recent decades, thanks to increasing mobility and the use of new communications channels, the creation of specific mechanisms and instruments, the participation of new actors and a new interest in and concern for problems transcending geopolitical frontiers or requiring expensive facilities. Cooperation has been extended to practically all areas of knowledge and, in one way or another, all countries share in it. The impact of these evolving forms of cooperation on science and scientific affairs can clearly be seen in the way science is organized, its work and its results.

Latin America has by no means remained a stranger to this process. How is cooperation organized in this region, what are its motivations, how does it operate, what obstacles and challenges does it face? Does it take full advantage of the opportunities, and does it make the most of them for Latin American science? Has this cooperation supported Latin America in its process of integration at the international level? Are all countries of the region involved in this process?

We felt it opportune to table questions like these and to contribute to finding answers to them. To do this, it was necessary to undertake a prior exercise of collecting and systematizing a body of information which, today, is widely dispersed and indeed sometimes not even available. As we know only too well, there is a great wealth of material on scientific collaboration which is never recorded in reports. Similarly, it would be absurd to claim that the present chapter gives a full and faithful account of all that occurs in terms of scientific cooperation in the region. Rather, it is offered as the partial result of a serious, although necessarily limited, attempt which we hope may assist and guide all our readers with a specific interest in the subject. We shall point out from the outset the low level of activity of the Latin American region and the existence of a greater potential for participation, and shall indicate those areas which appear to us to represent the principal advantages as well as threats.

As is customary, the term Latin America (or LAC) will be used in this chapter to cover all countries of the subcontinent, including those of the Caribbean; we shall nevertheless try to avoid any overlap with the chapter dealing with the non-Spanish-speaking countries which forms part of the present report.

COOPERATION FOR DEVELOPMENT

It is no coincidence that the subject of international cooperation assumed special importance at the World Conference on Science (Budapest, 1999) organized by UNESCO and the International Council for Science (ICSU), where scientists and society renewed their pledge to confront together the challenges of sustainable development. Today considerable moves are afoot in the area of cooperation for development, which involve defining new strategies with sounder criteria for the selection of programmes and investments in scientific and technical cooperation. Renewing the institutional agreements for these strategies invariably poses the three classic questions: (i) Why? Is it solidly motivated? (ii) What? Do the programmes make sense? (iii) How? Is implementation effective?

The answers to these questions put a new complexion on the situation, largely reflecting the growing role of science and technology (S&T) as factors for development in the industrialized and newly industrializing countries, and the perception of this role in those countries, still within the context of the national interest. Nowadays, developing countries – and all countries of Latin America fall into this category in one way or another – are all more or less aware of the need to strengthen their still weak S&T capabilities, and to that end to make use of cooperation as one of the motors by which to expand further their horizons beyond their national frontiers. With time, the quest for mere unilateral technical assistance is giving way to a both more complete and more equitable concept of cooperation between parties who, albeit unequal, are

entitled to participate fully in defining its modes and parameters. This necessarily implies the development of a national capacity on the part of governments to determine and harmonize action, and the will to work with a wide spectrum of countries and institutions with very different agendas and interests.

Table 1
CONTEXTUAL INDICATORS FOR LATIN AMERICA AND THE CARIBBEAN, 1998

	Population Millions	GDP Total Million US$	GDP Per capita US$	HDI[1]
Argentina	35.82	298 131	8 300	0.837
Barbados	0.27	2 389	8 800	0.858
Bolivia	8.00	8 571	1 100	0.643
Brazil	165.90	787 499	4 700	0.747
Canada	30.25	766 083	25 300	0.935
Chile	14.82	72 949	4 900	0.826
Colombia	40.89	100 539	2 500	0.764
Costa Rica	3.84	10 612	2 800	0.797
Cuba	11.14	14 754	1 300	0.783
Dominican Rep.	8.20	15 846	1 900	0.729
Ecuador	12.17	19 710	1 600	0.722
El Salvador	6.03	11 864	2 000	0.696
Guatemala	10.80	18 942	1 800	0.619
Guyana	0.77	601	800	0.709
Haiti	7.95	3 848	500	0.440
Honduras	6.10	5 247	900	0.653
Jamaica	2.57	7 042	2 700	0.735
Mexico	95.30	420 721	4 400	0.784
Nicaragua	4.80	2 126	400	0.631
Panama	2.76	9 345	3 400	0.776
Paraguay	5.41	8 594	1 600	0.736
Peru	24.80	58 337	2 400	0.737
Portugal	9.97	157 405	15 800	0.864
Spain	39.37	650 785	16 500	0.899
Trinidad and Tobago	1.28	6 124	4 800	0.793
USA	270.25	8 759 900	32 400	0.929
Uruguay	3.03	20 831	6 900	0.825
Venezuela	23.24	95 023	4 100	0.770
Latin America	**483.06**	**1 979 642**	**4 100**	**–**
LAC[2]	**495.91**	**1 999 646**	**4 000**	**0.758**
Ibero-America	**532.40**	**2 787 831**	**5 200**	**–**
Subtotal	**845.74**	**12 333 818**	**14 600**	**–**
WORLD	**5 897.00**	**29 232 000**	**5 000**	**0.712**

1. Human Development Index.
2. Including non-Latin Caribbean countries.

Sources: For population and GDP: RICYT (2000) *El estado de la ciencia. Principales indicadores de ciencia y tecnología*; for HDI: UNDP (2000) *Human Development Report 2000*; for world total: World Bank (2000) *World Development Report 2000*.

Scientific cooperation in Latin America cannot be conceived of as marginal to or independent of the challenges and limitations of development. On the contrary, its vocation is to overcome those challenges and limitations. It is compelled to take account of the need for an effective balance between growth and equity, management and participation, small and large-scale efforts, immediate concerns and long-term solutions, global programmes and attention to local needs; and to be governed by common sense – by an awareness of what can work, and why and how. When resources are so limited, and when needs are ever increasing, these criteria are particularly important.

For the countries of the North, scientific cooperation with Latin America has in general terms been pursued institutionally within the framework of "development aid". Correspondingly, agencies of scientific and technical cooperation and other specific instruments have been set up in most countries since the 1960s. The cumulative experience of these 40 years, the way in which the very concept of development has evolved, the gradual abandonment of the legacies of colonialism and the growing distance between the constituent parts of the so-called Third World compel the developed countries to question the relevance of the "aid" they provide and to revise their cooperation policies, with the aim of increasing their efficiency in terms of the three classic issues mentioned earlier. However, one must not lose sight of the fact that, in the first place, industrialized countries have an interest in cooperating with their counterparts; when countries see in S&T a way of positioning themselves in the international marketplace, the traditional spirit of cooperation of the scientist is easily surpassed by the national imperative to compete.

When we speak of international competition, there is an issue of balance of power, at the level both of institutions and of the people involved, hence the importance of developing a capacity for cooperative partnership. In any

form of collaboration there is an asymmetry which should be recognized; its result is mutually beneficial precisely in those cases where there are shared objectives and both parties give the best they can and receive the best they can, without that necessarily implying equality in the size or nature of their contributions. Clearly, in practice these principles work better in some fields than in others, and in specific instances and circumstances.

In the following pages the concrete experience of Latin America is presented by means of a necessarily brief and schematic summary of the programmes and cooperative actions among countries of the region and with the rest of the world. For reasons of space, this will be based on a selection, arbitrary as all selections are, of examples which may serve to illustrate experiences of cooperation in various fields. Before that, however, we shall propose a number of basic indicators which give a quantitative idea of the overall context in which science and cooperation are progressing in Latin America.

BASIC INDICATORS

Table 1 provides contextual indicators, while Table 2 contains figures relating to science, technology and higher education. Most of these data are themselves the product

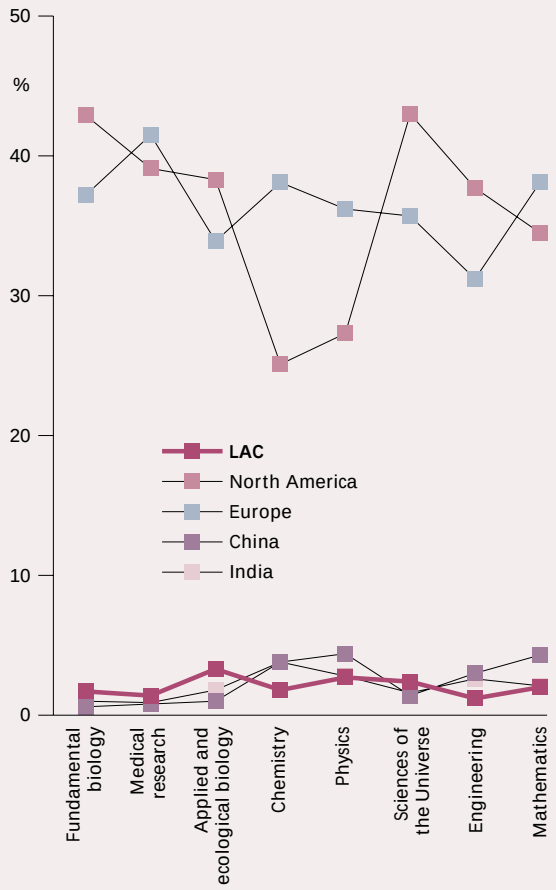
Table 2
S&T INDICATORS FOR LATIN AMERICA AND THE CARIBBEAN, 1997

	S&T expenditure As % of GDP, 1997		S&T personnel[1] 1997/98		University graduates[2], 1997	Doctorates[2] 1997	
	S&T[3]	R&D	Total	Researchers		Total	Per million population
Argentina	0.50	0.42	49 671	30 665	19 242[4]	311[4]	8.9
Bolivia	0.58	0.32	1 330	1 050	2 676	–	–
Brazil	1.29[4]	0.91	67 350[4]	49 702[5]	74 951[4]	1 822[4]	11.7
Canada	–	1.59	134 600[4]	82 240[5]	34 730	2 347	78.2
Chile	–	0.65	13 896	7 013	9 020	54	3.7
Colombia	0.65	0.41	–	8 200	28 903[4]	–	–
Costa Rica	1.13[4]	–	–	1 867[4]	+936[4]	–	–
Cuba	1.33	0.70	62 935	5 525	12 419	121	10.9
Ecuador	0.23	0.08	3 315	1 422	686[4]	–	–
El Salvador	0.30	–	–	467	3 956[5]	–	–
Mexico	0.42	0.34	44 924[4]	26 479	75 231	536	5.7
Nicaragua	0.14	0.13	1 082	459	–	–	–
Panama	0.92	0.37	2 051	841	2 414	–	–
Peru	0.67	0.06	–	–	20 256	–	–
Portugal	–	0.62	29 413	22 201	12 782	414	41.4
Spain	–	0.86	155 117	103 905	32 043	3 884	98.8
Trinidad and Tobago	0.36	0.14	1 077	356	407	2	1.5
USA	–	2.55	2 223 000	1 874 000	224 386[4]	47 909	178.9
Uruguay	–	0.42	3 213[6]	1 854	1 303	58	18.1
Venezuela	0.33	–	–	4 500	7 825	–	–
LAC	**0.81**	**0.59**	**–**	**142 688**	**268 780**	**2 925**	**6.0**
Ibero-America	**0.66**	**–**	**–**	**268 438**	**312 112**	**7 200**	**13.7**
Regional total	**2.06**	**–**	**–**	**2 225 034**	**571 537**	**57 479**	**68.9**

1. Individuals.
2. Natural and exact sciences, engineering and technology, medical and agricultural sciences.
3. Including R&D.
4. 1995/96.
5. Full-time equivalent.
6. 1999.

Source: RICYT (2000) *El estado de la ciencia. Principales indicadores de ciencia y tecnología.*

Figure 1
REGIONAL DISTRIBUTION OF PUBLICATIONS BY DISCIPLINE, 1997
As % of world total



Source: OST (2000) *Science et Technologie, Indicateurs 2000.*

of regional and international cooperation: they have been prepared by the Ibero-American Network of Science and Technology Indicators (RICYT, see below) based on information supplied by its member countries, in accordance with the regulations of the Organisation for Economic Co-operation and Development (OECD) *Frascati Manual*, adjusted for the characteristics of the Latin American countries.

In each case, we present the most recent figures generally available for comparison purposes. It can thus be seen that considerable differences exist between countries in terms not only of size and population, but also of funding for S&T and the human resources devoted to activities in this area. It should be made clear that in most cases the percentage of investment in S&T still fluctuates considerably from year to year, depending on both economic and political circumstances, which naturally affects the stability and development potential of national S&T systems. Overall, however, these indicators highlight the general problem of the serious shortage of resources, both human and financial, going to S&T activities in the region.

Some additional figures may help to situate LAC in the world context. While the region represents 8.4% of the world's population and 8.8% of total GDP, it contributes only 3.6% of total expenditure on research and development (R&D); whereas industrialized Asia, with a somewhat larger population, contributes 20.2%, Europe contributes 27.8% and North America (the USA and Canada) contribute 36.7% (OST, 2000). The richest nations each devote between 2% and 3% of their GDP to R&D, whereas the LAC countries typically devote between 0.1% and 1.0% to R&D, averaging 0.6%. Only the non-industrialized nations of Asia (excluding India) and those of sub-Saharan Africa devote a lower percentage to R&D, between 0.3% and 0.4% on average. When the figures for these countries are viewed as a whole, one observes a relatively marked correlation between this percentage and per-capita GDP. The distance between Latin America and the group of most developed countries is so great that it reaffirms of itself the need for the region's scientific and technological development both to build on original, innovative ideas, regardless of formulae generated in and for other contexts, and to take maximum advantage of regional cooperation efforts.

One commonly employed indicator of comparative scientific output is the volume of contributions to specialist publications and periodicals, although it is well known that this is a partial and imperfect indicator because it leaves out other products of scientific activity such as textbooks, monographs, popular introductions, the setting

up of laboratories, the registration of patents, etc. In international statistics for 1997, LAC scores a contribution of only 1.8% of the world total of publications on the basis of articles in mainstream periodicals, i.e. those listed by ISI (in SCI and COMPUMATH). Although this figure has increased in recent years (it was only 1.4% in 1990), it is much lower than the figure for industrialized Asia (10.8%) and almost insignificant compared with the figures for North America (36.6%) and Europe (37.5%) (OST, 2000).

When one analyses the distribution of these publications by scientific discipline, one finds considerable variations, as can be seen in Figure 1. This shows the relative strength of the biological sciences in the region, especially in the applied and ecological fields, and the weakness of chemistry and engineering. In addition to the figures for Europe and North America, data are given for China and India, two countries with an average output similar to that of LAC, to illustrate the existence of areas of greater or lesser relative strength – which could therefore be identified as areas of interest for cooperation.

When different databases are used, whether multi-disciplinary or by subject, the percentages for the contribution of LAC vary, as can be seen in Table 3 and Figure 2, the highest figure being that for agricultural research (6.1% according to CAB).

The relative contributions from the different countries of the region to these publications are very unequal. Brazil contributes invariably more than 40%, Argentina and Mexico a further 20% each, Chile, Venezuela, Cuba and Colombia less than 8% each, and the remaining countries together an equivalent proportion.

CHARACTERISTICS OF SCIENTIFIC COOPERATION

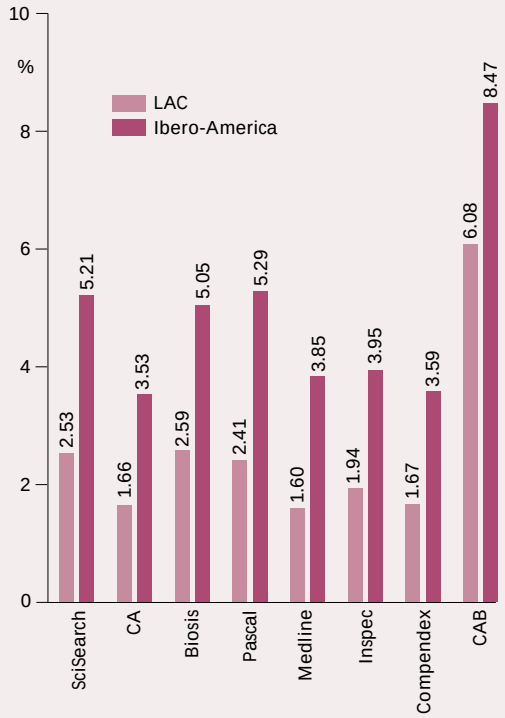
Scientific collaboration is an old phenomenon; an article by more than one author is known to have been published as early as 1678. Collaboration of this kind can take various forms at different levels, from simply giving advice, passing on a piece of information or exchanging ideas, to carrying out a research project. Although collaboration commonly obeys the need for specialized contributions in order to

Table 3
PUBLICATIONS IN DATABASES, LATIN AMERICA AND THE CARIBBEAN, 1998

	LAC	Ibero-America	World total
SciSearch	23 931	49 353	945 768
CA	11 884	25 285	714 959
Biosis	13 407	26 109	516 120
Pascal	12 352	27 026	510 692
Medline	6 758	16 266	421 833
Inspec	6 419	13 038	329 982
Compendex	3 337	7 165	199 233
CAB	9 521	13 263	156 439

Sources: RICYT (2000) Multidisciplinary databases: SciSearch (SCI/ISI), Pascal (INIST/CNRS). Subject databases: CA (Chemical Abstracts), Biosis (Biological Abstracts), Medline (Index Medicus), Inspec (Physics Abstracts), Compendex (Engineering Index), CAB (Commonwealth Agricultural Bureau).

Figure 2
PUBLICATIONS IN DATABASES, LATIN AMERICA AND THE CARIBBEAN
As % of world total



Source: As Table 3.

achieve research objectives, there are many other reasons why scientists work with others, whether to acquire new skills or knowledge, to enrich their ideas mutually, to optimize resources, to access expensive laboratories or local data or specimens, to extend the impact or range of influence of their work, or simply to work in a different atmosphere or with colleagues from other parts of the world.

"People working together" continue to form the basis of scientific cooperation, even when it is organized between institutions or internationally. In the case of LAC, a significant part of this interpersonal collaboration originates in periods spent abroad by scientists for their training, chiefly in institutions in developed countries, and sometimes continues for many years on the same basis. The influence of this phenomenon on the type of science pursued in the countries of the region, the subjects selected, the means of publication, etc., is clear, especially in the most basic areas of physics, mathematics, chemistry and biology.

However, many other initiatives exist which give rise to cooperation. Sometimes these come from scientists in countries of the North who need access to some particular field or resource found in Latin America; in such cases, collaboration often – but not always – ensues with local scientists, typically in disciplines such as geophysics, botany, ecology and geology. In other, perhaps fewer instances it concerns research representing a priority for the countries of the region, generally in agronomy, public health, the environment, water and biodiversity.

There has of late been an increase in the influence of organizations specially created for cooperation, or which have cooperation as part of their brief. Sometimes this influence has resulted in support for or a strengthening of pre-existing forms of collaboration, or has meant a change of direction or even the creation of new areas and patterns of collaboration. Certainly, the earmarking of funds proves an important and sometimes determining factor deciding on cooperation projects.

For the above reasons, information on international cooperation is hard to obtain and often partial, jumbled and patchy, which complicates analysis. The principal materials containing relevant information on cooperation in and with LAC, which have also been used in preparing this chapter, are:

- official reports, documents and web pages (of cooperation institutions, organizations and agencies);
- databases on scientific output (in particular, on co-authorship of publications);
- studies and analyses by experts in the subject (normally undertaken with a specific purpose, based on prior information and specially conducted interviews).

Given the multiplicity of levels and actors involved in cooperation, any way of classifying the information is bound in some respect to be arbitrary. Being aware of the problems this can present, we have arranged this exposition under two major headings: cooperation among groups or institutions, and cooperation on an international scale (bilateral and multilateral; international funding agencies).

COOPERATION AMONG GROUPS OR INSTITUTIONS

Laboratories and researchers

The level in question here is that at which research is actually conducted and knowledge produced. In practice, instances of this kind of cooperation take the form of periods spent by researchers, doctoral or postdoctoral students in foreign laboratories, the sending of preliminary results or samples, seminars, symposia and the like, and are carried out in two different ways:

- they are based on treaties or agreements, and are the material outcome of these; sometimes through participation in international institutions or organizations – such as the international agronomy centres of CGIAR or the International Centre for Theoretical Physics in Trieste – or through national or regional initiatives, such as bilateral agreements between national S&T organizations of Ibero-America, or SHIP (the Southern Hemisphere system for postgraduate exchange), or international institutions such as the INCOS and ALFA (Latin America Academic Training) programmes of the European Union (EU), PICS (Scientific International

Cooperation Programme), ECOS (Evaluation-Orientation of Scientific Cooperation) in France, CYTED (Ibero-American Programme on Sciences and Technology for Development) in Spain, etc.;

- or they are carried out directly on the initiative of the parties concerned, without reference to wider agreements, although they often give rise to such agreements.

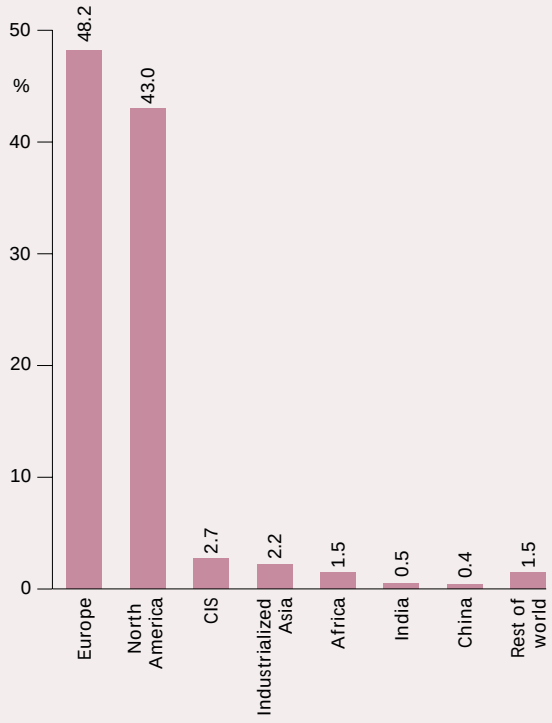
It is generally the case that no systematic record is kept of scientific cooperation and its results, and this makes analysis difficult. Some outputs are of a tangible nature and can give an albeit partial idea, but others are intangible and in many cases of great interest and impact beyond the purely scientific. Collaboration is always expected to produce something which could not be achieved by the same parties working individually; however, this value added is often not accounted for, and does not even form part of expressly stated objectives. This is particularly the case with so-called spontaneous collaboration, which arises from initiatives taken by co-workers or research groups.

One of the principal tools in use at present as a partial indicator of international cooperation among scientists is bibliometric analysis of co-publications. Although we are aware that the use of international databases has serious limitations, especially where countries of intermediate development are concerned, no alternative data sources yet exist to provide a more representative picture. The databases most commonly used for these studies are, once again, those of ISI, which maintains a complete record of the names and addresses of authors. Consequently, the data recorded refer once again to mainstream science, and it should be borne in mind that this does not fully cover all cooperation, especially among Latin American colleagues. It is important to remember that Latin American scientists publish their work to a great extent – hard to gauge but perhaps of the order of 50% – in periodicals not surveyed by ISI, especially in the most applied areas or those more particularly of local interest.

International studies indicate a noteworthy overall increase in collaboration: the average number of authors per document increased from 1.83 in 1955 to 3.89 in 1998, while the percentage of documents signed by a single author fell. An analysis of international co-authorship reveals the predominance of the USA, with a recent increase in interaction between two or more continents, outside traditional areas of "big science" such as space studies and studies of experimental high energy physics. Among European countries, Spain maintains strong relationships with Latin America (except Brazil), although its strongest collaborative efforts are with Cuba. A statistical analysis of the figures seems to show that international co-authorship increases the productivity of the countries and authors involved, as well as the quality of their work (measured by peer review and frequency of citation).

As far as the LAC countries are concerned, the overall figures (excluding the non-Latin countries of the

Figure 3
DISTRIBUTION BY COUNTRY AND REGION OF LATIN AMERICAN CO-PUBLICATION, 1997



Sources: ISI data, taken from OST (2000) *Science et Technologie, Indicateurs 2000.*

Table 4
NUMBER OF CO-PUBLICATIONS WITHIN LATIN AMERICA AND THE CARIBBEAN AND WITH THE EU AND THE USA, 1991-95

	Within LAC	With the EU	With the USA	Total
Argentina	599	1 301	964	2 864
Bolivia	27	121	51	199
Brazil	753	3 657	3 279	7 689
Chile	388	1 066	1 013	2 467
Colombia	196	240	362	798
Costa Rica	64	111	231	406
Cuba	91	211	40	342
Dominican Rep.	17	9	57	83
Ecuador	33	84	107	224
El Salvador	1	2	7	10
Guatemala	40	19	154	213
Honduras	12	7	43	62
Mexico	458	1 399	1 904	3 761
Nicaragua	13	18	24	55
Panama	30	44	149	223
Paraguay	12	14	16	42
Peru	82	121	284	487
Uruguay	107	126	79	312
Venezuela	191	521	553	1 265

Sources: ISI data, taken from Fernández *et al.* (1999) *Interciencia 23:6, 328.*

Caribbean) show a relatively low percentage of collaboration: LAC contributes around 6% of collaboration with Europe and North America (in fact this is the region which collaborates the least with scientifically more advanced countries), and only around 1% of collaboration with other countries or regions.

Figure 3 shows marked preferences in the percentage distribution of regions or countries with which Latin American scientists collaborate (other than LAC countries themselves). When data covering co-publication with Europe are broken down by country, the clear predominance of France emerges, followed by the UK, Germany and Spain (Fernández *et al*., 1999).

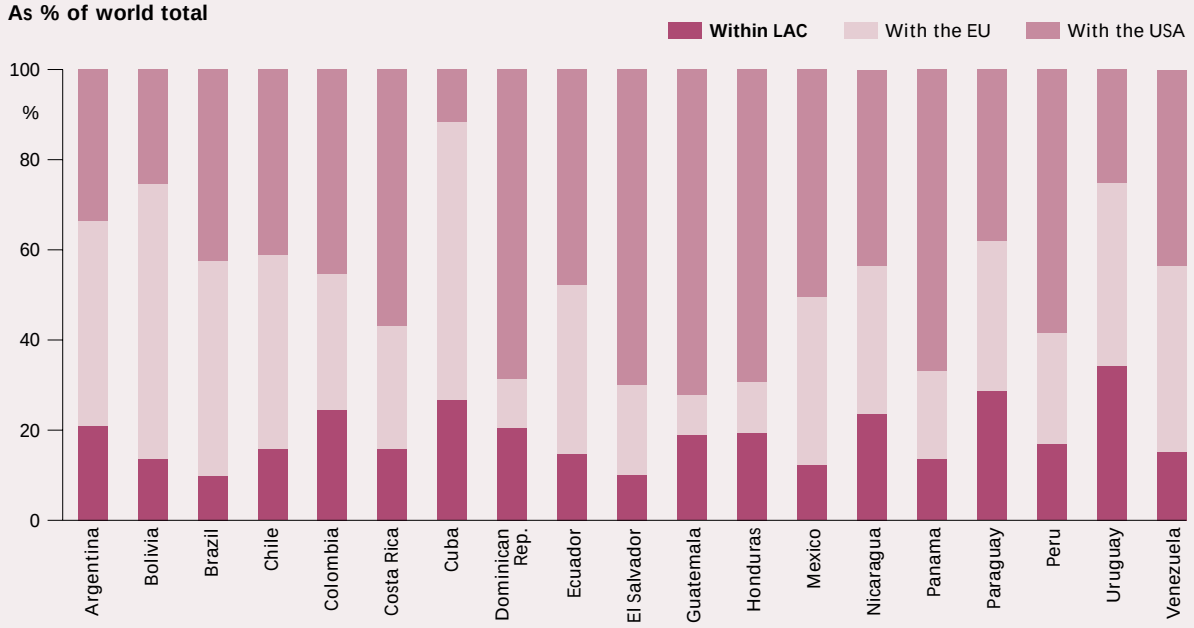
Table 4 shows the number of co-publications undertaken within Latin America, with Europe and with the USA between 1991 and 1995. As can be observed in Figure 4, there is a marked contrast between countries that tend to cooperate more with Europe (Bolivia, Cuba and, to a lesser extent, Argentina, Brazil and Chile) and others preferring to work with the USA (the Central American countries, the Dominican Republic and, to a lesser extent, Peru and Mexico). Only a few countries of the region exhibit a tendency to cooperate among themselves: Uruguay, Paraguay, Cuba and, to a lesser extent, Colombia and Nicaragua.

The distribution of co-publications by subject area reported in Figure 5 shows a preponderance of physics (due mainly to Chile, Brazil, Argentina and Mexico) and biomedicine (a subject area favoured by Uruguay and Paraguay). On the other hand, only half the countries record any co-publication at all in mathematics. It should be added that most of these co-publications are the work of two authors, although in physics there are also multi-authored publications, especially in nuclear and particle physics, due mainly to the Brazilian participation in the European network of CERN for more than ten years.

In contrast, an analysis of communications presented at regional meetings (and not normally registered in ISI journals) in the field of optics, of which 20% are internationally co-authored, shows a marked increase in the collaboration among Ibero-American colleagues and a simultaneous decline in collaborations with the rest of the world (Gaggioli, 2001).

Mention should be made of an analysis of the Mercosur countries, based on ISI data and the regional database PERIODICA. It can be observed that Paraguayan scientists tend to publish in international co-authorship, but not with their neighbours, while there is a high percentage of co-authorship between Argentina and Brazil that has risen since 1986, when two major collaboration programmes were set up between them, the school of informatics (*Escuela de Informática*) and CABBIO (see below). On the other hand, however, the establishment of the Mercosur alliance in 1991 does not yet appear to have had any notable effect on co-publications between the four countries (Narváez, Russell and Velho, 1999).

Figure 4
DISTRIBUTION OF CO-PUBLICATIONS WITHIN LATIN AMERICA AND THE CARIBBEAN AND WITH THE EU AND THE USA, 1991-95
As % of world total



Source: ISI data, taken from Fernández *et al.* (1999) *Interciencia 23:6, 328.*

Cooperation between scientific institutions

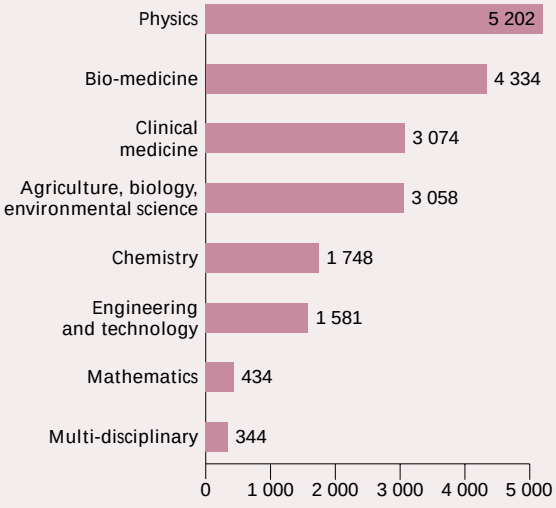
The commonest mechanisms for cooperation between research bodies, universities or academies of science are of two kinds:

- bilateral cooperation agreements between two research institutions specifying the aims, methods, means and duration of the planned cooperation activities;
- membership of such institutions in permanent coordinating and programming structures such as ICSU, UNESCO, etc., which are examined separately.

Universities

In general, the communities of Latin American universities which conduct research and teaching in the sciences have been traditionally linked to the international world. Their scientific capacity can be said to have largely developed with inputs from cooperation, chiefly with countries of the North. In recent decades, universities have in almost

Figure 5
LATIN-AMERICAN CO-PUBLICATIONS BY SUBJECT AREA, 1991-95



Source: ISI data, taken from Fernández *et al.* (1999) *Interciencia 23:6, 328.*

all countries organized their cooperation by means of special units, usually coming under the Rector's office, which are responsible for preparing and carrying out cooperation policies, for which purpose they link up increasingly with regional and international bodies. The very creation of these offices reflects the growing importance and complexity of international cooperation for universities. Generally the offices have made an effort to forge the necessary links with the foreign ministries and national S&T bodies of their countries so as to coordinate their activities more effectively.

In some cases universities have offices abroad in order to back up their internationalization, one example being the creation of International University Exchange Inc. by the University of Chile.

Elsewhere national bodies have appeared such as the International Colombian Cooperation Agency and the Colombian Cooperation Network, set up to meet the challenge of the internationalization of higher education. Similarly, in Mexico the National Association of Universities and Higher Education Institutions (ANUIES) has taken on responsibility for implementing broad-based international agreements on scientific and technological cooperation.

Normally universities have a number of framework cooperation agreements, specific agreements in particular disciplines, and agreements for exchanges of teachers or students. It is nevertheless generally recognized that the opportunities afforded by all these agreements are not taken full advantage of – whether for lack of resources to deliver on their undertakings, or in the absence of any special interest. (The University of Buenos Aires, one of the most actively engaged in cooperation, reports that with 1 200 ongoing research projects, only about 300 researchers went abroad in 1999 to attend congresses or take up internships.) Most agreements are between universities, though international, bilateral and multilateral bodies and private foundations are also involved. Recently universities have also increased their participation in international networks.

Scientific academies and societies

Recently National Academies of Science and their equivalents have stepped up their exchange programmes for researchers and corresponding members, and joint projects with sister institutions in other countries – in particular with the US National Academy of Sciences, the UK Royal Society and other European institutions. Some academies have also done much to promote horizontal cooperation through the establishment of regional or subregional federations, such as the recently formed Caribbean Scientific Union (Comunidad Científica del Caribe).

The Latin American Academy of Sciences (ACAL) was founded in 1982, with support from the Pontifical Academy of Sciences and established in Caracas. To foster the development and integration of LAC, it promotes cooperation between scientific institutions, exchanges of researchers, regional scientific activities, the conduct of science policy studies and the spreading of interest in science and science education for all. It now has 154 members in Argentina, Brazil, Colombia, Costa Rica, Cuba, Chile, Ecuador, Guatemala, Mexico, Peru, Uruguay and Venezuela. However, its presence is little felt in the region. Its academicians are recognized researchers, proposed and elected by themselves. ACAL has from the outset been sponsored by the Simón Bolívar Foundation, UNESCO, ICSU and the Third World Academy of Sciences (TWAS).

National scientific societies also conduct a variety of exchanges, traditionally with their counterparts in the countries of the North, though recently much of their effort has gone into regional cooperation through the creation of *ad hoc* networks or their incorporation in existing networks (see below).

In addition, since 2000, the National Academies of Argentina, Bolivia, Brazil, Chile, Colombia, Cuba, Guatemala, Mexico, Peru and the West Indies have enjoyed active membership of the Inter-Academy Panel, with a view to strengthening their capacity for participation in science policy issues at national and international level.

The University of São Paulo, Brazil

An example of a university which is outstandingly dynamic in its international cooperation activities is the University of São Paulo (USP), which in addition to its traditional responsibilities plans to take a proactive role in order to increase its visibility on the international scene. For this it relies on the International Cooperation Commission (CCI), a unit in the Rector's office which maintains close contact with the Ministry for Foreign Affairs, embassies of foreign countries, international bodies, etc.

The university's activities reflect the high levels of cooperation to be found in other universities of the region. It participates in the following university networks: CINDA (Inter-University Centre for Development), ALFA (Latin America Academic Training), RECLA (University Network for Continuing Education in Latin America and the Caribbean), FAUBAI (Advisory Faculty of the Brazilian Universities for International Affairs), IAU (International Association of Universities), OUI (Inter-American University Organization), UDUAL (Union of Latin American Universities), AULP (Association of Portuguese-Language Universities), Santos Dumont (Brazilian and French Universities Network at jointly supervised doctoral thesis level), PEPE (Partnership for Environmental Technology Education), and ISTEC (Ibero-American Science and Technology Education Consortium).

USP has 20 centres which conduct regional or international programmes in various fields, through agreements between universities or programmes assisted by the National Council for Scientific and Technological Development (CNPq), the São Paulo State Foundation for the Support of Research (FAPESP) or other external sources. It is estimated that some 50% of cooperation is on lines initiated by its teaching staff, not channelled through CCI. Almost all agreements are with universities in the most industrialized countries, reflecting the university's extensive role as a recipient of knowledge (sandwich Doctorates, post-Doctorates abroad, foreign visiting professors, etc.), although USP has more recently emerged as a partner in international research of definite substance. Furthermore, under its Student Programme Agreement it receives a large number of students from abroad, both undergraduate and postgraduate, mainly from LAC and Africa. Countries with which it has the most agreements are Japan (19), followed by France (18), the USA (17) and Italy (15). Given the existence of MERCOSUR, it is worth noting that there are only eight agreements with Argentina, and one each with Uruguay, Paraguay and Chile. In addition to respecting and furthering cooperation initiatives by teachers, CCI coordinates activities in three priority thematic areas: the environment and sustainable development, MERCOSUR and Latin America in general, and countries with Portuguese as their official language.

As the largest Brazilian university, USP recognizes that it has not done all it might have to spread knowledge of its experience, in particular to neighbouring countries. It therefore aims at acting as a university hub between the best world research centres and the least developed regions (even within Brazil), taking advantage of the fact that many of its teachers are familiar with both. It also seeks to increase its participation in government policies with an international component, creating closer links with organizations in the United Nations system, ICSU and other non-governmental organizations (NGOs). In this way it hopes to give Brazil a place in international issues which call for academic study, while steering clear of more pressing interests.

Various networks

The most successful instruments in facilitating multilateral cooperation include networks. Internationally, these have in fact become a mechanism for cooperation backed by scientists and their organizations and also by their supporting institutions, thanks to the great benefits to cooperation in return for low initial investment – even if the need for stable permanent financing to ensure the continuity of activities is often overlooked. LAC has seen the emergence of many networks, for example:

- between university institutions such as the Montevideo Group, the Caribbean University Level Programme (CULP), the Union of Latin American Universities (UDUAL), the Mexico Central America University Network (ANUIES-National Association of Universities and Higher Education Institutions, Mexico/CSUCA-Confederation of Central American Universities), university networks with European countries, etc., or covering a variety of activities in science;
- special-purpose networks in scientific cooperation: linking scientific societies, mixed networks of societies and governments, and those of researchers, laboratories or research centres, etc.

Among university networks, the following are remarkable for their scientific activities:

The Association of the Montevideo Group of Universities (AUGM), founded in 1991 with the aim, among others, of helping to build up a critical mass of high-level human resources and develop scientific and technological research, including innovation processes and technological adaptation and transfer, in strategic areas. AUGM brings together 12 State and autonomous universities: five in Argentina, five in Brazil, one each in Paraguay and Uruguay, all relatively close to each other, which facilitates exchanges and joint initiatives. Its *Escala* programme operates through unidisciplinary groups in areas of strategic importance for the region, such as materials science and engineering, natural bioactive products and their applications, applied mathematics, molecular virology, fine chemistry, mechanical engineering and production. Recent activities include the first meeting of the Regional Centre for Studies of the Genome, the outcome of an agreement between AUGM and the Max Planck Institute, with headquarters in the National University of La Plata (UNLP). AUGM is in fact a virtual university, with a supportive distribution of resources and highly qualified university staff. Its rapid growth has shown the conditions to be right for regional integration; it has even defined itself as being inherently a process of integration, regardless of what may be achieved in other current processes pursuing the same end.

The Inter-University Centre for Development (CINDA) is an institution comprising major universities in Latin America and Europe, whose basic aim is to link them all together to study the main problems of development. The members of the network are chosen for their high quality and as representing a variety of institutional practices. At present it has 31 member universities in Argentina, Bolivia, Brazil, Colombia, Costa Rica, Chile, Dominican Republic, Ecuador, Italy, Mexico, Panama, Peru, Spain and Venezuela. Its University, Science and Technology programme seeks to help develop the S&T capacity of Latin American universities and its use by government and by institutions of the productive sector, through study, training and advisory projects in such areas as: the S&T development system, the administration of S&T activities, outreach university work, technology management, and higher education and international cooperation.

The Ibero-American University Association for Postgraduate Studies (AUIP) is a non-governmental body concerned with furthering postgraduate and doctoral studies in Ibero-America and financed by its member institutions. It now comprises more than 120 prestigious institutions of higher education in Spain, Portugal and LAC and dispenses in common several thousand postgraduate programmes in almost all fields of knowledge. It provides information and communication services on available postgraduate opportunities, cooperates in internal and external assessment processes and the recognition and harmonization of the curricula offered; it facilitates mobility and exchanges of teachers and students, encourages

academic and research work by means of networks of centres of excellence in various fields of knowledge, sponsors academic and scientific events clearly related to the courses provided; and organizes international roving courses on subjects of interest to teachers and directors of postgraduate and doctoral studies.

The last few decades have seen the emergence of regional or subregional scientific networks of a uni- or multidisciplinary nature designed basically to promote the development of research and postgraduate studies, such as the Latin American Biotechnology and Bioengineering Association (ALABYB), the Latin American Association of Space Geophysics (ALAGE) and many others. For reasons of space, we merely give a brief selection:

The Latin American Network of Biological Sciences (RELAB), formed in 1985, started out in 1975 as a UNDP-financed project. In 1981 it served as a model for the creation by ICSU and UNESCO of international biology networks (IBNs). It now has 15 national, seven regional and two associate members. The national members are countries whose governments appoint a National Committee; regional members are societies bringing together biologists from the main biological science fields; and associate members are the Latin American Centre for Biological Sciences (CLAB) and the Association of Deans and Directors of Biology Schools and Faculties in Ibero-America. From 1975 to 1985 the network financed postgraduate scholarships, training courses, bi- and tri-national projects and numerous activities of National Committees. In its second stage (1985-94) most activities focused on intensive courses, workshops and symposia. In 1991 the RELAB Corporation was further set up to support scientific activities in member countries. Funding is now provided mainly by the countries and the Pan-American Health Organization (PAHO), supplemented by contributions from international organizations such as UNESCO and ICSU. In 2001, in view of the magnitude and variety of tasks, RELAB decided to set up coordinated facilities for the following additional themes: the perception of biology by society, the media and education; scholarships, internships, meetings and courses; relations with PAHO; bioinformatics; genomics and proteomics; and biodiversity and biotechnology.

The ICSU decision in 1993 to merge its two bodies IBN and COSTED (Committee for Science and Technology in Developing Countries) gave rise to the creation of regional networks in other basic science disciplines, along the lines of RELAB; and ICSU and UNESCO gave assistance for the creation of the Coordinating Committee of Latin American Science Networks (CCRCLA), which also serves as the COSTED Regional Secretariat. These networks, whose activities chiefly concern the training of high-level scientists and the consolidation of research, with special attention to relatively less developed countries, have been recognized as an effective model of regional cooperation and as sources of advice for international organizations. However, as with other similar initiatives, they are constantly faced with the challenges of maintaining active contact with their associates and securing steady funding for their activities. In addition to RELAB, this set of networks includes the:

- Latin American Physics Network (RELAFI), set up in 1996 as part of the joint action taken by the Latin American Physics Centre (CLAF: see below) and the Latin American Federation of Physics Societies (FELASOFI). The latter comprises 18 societies with 8 000 members, and forms part of the Ibero-American Union, of which the Spanish Royal Physics Society and the Portuguese Physics Society are also members;
- Mathematical Union of Latin America and the Caribbean (UMALCA), comprising the nine mathematical societies of: Argentina, Brazil, Chile, Colombia, Cuba, Mexico, Peru, Uruguay and Venezuela, and representatives of Bolivia, Ecuador and Costa Rica;
- Latin American Chemical Science Network (RELACQ), with members from 12 countries: Argentina, Bolivia, Brazil, Chile, Colombia, Cuba, Mexico, Panama, Paraguay, Peru, Uruguay and Venezuela, through the intermediary of National Chemical Societies, with the exception of Paraguay and Uruguay, represented by

the chemical science unit in the sole university institution in each country;

- Latin America Network of Astronomy (RELAA), covering the countries of the region in which astronomy exists as a professional activity. It has approximately 550 members, distributed by country as follows: Argentina (150), Brazil (200), Chile (25), Mexico (150), Uruguay (10) and Venezuela (15).

Through its Regional Office in Montevideo, UNESCO has also recently assisted in the creation of several regional or subregional networks of educational institutions and research centres, mainly to coordinate and strengthen postgraduate programmes in various scientific disciplines, for example: RED-CienciA (R&D and Postgraduate Programmes Network in Central America, 1998), CARISCIENCE (R&D and Postgraduate Programmes Network in the Caribbean, 1999) and GEOLAC (Latin America and the Caribbean Network of Faculties/Departments of Geosciences, 2001). These innovations are intended to strengthen and make better use of each institution's scientific and educational resources with a view to furthering the sustainable and equitable development of the region's smallest countries.

Noteworthy in another connection is the Interciencia Association (AI), a federation of organizations for the advancement of science, founded in 1974 on the initiative of the American Association for the Advancement of Science (AAAS) to promote scientific cooperation and public awareness of the value of science in the American hemisphere. AI now has member associations in Argentina, Bolivia, Brazil, Canada, Chile, Colombia, Costa Rica, Cuba, Ecuador, Jamaica, Mexico, Panama, Peru, Puerto Rico, Trinidad and Tobago, USA, Uruguay and Venezuela. It has its executive secretariat in Panama City, and publishes in Caracas the prestigious journal *Interciencia*, devoted to scientific topics linked to development. In order to avoid overlapping, AI frequently collaborates with other bodies in promoting S&T, in particular with the Organization of American States (OAS) offices, the US National Science Foundation, the Inter-American Development Bank (IDB) and CYTED.

There are also networks directly linked with research groups to conduct joint activities in the form of projects in which groups complement their capacities and share the tasks. Particularly in Europe and the USA, such networks help to transform ways of producing knowledge by encouraging the acquisition of new methods, access to more sophisticated instruments, inter- and trans-disciplinarity and the tackling of more wide-ranging objectives. One example in Latin America seen as a success story is CABBIO (see box).

A more recent example, in a different context, is the FLACAM Network (Latin American Forum of Environmental Sciences), originated in 1988 to develop scientific and training links between non-governmental organizations (NGOs) of the Southern Cone. FLACAM members now include a number of universities, research centres and foundations. Its headquarters are in La Plata, Argentina, and it has members in Argentina, Bolivia, Brazil, Colombia, Chile, Cuba, Italy, Mexico, Paraguay, Peru, Spain, Uruguay and Venezuela. FLACAM's objectives are:

- training researchers for activities in specific projects on the ground;
- carrying out applied research projects for sustainable development;
- promoting the creation of a critical mass of human resources for environmental training and management in Latin America.

Since 1990 it has been running a Master's degree course in sustainable development, open to students from the region, and in 1994 the UNESCO Chair in Sustainable Development was set up in association with this network.

Information networks

The importance of telecommunications and information infrastructures was recognized at the 1994 Summit of the Americas held in Miami, when governments undertook to urge the main institutions to acquire access to networks of this kind. In 1992, OAS had approved the creation of the Inter-University Hemispheric Scientific and Technological Information Network (RedHUCyT), and provided it with

CABBIO

CABBIO, the Argentine-Brazilian Biotechnological Centre, which dates from 1985, is a coordinating body combining official and private working groups in Argentina and Brazil involved in special production-related projects, financed equally by both governments. It is a subregional integration programme in biotechnology that has helped to consolidate national activities in support of both long-standing and recent groups.

One of its most important tasks concerns banks of microbial families and micro-organisms, which collect and preserve the existing biodiversity of the region. Despite its importance, CABBIO has suffered a period of relative stagnation, due at least in part to resistance from the markets to genetically modified products, which many of its projects seek to develop.

Fifty doctoral theses and 150 technology training exchanges were part of the outcome of projects up to 1999. In the same period CABBIO's teaching activities consisted of 133 further training courses attended by 1 850 graduates. Since 1993, graduates from Uruguay and Paraguay have also been attending and graduates from the Latin American Biotechnology Network (RELABIO-UNDP) have been able to enrol. CABBIO courses are recognized for doctoral programmes in most of the region's universities.

CABBIO participates in the specialized meetings of RELAB-UNDP (Latin American Network of Biological Sciences), RELABIO-UNDP (Latin American Biotechnology Network), ICGEB (International Centre for Genetic Engineering and Biotechnology), WIPO (World Intellectual Property Organization), PROCISUR, MERCOSUR and BIOLATINA.

funding as seed capital. The main aim of RedHUCyT is to link up Member States' institutions to the Internet for S&T information exchange. OAS also supports, among others, the following regional S&T information systems:

- LAC-INFOCyT Scientific and Technological Information System;
- Ibero-American Network of Science and Technology Indicators (RICYT);
- Latin American Chemical Science Network (RelaQ);
- Multinational Specialized Information System in Biotechnology and Food Technology for Latin America and the Caribbean (SIMBIOSIS);
- Regional Network for Information on Agricultural Research in the Southern Cone;
- Inter-American Metrology System (SIM);
- Pan-American Standards Commission (COPANT).

In particular, RICYT was set up by CYTED (see below) on a proposal by the first Ibero-American Workshop on Science and Technology Indicators in late 1994. From its inception, RICYT has conducted its activities in coordination with OAS. This cooperation strategy was strengthened when the Network became responsible for carrying out the project Regional Science and Technology Indicators financed by the Inter-American Council for Integral Development (CIDI). RICYT's general objective is to promote the development of instruments for the measurement and analysis of S&T in Ibero-America with the aim of gaining in-depth knowledge of science and its uses as a policy instrument in decision-making, taking into account:

- the incorporation of the region in international systems of science, technology and innovation indicators;
- analysis of the specific problems of the region, seeking solutions to problems in areas such as bibliography, bibliometry, the institutional organization of S&T statistics and the training of specialists in indicators and other subjects;

- the creation of a Latin American norm for specific aspects of S&T activities in the region.

In its activities for the training of human resources, RICYT works with the UNESCO Chair on Science and Technology Indicators.

Also outstanding among the regional activities in the information field is LATINDEX, an automated scientific periodical information system for LAC, Spain and Portugal. The system was set up in 1995 to disseminate, provide access to and raise the quality of the journals produced in the region, and it is the outcome of cooperation with a network of regional clearing houses which operate in a coordinated manner with shared resources, seeking to:

- pool efforts in the various participating regions and countries regarding the production, dissemination, systematization and use of scientific information;
- reinforce and upgrade science publishing in the LAC region;
- increase the international visibility and coverage of such publications;
- use the information processed as a basis for by-products;
- influence national and international circles in regard to scientific information, documentation and publication.

The first of its products, the online *Latindex Directory,* contains basic information on more than 11 000 scientific or academic journals. Present members of the system are institutions in Argentina, Brazil, Chile, Colombia, Costa Rica, Cuba, Mexico, Portugal, Puerto Rico, Spain, Uruguay and Venezuela.

Emigrant networks

These are networks set up to do something about the *brain drain* of qualified scientists, seen as a loss to countries and the region as a whole. Given the importance of this issue, it has to be recalled at some length, although unfortunately there is no precise information indicating the extent of the phenomenon and how best to tackle it.

As already noted, many young students (and also technicians and professionals) of Latin American origin enrol in universities abroad to round off their scientific education. Many are sent on scholarships from their own countries or institutions, others hold scholarships from foreign institutions, and still others take employment in the host country which enables them to complete their training. For many of the developed countries, attracting qualified personnel has become a central policy objective, which includes the active recruitment and retention of foreign students. The USA, in particular, officially hails as a success the fact that almost 50% of foreign students who graduated in science and engineering in 1990/91 were still living in the USA five years later. Statistics provided by the National Science Foundation itself show, for example, that Mexico alone had some 4 200 university students in science and engineering in the USA in 1995/96, and more than 35 000 residents in 1997 with a science or engineering degree. Graduates remaining in the USA after completing their studies thus contribute their talents to its workforce. More generally, over one third of the scientists and engineers in Silicon Valley are of foreign origin, and a high proportion of the scientists working in the USA who are awarded Nobel Prizes were born elsewhere. For some LAC countries, this migration means that their professionals contribute a greater percentage of their economically active population to the workforce in the USA than back home (during the 1990s this was the case for Bolivia, Chile, Guyana, Jamaica, Panama, Paraguay, Trinidad and Tobago and Venezuela; see Pellegrino, 2001).

Several national S&T bodies in the region have introduced specific measures to address the problem of the emigration of scientists. The greatest difficulty seems to be to prevent emigration itself, since this would require a substantial improvement in working conditions for scientists in their own countries to lessen the lure of the countries of the North. Since trying to recover emigrant scientists is expensive and not that effective, some bodies have preferred to re-establish and maintain contact with them from a distance. This is intended to assist a *brain gain* policy, where the aim is to draw on the intellectual capacity of expatriate researchers without hoping to bring

Qualified migrants: a present and future challenge

At its meeting in Antigua, Guatemala, in October 2001, the Latin American Union of Universities (UDUAL) discussed at length the problem of the brain drain and produced a declaration on the following lines:

In developed countries the demand for specialized professionals has led to the adoption of policies and programmes designed to attract highly qualified migrants. The present global context confronts Latin American societies with profound challenges and dilemmas, since their economic development will depend to a great extent on their own scientific and technological progress. The intensification of academic and professional links in an international context of inequality is partly responsible for the fact that the accumulation of knowledge and the creation of a "critical mass" in science does not produce the benefits originally hoped for by the Latin American countries.

The available statistics show that qualified migrants tend to remain in the countries in which they specialize. Influential factors are not only the differences in working conditions and levels of entry of qualified professionals but also the political instability and economic crisis in most countries of Latin America. The economic losses represented by the non-return of highly qualified professionals are borne by the countries of origin. Thus the price paid by Latin America for "exporting" talent is usually underestimated, which makes it urgent to devise and apply alternative policies. UDUAL therefore proposes steps to:

- Establish government policies designed to recover highly qualified professionals by means of programmes promoting either their return or renewed links with them, which programmes should receive technical and financial support from international organizations.
- Improve the quality of employment in Latin America with respect to both salaries and working conditions, thereby encouraging the retention and/or recovery of highly qualified professionals.
- Promote cooperation agreements between Latin American countries and countries receiving qualified migrants, in order to make of the latter active agents of scientific, technological and humanist development in their countries of origin.
- Intensify links between Latin American universities for the purpose of joining forces to create wider and more diversified critical masses of qualified professionals who will stimulate scientific and technological development in their countries in parallel with the development of knowledge in the social sciences, humanities and arts.
- Create and consolidate postgraduate programmes of excellence to be jointly conducted by Latin American universities so as to enable their students and teachers to complete their training in their own academic setting.

UDUAL likewise resolved to set up a committee to collect and analyse information for the sake of determining the best possible policies to counter the phenomenon.

them home. Recently, the development of communications and transport has produced a great variety of migration patterns also being utilized in the LAC countries for temporary exchanges of specialists and a means of partially offsetting the losses due to emigration. Since, however, qualified workers are beginning to be seen as a rare commodity worldwide, it is to be expected that the developed world will come up with even greater

incentives for scientists from elsewhere. This makes it all the more urgent to create better conditions so as to retain scientists in the LAC countries.

Out of 41 knowledge exchange networks comprising expatriates from 30 countries, according to 1999 data, seven are Latin American and based in Argentina, Colombia, El Salvador, Uruguay, Peru and Venezuela (Pellegrino, 2001). The Caldas Network was officially set up in November 1991 by *Colciencias* as one of the first initiatives for drawing together the LAC "scientific diaspora". Within this network a start was made on establishing a new status for emigrant Colombian scientists as focal points in creating and strengthening international links for the benefit of science in Colombia. Its activities include a start on forming denser networks to take in research projects between groups of researchers in Colombia and Colombian researchers abroad (e.g. the BIO-2000 project and the Automation Project), who have provided each project with access to the network built up by them in their countries of residence. However, once projects reach an initial stage of consolidation, in a typical network dynamic, they go underground and out of sight for the initial network; and this may have happened also with the Caldas Network. Relations continue solely between the individuals and institutions involved. In other words, at a given time each project creates its own independent network of relations, making it difficult to gauge and examine its coverage.

COOPERATION AT THE COUNTRY LEVEL

Bilateral and multilateral intergovernmental agreements

Bilateral agreements in LAC are usually expressed through cooperation agreements between national S&T bodies. The basic duties of these bodies are to organize international mobility programmes, either through grants or the transfer of researchers. They also draw up bilateral agreements with countries in other regions, multilateral agreements as in the case of bodies set up at a regional level such as the EU, MERCOSUR, NAFTA (North American Free Trade Agreement), OAS, CAN (Andean Community of Nations) and the Andrés Bello Convention, and agreements within the framework of international institutions such as UNESCO, ICSU and TWAS. Over the last few years, the international cooperating offices of the national S&T bodies have significantly extended their activities and regularly manage a portfolio of several hundreds or even thousands of cooperation conventions or agreements with foreign or international organizations and institutions. Noteworthy efforts have recently been made to draw up cooperation agreements geared towards technological modernization, involving both research and development teams and businesses in industrialized countries.

Postgraduate education and research training remain an important element of North-South cooperation. In several LAC countries, this modality is favoured by the institutions themselves, which require young researchers to gain experience in a prestigious foreign institution (of "excellence") before taking them on. Over the last decades, the presence of Latin American students has substantially increased (including from those countries offering postgraduate training of international repute) in Northern universities, particularly in the USA, as mentioned previously. In 1995, 91 358 Latin American students enrolled abroad, a substantially lower figure than that for Asian students (IIE, 1996), but nonetheless significant as compared to the total number of graduate students enrolled in the same region.

Cooperation with the USA

US international scientific cooperation is an activity that involves various agencies in response to the variety of opportunities arising throughout the world in science and engineering. The National Science Foundation (NSF) is notable for the international component of its research, postgraduate education, postdoctoral positions, and to a lesser extent, pre-university and university education programmes. Most of its international activities revolve around "field" sciences, both bilateral and multilateral. With regard to LAC, such activities include for instance astronomical observatories, such as the Inter-American

Observatory of Cerro Tololo in Chile or the Ushuaia site in Argentina; the Inter-American Institute for Global Change Research (IAI) and the Organization for Tropical Studies (OTS) in Costa Rica; the global network of seismographs, which includes Mexico, and the Brazilian and Colombian sites of the Long-Term Ecological Research (LTER) group. Furthermore, all the US centres that are supported by NSF are open to scientists and students from other countries. In the area of high-energy physics, in particular, there has been a long-standing collaboration of research groups in Latin America with Fermilab in Chicago, promoted by its Director Emeritus, the Nobel Laureate Leon Lederman.

Since 1973 the American Association for the Advancement of Science (AAAS) has conducted a programme promoting cooperation with LAC, structured around three priority areas: bringing new actors into the LAC scientific world, promoting cooperation and scientific ability in LAC, and introducing interdisciplinary solutions to development problems in the region. In recent years, the programme has organized scientific conferences and symposia, as well as interdisciplinary sessions during its annual meeting focusing on topics such as ethnobotany and bioprospecting during the next millennium, and international scientific funding and cooperation in LAC. The AAAS has also been cooperating with the Interciencia Association, since its foundation.

Philanthropic foundations have historically been part and parcel of the means by which the foreign policy interests of the USA were advanced. The Ford Foundation, Rockefeller, Kellogg and Carnegie Corporation programmes have been linked to the development of distinct areas of scientific and technical knowledge in Latin America. Similarly, agencies such as the NIH and NASA maintain cooperation programmes with various LAC countries and have Latin American employees.

Cooperation with Canada

Notable in its efforts to foster cooperation with Latin America is the Canadian International Development Research Center (IDRC) which, since its creation in 1970, has fostered and supported research on problems facing developing countries through the funding of university researchers, governments, commercial firms and non-profit organizations. Recently, its support for national policy research has increased both at its headquarters and its regional centre in Montevideo. In the fields of environment and natural resource management it has programmes for the sustainable use of biodiversity and natural resource management in LAC (MINGA); the other major fields are information and communication technologies and social and economic equity. Over the last three years, more than 25 research projects and activities have received support from the Pan-Global Networking Programme introduced by IDRC.

Cooperation with Spain and other European countries

By any reckoning, Spain is the European country that has been most involved in cooperation with Latin America in recent years, with the support of various programmes, through the Spanish Agency for International Cooperation (AECI). The AECI yearly offers grants for Latin American graduates to undertake PhD courses and research in Spain, various Latin American countries and Portugal, through the Becas Mutis Programme. For example, between 1991 and 1997, over 9 000 grants were awarded, the main recipients of which were Mexico, Argentina and Cuba. The MEC-MAE (Ministry of Education-Ministry of Foreign Affairs) Programme for Scientific Cooperation with Latin America aims to promote joint activities in the framework of scientific research projects by Spanish and Latin American technicians and scientists, as well as knowledge transfer through postgraduate course provision.

The above mentioned Ibero-American Programme on Sciences and Technologies for Development (CYTED), set up in 1984 through a framework agreement concluded by 19 countries, stands out for its scale and importance. Since 1995, CYTED has been officially included in the Latin American Summit Cooperation Programmes as an invaluable tool for integration. By 2001 it had generated

76 thematic networks, 95 Research Projects and 166 Innovation Projects involving over 10 000 Latin American scientists and technologists; moreover, it participates in other initiatives to offset resource expenditure. The thematic areas currently encompassing the 19 sub-programmes are: Support for Science and Technology Policies, Environment, Energy Resources, Information and Communication Technologies, Health and Food Technology, and Materials Technology.

The other European industrialized countries each have permanent cooperation programmes for development, usually conducted by offices dependent on the ministry of foreign affairs. A significant part of such cooperation – which for instance exceeds 30% in the case of Sweden – is channelled through international or multilateral organizations such as the United Nations agencies, the World Bank Group and regional development banks; moreover, in several European countries, development cooperation is focused primarily on Africa and South Asia, then on LAC. In contrast, purely scientific cooperation with developing countries is generally subject to bilateral agreements concluded with national S&T bodies to facilitate academic exchange, further closer links among research groups and support the training of leading scientists. As regards scientific cooperation with LAC, areas of major interest for European countries are natural resources, tropical agriculture, health, and to a lesser extent mathematical, physical and engineering sciences; priority areas are clearly reflected in the portfolio of LAC countries appearing as partners in these cooperation agreements.

Although the traditional donor-recipient pattern still prevails in the field of "development cooperation", in the specific field of bilateral academic cooperation between Europe and LAC this pattern has been largely replaced by the concept of horizontal cooperation among peers or colleagues who jointly define their objectives and share their knowledge, for their mutual benefit. Those directly involved in this kind of cooperation have, to some extent, managed to transmit this new vision to official development cooperation circles.

Cooperation with the EU

EU cooperation policy with LAC endeavours to reconcile Europe's contribution to socio-economic development in the region with European scientific and economic interests. The pursuit of this policy has helped European scientists to gain access to sites with environmental, agricultural, ecological and other characteristics of particular relevance to research. Areas of cooperation have been chosen following extensive dialogue with LAC scientific authorities; thus, agriculture and agro-industry, health, the environment, and information technologies were defined as priority areas. Nevertheless, in order to make the most of the available human potential, research has also been supported in other fields such as materials and Earth sciences and certain engineering sciences.

During the 1990-94 period, two complementary schemes operated: Sciences and Technologies for Development (STDIII) and International Scientific Cooperation (ISC), the latter geared towards building lasting relationships between EU and LAC scientists. A scheme combining these ideas was introduced in 1994-98, the INCO-DEV Programme for Scientific and Technological Cooperation with Developing Countries, focusing mainly on three sectors: sustainable management of renewable natural resources, sustainable improvement of agricultural and agro-industrial production, and health. By 1998, 900 activities involving 2 780 institutional partners had received support, with a European contribution of approximately EUR 200 million. (By the same date, 17 000 multi-national projects, most of them intra-European, had been financed, including approximately 85 000 partnerships among groups or laboratories). This Programme has fostered the development of Euro-Latin American research networks involving at least one LAC and two European countries; over 200 Latin American organizations have participated in these networks although 95% are coordinated by European researchers. Cooperation was most intensive with Brazil, followed by Argentina and Mexico and, to a lesser extent, Colombia and Chile; the European countries involved were

predominantly the UK, France, Spain and Germany. Since 1999, for a four-year period, the INCO-DEV component of the fifth EU Framework Programme has been supporting problem-oriented research, whilst maintaining the regional and thematic approach of the previous programme, combined with a section on research into sustainable development policies.

Furthermore, the ALFA Programme for cooperation between the EU and LAC in the area of higher education offers the opportunity for multilateral academic interaction between the two regions. One of its basic dimensions is academic mobility, the aim being to promote the highest possible level of knowledge, discourage the brain drain, generate a critical mass, stimulate bilateral research interests – regional or bi-regional, help to focus scarce resources, and develop infrastructure. Another of ALFA's fundamental objectives is to form networks, based on the requirement for at least three Latin American and three European institutions to team up. This objective is linked to the purpose of promoting the international dimension and improving the quality of education. A third component of the programme is continuing education, aimed at maintaining the highest possible levels of abilities in the workforce. During the second phase of the Programme, between 2000 and 2005, the EU will make a contribution of EUR 42 million. A new component of postdoctoral and higher education grants, ALFA+, will involve a significant increase in Programme funding.

Agreements among the countries of the region

After the "lost decade" of the 1980s, there was a reactivation of integration processes. As a result of this new impetus, the current integration map of LAC is quite different from that of a few years ago. In 2000 there were four common markets, ten free trade treaties, with others under negotiation, and many additional agreements (including 65 partial agreements). This change has led some to call the 1990s the decade of Latin American and Caribbean integration. The pragmatic and realistic way in which the integration process has evolved has led to the creation of subregional and bilateral, rather than multilateral, agreements, for the sake of more flexible and functional mechanisms. But attempts at intraregional integration have in practice come up against persistent weaknesses and obstacles connected with development problems and political and financial instability, so the prevalent trend is still that countries join the dominant economic and financial system separately. The world is globalizing and Latin America is not even getting itself together.

Despite their few integrative outcomes, the holding of the Ibero-American Summits, annually since 1991, must be regarded as an improvement. Although the recent Summits have revolved around free trade, sustainable development and democracy, S&T has not been entirely excluded from the agenda. Noteworthy here is the first regional meeting of ministers responsible for S&T, held in Cartagena, Colombia, in 1996 and attended by 30 countries of the hemisphere (including the USA), with the cooperation of the IDB and OAS. The Cartagena Declaration is regarded as a milestone in the history of the region, as strategic guidance and as a common framework for lines of action. The resultant Plan of Action outlines three basic strategies: strengthening of existing cooperation activities and creation of new joint programmes, establishment of new funding mechanisms, and introduction of a coordination and monitoring mechanism. Governmental action in the field of cooperation is now guided largely by the Cartagena documents.

Various cooperation programmes in the region have contributed to the development of its scientific and technological infrastructure; in addition to those already mentioned, they include the programmes conducted by IDB, OAS, the United Nations Industrial Development Organization (UNIDO), COLCYT, the Caribbean Council for Science and Technology (CCST), the international agricultural research and development system (which is coordinated by CGIAR), regional and subregional systems like IICA (Inter-American Institute for Cooperation on Agriculture) and the agricultural research cooperation programmes (PROCIs). New programmes have been

launched more recently, including MERCOCYT, the Bolivar Programme, the Inter-American Institute for Global Change Research (IAI), the above mentioned International Research Institute for Climate Prediction (IRI), the GLOBE Programme and others in the field of sustainable development.

In this context, one should also mention the Commission for the Scientific and Technological Development of Central America and Panama (CTCAP), an intergovernmental organization with headquarters in Tegucigalpa created to coordinate the subregion's S&T policy in harmony with each member country's socio-economic policies and programmes. Since its inception in 1976, it has played a decisive part in strengthening the scientific and technological infrastructure in the countries of the region, which has resulted in a series of legal documents, programmes and projects that contribute to its development.

At present, the strategic areas and policy lines of the Organization of American States (OAS) Inter-American Science and Technology Programme (PRICYT) are logically based on the Cartagena Declaration and the Plan of Action adopted in March 1996. They take into account the Strategic Plan for Partnership for Development 1997-2001 of the Inter-American Council for Integral Development (CIDI) and mandates given by the OAS General Assembly and Summits of the Americas, together with experience gained in the region in formulating and implementing S&T policies and the contribution of the MERCOCYT Programme. The three major thematic areas regarded as crucial to the region's development under the PRICYT Programme are science, technology and innovation to promote social development, strengthen the entrepreneurial sector and promote sustainable development and the preservation of a healthy environment. Member States' voluntary contributions to the projects are used to fund activities; in particular, the consequence of this is access to funds insofar as they are associated with multinational projects. The Inter-American Commission on Science and Technology (COMCYT) is in charge of carrying out programme actions and of evaluating their results.

The Organization of Ibero-American States for Education, Science and Culture (OEI), previously the Ibero-American Bureau of Education, was set up as an intergovernmental organization to promote cooperation among Ibero-American countries in the fields of education, science, technology and culture in the context of all-round development. Its headquarters are in Madrid and it has regional offices in Argentina, Colombia, El Salvador, Mexico and Peru and a technical office in Chile. The OEI's funding comes from Member States' assessments and voluntary contributions and from any contributions by institutions, foundations and other bodies to specific projects. Its Science, Technology, Society and Innovation Programme (CTS+I) involves two complementary approaches, one emphasizing S&T linkages with society, and the other giving special attention to the educational aspects of S&T. OEI's most recent and interesting initiatives include the encouragement of CTS+I chairs and the creation in 2001 of an electronic journal also called *CTS+I.*

Cooperation with and among international organizations

International organizations involved in science differ significantly in terms of their objectives and nature; some are United Nations agencies, others are based on intergovernmental agreements, and others still are NGOs. Such bodies do not generally conduct research themselves but, in their field of competence, promote or support international research projects, or recommend priorities to governments or to other international organizations. Most of the United Nations agencies (e.g. the World Health Organization (WHO), the Food and Agriculture Organization (FAO) and the International Atomic Energy Agency (IAEA)) have specific mandates – such as raising levels of nutrition and living standards, increasing agricultural productivity, or promoting the peaceful application of nuclear technology – and carry out a range of technical cooperation activities aimed at fulfilling those

The Latin American Centre for Physics

The Latin American Centre for Physics (CLAF) was founded in 1962 following a UNESCO resolution; the constituent assembly of CLAF was held in Buenos Aires in 1966 and the first Governing Council in Montevideo in 1968. Its headquarters are at the Brazilian Center for Research in Physics (CBPF) in Rio de Janeiro and a subsidiary office has been operating in Mexico City for the Mexico, Central America and Caribbean region since 1993.

CLAF is funded by Member States, of which there are now 13. The largest cash contribution comes from Brazil, which also contributes with headquarters maintenance, the payment of staff salaries and 25 PhD and post-PhD fellowships. Argentina grants two fellowships and Mexico contributes the same amount to the subsidiary office as to CLAF.

CLAF maintains substantial relations with international organizations. In recent years UNESCO has cooperated in the holding of meetings in Havana of potential users of the Microtron accelerator located there. ICTP cooperation has encouraged physics research in the relatively less developed countries, and a cooperative PhD programme has been in place with the universities of the region since 1999. In 1998, an agreement was signed with JINR in Dubna, Russia, and two Latin American students are doing their PhD studies there. At the beginning of 2001, an agreement was also signed with CERN in Geneva to hold a joint school of high energy physics in Latin America every two years. An agreement was signed recently with the Academy of Sciences of Bolivia and the University of La Paz to confer international status on the Chacaltaya Observatory, with the provision of international funds.

With regard to the dissemination of modern physics, CLAF systematically supports schools and conferences on the most varied topics, totalling 40 in 2000: 13 in Brazil, 8 in Argentina, 4 in Mexico, 4 in Chile, 3 in Colombia, 2 in Bolivia, 2 in Costa Rica and 1 in Cuba, Peru, Uruguay and Venezuela. CLAF's limited resources have meant that meetings were largely dependent on other sources and it has therefore not been possible to formulate a strategy, but an attempt is now being made in this respect, at least in the field of high energy physics. The human resources training programme has become the most substantial one conducted by CLAF. Thirty-eight PhD and post-PhD students currently hold fellowships in a dozen countries and new initiatives are being encouraged for the relatively less developed countries. As a whole, the percentages for the various research areas are as follows: 22% particles, fields and cosmology; 19% materials science; 16% optics; 14% condensed matter; 16% statistical physics; 6% nuclear physics; 6% astrophysics and 3% atomic physics.

mandates. The paragraphs that follow refer briefly only to agencies most directly involved in scientific cooperation activities, and more specifically those of relevance to LAC.

The United Nations University (UNU) has been functioning since 1975 as an autonomous body under the auspices of the United Nations and UNESCO, with 13 research and training centres and programmes in the fields of peace and governance, and environment and sustainable development. One of its specialized programmes, the Programme for Biotechnology in Latin America and the Caribbean (BIOLAC), founded with the backing of the Venezuelan government in 1988 and based in Caracas, is being reoriented in the present biennium to focus on three strategic areas through specific projects: Biosafety working guidelines for LAC, Bioethics studies in the LAC context, and the Bioinformatics network for LAC.

With regard to human resources training, BIOLAC offers fellowships for research and training periods abroad in bioethics and biosafety.

Although there has usually been some Latin American participation in the various UNU programmes, mostly through training courses, it is considered that adding a few strategic partners in the region would considerably reinforce cooperation ties and give the University's activities a more integrated focus. In this respect, UNU is paying attention to new project initiatives that may originate in countries of the region.

UNESCO undertakes a great many activities in LAC, mostly in the important fields of environment and sustainable development, and basic sciences and engineering. These activities often form part of major international programmes in which UNESCO works with other organizations (see below), seeking to coordinate efforts and create synergies to make better use of resources. This strategy has practically become a necessity given the financial limitations facing the Organization. UNESCO implements other, more *ad hoc* activities in the fields of science policy; women in science and technology (a regional Chair has recently been established in this subject, based in the Latin American Faculty of Social Sciences (FLACSO) Argentina); and transdisciplinary themes (such as the project Educating for a Sustainable Future).

UNESCO's presence in the region is increased through the activities of its Regional Office for Science and Technology for Latin America and the Caribbean (ROSTLAC), based in Montevideo. In the basic sciences, support has been given to undergraduate and postgraduate university programmes and to the establishment of scientific networks such as those mentioned above. In the Earth sciences, the Organization has supported human resources training, research projects under the International Geological Correlation Programme (IGCP), and training and assistance in emergency situations caused by natural disasters. In the ecological sciences, UNESCO has strengthened the programme on Man and the Biosphere (MAB) through the Latin American Network of Biosphere Reserves (IberoMAB), the establishment of MAB Committees and support for their activities. It also encourages the conservation of biodiversity and sustainable development through the participation of local communities, academic institutions and governments, and supports human resources training in the ecological sciences. In the water sciences (International Hydrological Programme), it has contributed recently to the Latin America and Caribbean Hydrological Cycle and Water Resources Activities Observation and Information System (LACHYSIS), the Water Centre for the Humid Tropics of Latin America and the Caribbean (CATHALAC) in Panama, and the hydrological data electronic network for LAC. In the marine sciences, it took part in the Major UNESCO Interregional Project on Research and Training Leading to the Integrated Management of Coastal Systems (COMAR project); it coordinates the BioPlata project, intended to establish an information and consultation system on biodiversity in the Río de la Plata, the coast and coastal lagoons, and also supports the ECOPLATA Project – Integrated Management and Sustainable Development of the Uruguayan Coast of the Río de la Plata. Through an agreement with the University of Puerto Rico and the Caribbean Development Bank, it supports the Coast and Beach Stability in the Eastern Caribbean (COSALC) project, which involves 11 countries and territories whose economies are significantly dependent on their coasts: Anguilla, Antigua and Barbuda, Dominica, Grenada, the British Virgin Islands, the US Virgin Islands, Montserrat, Saint Lucia, Saint Kitts and Nevis, Saint Vincent and the Grenadines, and Trinidad and Tobago. It also supports activities in the region organized by the Intergovernmental Oceanographic Commission (IOC).

The multilateral organizations that are not part of the United Nations system also have highly varied objectives. Some are research centres proper, purpose-built for high-cost programmes that are beyond the capacities of any one country. Here, more than in any other aspect, is perhaps where differences can be seen in the region's participation as compared with other regions of the world. It is

Pierre Auger Observatory project

The Pierre Auger Observatory project is an international effort to study the high-energy cosmic rays that collide with the Earth's atmosphere. There is as yet no satisfactory explanation for the origin of these rays, and the world scientific community hopes that the Auger Observatory will contribute to solving this mystery, thus providing a better understanding of the universe and perhaps of its beginning.

Two giant detector arrays, each covering 3 000 square kilometres, one in the southern hemisphere (Pampa Amarilla, Mendoza Province, Argentina) and the other in the northern hemisphere (Millard County, Utah, USA) will measure the arrival direction, energy, and composition of the air showers produced by high-energy cosmic rays (above 10^{19} eV) on colliding with the atmosphere; this will be made possible by the 1 600 particle detectors and three atmospheric fluorescence detectors in each of the Observatories.

The Auger Project was designed in a series of workshops in Paris (1992), Adelaide (1993), Tokyo (1993) and, lastly, Fermilab (1995). At the time of writing (end 2001) it includes 250 scientists from over 30 institutions in 19 countries: Argentina, Armenia, Australia, Bolivia, Brazil, China, Czech Republic, France, Germany, Greece, Italy, Japan, Mexico, Poland, Russian Federation, Slovenia, UK, USA and Viet Nam. With the backing of the respective governments, construction work has begun on the site in Argentina, and at a later stage work will begin on the US site. Although construction of the first Observatory, budgeted at around US$ 50 million, will be completed in 2005, some preliminary observations of cosmic showers have already been recorded. The groups in Latin America taking part in the Project belong to the following institutions:

- Argentina: TANDAR Department of Physics, National University of La Plata, National University of Cuyo, National Technological University, University of Buenos Aires, Bariloche Atomic Centre, National Space Activities Commission, Institute of Astronomy and Space Physics (IAFE), Argentine Institute of Radioastronomy, Regional Centre for Scientific and Technological Research;
- Bolivia: University of San Andrés (Universidad Mayor de San Andrés);
- Brazil: State University of Campina, Federal University of Rio de Janeiro, Cosmology and High-Energy Experimental Physics Laboratory-CBPF, University of São Paulo;
- Mexico: IPN Research and Advanced Studies Centre (CINVESTAV), National Autonomous University of Mexico (UNAM), Autonomous University of Puebla and University of San Nicolás de Hidalgo in Michoacán.

At present, the above institutions are taking part in the construction of the observatory, mainly through:

(1) the design, optimization and installation of the particle detectors,

(2) the design of some components of the fluorescence detectors' optical system, and

(3) the design of data-handling software. There are also various theoretical groups whose participation will be evident once data recorded by the Observatory starts to accumulate.

difficult for countries in the region to gain access to "megascience", that is, projects requiring hugely expensive facilities concentrated in one place, such as high-energy laboratories, large telescopes and radio telescopes, observation satellites, and so on, except where geography dictates the location of equipment in one of

them, as in the case of the astronomical observatories (see *World Science Report 1998)*. In this context, the Geneva-based European Organization for Nuclear Research European Laboratory for Particle Physics (CERN), a major centre for particle physics research, warrants special mention. Founded in 1954, it currently has 20 Member States, all of them European; however, some 6 500 scientists from 500 universities and of more than 80 nationalities go to CERN's laboratories to conduct research, and they include a good share of the particle physicists working in LAC. Since 1990 CERN has signed cooperation agreements with Brazil, Chile, Argentina. Peru, Colombia, Mexico and Ecuador.

When research takes place in a more "deconcentrated" way, in laboratories scattered across different contexts, opportunities open up for high-quality research groups in the region which can thus gain access to better equipment, literature and (at least in theory) manage to take part eventually in exploiting solutions to cutting-edge problems that may also prove to be highly relevant. An example of this kind is the Brazilian experience in the Organization of Nucleotide Sequencing and Analysis (ONSA), a virtual network on genomics with more than 50 Brazilian laboratories, through a project whose main goal was to create a network of laboratories in the State of São Paulo to sequence the complete genome of the bacteria *Xylella fastidiosa*, the pathogen causing a disease damaging 34% of Brazil's orange crop (São Paulo State is one or the largest orange producing regions in the world, with almost 30% of the world production of orange juice). Foreign scientific cooperation was sought for defining crucial issues such as for example, the choice of the organism to be mapped, and for discussing eventual promising directions to be followed in research, but the programme, the network and the cooperation mechanisms (as well as the funding) were basically defined by the country itself. The sequencing of the bacteria was finalized in January 2000, almost four months ahead of schedule. This was the first time scientists had ever mapped the structure of the genome of a plant pathogen. The key to its success, it has been argued, would be in the way the complex actors' integration took place.

Other large-scale international programmes are also "deconcentrated", such as those dealing with the study of climate change, oceanography, meteorology, and so on. These programmes are often coordinated by a national committee, which is in turn in contact with a general secretariat; intergovernmental programmes such as the above-mentioned IOC and IGCP operate in this way.

Prominent in the non-governmental sphere are the programmes under the auspices of the International Council for Science (ICSU), founded in 1931 to promote international scientific activity. With a membership of 98 National Scientific Members (academies and scientific and technical national organizations), 26 International Scientific Union Members and 28 Scientific Associates, ICSU can draw on a wide spectrum of scientific expertise to address major international, interdisciplinary issues. Furthermore, it acts as a focus for the exchange of ideas and information and the development of standards in science, organizes and participates in major international conferences and fosters the creation of networks with similar objectives. From time to time, and in conjunction with other organizations, it promotes the creation of major international programmes, such as the World Climate Research Programme (WCRP), the International Geosphere-Biosphere Programme (IGBP), the International Human Dimensions Programme on Global Environmental Change (IHDP), the International Programme of Biodiversity Science DIVERSITAS, and the Global Terrestrial, Ocean and Climate Observing Systems.

LAC takes part in ICSU through national members in 11 countries – Argentina, Bolivia, Brazil, Chile, Colombia, Costa Rica, Cuba, Jamaica, Mexico, Uruguay and Venezuela – and through the voluntary participation of scientists from the region in various international bodies and programmes. Nevertheless, the limited active participation of LAC scientists and, in general, those of developing countries in these forums means that the issues surrounding science in these countries are not sufficiently

understood and heeded. In order to remedy this, ICSU set up the Committee on Science and Technology in Developing Countries (COSTED), whose main task is to advise ICSU and its members on effective action they could take in these countries. The Committee has regional secretariats, with one in LAC, to carry out activities to support science in line with ICSU's objectives. Some International Unions also have regional committees, such as the International Brain Research Organization (IBRO), or committees for developing countries, such as the International Union of Geodesy and Geophysics (IUGG) and the International Union of Pure and Applied Physics (IUPAP). In other cases, there are national associations (as in the case of physiological sciences, and the history of science) or regional networks and federations (such as the Federation of Latin American Immunological Societies) associated with international Unions. Most of the Unions provide small subsidies to help organize scientific meetings in LAC and pay for visits by young researchers, and travel costs for researchers from leading laboratories. Other Unions or programmes carry out specific projects on local themes (in meteorology, geography, geology, etc.), usually with the participation of local scientists.

With regard to international scientific programmes, it must be noted that a Latin American presence in them is often impeded not only by a lack of support for individual participation by scientists, for whom such responsibilities come on top of their already heavy workload, but also by the lack of local material and organizational infrastructure required for such programmes. To take just one example, there are no data centres in the region linked to the World Data Centres System.

The International Centre for Theoretical Physics (ICTP), based in Trieste, Italy, has been a key institution for scientific cooperation with developing countries. It was founded in 1964 by Abdus Salam, a Nobel Prize-winning theoretical physicist of Pakistani origin, and functions under the auspices of UNESCO and the International Atomic Energy Agency (IAEA), with the Italian Government as its main source of funding. It supports developing countries through four programmes: affiliated centres, networks, visiting researchers and scientific meetings. The programmes and networks supported by ICTP in LAC are considered particularly successful, thanks to the long-standing collaboration between educational institutions in the region. In the past 15 years, ICTP has given partial financial support to more than 400 meetings organized in LAC. Furthermore, ICTP has programmes for donating books and laboratory equipment which it has extended since 1986 to the fields of biology and chemistry with backing from the Third World Academy of Sciences (TWAS). Other centres in Trieste that provide support for science in developing countries in various fields are the International Centre for Genetic Engineering and Biotechnology (ICGEB) and the International Centre for Science and High Technology (ICS).

The Third World Academy of Sciences (TWAS) is an autonomous organization founded in 1983 in Trieste, also under the leadership of Abdus Salam. Its objectives include recognizing and supporting excellence in science being carried out in developing countries, and facilitating contacts among scientists in those countries, and between them and the rest of the world. Of its 583 members elected up to 2001, 24% are from LAC, distributed as follows: Argentina (19), Bolivia (1), Brazil (45), Chile (18), Colombia (4), Costa Rica (1), Cuba (5), Ecuador (1), Guatemala (2), Jamaica (2), Mexico (22), Peru (4), Trinidad and Tobago (2), Uruguay (1) and Venezuela (11). The Academy carries out various programmes to support developing countries, concerning: awards and recognition for outstanding scientists in all fields of the basic and applied sciences; support for research projects (it awarded 106 grants in 33 countries in 2000); South-South fellowships for the mobility of scientists (27 awarded in 2000); associated institutions; support for international meetings, and guest lecturers. TWAS also played a key role in creating the Third World Network of Scientific Organizations (TWNSO) and the Third World Organization for Women in Science (TWOWS), both of which have an important level of Latin American participation.

The International Foundation for Science (IFS), based in Sweden, was set up in 1972 to support developing countries in their capacity to carry out research in the fields of use, management and conservation of natural resources. The organization has become important in the region through its financial backing, together with a scrupulous selection and follow-up of grantees after the grant has finished. Timely support for young researchers at the start of their scientific careers in their own countries is a factor that tends to curb the loss of this scientific talent. Until the mid-1980s it only awarded a handful of grants annually, but by 1990 they had increased tenfold. IFS policy has favoured Latin America through the award of a high proportion of grants to young researchers in the region (30% of the total of over 3 000), including its most advanced countries, such as Argentina and Mexico. National organizations from the following countries are members of IFS: Argentina, Bolivia, Brazil, Chile, Colombia, Costa Rica, Cuba, Ecuador, El Salvador, Guyana, Haiti, Jamaica, Mexico, Panama, Peru, Uruguay Venezuela, in addition to the Caribbean Academy of Sciences, the Caribbean Agricultural Research and Development Institute, and the Tropical Agronomic Research and Training Centre. A good many Latin American scientists work with IFS as consultants, members of its committees and members of its Board of Trustees. The most common area of study in LAC is that of animal husbandry (animal disease and nutrition). As is to be expected, cattle are the most studied species, although there are also a significant number of projects on camelids in relation to rural Andean regions.

International financial institutions

By virtue of its scope, the World Bank has considerable influence on the main thrust of higher education, S&T and changes in infrastructure. In recent decades, the World Bank's efforts to promote S&T have been stepped up; however, they have been geared more towards supporting specific programmes in certain sectors, such as agriculture and health, and have been defined more from a global perspective than in terms of the interests of the countries themselves. The World Bank is currently looking into the possibility of supporting new areas of S&T in developing countries and of offering new forms of support for regional S&T programmes. Over and above the specific characteristics of each country, the common trend is to

Table 5
IDB FUNDING OF S&T IN LATIN AMERICA

	Project description	Year	Amount Million US$	% of disbursement for S&T
Argentina	Technological modernization, 2nd S&T programme	1999	140.00	14.60
Brazil	FINEP II	1995	160.00	97.60
Chile	Technological innovation	2000	100.00	16.20
Colombia	3rd S&T programme	1995	100.00	89.10
Ecuador	S&T programme	1995	24.00	99.70
Guatemala	Technological development programme	1999	10.70	0.00
Mexico	S&T programme	1993	116.18	86.20
Nicaragua	Technological innovation support	2001	6.79	0.00
Panama	Support to competitive production sectors	1998	14.20	55.40
Panama	Implementation support for S&T and innovation	2000	3.30	19.00
Uruguay	Technological development	2000	30.00	2.50
Venezuela	2nd stage S&T programme	1999	100.00	15.10

Sources: IDB, *Annual Reports*, Washington.

encourage private sector funding and implementation of R&D, which entails reducing the role of state institutions, the declared intention being to raise quality and equity in higher education, increase and strengthen S&T human resources and create the necessary support services to enhance the effectiveness of public and private investments in S&T.

Similarly, the Inter-American Development Bank (IDB) has had a significant influence on the way people in Latin American countries think about S&T funding. Since 1968, it has been operating with an explicit S&T policy that was geared initially to S&T capacity-building in public universities and research centres, through investment in fellowships and infrastructure. Around 1980, the IDB moved towards promoting private sector demand and linkages between knowledge producers and users and technologies. It was during this second stage that the peer review system was introduced as effective practice for the establishment of the distinctive quality standards of the world of science. During the past decade, the IDB has shifted towards funds for technological development, tenders for the non-reimbursable funding of research projects and services in S&T, human resources training, the strengthening of infrastructure, the diffusion of technology, information and dissemination activities and the study and coordination of policies for national innovation systems. These elements are a clear indication of the way in which agreements between the IDB and the national S&T bodies have been adjusting over the years to changing demands. Table 5 gives an idea of the size of the effort in recent years, implying an important proportion of the public monies disbursed for S&T activities.

SOME FINAL REMARKS

One of the constraints that cooperation systematically faces is finance, particularly with regard to the possibility of making independent decisions on programme definition. A great deal of cooperation funding seems to come from loans, such as those provided by the World Bank, the IDB and other bodies which, while allowing some room for manoeuvre for establishing contacts and linkages in disciplinary or thematic networks with other national, regional or international groups, impose on the other hand the conditions under which such activities can be undertaken and lead to debt being incurred, with a cumulative effect known to all. Unfortunately, no reliable data and figures are available on the subject. Several questions therefore remain open, for consideration in other studies. For example, how much is being earmarked for S&T cooperation in the Latin American region? How (un)stable are budgets allocated for such cooperation? To what extent does external funding provide benefits or entail inconvenient restrictions? Do agreements and statements of intent remain a dead letter for lack of financial resources, or for lack of political interest? It would seem that some of these questions are relevant since the amounts committed from States' contributions to regional activities have not kept pace with inflation during the last few decades. Generally speaking, even the contributions made by the most developed countries of the region to this type of supranational activity are not higher than the amounts granted within those same countries as subsidies to individual research groups. In LAC, international cooperation generally still does not systematically form part of national S&T programmes.

Attempts have recently been made to set up a regional fund to finance S&T cooperation, in particular the initiative concerning the Ibero-American Fund for Scientific and Technological Integration (FIICYT), which the Ibero-American Summit, at the request of Chile, submitted to the IDB for funding in 1998. A new initiative in the region, PROSUL, came into being at the end of 2001 as a result of a proposal submitted by Brazil in August 2000 at the meeting of the Presidents of South America in the context of the establishment of an integrated South American body for science, technology and innovation, outlined in the Budget Law under the title Development of Joint Science and Technology Projects between Brazil and the Countries of South America. The programme seeks to step up cooperative efforts in S&T, to organize links between

multilateral organizations and the cooperation projects supported and to provide the South American S&T system with an instrument for the formulation of a specific regional strategy in this field.

The international scientific scene currently offers a highly complex picture and the situation of the Latin American region appears to be both economically and politically unstable, which weakens their bargaining power. In a hardening climate between North and South owing to the emergence of too many causes of friction, the difficult negotiations over the growing debt, the painful economic adjustments demanded by the International Monetary Fund (IMF), pressure in relation to licences and intellectual property problems in general, the application of free trade agreements, protection from foreign investments, efforts to control drug trafficking, the proliferation of weapons, including nuclear arms, and terrorism all play a part in encouraging the developed countries to redefine the significance and scope of their cooperation, if not to adopt an attitude of withdrawal and reluctance towards cooperation with developing countries, including those of Latin America.

Under the new conditions, traditional scientific communities are being sidelined both by commercially oriented multilateral organizations, which prefer to avoid scientists and seek profitable partners and business relations with local businesses, and by international organizations seeking involvement in causes such as poverty alleviation, the defence of the rights of minorities and social empowerment. It has become clear that the United Nations system is not prepared to lead in the mobilization of S&T for sustainable development; neither the World Bank, nor the regional development banks, nor the bilateral agencies, nor private foundations will take up this role in the near future. In its own interest, LAC must tackle this void by taking the political decision to mobilize S&T for its development.

New forms of international cooperation in Latin America will probably emerge in areas and sectors where there is real interdependence, as well as institutions, programmes and activities that could provide solutions and interest all the parties involved. To organize cooperation on real foundations, an adequate, stable and reliable mechanism must be set up. The task for Latin American countries that wish to take part in this new type of cooperation is to establish and guarantee the quality and competence of the various institutions and groups that are to become the local base for international exchanges. In view of the gaps between the developed and the Latin American countries, in terms of both wealth and skills, these links will take a very long time to be truly symmetrical as regards resources and the transfer of knowledge, but they must at least be as symmetrical as possible in terms of the effort invested by each party in identifying the other's needs, situation and prospects. This problem is especially acute for the smallest or the least advanced countries in the field of S&T. The strengthening of ties among the countries of the region so that they can reinforce each other and progress in an integrated manner is indispensable if LAC wish to begin to compete as a force to be reckoned with on the international scene.

As was noted *inter alia* at the Meeting of Ministers Responsible for Science and Technology in Havana in 1999, there is untapped potential in LAC for the horizontal transfer of knowledge and technologies under mutually advantageous conditions, and for the creation of alliances between the productive sector and research groups in various countries to develop endogenous technologies for production under socially and environmentally sustainable conditions. It is also important to make an effort to regionalize and internationalize the universities and co-ordinate them so that their curricula can be strengthened and made to respond to the region's real needs, and facilitate the exchange of scientists and mobility of graduate students for a better use of the region's resources. It is also necessary to exchange criteria and points of view on national legislation on science, technology and innovation and to strengthen consultation and coordination in order to work out joint positions for Latin American countries in international forums and meetings

to enable them to defend common points of view and prevent decisions from being taken which would widen even further the scientific and technological gap between them and the more developed countries. The solidarity component of integration processes must be strengthened to take advantage of the opportunities afforded by globalization, which should be regarded not as a kind of uniformity or subordination but from the perspective of sharing benefits without eliminating differences, of preserving endogenous features while enriching the universal dimension.

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