Bibliometric study of Latin American countries supported by INASP 1996–2008

Project report

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Research

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Executive summary

Objectives

This report presents the findings of a collaborative study conducted by the Cuban Ministry of Higher Education, the National Center for Scientific Research and INASP. It consists of a bibliometric analysis of the scientific production of five Latin American countries (Cuba, Ecuador, Bolivia, Nicaragua and Honduras) during the period 1996–2008. The report examines changes in the scientific research output of these countries, and compares them to patterns in a control group of eight countries whose development is at a comparable level to that of the studied countries. This allows findings to be considered in the context not only of regional but also international trends, particularly, so that strengths and weakness can be identified to support future decision-making processes.

The report aims to answer the following questions:

- How have research publication patterns changed over the last ten years in the selected countries?
- What is the number of research publications produced per country per year?
- What are the top research institutions in each country, as ranked by publication output?
- What is the breakdown of research publications by subject area?
- How has this research been cited by others in their research publications?
- What are the changing patterns of international research collaboration, as indicated by multi-author publications with different country affiliation per author?

Methodology

Quantitative indicators used to assess scientific production included: total publication output, cited documents, growth rate and the activity index. The qualitative dimension was studied through a set of impact indicators: total of cited documents, percentage of cited documents, total of citations, average of citations by document, atractivity index, SCImago Journal Rank (SJR) and distribution by quartiles based on the SJR.

The main data source for the study was Scopus, the main Elsevier database for bibliometric research. Further data was extracted from the scientometric tool SCImago Journal & Country Rank and the SCImago Institutions Rankings. Data were retrieved in May 2010.

Latin America in an international context

The growth in Latin American scientific production between 1996 and 2008 is of particular note, because although internationally production increased by 67.8%, for Latin America the figure was 190.5%. The level of Latin American scientific production does not regress in any of the years studied, and almost 70% of its published articles across the study period were cited at least one time. Furthermore, three times more articles were published in Latin America in 2008 than in 1996. The region experienced growth throughout the last five years covered by the study, and in 2006, 2007 and 2008 it published more than 3% of the world's scientific production.

Findings

Section 4 sets out the study's findings. Key findings for each of the five countries are set out below.

Cuba

- Cuban scientific production has a clear biomedical orientation.
- The most active and visible areas of research are *pharmacology, toxicology and pharmacy*, *immunology and microbiology*, *agriculture and biological sciences*, *chemistry* and *biochemistry, genetics and molecular biology.*
- The University of Havana is the most productive institution of the country, and the core of most productive authors shows high levels of visibility.
- A high proportion of the scientific production is published in Cuban less-cited journals, which is probably the cause of the low impact of the country in a high number of subject areas. Spain, Mexico and Brazil, are Cuba's main scientific partners.

Ecuador

- *Medicine* and *agriculture and biological sciences* are the two main subject areas in Ecuadorian scientific production.
- The greatest output is in *agriculture and biological sciences*, *environmental sciences*, *earth and planetary science*, *immunology and microbiology*, and *physics and astronomy.*
- The University of San Francisco de Quito, and the Catholic University of Ecuador are the most productive institutions of the country.
- There is no strong core of Ecuadorian productive authors, which is the result of a high level of international collaboration where the leader authors are from international institutions. Although the *Revista Ecuatoriana de Neurologia* is the journal leader in the scientific production of Ecuador, a big proportion of papers is published in other

well known journals. The United States of America, the United Kingdom and France are Ecuador's main scientific partners.

Bolivia

- Bolivian scientific production is mainly concentrated on *agriculture and biological science*s, although *environmental sciences*, *immunology and microbiology*, *earth and planetary science*, *veterinary* and *social sciences* are also highly productive and visible.
- The Major University of San Andres and the Major University of San Simon are the two most productive Bolivian institutions. The most productive authors mainly belong to these two institutions.
- Well known American and British journals publish a large number of Bolivian papers.
- The United States of America, France, Belgium and the United Kingdom are Bolivia's main scientific partners.

Nicaragua

- *Medicine* is the most productive subject area for Nicaragua. The best performances are mainly achieved in *environmental sciences*, *immunology and microbiology*, *agriculture and biological sciences*, *earth and planetary science*, *social science* and *medicine*.
- The National Autonomous University of Nicaragua (León) is the most prolific institution.
- The majority of the most prolific authors specialize in medical sciences.
- Nicaraguan papers are essentially published in journals edited by the United States of America and the United Kingdom.
- The United States of America, Sweden and Costa Rica are Nicaragua's most important scientific partners.

Honduras

- In Honduras, *agriculture and biological sciences* is the most productive, active and visible research area. Other high performers include *immunology and microbiology*, *economy, econometrics and finance*, *environmental sciences*, *neuroscience*, *medicine* and *veterinary science*.
- The National Autonomous University of Honduras is the leader institution.

- The most prolific authors are headed by the Honduran neuroscientist Marco T. Medina, with an important research on epilepsy.
- Honduran papers are basically published in journals edited by the United States of America. However, the Spanish journal *Revista de Neurología* is at the top of this ranking.
- The United States of America is clearly the main scientific partner, followed by Mexico and Costa Rica.

Conclusions

It is hoped that these findings will contribute to broader research into the changes in scientific output in developing countires to:

- provide data to inform future policy-making;
- create firmer links between trends in scientific output and policy decisions; and
- gauge the impact of specific policy decisions on scientific output.

Possible next steps include widening this research to incorporate all African partner countries or working with the Latin American countries featured here to extend the analysis conducted so far.

1. Introduction

This report is a bibliometric study of the scientific production of five Latin American countries (Cuba, Ecuador, Bolivia, Nicaragua and Honduras) with which the International Network for the Availability of Scientific Publications (INASP) works. The report considers scientific papers published in high visibility journals, and it uses Scopus-based quantitative data to analyze the activity and visibility of the above countries during the period 1996–2008. Activity and visibility comprise:

- the entire scientific production of the countries; and
- the relative quality or impact of research, measured by citation-based indicators.

The main focus of the study is how research patterns in the selected studies have changed over the last ten years. The study demonstrates how bibliometric indicators can be applied in: measuring the scientific output of countries and organizations; identifying the level of specialization of each country by knowledge areas; and identifying the leader scientific institutions, and the most productive researchers from these countries. The aim is to enhance the use of bibliometric indicators in research evaluation policy across the globe.

The study tries to answer the following questions:

- How have research publication patterns changed over the last ten years in the selected countries?
- What is the number of research publications produced per country per year?
- What are the top research institutions in each country, as ranked by publication output?
- What is the breakdown of research publications by subject area?
- How has this research been cited by others in their research publications?
- What are the changing patterns of international research collaboration, as indicated by multi-author publications with different country affiliation per author?

The preliminary findings presented in this report were revealed during the First International Seminar of Scientometrics Studies related to the Biomedical Sciences, developed in Havana, Cuba, from 28 June to 1 July 2010, and organized by the National Centre for Scientific Research (CNIC) and the Cuban Ministry of Higher Education with support from INASP and the SCImago Research Group.

2. Methodological aspects

2.1. Data sources

Scopus, the main Elsevier database for bibliometric research purposes, was used as the primary data source. Scopus has a total of 19 million documents with bibliographic references, belonging to more than 18 000 serial publications from all knowledge domains, published since 1996. This database is twice as large as the Thomson Reuter´s Web of Science, which has the advantage of wider thematic and geographic coverage.

The search strategy consisted of inserting the names of the featured countries into the 'Affiliation Country' field. The retrieved items were downloaded to an *ad hoc* database, with the aim of eliminating false items, normalizing affiliation data, and identifying the most productive institutions of these countries.

Data from the period 1996–2008 (and sub-periods 1999–2003 and 2004–2008) were extracted from the scientometric tool SCImago Journal & Country Rank (SJCR, available at http://www.scimagojr.com), created by the SCImago Research Group, a Spanish research team belonging to the Institute of Goods and Public Policies (IPP-CSIC). Some data related to the period 2003–2007 were also collected from the most recent tool created by the SCImago Research Group: the SCImago Institutions Rankings (SIR, available at http://www.scimagoir.com). Both tools offer a wide range of scientometric indicators, very useful for scientific and technological researchers and decision-makers.

Data were retrieved in May 2010.

2.2. Indicators

Quantitative indicators used to assess scientific production included: total publication output, cited documents, growth rate and the activity index. The qualitative dimension was studied through a set of impact indicators: total of cited documents, percentage of cited documents, total of citations, average of citations by document, atractivity index (based on Braun and Schubert (1997) proposal, and renamed "visibility index"), SCImago Journal Rank (SJR) and distribution by quartiles based on the SJR.

These indicators were used to assess data for each of the five Latin American countries studied. Activity and visibility indexes were also calculated for eight countries selected as

a control group so that results for the five countries studied could be compared to other countries with the same level of development, in the same region and in Asia and Africa (see 2.3 below).

2.3. Countries studied

The five Latin American Countries supported by the INASP were: Cuba, Ecuador, Bolivia, Nicaragua and Honduras.

The control group consisted of: Guatemala and El Salvador (non PERii members) from Latin America; Ghana, Kenya, Rwanda and Tanzania from Africa; and Bangladesh and Vietnam from Asia. These countries were selected because their development level is comparable to that of the five countries that were the focus of the study and because they would allow regional and international comparisons once findings had been completed.

2.4. Limitations

The main limitations of this report concern the primary data source (Scopus). Some authors report inconsistent coverage of journals and problems with the identification of the countries in the affiliation field of the database registers (Jacsó, 2009). However, the main problem is actually the normalization of authors names and affiliation data, which gives a minimal margin of error to the analysis that may result from this report.

In the same way, Scopus only covers a core of approximately 16,000 journals from the total amount of peer reviewed journals published in the world. This evidently implies that this report is not based on the total scientific output of the countries. The report should be taken as the study of the more visible scientific literature produced by the studied countries.

3. General overview

3.1. Regional distribution of the world scientific output indexed by Scopus

Data extracted from Scopus indicates that international scientific production has been growing during the last 13 years. However, it's interesting to analyze the changes that have occurred across the international scientific community, most notably:

- the exponential growth in some Asian countries (Arunachalam, 2008; SCImago Research Group, 2008; Zhou and Leydesdorff, 2008);
- the emergence of Brazil as a key player in Latin American research;
- the expansion of the European Union block (SCImago Research Group, 2007); and
- the relative deadlock of the North American scientific output (Leydesdorff and Wagner, 2009) (Table 1; Figures 1, 2 and 3).

Three regions produce more than the 80% of the world's scientific output: North America, Western Europe and Asia (Moya Anegón, 2008). Data from Scopus suggests that in 1996 North America had 31.65% of the total output, followed by Western Europe (29.83%) and the Asiatic region (14.17%). However, 13 years later Western Europe had the higher raw number of documents (529,463 or 28.08%), followed by Asia (25.36%) and North America (22.32%). The regions with the greatest grown during this period, therefore, were Asia and Latin America, with a growth rate higher than 100 % (See Table 1).

When international visibility is measured in terms of citations, however, a different picture emerges. North America and Western Europe have the largest number of citations across the study period, with an average figure of 15.23 and 10.97 citations per document, respectively. Even though the Asiatic region is third with regard to citations received during the studied period, it has a high number of non-cited documents, with the lowest average number of citations per article (5.87), a figure which is lower than that for regions like the Middle East (7.71), South Africa (7.24), and also Latin America (6.39). Besides North America and Western Europe, the other region with an average greater than the world mean (8.74) is the Pacific Region (10.75), thanks to the high visibility achieved by Australia and New Zealand (See the *SCImago Journal & Country Rank*).

3.2. The scientific production of Latin America

The Latin American region deserves special mention. Internationally, the growth rate of scientific production during the period 1996–2008 is 67.8%; for Latin America the figure is 190.5%, and three times more articles were published in 2008 than in 1996. The region experienced growth throughout the last five years covered by the study, and in 2006, 2007 and 2008 published more than 3% of the world's scientific production. Without any doubt, this growth is due to the Brazilian scientific output, whose share of international production increased from 0.76% in 1996 to 1.75% in 2008. One of the factors supporting Brazil's progress has been Scopus's wider coverage of Brazilian journals.

As shown in Table 2, the level of Latin American scientific production does not regress in any of the years studied, and almost 70% of its published articles across the study period were cited at least one time.

3.3. Distribution by subject areas in Scopus

Another important topic is the thematic distribution of the scientific output covered by Scopus, and the world and regional proportions in each of the 27 subject areas (295 subject categories) of this database.

According to the SJCR, Scopus has a total of ten subject areas that are ranked as having over 750,000 documents:

- The three most productive areas are: *medicine*, with more than five million documents (28.07%), *engineering* (12.36%) and *biochemistry, genetic and molecular biology* (11.38%).
- These are followed by *physics and astronomy* (7.45 %), *agriculture and biological sciences* (7.02%), *chemistry* (6.75%) and *material sciences* (6.02 %), each with more than one million documents.
- *Computer science* (4.39%), *earth and planetary sciences* (4.07%) and *chemical engineering* (4.02 %) also produce over the 750,000 documents (Table 3).

Subjects with a lesser rank of between 200,000 and 700,000 documents are: *mathematics* (3.71%), s*ocial sciences* (3.52%), *environmental sciences* (3.44%), *immunology and microbiology* (3.12%), *pharmacology, toxicology and pharmacy* (2.61%), *business management and accounting* (1.86%), *neuroscience* (1.85%), *energy* (1.36%), *psychology* (1.32 %) and *art and humanities* (1.24 %).

Finally, there is a third group of of subjects with between 70,000 and 200,000 documents: *multidisciplinary area* (1.05%), *nursing* (1.03%), *Eonomy, econometrics and finance* (0.97%), *veterinary* (0.96%), *health professions* (0.63%), *decision sciences* (0.43%) and *dentistry* (0.42%).

When citations are considered, there are ten subject areas with values over the world mean of 8.7 citations per article. Those with highest visibility are: the *multidisciplinary area* (35.6 citations per article), *neuroscience* (20.2), *biochemistry, genetic and molecular biology* (17.8), *immunology and microbiology* (17.1), *chemistry* (11.3) and *health professions* (10.2). The group is completed by *environmental* science (9.7), *psychology* (9.5), *physics and astronomy* (9.4) and *agriculture and biological sciences* (9.1).

Eight of the most productive world areas are also the most productive in Latin America. *Computer science* and *chemical engineering* are not included among the ten most productive areas of the region, and are replaced by *immunology and microbiology* and *mathematics.* After *medicine* (22.86%), *agriculture and biological sciences* (17.19%) is the second most productive subject area of the region, heading a ranking of twelve areas where the proportion of published articles is higher than the world mean. These areas include *biochemistry, genetic and molecular biology* (11.79%), *physics and astronomy* (10.41%) and *chemistry* (7.84%).

The behavior of the citations per article is similar in the leader areas: the *multidisciplinary area* (25.2 citations per article), *neuroscience* (11.1), *biochemistry, genetic and molecular biology* (10.2) and *immunology and microbiology* (10.1). Nevertheless, it is necessary to emphasize that *earth and planetary sciences* (10.1), *chemical engineering* (6.9), and *energy* (3.8) are the three Latin American areas with an average number of citations per article higher than the world mean.

Although there are coincidences between the main areas, it's easy to find important differences between the scientific production of Latin America and that of the World. For example, the rest of the world is more specialized in *engineering* and *computer science*, whereas Latin America is a leader in *agriculture and biological sciences*, *physics and astronomy*, *earth and planetary sciences* and *immunology and microbiology.*

Additonally, areas like the *social sciences*, *business management and accounting*, *psychology* and *arts and humanities* which are relatively well represented in Scopus, do not have the same activity at regional level. The poor representation of the region in these

subject areas must be affected by factors such as insufficient coverage of non-English journals in Scopus, and the tendency of scientists in these knowledge domains to use different communication channels.

The difference between regional and global scientific production can be seen in Table 4, through the calculus of the Activity Index (AI), the Visibility (attractivity) Index (VI), and the Relative Impact (RI).

First, there are areas where the regional scientific production is more active and visible than global production: *agriculture and biological sciences*; *chemistry*; *immunology and microbiology*; *pharmacology, toxicology and pharmacy*; *dentistry*; *earth and planetary sciences*; *environmental sciences*; *mathematics*; *physics and astronomy*; *and veterinary.*

Second, there are areas with more activity but less visibility regionally than globally: *neuroscience* and *biochemistry, genetic and molecular biology.* Finally, there are areas with more visibility but less activity than the world: *chemical engineering*; *energy*; and *material science*. *Earth and planetary sciences* is the only subject area where all three bibliometric indicators (activity, visibility and relative impact) are higher regionally than for the world.

Table 1. Annual distribution of the world scientific output in Scopus by region (SJCR 1996–2008).

	Northern America	Western Europe	Asiatic Region	Eastern Europe	Middle East	Latin America	Pacific Region	Northern Africa	Central Africa	Southern Africa
1996	354,269	334,420	159,052	66,808	17,314	22,120	26,100	1,646	2,119	6,235
1997	351,267	351,390	171,533	69,004	18,044	25,474	27,337	1,896	2,251	6,357
1998	344,331	355,291	178,062	69,352	17,968	26,868	28,067	2,135	2,306	6,349
1999	343,224	363,591	187,781	69,595	18,458	29,169	28,990	2,366	2,333	6,647
2000	348,296	373,960	199,746	72,125	19,610	30,510	29,759	2,436	2,186	6,397
2001	344,087	372,858	217,054	74,087	19,987	31,285	30,864	2,604	2,018	6,473
2002	349,675	378,672	218,864	74,858	21,294	34,712	31,574	2,822	2,179	7,077
2003	375,473	419,789	251,756	81,730	25,619	39,291	36,207	3,341	2,934	8,052
2004	360,862	439,914	296,032	84,748	27,784	41,617	39,547	3,992	3,038	8,535
2005	391,452	480,101	370,477	94,732	31,239	46,738	43,715	4,378	3,719	9,473
2006	415,301	507,737	416,089	93,399	36,353	55,521	48,559	5,324	4,832	10,834
2007	431,348	522,818	447,061	96,663	41,364	59,982	51,596	6,106	5,538	11,710
2008	431,522	538,489	487,563	103,360	46,159	66,450	55,299	7,160	5,530	12,458

Figure 1. Annual patterns of scientific production in Europe, Northern America and the Asiatic Region (SJCR 1996–2008).

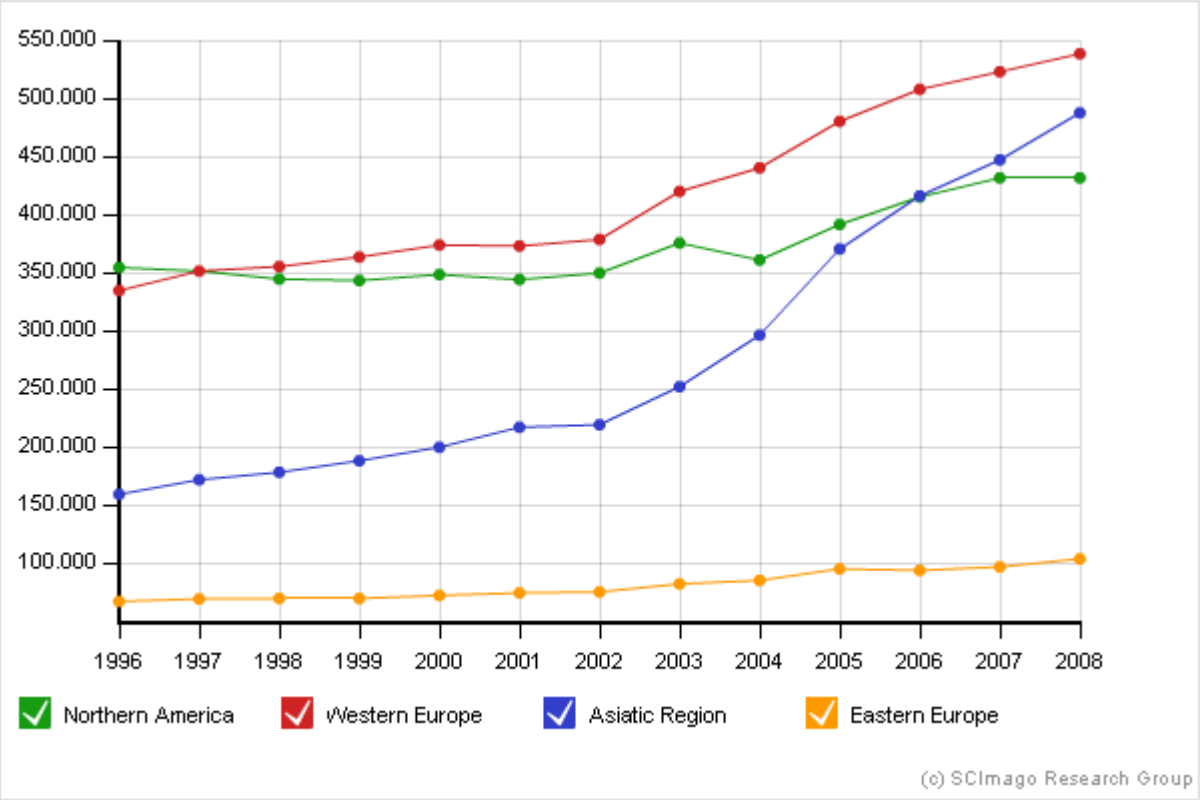


Figure 2. Annual patterns of scientific production in Latin America, the Pacific Region and the Middle East (SJCR 1996–2008).

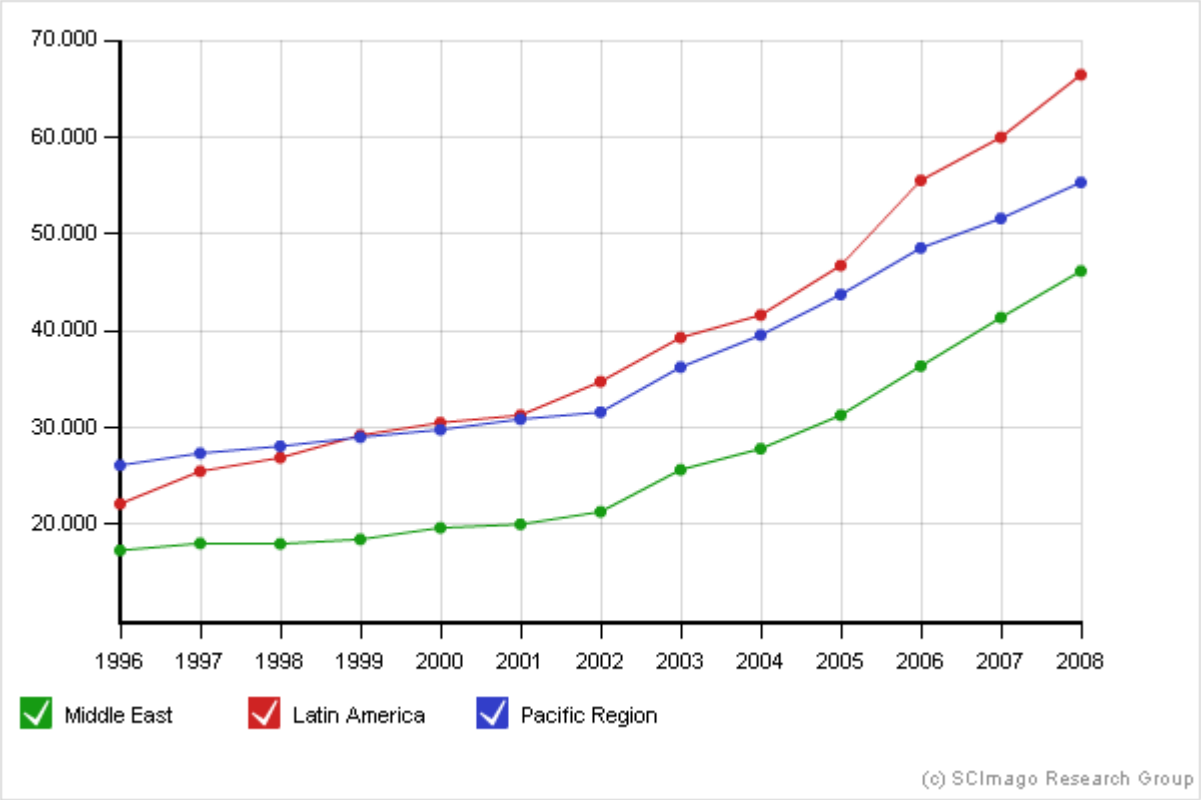


Figure 3. Annual patterns of scientific production in Northern, Central and Southern Africa (SJCR 1996–2008).

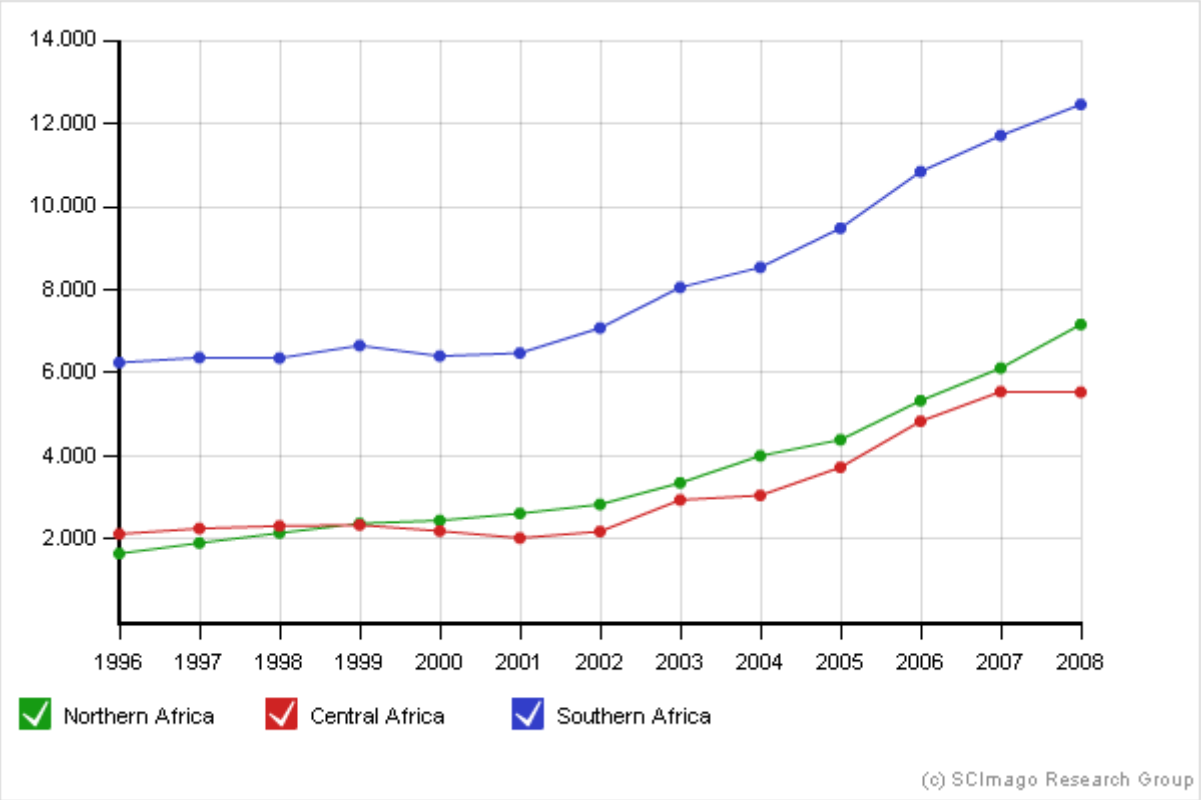


Table 2. Bibliometric indicators of the Latin American output in Scopus (SJCR 1996–2008).

Latin America								
Año	Documents	Primary Documents	Citations	Self-citations	Citations per Document	Self-citations per Document	% of Cited Documents	% World
1996	22114	21809	262167	80331	11.86	3.63	79.60	1.97
1997	25468	25133	291678	87217	11.45	3.42	78.00	2.22
1998	27077	26635	319431	97246	11.80	3.59	80.14	2.35
1999	29140	28594	334725	93980	11.49	3.23	79.96	2.53
2000	30470	29831	336320	104017	11.04	3.41	80.07	2.50
2001	31176	30446	308335	99107	9.89	3.18	80.08	2.37
2002	34847	34002	318952	91301	9.15	2.62	79.63	2.57
2003	39023	38022	342989	92424	8.79	2.37	79.70	**2.77**
2004	41392	40359	310131	78911	7.49	1.91	77.11	2.65
2005	46493	45112	265683	64020	5.71	1.38	72.43	2.69
2006	55324	53526	212808	70745	3.85	1.28	64.84	**3.07**
2007	59550	57432	137094	23342	2.30	0.39	54.65	**3.17**
2008	64235	61542	52160	17978	0.81	0.28	32.03	**3.41**
Total	**506309**	**492443**	**3492473**	**1000619**	**6.90**	**1.98**	**68.19**	**2.70**

Table 3. Scopus subject areas as a proportion of total scientific production, and number of citations per document, for the world and Latin America (SJCR 1996–2008).

Subject areas	World	%	CxD	Latin America	%	CxD
med	5259292	28.07	9.03	115733	22.86	6.76
eng	2314775	12.36	3.68	35782	7.07	3.62
bgmb	2130934	11.38	17.79	59685	**11.79**	10.22
pa	1395456	7.45	9.40	52704	**10.41**	7.31
abs	1314553	7.02	9.11	87024	**17.19**	6.13
che	1263622	6.75	11.33	39685	**7.84**	8.21
ms	1126954	6.02	6.10	29570	5.84	5.34
cs	822461	4.39	5.22	15440	3.05	3.50
eps	763347	4.07	9.05	30517	**6.03**	**10.08**
ce	753106	4.02	5.22	19620	3.88	**6.87**
mat	695309	3.71	5.09	27430	**5.42**	4.66
sc	658927	3.52	3.70	10283	2.03	2.24
es	644452	3.44	9.66	25119	**4.96**	8.88
im	584851	3.12	17.09	28209	**5.57**	10.11
ptp	489673	2.61	9.08	14979	**2.96**	7.12
bma	347821	1.86	4.07	2066	0.41	3.13
neu	347003	1.85	20.25	11901	**2.35**	11.11
ene	254372	1.36	3.01	5367	1.06	**3.83**
psy	247843	1.32	9.52	3568	0.70	4.60
ah	231721	1.24	1.44	1899	0.38	1.36
mul	197271	1.05	35.63	3717	0.73	25.19
nur	193607	1.03	5.81	2251	0.44	4.74
eef	181171	0.97	7.39	2463	0.49	5.12
vet	179786	0.96	5.22	10025	**1.98**	4.17
hp	118914	0.63	10.15	1762	0.35	4.30
ds	79887	0.43	6.48	2111	0.42	4.76
den	79393	0.42	7.55	5093	**1.01**	5.47
Total	**18733229**	**100**	**8.74**	**506309**	**100**	**6.90**

Abbreviations of the subject areas: Agricultural and Biological Sciences **abs**; Arts and Humanities **ah**; Biochemistry, Genetics and Molecular Biology **bgmb**; Business, Management and Accounting **bma**; Chemical Engineering **ce**; Chemistry **che**; Computer Science **cs**; Decision Sciences **ds**; Dentistry **de**; Earth and Planetary Sciences **eps**; Economics, Econometrics and Finance **eef**; Energy **ene**; Engineering **eng**; Environmental Science **es**; Health Professions **hp**; Immunology and Microbiology **im**; Materials Science **ms**; Mathematics **mat**; Medicine **med**; Multidisciplinary **mul**; Neuroscience **neu**; Nursing **nur**; Pharmacology, Toxicology and Pharmaceutics **ptp**; Physics and Astronomy **pa**; Psychology **psy**; Social Sciences **ss**; Veterinary **vet**. (The dark color includes the ten leader areas. The dark Font, the Latin American values higher than the world). **CxD** Citations per document.

Table 4. Activity, visibility and relative impact of the regional scientific production with respect to the world in the 27 Scopus subject areas (SJCR 1996–2008).

	Latin America		
Scopus subject areas	**AI**	**VI**	**RI**
Agricultural and biological sciences	2.45	2.09	0.67
Arts and humanities	0.30	0.36	0.94
Biochemistry, genetics and molecular biology	1.04	0.75	0.57
Business, management and accounting	0.22	0.21	0.77
Chemical engineering	0.96	1.61	1.32
Chemistry	1.16	1.07	0.72
Computer science	0.69	0.59	0.67
Decision sciences	0.98	0.91	0.73
Dentistry	2.37	2.18	0.72
Earth and planetary sciences	1.48	2.09	1.11
Economics, econometrics and finance	0.50	0.44	0.69
Energy	0.78	1.26	1.27
Engineering	0.57	0.71	0.99
Environmental science	1.44	1.68	0.92
Health professions	0.55	0.29	0.42
Immunology and microbiology	1.78	1.34	0.59
Materials science	0.97	1.08	0.87
Mathematics	1.46	1.69	0.92
Medicine	0.81	0.77	0.75
Multidisciplinary	0.70	0.62	0.71
Neuroscience	1.27	0.88	0.55
Nursing	0.43	0.44	0.81
Pharmacology, toxicology and pharmaceutics	1.13	1.12	0.78
Physics and astronomy	1.40	1.38	0.78
Psychology	0.53	0.33	0.48
Social sciences	0.58	0.44	0.61
Veterinary	2.06	2.09	0.80

AI: Activity or Specialization Index; **VI:** Visibility (Atractivity) Index; **RI:** Relative Impact. The dark color is for areas with activity and visibility higher than the world. A less dark color is for areas where only one of these indicators is higher than the world.

4. Bibliometric study of selected sample of five Latin American countries, 1996–2008

In this section, the statistical data for each studied country is presented. Specialists, analysts and decision-makers can compare the bibliometric information of each country with the information from the previous section.

For each country the information was structured in four topics:

1. General data (output and impact)
2. Research areas
3. The most productive institutions, journals and authors
4. International collaboration

The topic 'General data' presents information extracted from SJCR in three tables that deal with the scientific production of the country in Scopus. It has used a battery of output and impact indicators: total number of documents **Doc**, primary documents (articles, reviews, letter, short communications and conference proceedings) **P.Doc**, total number of citations **Cit**, self-citations **S-Cit**, average of citations per document **CxD**, average of self-citations per document **SCxD**, cited documents **CD**, uncited documents **UD**, percentage of international collaboration **IC(%)**, proportion of the world scientific production **% World**, and the Hirsch Index of the country **H index**. The battery of output and impact indicators is calculated for the whole period and for the two periods established for comparative purposes. The figure presented is extracted from the SIR, and reflects the scientific production according to the four quartiles which qualitatively divides the documents. The position in the quartiles depends on the value of the SCImago Journal Rank (SJR), the SJCR alternative to the Journal Citation Report´s Impact Factor.
The topic 'Research areas' shows output, impact, and relative indicators (Activity Index **AI**; Visibility Index **VI**; and Relative Impact **RI**) in each of the 27 Scopus subject areas. The next topic presents the most productive institutions and authors, as well as the main journals that publish the research of the country. Finally, the topic 'International collaboration' shows a geographical map of the collaboration activity of the country, and a list of the 15 most collaborative countries for each of them.

4.1. Cuba

4.1.1. General data (output and impact)

Table 5. Total output and impact of the Cuban scientific activity (SJCR 1996–2008).

Cuba 1996–2008	Total
Documents	15 153
Citable documents	14 789
Citations	62 320
Self citations	16 327
Citations per document	4.11
H index	66

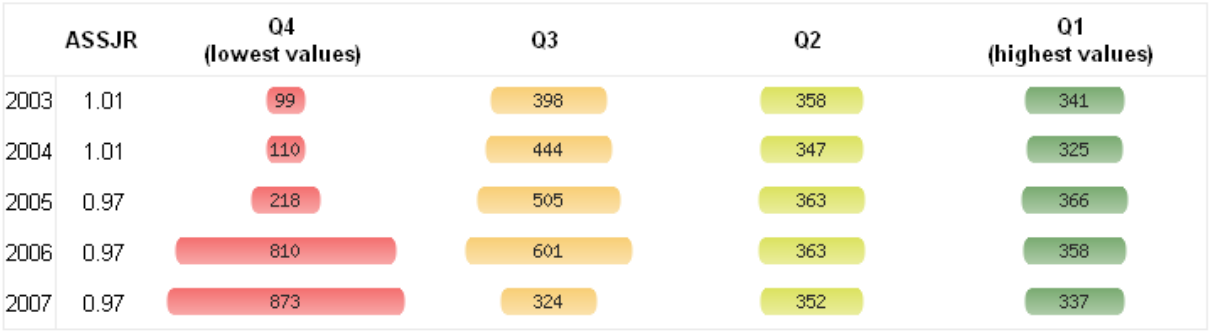
Table 6. Annual output and impact of the Cuban scientific activity (SJCR 1996–2008).

	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	Total
Doc	731	852	1 060	1 251	1 207	1 262	1 242	952	943	1 135	1 519	1 511	1 488	15 153
P. Doc	729	852	1 042	1 218	1 197	1 249	1 225	936	928	1 105	1 471	1 436	1 401	14 789
Cit	5 531	4 181	7 407	6 890	6 148	6 407	4 655	5 776	4 742	4 284	3 474	2 124	701	62 320
S-Cit	1 295	1 307	1 830	1 610	1 642	1 547	1 204	1 438	1 364	1 331	984	587	188	16 327
CxD	7.57	4.91	6.99	5.51	5.09	5.08	3.75	6.07	5.03	3.77	2.29	1.41	0.47	4.11
SCxD	1.77	1.53	1.73	1.29	1.36	1.23	0.97	1.51	1.45	1.17	0.65	0.39	0.13	1.08
CD	485	512	669	764	703	722	644	666	591	614	595	522	303	7 790
UD	246	340	391	487	504	540	598	286	352	521	924	989	1 185	7 363
IC(%)	55.13	51.41	50.38	55.48	55.84	57.69	55.23	53.47	57.79	67.05	69.98	70.35	54.64	*58.03*
% World	0.07	0.07	0.09	0.11	0.10	0.10	0.09	0.07	0.06	0.07	0.08	0.08	0.08	0.08

Table 7. Output and impact of the Cuban scientific activity by periods (SJCR 1999–2008).

Indicators	1999-03	%	2004-08	%
Documents	5 914	39.03	6 596	43.53
Citable documents	5 825	39.39	6 341	42.88
Cites	29 876	47.94	15 325	24.59
Self cites	7 441	45.57	4 454	27.28
Cites per doc.	5.05		2.32	
Self cites per doc.	1.26		0.68	
Cited docs.	3 499	44.92	2 625	33.70
Uncited docs.	2 415	32.80	3 971	53.93
% International collaboration	*55.54*		*63.96*	
% world	0.09		0.07	

Figure 4. Document distribution by quartiles according to the SIR (Cuba 2003–2007).

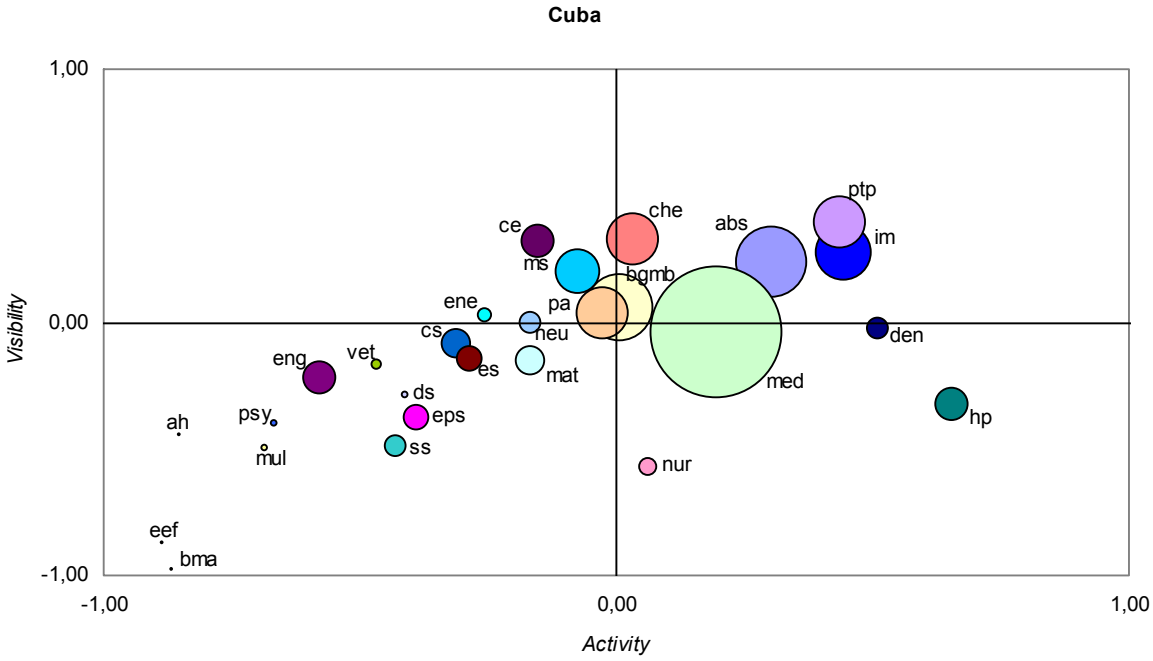


4.1.2. Research areas

Table 8. Bibliometric indicators by subject areas (Cuba-SJCR 1996–2008).

Subject Areas	Output and impact				Relative indicators		
	Cuba	%	Cit	CxD	AI	VI	RI
Agricultural and biological sciences	1 996	13.18	7 406	3.71	1.88	1.62	0.41
Arts and humanities	15	0.10	49	3.27	0.08	0.38	2.26
Biochemistry, genetics and molecular biology	1 748	11.54	16 268	9.31	1.01	1.13	0.52
Business, management and accounting	20	0.13	6	0.30	0.07	0.01	0.07
Chemical engineering	447	2.95	2 910	6.51	0.73	1.94	1.25
Chemistry	1 094	7.22	10 762	9.84	1.07	1.97	0.87
Computer science	349	2.30	1 379	3.95	0.52	0.84	0.76
Decision sciences	27	0.18	109	4.04	0.42	0.55	0.62
Dentistry	199	1.31	215	1.08	3.10	0.94	0.14
Earth and planetary sciences	271	1.79	1 194	4.41	0.44	0.45	0.49
Economics, econometrics and finance	9	0.06	34	3.78	0.06	0.07	0.51
Energy	122	0.81	306	2.51	0.59	1.05	0.83
Engineering	502	3.32	2 058	4.10	0.27	0.63	1.11
Environmental science	289	1.91	1 774	6.14	0.55	0.75	0.64
Health professions	460	3.04	235	0.51	4.78	0.51	0.05
Immunology and microbiology	1 227	8.10	6 684	5.45	2.59	1.76	0.32
Materials science	787	5.20	3 925	4.99	0.86	1.50	0.82
Mathematics	401	2.65	993	2.48	0.71	0.74	0.49
Medicine	6 346	41.91	16 560	2.61	1.49	0.92	0.29
Multidisciplinary	30	0.20	888	29.60	0.19	0.33	0.83
Neuroscience	200	1.32	2 640	13.20	0.71	0.99	0.65
Nursing	178	1.18	116	0.65	1.14	0.27	0.11
Pharmacology, toxicology and pharmaceutics	1 011	6.68	3 892	3.85	2.55	2.30	0.42
Physics and astronomy	1 070	7.07	5 326	4.98	0.95	1.07	0.53
Psychology	40	0.26	383	9.58	0.20	0.43	1.01
Social sciences	213	1.41	317	1.49	0.40	0.34	0.40
Veterinary	53	0.35	253	4.77	0.36	0.71	0.91
Total	**15 153**	**100**	**62 320**	**4.11**			**0.47**

Figure 5. Activity and visibility of the Cuban scientific output by subject areas (SJCR 1996–2008).



4.1.3. The most productive institutions, authors and journals

Table 9. The ten most productive Cuban institutions (Scopus 1996–2010).

Institutions	Total
Universidad de La Habana (UH)	2 494
Centro de Ingeniería Genética y Biotecnología (CIGB)	979
Centro Nacional de Investigaciones Científicas (CNIC)	693
Instituto de Medicina Tropical “Pedro Kourí” (IPK)	652
Instituto de Ciencia Animal (ICA)	636
Universidad Central de Las Villas “Marta Abreu” (UCLV)	571
Hospital “Hermanos Ameijeiras“ (HHA)	528
Instituto Superior de Ciencias Médicas de La Habana (ISCMH)	508
Universidad de Oriente (UO)	426
Instituto de Cibernética, Matemática y Física (ICIMAF)	308

Table 10. The most productive Cuban authors (SIR 2003–2007).

Surname	Name	Output	Cites	Cites per document
Más	Rosa	60	363	6.05
Guzmán	Maria G.	53	512	9.66
Villalonga	Reynaldo	49	250	5.10
Cao	Roberta	42	247	5.88
Marbot	Rolando	36	71	1.97
Fernández	Michael	35	380	10.86
Marrero Ponce	Yovani	34	645	18.97
Caballero	Julio	30	290	9.67
González Díaz	Humberto	29	560	19.31
Pérez	Rolando	29	224	7.72
Trallero-Giner	C.	29	93	3.21
Delgado	René	28	232	8.29
Guillén	G.	27	96	3.56
Reguera	E.	26	99	3.81
Rodríguez-Ramos	Reinaldo	24	78	3.25

Table 11. The ten most productive journals that publish Cuban documents (SIR 2003–2007).

	Source	Country	Output
1	ACIMED	CU	239
2	Revista Cubana de Medicina General Integral	CU	231
3	Revista cubana de medicina tropical	CU	173
4	Cuban Journal of Agricultural Science	CU	157
5	Revista Cubana de Medicina	CU	155
6	Revista de Neurología	ES	132
7	Lecture Notes in Computer Science	DE	128
8	Revista Cubana de Farmacia	CU	126
9	Revista Cubana de Medicina Militar	CU	95
10	Revista Cubana de Higiene y Epidemiologia	CU	91

4.1.4. International collaboration

Figure 6. Geographical distribution of the Cuban international collaboration (SIR 2003–2007).

Table 12. The 15 most collaborative countries in the Cuban scientific production (SIR 2003–2007).

Country	Documents	Cites	Cites per document
ES	781	3 898	4.99
MX	509	1 506	2.96
BR	373	1 169	3.13
DE	239	1 589	6.65
US	233	2 141	9.19
IT	191	1 618	8.47
GB	159	1 106	6.96
BE	136	520	3.82
FR	110	821	7.46
AR	105	771	7.34
CA	95	755	7.95
CO	68	131	1.93
CL	65	259	3.98
VE	61	145	2.38
JP	59	407	6.90

4.2. Ecuador

4.2.1. General data (output and impact)

Table 13. Total output and impact of the Ecuadorian scientific activity (SJCR 1996–2008).

Ecuador 1996–2008	Total
Documents	2 422
Citable documents	2 336
Citations	19 975
Self citations	2 734
Citations per document	8.25
H index	55

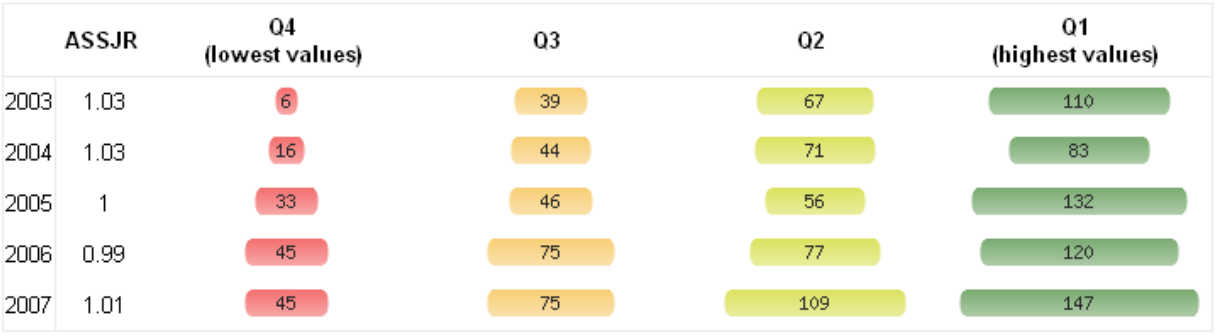
Table 14. Annual output and impact of the Ecuadorian scientific activity (SJCR 1996–2008).

	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	Total
Doc	96	150	139	114	119	106	135	196	180	244	269	316	358	2 422
P. Doc	92	146	138	112	116	100	131	185	175	234	257	308	342	2 336
Cit	1 381	1 738	1 518	1 692	1 635	1 626	1 494	1 801	2 077	1 912	1 652	957	492	19 975
S-Cit	88	168	135	154	194	253	267	240	259	340	328	178	130	2 734
CxD	14.39	11.59	10.92	14.84	13.74	15.34	11.07	9.19	11.54	7.84	6.14	3.03	1.37	8.25
SCxD	0.92	1.12	0.97	1.35	1.63	2.39	1.98	1.22	1.44	1.39	1.22	0.56	0.36	1.13
CD	80	107	84	98	93	92	107	163	144	178	186	197	170	1 699
UD	16	43	55	16	26	14	28	33	36	66	83	119	188	723
IC(%)	64.58	57.33	51.08	80.7	60.5	60.38	54.07	73.98	78.33	82.38	76.95	84.49	85.2	*70.00*
% World	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.01

Table 15. Output and impact of the Ecuadorian scientific activity by periods (SJCR 1999–2008).

Indicators	1999-03	%	2004-08	%
Documents	670	27.66	1 367	56.44
Citable documents	644	27.57	1 316	56.34
Cites	8 248	41.29	7 090	35.49
Self cites	1 108	40.53	1 235	45.17
Cites per doc.	12.31		5.19	
Self Cites per doc.	1.65		0.90	
Cited docs.	553	32.55	875	51.50
Uncited docs.	117	16.18	492	68.05
% International collaboration	*65.93*		*81.47*	
% world	0.01		0.02	

Figure 7. Document distribution by quartiles according to the SIR (Ecuador 2003–2007).

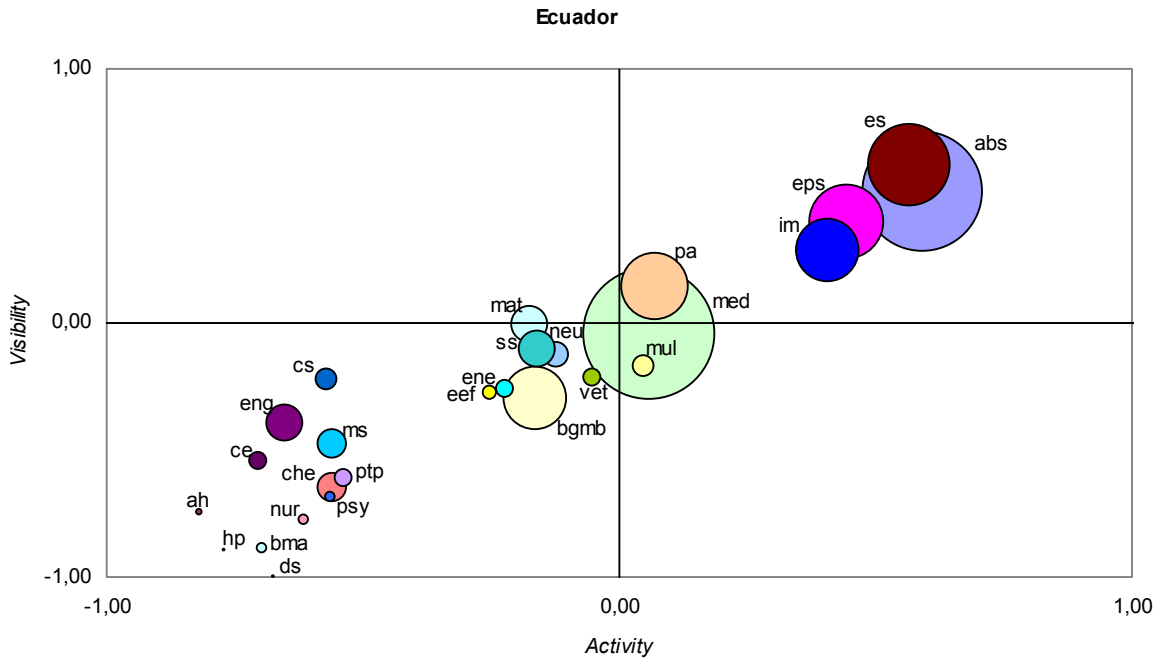


4.2.2. Research areas

Table 16. Bibliometric indicators by subject areas (Ecuador-SJCR 1996-2008).

Subject areas	Output and impact				Relative indicators		
	Ecuador	%	Cit	CxD	AI	VI	RI
Agricultural and biological sciences	666	27.50	4 568	6.86	3.92	3.12	0.75
Arts and humanities	3	0.12	6	2.00	0.10	0.15	1.39
Biochemistry, genetics and molecular biology	199	8.22	2 517	12.65	0.72	0.54	0.71
Business, management and accounting	8	0.33	10	1.25	0.18	0.06	0.31
Chemical engineering	17	0.70	142	8.35	0.17	0.30	1.60
Chemistry	46	1.90	371	8.07	0.28	0.21	0.71
Computer science	29	1.20	332	11.45	0.27	0.63	2.19
Decision sciences	2	0.08	0	0.00	0.19	0.00	0.00
Dentistry	0	0.00	0	0.00	0.00	0.00	0.00
Earth and Planetary sciences	257	10.61	1 954	7.60	2.60	2.32	0.84
Economics, econometrics and finance	14	0.58	92	6.57	0.60	0.56	0.89
Energy	21	0.87	55	2.62	0.64	0.59	0.87
Engineering	63	2.60	450	7.14	0.21	0.43	1.94
Environmental science	302	12.47	3 209	10.63	3.62	4.22	1.10
Health professions	2	0.08	8	4.00	0.13	0.05	0.39
Immunology and microbiology	179	7.39	2 168	12.11	2.37	1.78	0.71
Materials science	41	1.69	294	7.17	0.28	0.35	1.18
Mathematics	63	2.60	423	6.71	0.70	0.98	1.32
Medicine	767	31.67	5 315	6.93	1.13	0.92	0.77
Multidisciplinary	28	1.16	604	21.57	1.10	0.70	0.61
Neuroscience	35	1.45	669	19.11	0.78	0.78	0.94
Nursing	6	0.25	17	2.83	0.24	0.12	0.49
Pharmacology, toxicology and pharmaceutics	19	0.78	132	6.95	0.30	0.24	0.77
Physics and astronomy	207	8.55	2 135	10.31	1.15	1.33	1.10
Psychology	9	0.37	54	6.00	0.28	0.19	0.63
Social sciences	62	2.56	241	3.89	0.73	0.81	1.05
Veterinary	21	0.87	74	3.52	0.90	0.65	0.67
Total	**2 422**	**100**	**19 975**	**8.25**			**0.94**

Figure 8. Activity and visibility of the Ecuadorian scientific output by subject areas (SJCR 1996–2008).



4.2.3. The most productive institutions, authors and journals

Table 17. The ten most productive Ecuadorian institutions (Scopus 1996–2010).

Institutions	Total
Universidad San Francisco de Quito (USFQ)	333
Pontificia Universidad Católica de Ecuador (PUCE)	218
Escuela Politécnica Nacional de Ecuador (EPNE)	165
Fundación Charles Darwin de Santa Cruz, Ecuador (FCDE)	113
Universidad Central de Ecuador (UCE)	100
Escuela Superior Politécnica del Litoral (ESPL)	93
Hospital Vozandes del Oriente (HVO)	68
Universidad de Cuenca (UCUE)	62
Hospital General “Luis Vernaza” (HGLV)	59

Table 18. The most productive Ecuadorian authors (SIR 2003–2007).

Surname	Name	Output	Cites	Cites per document
Ortega	Fernando	7	35	5
Cisneros-Heredia	Diego F.	6	12	2
Zambrano	Cesar H.	5	6	1.2
Armijos	R. X.	4	67	16.75
Stashans	A.	4	17	4.25
Valarezo	C.	3	35	11.67
Procel	Luis Miguel	3	8	2.67
Waters	William F.	2	2	1
Frugone	L.	2	14	7
Costa Vera	César	2	6	3
Guevara Hidalgo	Esteban	2	2	1
Viteri	Ricardo	2	1	0.5

Table 19. The ten most productive journals that publish Ecuadorian documents (SIR 2003–2007).

	Source	Country	Output
1	Revista Ecuatoriana de Neurologia	EC	53
2	Ornitologia Neotropical	US	31
3	Physical Review D	US	20
4	Physics Letters, Section B	NL	19
5	Physical Review Letters	US	15
6	Pan American Journal of Public Health	US	14
7	American Journal of Tropical Medicine and Hygiene	US	12
8	Revista de Neurologia	ES	12
9	IAHS-AISH Publication	GB	10
10	Zootaxa	NZ	9

4.2.4. International collaboration

Figure 9. Geographical distribution of the Ecuadorian international collaboration (SIR 2003–2007).

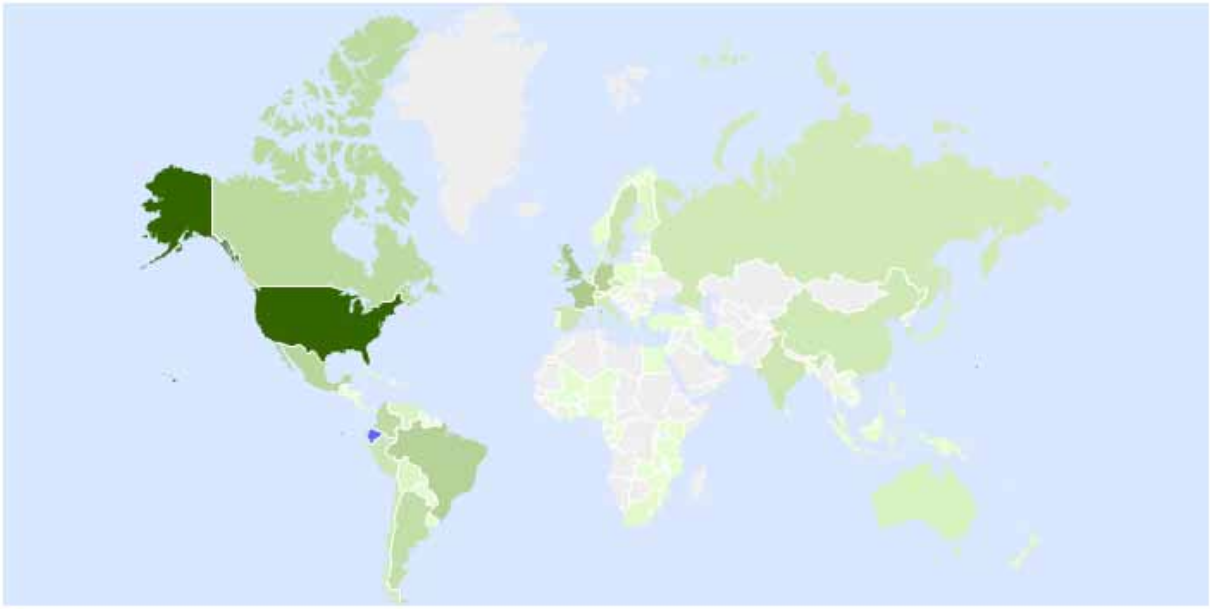


Table 20. The 15 most collaborative countries in the Ecuadorian scientific production (SIR 2003–2007).

Country	Documents	Cites	Cites per document
US	438	3 706	8.46
GB	162	1 880	11.6
FR	145	972	6.70
DE	122	1 040	8.52
BR	121	1 198	9.90
MX	116	708	6.10
CA	103	829	8.05
CO	99	886	8.95
AR	88	750	8.52
NL	81	475	5.86
CH	76	516	6.79
SE	72	448	6.22
BE	68	339	4.99
IN	67	450	6.72
ES	67	342	5.10

4.3. Bolivia

4.3.1. General data (output and impact)

Table 21. Total output and impact of the Bolivian scientific activity (SJCR 1996–2008).

Bolivia 1996–2008	Total
Documents	1 584
Citable documents	1 558
Citations	13 755
Self citations	1 672
Citations per document	8.68
H index	43

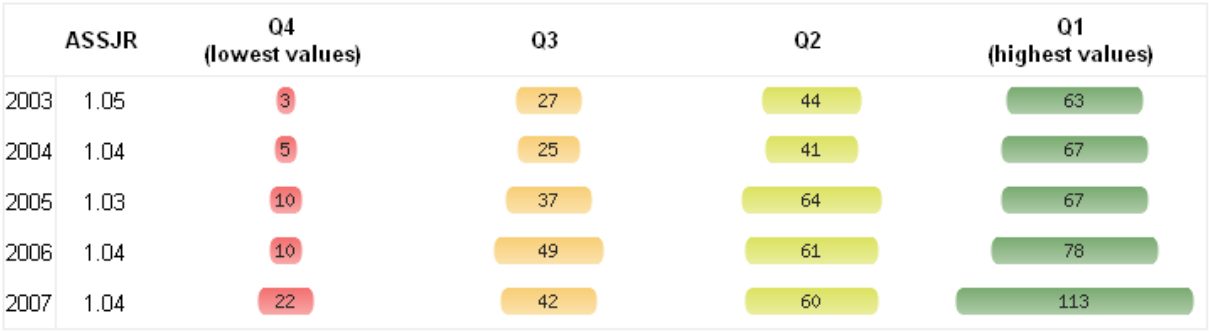
Table 22. Annual output and impact of the Bolivian scientific activity (SJCR 1996–2008).

	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	Total
Doc	64	92	97	114	69	83	89	120	122	136	172	203	223	1 584
P. Doc	64	91	94	114	68	83	88	120	119	133	168	198	218	1 558
Cit	861	1 270	1 424	1 975	1 009	869	950	1 078	1 572	797	812	731	407	13 755
S-Cit	93	157	187	216	88	68	104	149	158	112	149	114	77	1 672
CxD	13.45	13.8	14.68	17.32	14.62	10.47	10.67	8.98	12.89	5.86	4.72	3.6	1.83	8.68
SCxD	1.45	1.71	1.93	1.89	1.28	0.82	1.17	1.24	1.3	0.82	0.87	0.56	0.35	1.06
CD	56	79	83	108	61	66	76	109	104	112	133	140	116	1 243
UD	8	13	14	6	8	17	13	11	18	24	39	63	107	341
IC(%)	87.5	88.04	86.6	84.21	81.16	71.08	80.9	88.33	91.8	91.18	86.05	88.18	87.89	*85.61*
% World	0.29	0.36	0.36	0.39	0.23	0.27	0.26	0.31	0.29	0.29	0.31	0.34	0.35	0.08

Table 23. Output and impact of the Bolivian scientific activity by periods (SJCR 1999–2008).

Indicators	1999-03	%	2004-08	%
Documents	475	29.99	856	54.04
Citable Documents	473	30.36	836	53.66
Cites	5 881	42.76	4 319	31.40
Self Cites	625	37.38	610	36.48
Cites per Doc.	12.38		5.05	
Self Cites per Doc.	1.32		0.71	
Cited Docs.	420	33.79	605	48.67
Uncited Docs.	55	16.13	251	73.61
% International Collaboration	*81.14*		*89.02*	
% World	*0.29*		*0.32*	

Figure 10. Document distribution by quartiles according to the SIR (Bolivia 2003-007).

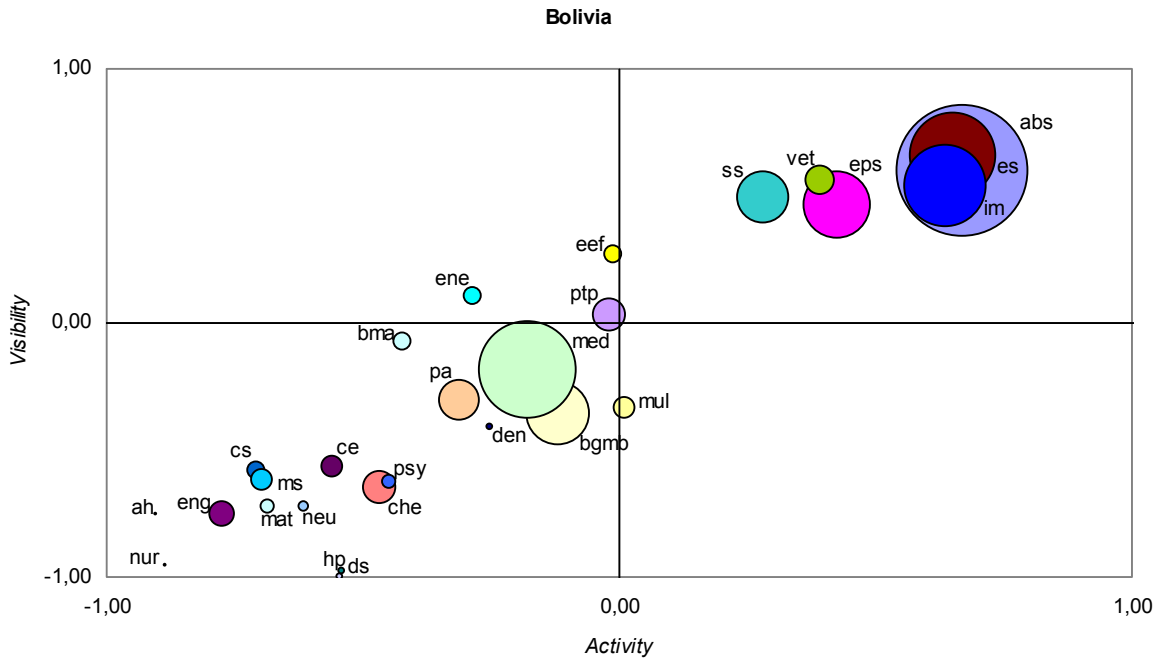


4.3.2. Research areas

Table 24. Bibliometric indicators by subject areas (Bolivia-SJCR 1996–2008).

	Output and impact				Relative indicators		
Subject areas	**Bolivia**	**%**	**Cit**	**CxD**	**AI**	**VI**	**RI**
Agricultural and biological sciences	561	35.42	4 021	7.17	5.05	3.99	0.79
Arts and humanities	1	0.06	4	4.00	0.05	0.14	2.77
Biochemistry, genetics and molecular biology	142	8.96	1 504	10.59	0.79	0.47	0.60
Business, management and accounting	12	0.76	103	8.58	0.41	0.86	2.11
Chemical engineering	18	1.14	92	5.11	0.28	0.28	0.98
Chemistry	39	2.46	255	6.54	0.37	0.21	0.58
Computer science	12	0.76	95	7.92	0.17	0.26	1.52
Decision sciences	2	0.13	0	0.00	0.30	0.00	0.00
Dentistry	4	0.25	21	5.25	0.60	0.42	0.70
Earth and planetary sciences	161	10.16	1 591	9.88	2.49	2.74	1.09
Economics, econometrics and finance	15	0.95	194	12.93	0.98	1.72	1.75
Energy	12	0.76	80	6.67	0.56	1.24	2.21
Engineering	25	1.58	101	4.04	0.13	0.14	1.10
Environmental science	260	16.41	2 527	9.72	4.77	4.83	1.01
Health professions	3	0.19	1	0.33	0.30	0.01	0.03
Immunology and microbiology	224	14.14	2 797	12.49	4.53	3.33	0.73
Materials science	17	1.07	137	8.06	0.18	0.24	1.32
Mathematics	11	0.69	47	4.27	0.19	0.16	0.84
Medicine	311	19.63	2 741	8.81	0.70	0.69	0.98
Multidisciplinary	17	1.07	294	17.29	1.02	0.50	0.49
Neuroscience	7	0.44	94	13.43	0.24	0.16	0.66
Nursing	1	0.06	2	2.00	0.06	0.02	0.34
Pharmacology, poxicology and pharmaceutics	40	2.53	398	9.95	0.97	1.07	1.10
Physics and astronomy	62	3.91	590	9.52	0.53	0.53	1.01
Psychology	8	0.51	45	5.63	0.38	0.23	0.59
Social sciences	99	6.25	601	6.07	1.78	2.93	1.64
Veterinary	35	2.21	277	7.91	2.30	3.51	1.52
Total	**1 584**	**100**	**13 755**	**8.68**			**0.99**

Figure 11. Activity and visibility of the Bolivian scientific output by subject areas (SJCR 1996–2008).



4.3.3. The most productive institutions, authors and journals

Table 25. The ten most productive Bolivian institutions (Scopus 1996–2010).

Institutions	Total
Universidad Mayor de San Andrés (UMSA)	297
Universidad Mayor de San Simón (UMSS)	223
Institut de Recherche pour le Dévelopement, La Paz, Bolivia (IRD)	145
Instituto Boliviano de Biología de Altura (IBBA)	98
Museo de Historia Natural “Noel Kempff” (MHNNK)	55
Instituto Nacional de Laboratorios de Salud (INLASA)	39
Herbario Nacional de Bolivia (HNB)	37
Proyecto de Manejo Forestal Sostenible (BOLFOR)	33
Instituto Boliviano de Investigaciones Forestales (IBIF)	31
Fundación para la Promoción e Investigación de Productos Andinos (PROINPA)	28

Table 26. The most productive Bolivian authors (SIR 2003–2007).

Surname	Name	Output	Cites	Cites per document
Torrico	Faustino	11	56	5.09
Torrico	M. C.	7	46	6.57
Alonso-Vega	C.	7	34	4.86
Ticona	R.	7	7	1
Suarez	Eduardo	6	44	7.33
Carlier	Yves	6	4	0.67
Martinic	N.	5	7	1.4
Truyens	Carine	5	4	0.8
Velarde	A.	4	12	3
Miranda	P.	4	12	3
Billot	Claire	3	3	1
Rodriguez	P.	3	40	13.33
Solano	Marco	3	12	4
Rodriguez	Patricia	3	1	0.33
Garcia	Magali	2	10	5
Torrico	Faustino	2	3	1.5
Baya	Ana	2	14	7
Delgado	R.	2	9	4.5
Loayza	Ingrid	2	3	1.5
Noireau	Francois	2	7	3.5
Vega	Cristina Alonso	2	9	4.5
Cortez	Mirko Rojas	2	11	5.5
Torrico	Faustino	2	2	1

Table 27. The ten most productive journals that publish Bolivian documents (SIR 2003–2007).

	Source	Country	Output
1	American Journal of Tropical Medicine and Hygiene	US	12
2	Biotropica	US	10
3	Forest Ecology and Management	NL	8
4	Journal of Fish Biology	GB	8
5	Revista da Sociedade Brasileira de Medicina Tropical	BR	8
6	Biodiversity and Conservation	GB	7
7	Journal of ethnopharmacology	IE	7
8	Journal of Infectious Diseases	US	7
9	American Journal of Human Biology	US	6
10	Journal of Essential Oil Research	US	6

4.3.4. International collaboration

Figure 12. Geographical distribution of the Bolivian international collaboration (SIR 2003–2007).

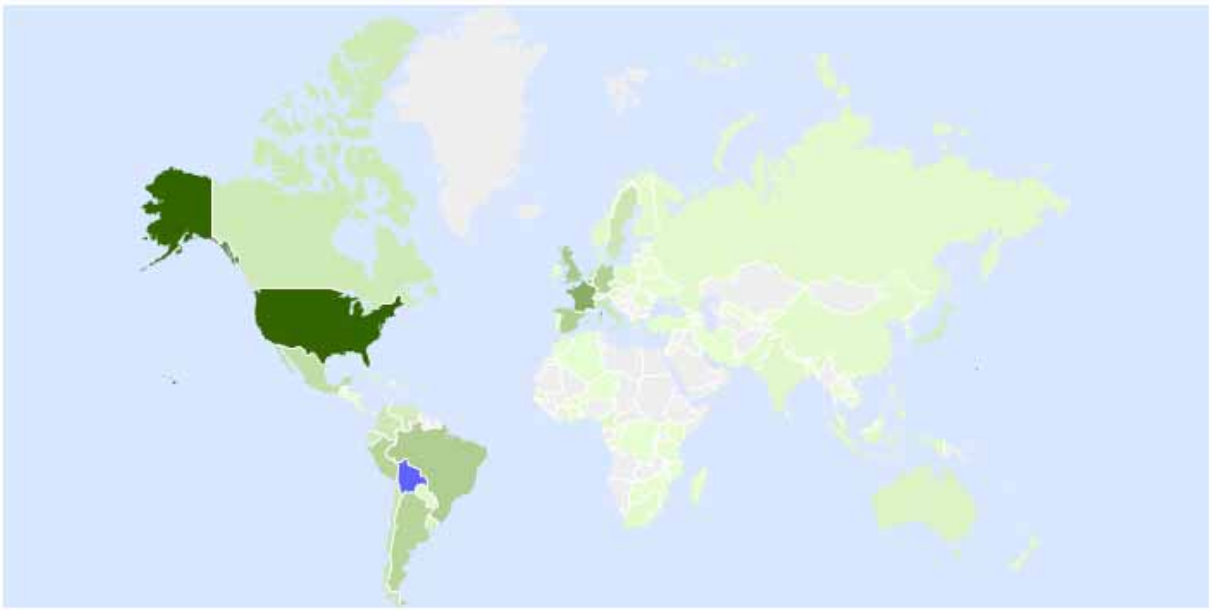


Table 28. The 15 most collaborative countries in the Bolivian scientific production (SIR 2003–2007).

Country	Documents	Cites	Cites per document
US	207	1 596	7.71
FR	107	903	8.44
BE	75	476	6.35
GB	73	846	11.59
BR	64	712	11.13
ES	62	503	8.11
DE	57	643	11.28
PE	55	653	11.87
AR	55	457	8.31
MX	44	348	7.91
NL	43	409	9.51
CL	34	147	4.32
IT	32	488	15.25
SE	31	192	6.19
CO	29	264	9.1

4.4. Nicaragua

4.4.1. General data (output and impact)

Table 29. Total output and impact of the Nicaraguan scientific activity (SJCR 1996–2008).

Nicaragua 1996–2008	Total
Documents	529
Citable documents	515
Citations	4 208
Self citations	398
Citations per document	7.95
H index	28

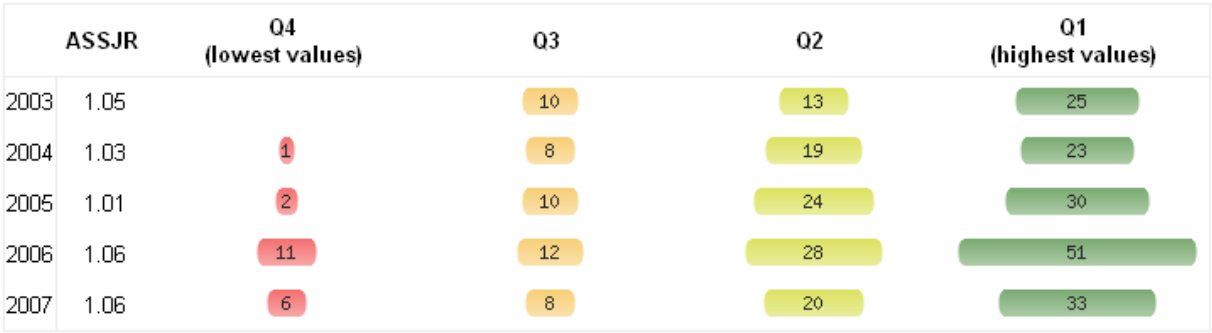
Table 30. Annual output and impact of the Nicaraguan scientific activity (SJCR 1996–2008).

	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	Total
Doc	35	36	28	26	28	19	13	37	44	49	84	58	72	529
P. Doc	34	36	28	25	28	19	12	35	44	49	79	57	69	515
Cit	400	497	573	402	456	203	147	247	247	378	417	134	107	4 208
S-Cit	48	46	40	32	37	19	8	19	32	39	49	17	12	398
CxD	11.43	13.81	20.46	15.46	16.29	10.68	11.31	6.68	5.61	7.71	4.96	2.31	1.49	7.95
SCxD	1.37	1.28	1.43	1.23	1.32	1.00	0.62	0.51	0.73	0.80	0.58	0.29	0.17	0.75
CD	32	32	28	22	24	17	11	31	41	43	65	36	29	411
UD	3	4	0	4	4	2	2	6	3	6	19	22	43	118
IC(%)	88.57	88.89	92.86	92.31	78.57	68.42	76.92	89.19	90.91	93.88	90.48	96.55	91.67	*87.63*
% World	0.003	0.003	0.002	0.002	0.002	0.001	0.001	0.003	0.003	0.003	0.005	0.003	0.004	0.003

Table 31. Output and impact of the Nicaraguan scientific activity by periods (SJCR 1999–2008).

Indicators	1999–03	%	2004–08	%
Documents	123	23.25	307	58.03
Citable documents	119	23.11	298	57.86
Cites	1 455	34.58	1 283	30.49
Self cites	115	28.89	149	37.44
Cites per doc.	11.83		4.18	
Self cites per doc.	0.93		0.49	
Cited docs.	105	25.55	214	52.07
Uncited docs.	18	15.25	93	78.81
% international collaboration	*81.08*		*92.70*	
% world	0.002		0.003	

Figure 13. Document distribution by quartiles according to the SIR (Nicaragua 2003–2007).

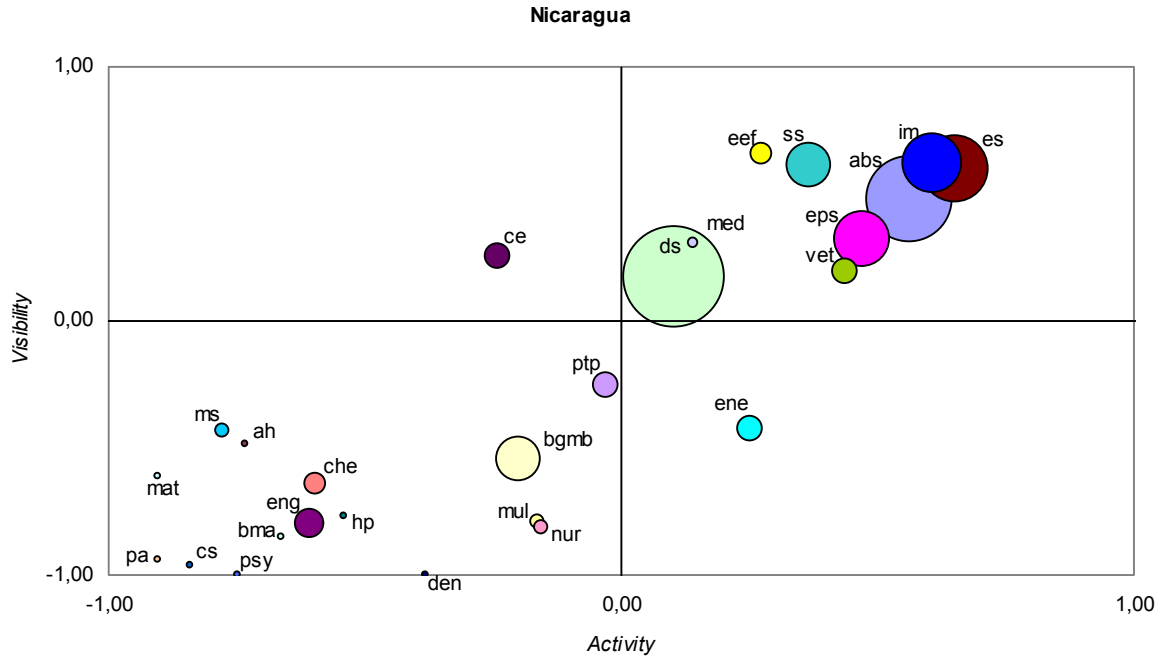


4.4.2. Research areas

Table 32. Bibliometric indicators by subject areas (Nicaragua-SJCR 1996–2008).

Subject Areas	Output and Impact				Relative indicators		
	Nicaragua	%	Cit	CxD	AI	VI	RI
Agricultural and biological sciences	133	25.14	872	6.56	3.58	2.83	0.72
Arts and humanities	1	0.19	3	3.00	0.15	0.35	2.08
Biochemistry, genetics and molecular biology	40	7.56	286	7.15	0.66	0.29	0.40
Business, management and accounting	2	0.38	3	1.50	0.20	0.08	0.37
Chemical engineering	13	2.46	170	13.08	0.61	1.68	2.51
Chemistry	9	1.70	81	9.00	0.25	0.22	0.79
Computer science	2	0.38	2	1.00	0.09	0.02	0.19
Decision sciences	3	0.57	25	8.33	1.33	1.88	1.29
Dentistry	1	0.19	0	0.00	0.45	0.00	0.00
Earth and planetary sciences	60	11.34	346	5.77	2.78	1.95	0.64
Economics, econometrics and finance	9	1.70	168	18.67	1.76	4.88	2.53
Energy	12	2.27	8	0.67	1.67	0.41	0.22
Engineering	16	3.02	25	1.56	0.24	0.11	0.42
Environmental science	86	16.26	640	7.44	4.73	4.00	0.77
Health professions	1	0.19	4	4.00	0.30	0.13	0.39
Immunology and microbiology	68	12.85	1 091	16.04	4.12	4.25	0.94
Materials science	4	0.76	70	17.50	0.13	0.40	2.87
Mathematics	1	0.19	22	22.00	0.05	0.24	4.32
Medicine	183	34.59	1 731	9.46	1.23	1.42	1.05
Multidisciplinary	4	0.76	21	5.25	0.72	0.12	0.15
Neuroscience	0	0.00	0	0.00	0.00	0.00	0.00
Nursing	4	0.76	3	0.75	0.73	0.10	0.13
Pharmacology, toxicology and pharmaceutics	13	2.46	68	5.23	0.94	0.59	0.58
Physics and astronomy	2	0.38	11	5.50	0.05	0.03	0.58
sychology	1	0.19	0	0.00	0.14	0.00	0.00
Social sciences	40	7.56	259	6.48	2.15	4.13	1.75
Veterinary	13	2.46	36	2.77	2.56	1.49	0.53
Total	**529**	**100**	**4 208**	**7.95**			**0.91**

Figure 14. Activity and visibility of the Nicaraguan scientific output by subject areas (SJCR 1996–2008).



4.4.3. The most productive institutions, authors and journals

Table 33. The ten most productive Nicaraguan institutions (Scopus 1996–2010).

Institutions	Total
Universidad Nacional Autónoma de Nicaragua, León (UNAN-León)	110
Universidad Nacional Autónoma de Nicaragua, Managua (UNAN-Managua)	46
Universidad Nacional Agraria, Managua (UNA)	45
Ministerio de Salud Pública de Nicaragua (MINSAL)	44
Universidad Centroamericana (UCA)	31
Instituto Nicaragüense de Estudios Territoriales (INETER)	27
Universidad Nacional de Ingeniería (UNI)	20
Hospital Infantil “Manuel de Jesús Rivera” (HIMJR)	18
Hospital Escuela “Oscar Danilo Rosales Arguello” (HEODRA)	11
Instituto Centroamericano de Salud (ICAS)	10

Table 34. The most productive Nicaraguan authors (SIR 2003–2007).

Surname	Name	Output	Cites	Cites per document
Balmaseda	Angel	8	144	18
Valle	Sonja	5	16	3.2
Saborio	Saira	4	75	18.75
Téllez	Y.	4	75	18.75
Pérez	Leonel	4	68	17
Blanco	Luis	4	19	4.75
Peña	Rodolfo	4	32	8
Gorter	A.	4	5	1.25
Espinoza	Felix	4	28	7
Rocha	Crisanta	4	72	18
Medina	A.	4	28	7
Rocha	J.	4	73	18.25

Table 35. The ten most productive journals that publish Nicaraguan documents (SIR 2003–2007).

	Source	Country	Output
1	American Journal of Tropical Medicine and Hygiene	US	6
2	Pan American Journal of Public Health	US	5
3	WIT Transactions on Ecology and the Environment	GB	5
4	Tropical Medicine and International Health	GB	4
5	Biodiversity and Conservation	GB	3
6	Biotropica	US	3
7	Carbohydrate Research	GB	3
8	Hydrogeology Journal	US	3
9	International Journal of Tuberculosis and Lung Disease	FR	3
10	Journal of Clinical Microbiology	US	3

4.4.4. International collaboration

Figure 15. Geographical distribution of the Nicaraguan international collaboration (SIR 2003–2007).

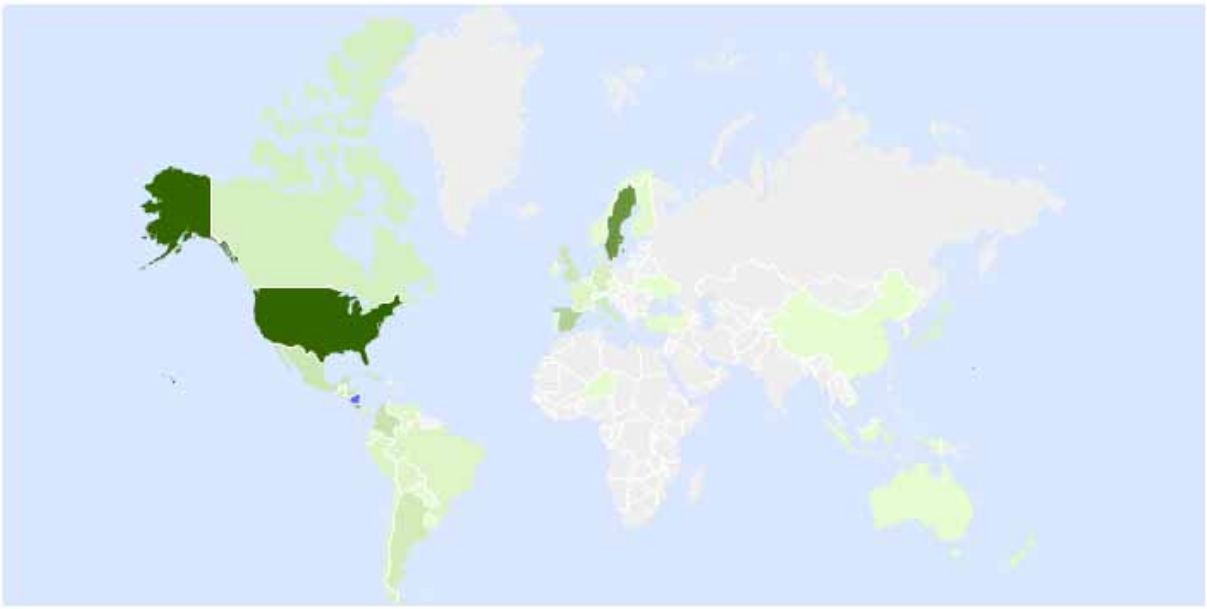


Table 36. The 15 most collaborative countries in the Nicaraguan scientific production (SIR 2003–2007).

Country	Documents	Cites	Cites per document
US	93	556	5.98
SE	63	267	4.24
CR	40	170	4.25
ES	26	72	2.77
CO	16	70	4.38
HN	15	88	5.87
NL	15	22	1.47
MX	15	130	8.67
GB	14	116	8.29
CU	12	128	10.67
SV	12	78	6.50
AR	11	135	12.27
GT	10	63	6.30
IT	10	34	3.40
BE	9	61	6.78

4.5. Honduras

4.5.1. General data (output and impact)

Table 37. Total output and impact of the Honduran scientific activity (SJCR 1996–2008).

Honduras 1996-2008	Total
Documents	394
Citable documents	386
Citations	3 502
Self citations	212
Citations per document	8.89
H index	28

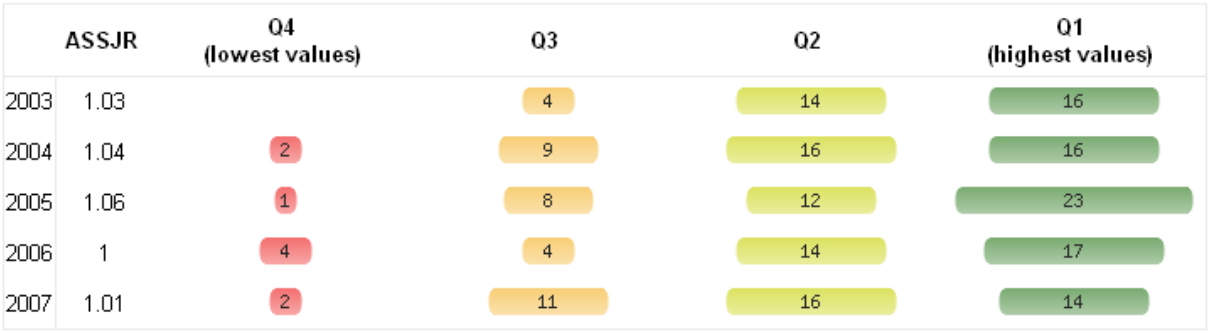
Table 38. Annual output and impact of the Honduran scientific activity (SJCR 1996–2008).

	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	Total
Doc	24	25	31	38	22	17	31	30	35	34	39	32	36	394
P. Doc	24	24	31	37	22	17	31	30	35	29	39	32	35	386
Cit	271	405	434	470	211	197	335	238	319	241	171	165	45	3 502
S-Cit	20	22	35	45	10	5	18	9	19	10	7	8	4	212
CxD	11.29	16.20	14.00	12.37	9.59	11.59	10.81	7.93	9.11	7.09	4.38	5.16	1.25	8.89
SCxD	0.83	0.88	1.13	1.18	0.45	0.29	0.58	0.30	0.54	0.29	0.18	0.25	0.11	0.54
CD	19	21	29	36	18	13	26	27	29	29	26	23	13	309
UD	5	4	2	2	4	4	5	3	6	5	13	9	23	85
IC(%)	87.50	84.00	83.87	71.05	72.73	76.47	90.32	90.00	85.71	94.12	92.31	90.63	88.89	*85.20*
% World	0.002	0.002	0.003	0.003	0.002	0.001	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002

Table 39. Output and impact of the Honduran scientific activity by periods (SJCR 1999–2008).

Indicators	1999–03	%	2004–08	%
Documents	138	35.03	176	44.67
Citable documents	137	35.49	170	44.04
Cites	1 451	41.43	941	26.87
Self cites	87	41.04	48	22.64
Cites per doc.	10.51		5.35	
Self Cites per doc.	0.63		0.27	
Cited docs.	120	38.83	120	38.83
Uncited docs.	18	21.18	56	65.88
% international collaboration	*80.11*		*90.33*	
% world	0.002		0.002	

Figure 16. Document distribution by quartiles according to the SIR (Honduras 2003–2007).

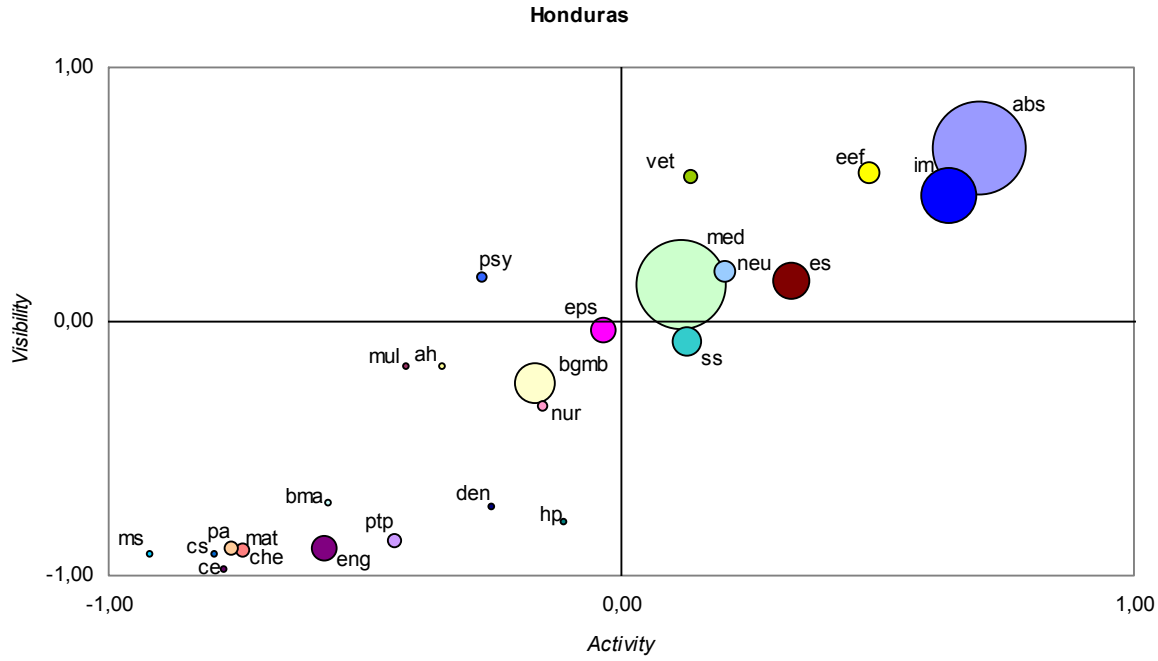


4.5.2. Research areas

Table 40. Bibliometric indicators by subject areas (Honduras-SJCR 1996–2008).

Subject areas	Output and impact				Relative indicators		
	Honduras	%	Cit	CxD	AI	VI	RI
Agricultural and biological sciences	156	39.59	1 336	8.56	5.64	5.21	0.94
Arts and humanities	2	0.51	5	2.50	0.41	0.70	1.73
Biochemistry, genetics and molecular biology	32	8.12	489	15.28	0.71	0.60	0.86
Business, management and accounting	2	0.51	5	2.50	0.27	0.16	0.61
Chemical engineering	2	0.51	1	0.50	0.13	0.01	0.10
Chemistry	4	1.02	16	4.00	0.15	0.05	0.35
Computer science	2	0.51	4	2.00	0.12	0.04	0.38
Decision sciences	0	0.00	0	0.00	0.00	0.00	0.00
Dentistry	1	0.25	2	2.00	0.60	0.16	0.27
Earth and planetary sciences	15	3.81	137	9.13	0.93	0.93	1.01
Economics, econometrics and finance	11	2.79	108	9.82	2.89	3.77	1.33
Energy	0	0.00	0	0.00	0.00	0.00	0.00
Engineering	13	3.30	10	0.77	0.27	0.05	0.21
Environmental science	27	6.85	184	6.81	1.99	1.38	0.71
Health professions	2	0.51	3	1.50	0.80	0.12	0.15
Immunology and microbiology	56	14.21	625	11.16	4.55	2.92	0.65
Materials science	1	0.25	6	6.00	0.04	0.04	0.98
Mathematics	2	0.51	4	2.00	0.14	0.05	0.39
Medicine	140	35.53	1 345	9.61	1.27	1.32	1.06
Multidisciplinary	2	0.51	104	52.00	0.48	0.69	1.46
Neuroscience	11	2.79	224	20.36	1.51	1.49	1.01
Nursing	3	0.76	12	4.00	0.74	0.50	0.69
Pharmacology, toxicology and pharmaceutics	4	1.02	7	1.75	0.39	0.07	0.19
Physics and astronomy	4	1.02	15	3.75	0.14	0.05	0.40
Psychology	3	0.76	71	23.67	0.58	1.41	2.48
Social sciences	18	4.57	44	2.44	1.30	0.84	0.66
Veterinary	5	1.27	72	14.40	1.32	3.58	2.76
Total	**394**	**100**	**3 502**	**8.89**			**1.02**

Figure 17. Activity and visibility of the Honduran scientific output by subject areas (SJCR 1996–2008).



4.5.3. The most productive institutions, authors and journals

Table 41. The ten most productive Honduran institutions (Scopus 1996–2010).

Institutions	Total
Universidad Nacional Autónoma de Honduras (UNAH)	80
Escuela Agrícola Panamericana El Zamorano (EAP)	61
Secretaría de Salud de Honduras (SSH)	19
Ministerio de Salud Pública de Honduras (MSPH)	16
Hospital Escuela Materno Infantil, Tegucigalpa (HEMI)	15
Hospital Escuela de la Universidad Nacional Autónoma de Honduras (UNAH)	10
Centro Internacional de Agricultura Tropical (CIAT)	5
Instituto de Ciencias Marinas de Roatán (ICM)	5
Escuela Nacional de Ciencias Forestales (ENCIFOR)	5
Instituto de Neurociencias de Honduras (INEURO)	5

Table 42. The most productive Honduran authors (SIR 2003–2007).

Surname	Name	Output	Cites	Cites per document
Medina	M. T.	15	214	14.27
Ponce	Carlos	6	50	8.33
Durán	R. M.	6	43	7.17
Fu	L.	6	53	8.83
Peña	Armando	5	48	9.6
Gernat	A. G.	3	8	2.67
Sherman	C.	3	11	3.67
Sandoval	G.	2	19	9.5
Rosas	Juan Carlos	2	12	6
Cave	Ronald D.	2	10	5
Delgado-Escueta	A. V.	2	7	3.5
Ponce	Elisa	2	25	12.5
Elvir	José Alexander	2	3	1.5
Alvarado-Gálvez	Carlos	2	13	6.5
Pavón	Ada	2	13	6.5
Pérez	Melly	2	13	6.5
Trejo	M. T.	2	22	11
Matamoros	I.	2	9	4.5
Vittetoe	Kenneth	2	30	15
Triminio-Meyer	Suyapa	2	1	0.5
Martínez	Mercedes	2	6	3
Dravet	Charlotte	2	7	3.5
Bailey	Julia N.	2	7	3.5
Martínez-Juárez	Iris E.	2	7	3.5

Table 43. The ten most productive journals that publish Honduran documents (SIR 2003–2007).

	Source	Country	Output
1	Revista de Neurologia	ES	7
2	Pan American Journal of Public Health	US	6
3	Journal of Clinical Microbiology	US	4
4	Pediatric Blood and Cancer	US	4
5	American Journal of Tropical Medicine and Hygiene	US	3
6	Epilepsia	US	3
7	Geoderma	NL	3
8	Memorias do Instituto Oswaldo Cruz	BR	3
9	Advances in neurology	US	2
10	Agroforestry Systems	NL	2

4.5.4. International collaboration

Figure 18. Geographical distribution of the Honduran international collaboration (SIR 2003–2007).

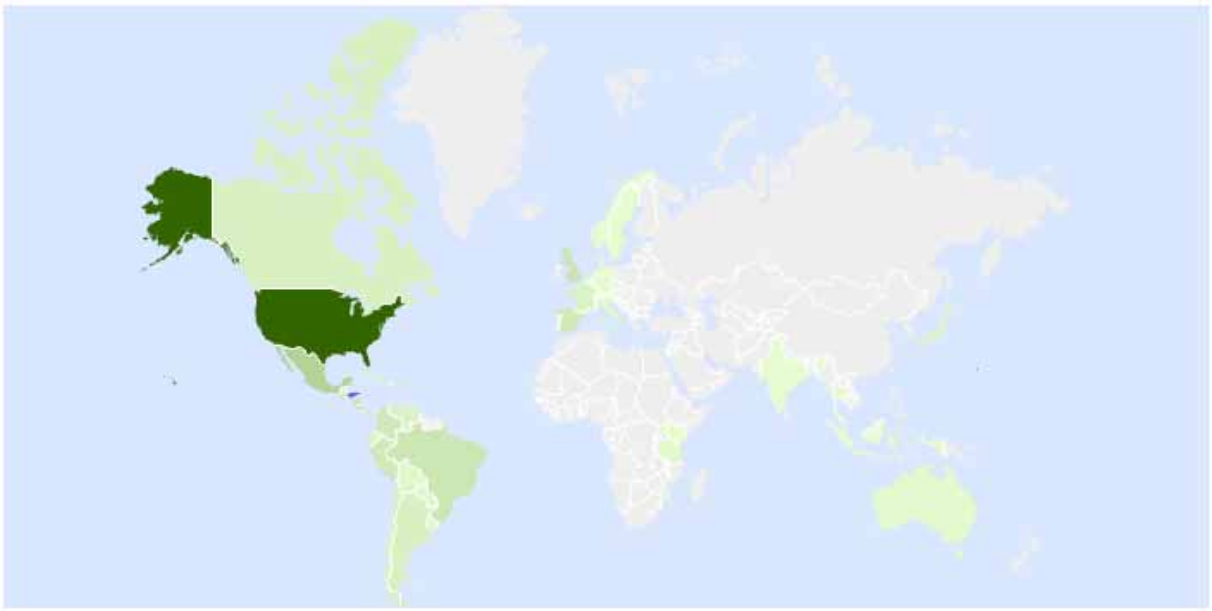


Table 44. The 15 most collaborative countries in the Honduran scientific production (SIR 2003–2007).

Country	Documents	Cites	Cites per document
US	104	671	6.45
MX	29	294	10.14
CR	18	83	4.61
GB	17	159	9.35
BR	16	138	8.63
NI	15	88	5.87
GT	14	63	4.5
PE	13	94	7.23
CO	13	57	4.38
ES	13	125	9.62
SV	13	99	7.62
PA	9	66	7.33
AR	9	81	9
CA	9	48	5.33
VE	7	61	8.71
FR	7	25	3.57
CL	7	40	5.71

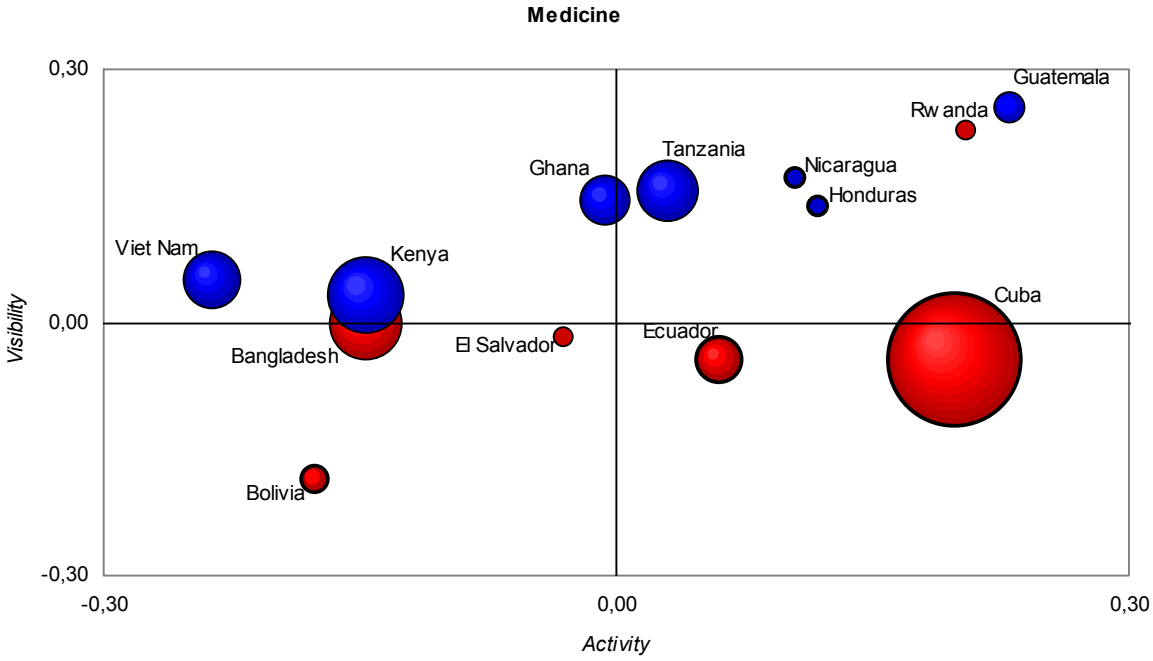
5. Comparative analysis by subject area

This section compares the studied countries with those belonging to the control group (El Salvador, Guatemala, Kenya, Ghana, Tanzania, Rwanda, Viet Nam, and Bangladesh).
The activity and visibility indicators applied to each of the 27 Scopus subject areas can be observed through multiple representations. In each graph and for each country the size of the bubbles expresses the volume of the scientific production (**Doc**), the position in the vertical axis reflects the relative visibility (**RVI**, Relative Visibility Index), the position in the horizontal axis reflects the relative activity (**RAI**, Relative Activity Index), and the colour of the bubbles shows the relative impact (**RI**): blue, if the citation per paper of the country is over the world mean; red, if it is under the world mean.

The quadrant of the positive values for RVI and RAI (top right in the figure) shows the countries with high level of specialization and impact in each field.

5.1. Medicine

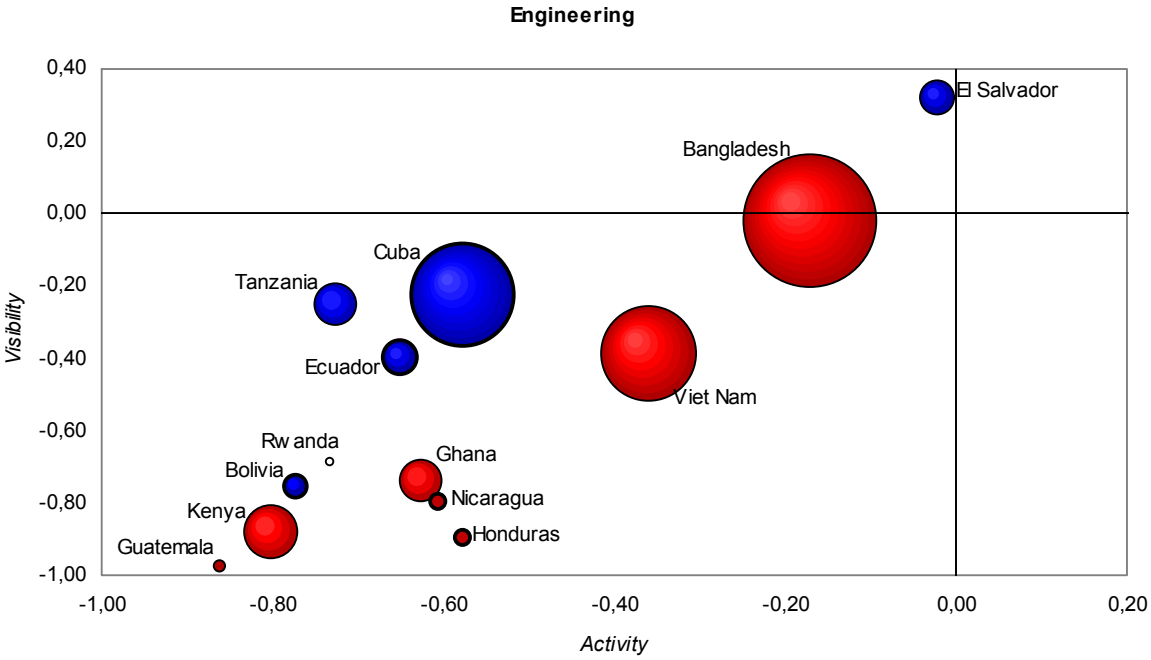
Figure 19. Activity and visibility in the context of *medicine*.



	Doc	RAI	RVI	RI
Cuba	6 346	0.20	-0.04	0.29
Kenya	2 091	-0.15	0.03	1.63
Bangladesh	1 993	-0.15	0.00	0.77
Tanzania	1 353	0.03	0.16	1.30
Viet Nam	1 274	-0.24	0.05	1.50
Ghana	935	-0.01	0.15	1.02
Ecuador	767	0.06	-0.04	0.77
Guatemala	391	0.23	0.26	1.06
Bolivia	311	-0.18	-0.19	0.98
Nicaragua	183	0.10	0.17	1.05
Honduras	140	0.12	0.14	1.06
El Salvador	136	-0.03	-0.02	0.78
Rwanda	134	0.20	0.23	0.83

5.2. Engineering

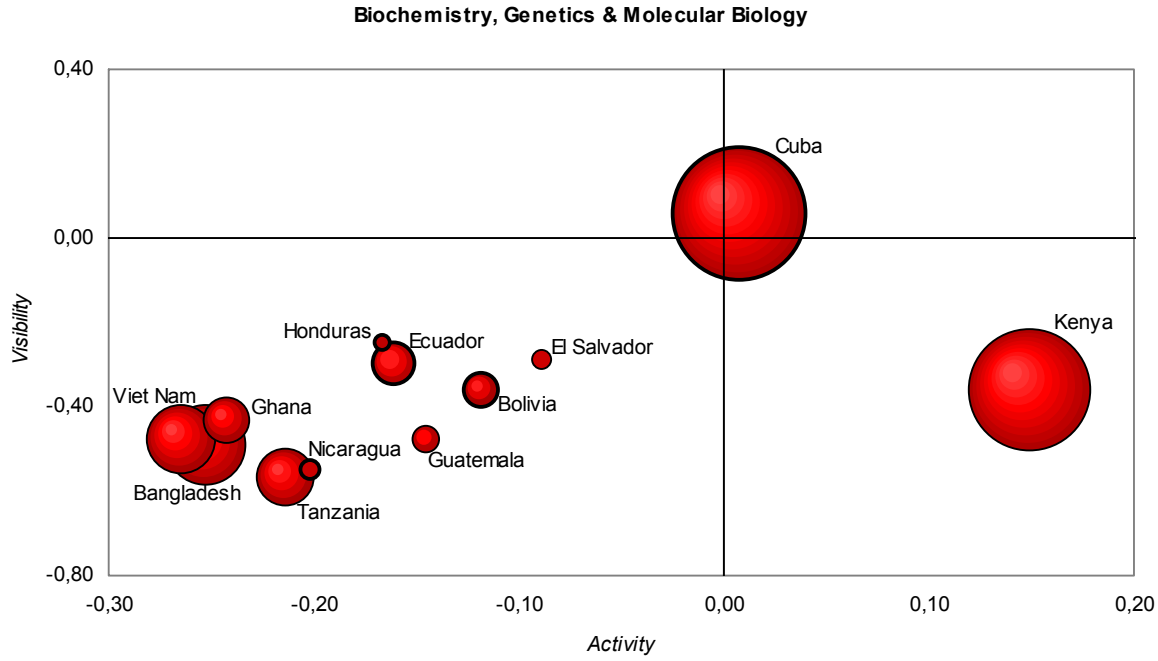
Figure 20. Activity and visibility in the context of *engineering.*



	Doc	RAI	RVI	RI
Bangladesh	833	-0.17	-0.02	0.78
Cuba	502	-0.58	-0.22	1.11
Viet Nam	428	-0.36	-0.39	0.79
Kenya	135	-0.80	-0.88	0.65
Ghana	96	-0.63	-0.74	0.49
Tanzania	89	-0.73	-0.25	3.78
Ecuador	63	-0.65	-0.40	1.94
El Salvador	61	-0.02	0.32	1.54
Bolivia	25	-0.77	-0.75	1.10
Nicaragua	16	-0.61	-0.80	0.42
Honduras	13	-0.58	-0.90	0.21
Guatemala	8	-0.86	-0.98	0.17
Rwanda	6	-0.73	-0.69	0.95

5.3. Biochemistry, genetics and molecular biology

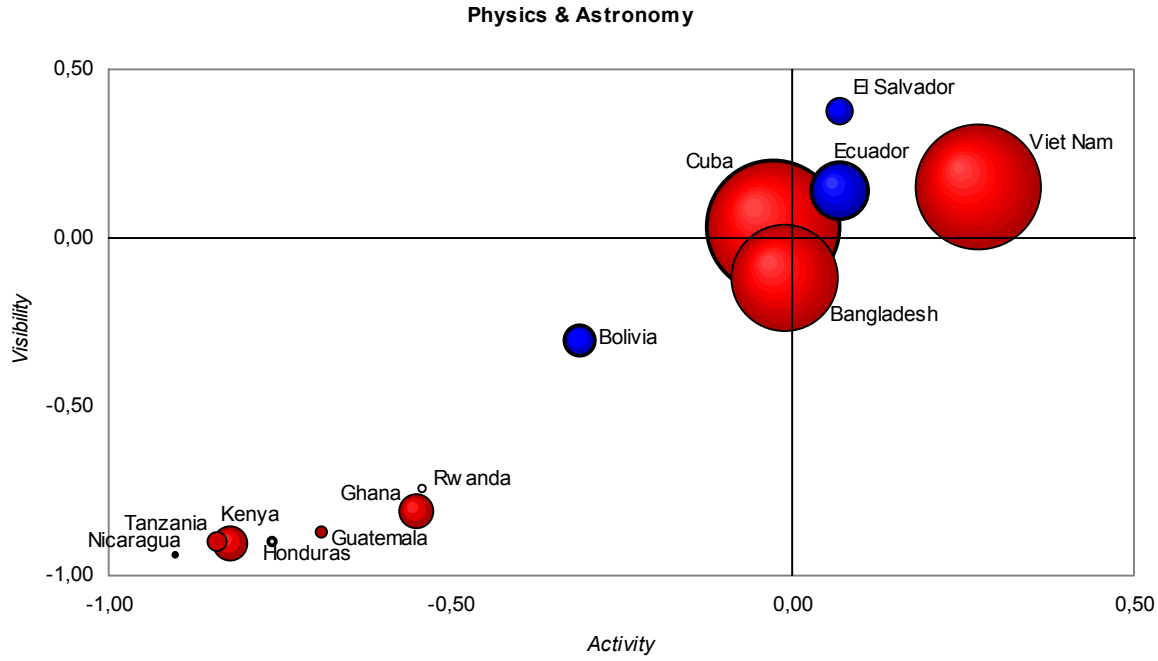
Figure 21. Activity and visibility in the context of *biochemistry, genetics and molecular biology.*



	Doc	RAI	RVI	RI
Cuba	1 748	0.01	0.06	0.52
Kenya	1 535	0.15	-0.36	0.40
Bangladesh	648	-0.25	-0.49	0.33
Viet Nam	486	-0.26	-0.48	0.51
Tanzania	334	-0.21	-0.56	0.43
Ghana	234	-0.24	-0.43	0.49
Ecuador	199	-0.16	-0.30	0.71
Bolivia	142	-0.12	-0.36	0.60
Guatemala	74	-0.15	-0.48	0.48
El Salvador	49	-0.09	-0.29	0.51
Nicaragua	40	-0.20	-0.55	0.40
Honduras	32	-0.17	-0.25	0.86
Rwanda	15	-0.41	-0.62	0.45

5.4. Physics and astronomy

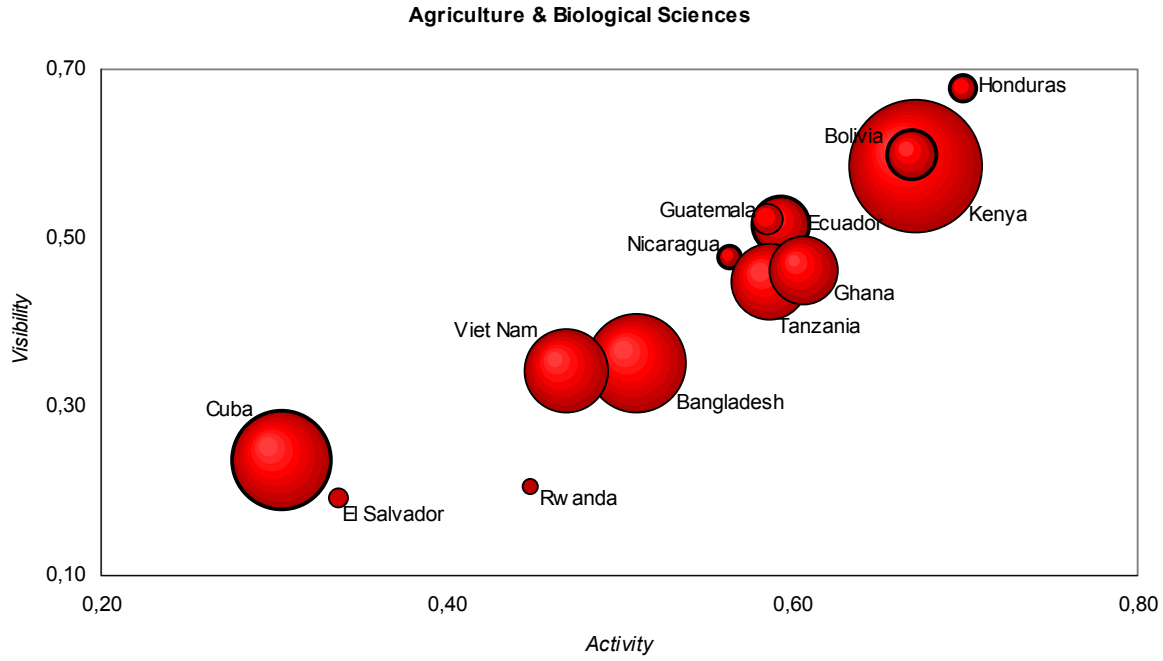
Figure 22. Activity and visibility in the context of *physics and astronomy.*



	Doc	RAI	RVI	RI
Cuba	1 070	-0.03	0.03	0.53
Viet Nam	956	0.27	0.15	0.65
Bangladesh	695	-0.01	-0.12	0.46
Ecuador	207	0.07	0.14	1.10
Kenya	73	-0.82	-0.90	0.58
Ghana	73	-0.55	-0.81	0.28
Bolivia	62	-0.31	-0.30	1.01
El Salvador	44	0.07	0.38	1.47
Tanzania	29	-0.84	-0.90	0.61
Guatemala	12	-0.69	-0.87	0.38
Rwanda	7	-0.54	-0.74	0.40
Honduras	4	-0.76	-0.90	0.40
Nicaragua	2	-0.90	-0.94	0.58

5.5. Agriculture and biological science

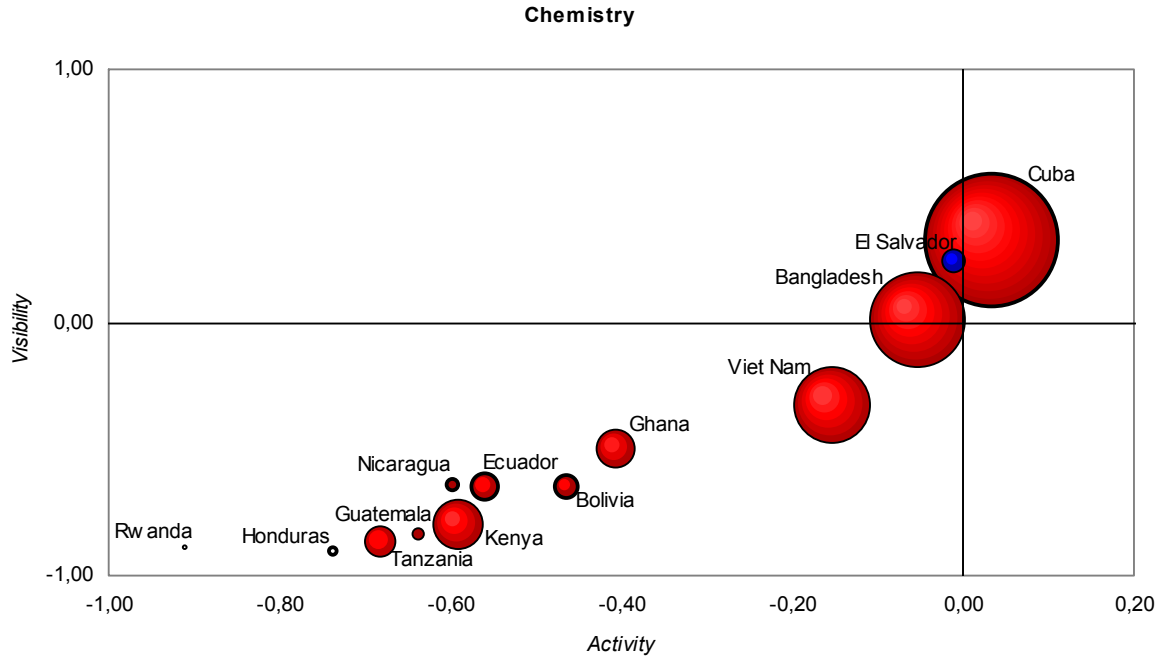
Figure 23. Activity and visibility in the context of *agriculture and biological science*.



	Doc	RAI	RVI	RI
Kenya	3 570	0.67	0.58	0.85
Bangladesh	2 062	0.51	0.35	0.39
Cuba	1 996	0.30	0.24	0.41
Viet Nam	1 427	0.47	0.34	0.62
Tanzania	1 224	0.59	0.45	0.69
Ghana	968	0.61	0.46	0.50
Ecuador	666	0.59	0.51	0.75
Bolivia	561	0.67	0.60	0.79
Guatemala	234	0.59	0.52	0.84
Honduras	156	0.70	0.68	0.94
Nicaragua	133	0.56	0.48	0.72
El Salvador	73	0.34	0.19	0.56
Rwanda	58	0.45	0.21	0.46

5.6. Chemistry

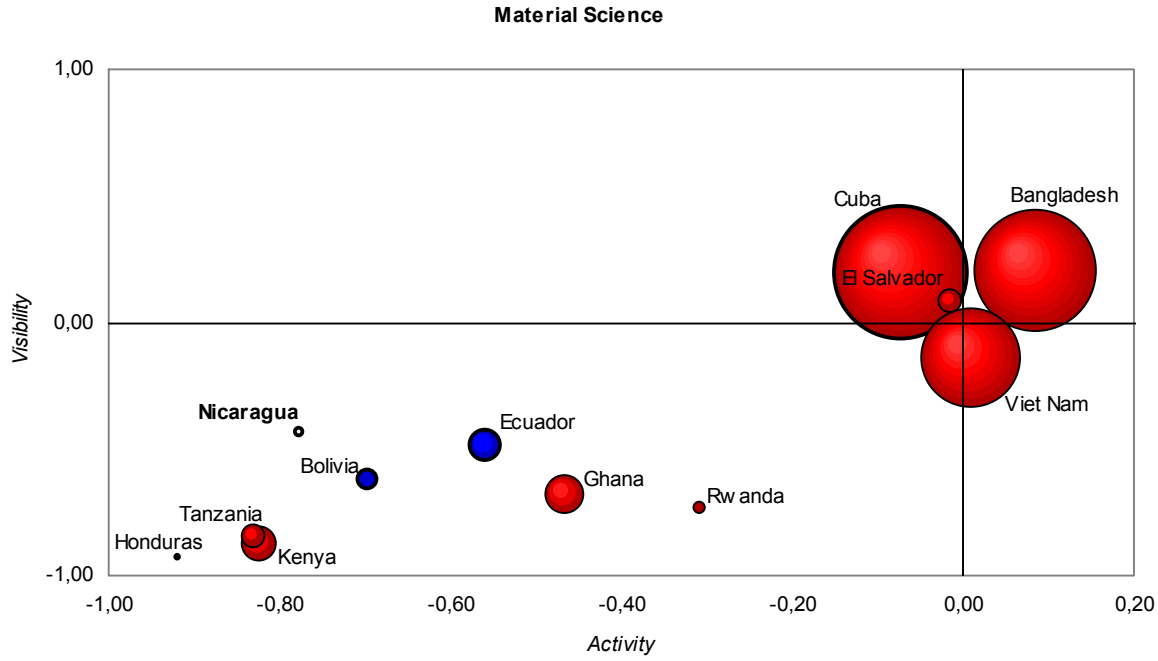
Figure 24. Activity and visibility in the context of *chemistry*.



	Doc	RAI	RVI	RI
Cuba	1 094	0.03	0.33	0.87
Bangladesh	579	-0.05	0.01	0.65
Viet Nam	363	-0.15	-0.32	0.58
Kenya	173	-0.59	-0.80	0.51
Ghana	96	-0.41	-0.50	0.60
Tanzania	58	-0.68	-0.87	0.37
Ecuador	46	-0.56	-0.65	0.71
Bolivia	39	-0.47	-0.65	0.58
El Salvador	34	-0.01	0.24	1.27
Guatemala	13	-0.64	-0.84	0.41
Nicaragua	9	-0.60	-0.64	0.79
Honduras	4	-0.74	-0.90	0.35
Rwanda	1	-0.91	-0.89	0.97

5.7. Materials science

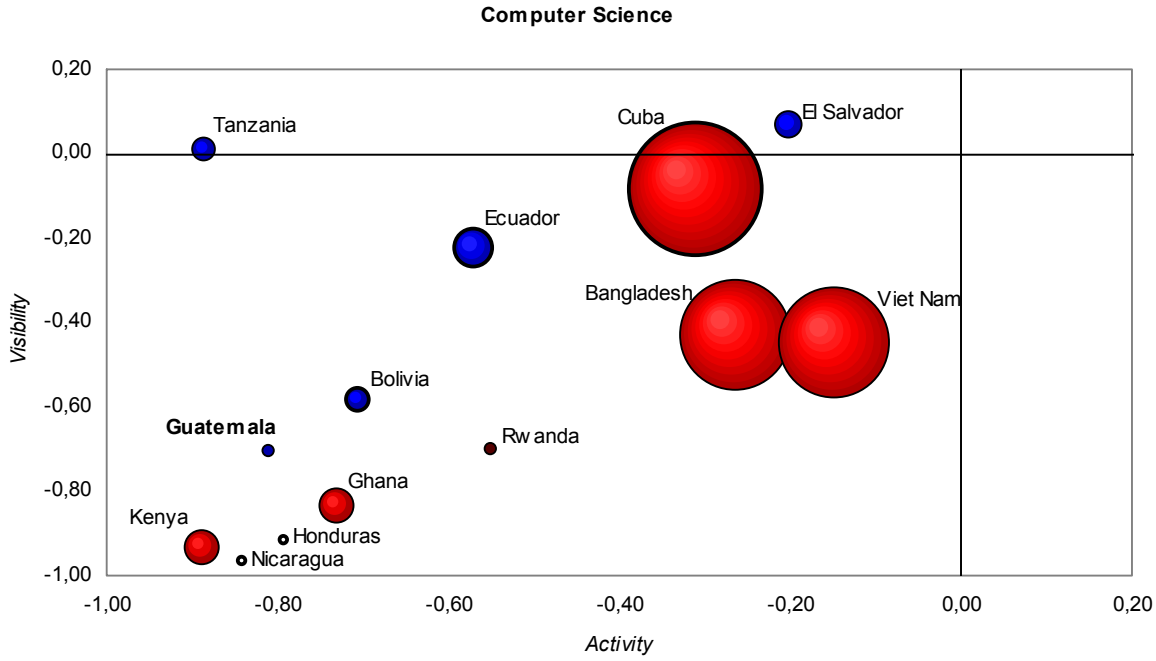
Figure 25. Activity and visibility in the context of *materials science*.



	Doc	RAI	RVI	RI
Cuba	787	-0.07	0.20	0.82
Bangladesh	681	0.09	0.21	0.74
Viet Nam	450	0.01	-0.14	0.62
Ghana	74	-0.47	-0.68	0.39
Kenya	58	-0.82	-0.87	0.79
Ecuador	41	-0.56	-0.48	1.18
El Salvador	30	-0.02	0.09	0.93
Tanzania	25	-0.83	-0.84	0.95
Bolivia	17	-0.70	-0.62	1.32
Rwanda	10	-0.31	-0.73	0.23
Nicaragua	4	-0.78	-0.43	2.87
Honduras	1	-0.92	-0.92	0.98
Guatemala	0	-	-	-

5.8. Computer science

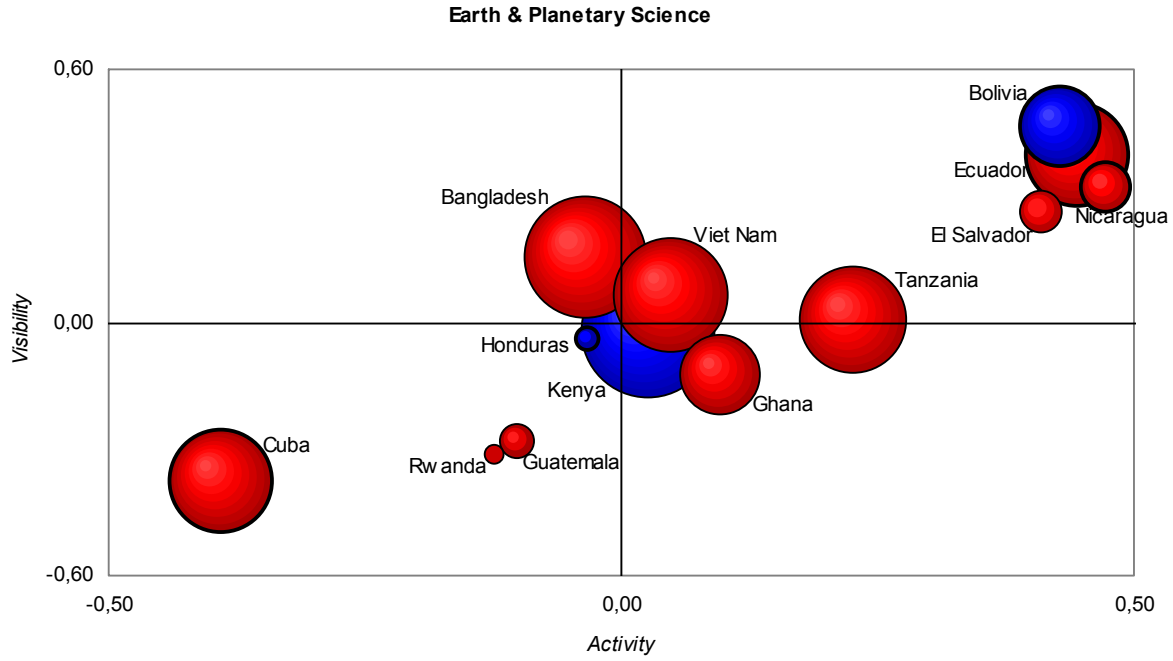
Figure 26. Activity and visibility in the context of *computer science*.



	Doc	RAI	RVI	RI
Cuba	349	-0.31	-0.08	0.76
Bangladesh	244	-0.26	-0.43	0.39
Viet Nam	239	-0.15	-0.45	0.43
Ecuador	29	-0.57	-0.22	2.19
Kenya	26	-0.89	-0.93	0.66
Ghana	23	-0.73	-0.83	0.44
El Salvador	15	-0.20	0.07	1.32
Bolivia	12	-0.71	-0.58	1.52
Tanzania	12	-0.89	0.01	16.97
Guatemala	4	-0.81	-0.70	1.68
Rwanda	4	-0.55	-0.70	0.48
Nicaragua	2	-0.84	-0.96	0.19
Honduras	2	-0.79	-0.92	0.38

5.9. Earth and planetary sciences

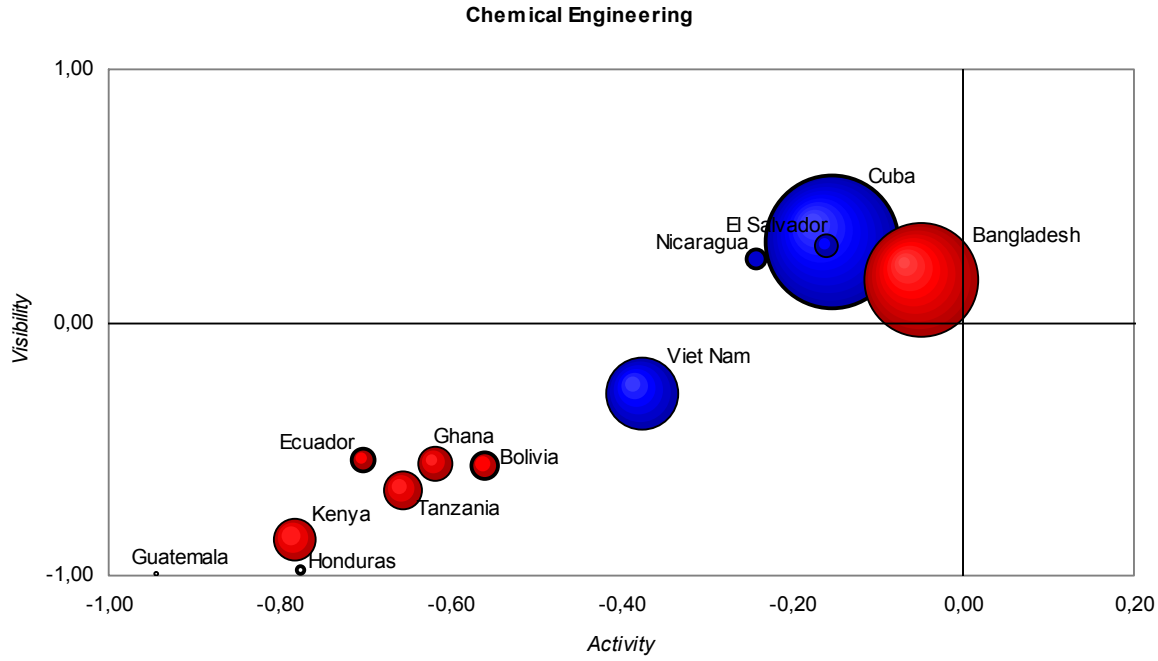
Figure 27. Activity and visibility in the context of *earth and planetary sciences*.



	Doc	RAI	RVI	RI
Kenya	429	0.03	-0.02	1.03
Bangladesh	363	-0.03	0.16	0.84
Viet Nam	330	0.05	0.07	0.87
Tanzania	293	0.23	0.01	0.64
Cuba	271	-0.39	-0.38	0.49
Ecuador	257	0.45	0.40	0.84
Ghana	167	0.10	-0.13	0.48
Bolivia	161	0.43	0.47	1.09
Nicaragua	60	0.47	0.32	0.64
El Salvador	50	0.41	0.26	0.55
Guatemala	29	-0.10	-0.28	0.69
Honduras	15	-0.03	-0.04	1.01
Rwanda	10	-0.12	-0.31	0.53

5.10. Chemical engineering

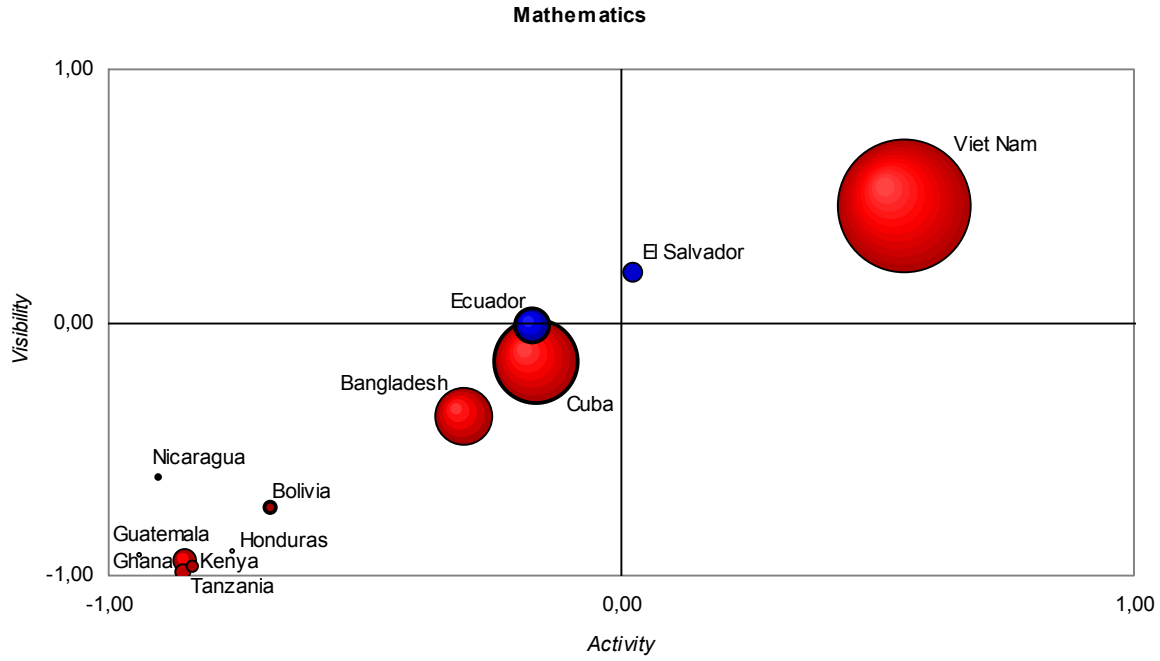
Figure 28. Activity and visibility in the context of *chemical engineering*.



	Doc	RAI	RVI	RI
Cuba	447	-0.15	0.32	1.25
Bangladesh	348	-0.05	0.17	0.89
Viet Nam	134	-0.38	-0.28	1.05
Kenya	49	-0.78	-0.85	0.73
Tanzania	38	-0.66	-0.66	0.97
Ghana	32	-0.62	-0.56	0.90
Bolivia	18	-0.56	-0.56	0.98
Ecuador	17	-0.70	-0.54	1.60
El Salvador	15	-0.16	0.30	1.96
Nicaragua	13	-0.24	0.25	2.51
Honduras	2	-0.78	-0.98	0.10
Guatemala	1	-0.94	-0.99	0.19
Rwanda	0	-	-	-

5.11. Mathematics

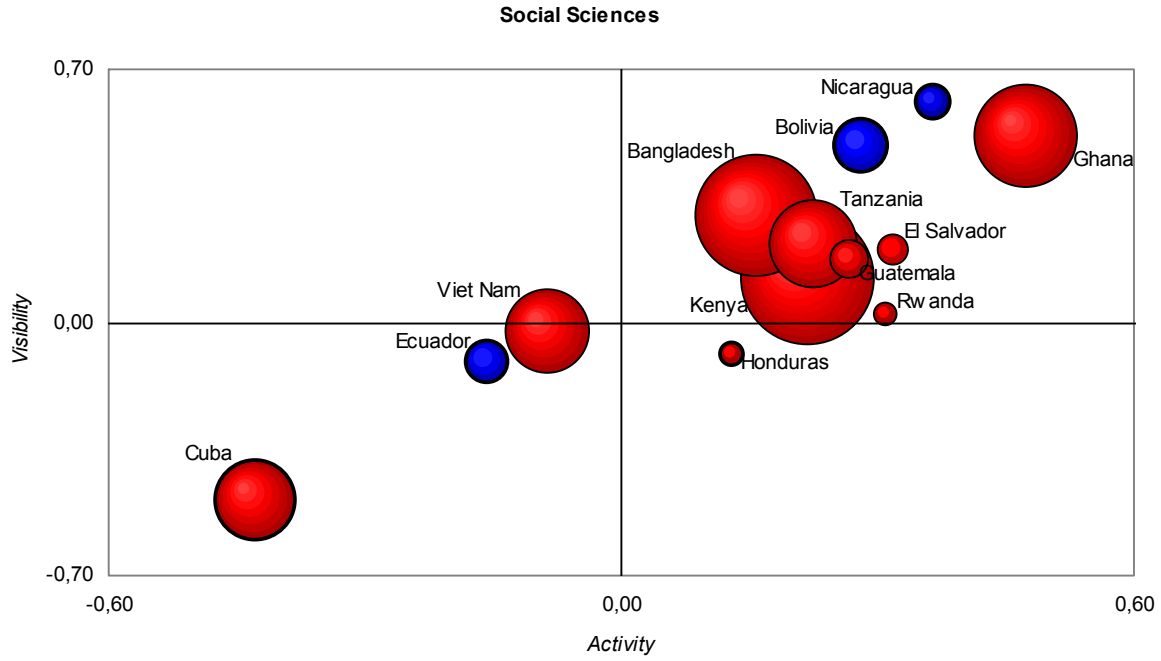
Figure 29. Activity and visibility in the context of *mathematics*.



	Doc	RAI	RVI	RI
Viet Nam	943	0.55	0.46	0.65
Cuba	401	-0.17	-0.15	0.49
Bangladesh	188	-0.31	-0.37	0.50
Ecuador	63	-0.18	-0.01	1.32
Kenya	30	-0.85	-0.94	0.45
El Salvador	20	0.02	0.20	1.09
Tanzania	13	-0.86	-0.98	0.12
Bolivia	11	-0.68	-0.73	0.84
Ghana	11	-0.84	-0.96	0.16
Honduras	2	-0.76	-0.90	0.39
Nicaragua	1	-0.90	-0.61	4.32
Guatemala	1	-0.94	-0.92	1.38
Rwanda	0	-	-	-

5.12. Social sciences

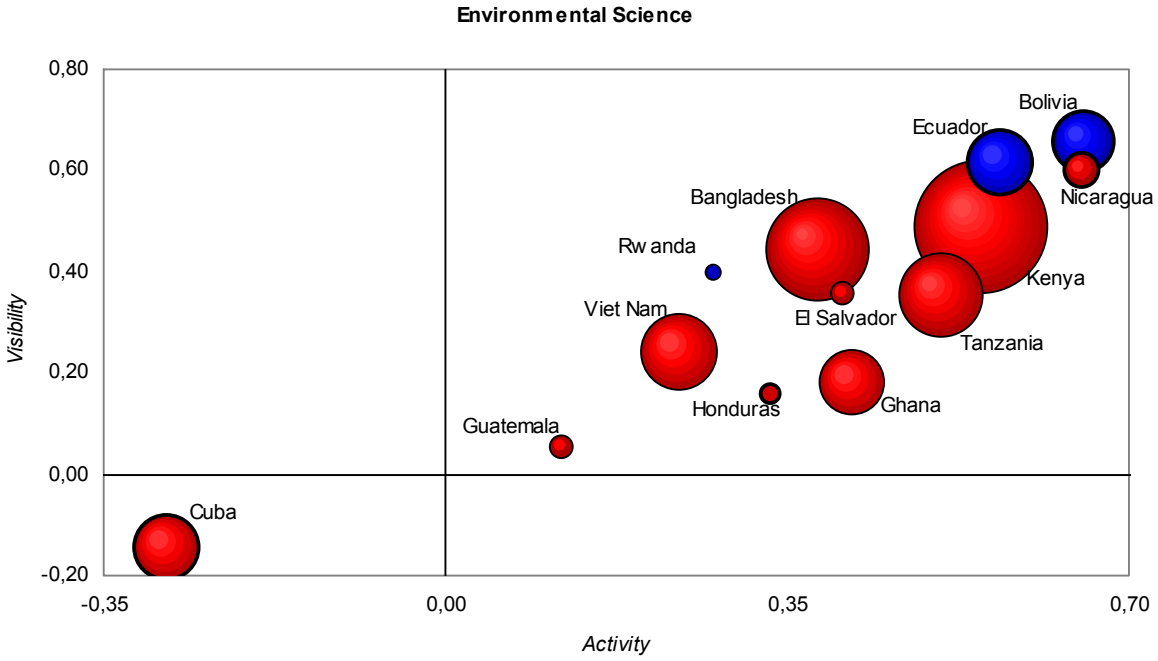
Figure 30. Activity and visibility in the context of *social sciences*.



	Doc	RAI	RVI	RI
Kenya	547	0.22	0.13	0.94
Bangladesh	462	0.16	0.30	0.76
Ghana	333	0.47	0.52	0.84
Tanzania	252	0.22	0.22	0.99
Viet Nam	217	-0.09	-0.02	0.95
Cuba	213	-0.43	-0.49	0.40
Bolivia	99	0.28	0.49	1.64
Ecuador	62	-0.16	-0.11	1.05
Guatemala	53	0.27	0.17	0.83
Nicaragua	40	0.37	0.61	1.75
El Salvador	35	0.32	0.20	0.59
Rwanda	21	0.31	0.03	0.44
Honduras	18	0.13	-0.09	0.66

5.13. Environmental sciences

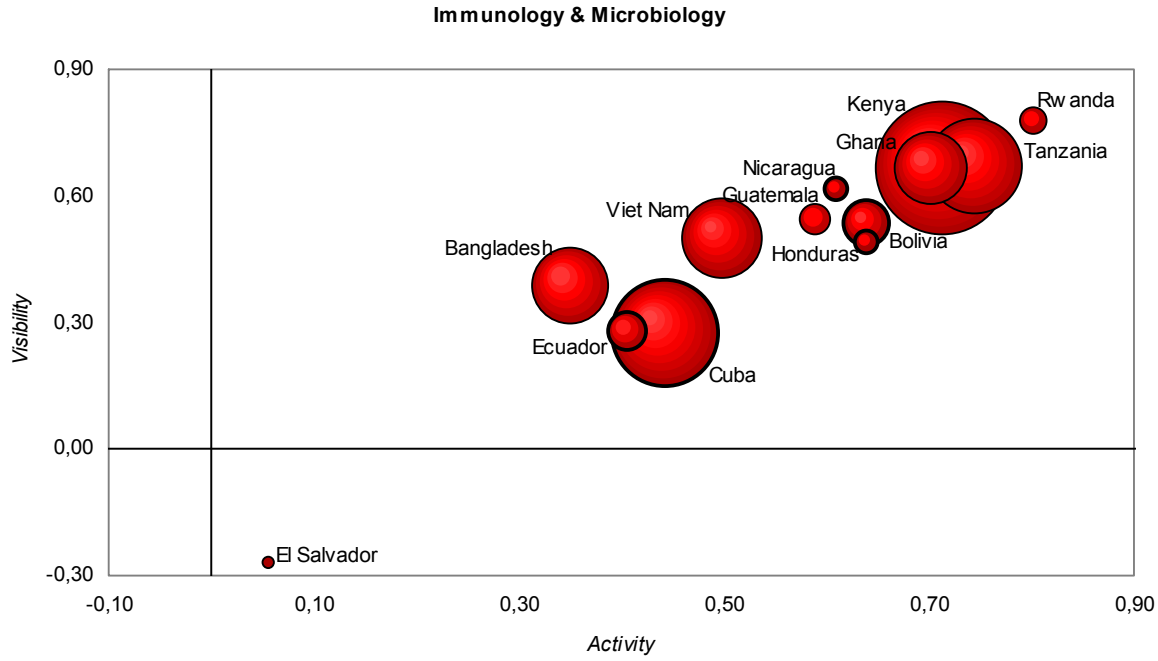
Figure 31. Activity and visibility in the context of *environmental sciences*.



	Doc	RAI	RVI	RI
Kenya	1 181	0.55	0.49	0.96
Bangladesh	734	0.38	0.44	0.66
Tanzania	479	0.51	0.36	0.69
Viet Nam	411	0.24	0.24	0.85
Ecuador	302	0.57	0.62	1.10
Cuba	289	-0.29	-0.14	0.64
Ghana	282	0.42	0.18	0.45
Bolivia	260	0.65	0.66	1.01
Nicaragua	86	0.65	0.60	0.77
El Salvador	42	0.41	0.36	0.68
Guatemala	38	0.12	0.05	0.88
Honduras	27	0.33	0.16	0.71
Rwanda	19	0.27	0.40	1.05

5.14. Immunology and microbiology

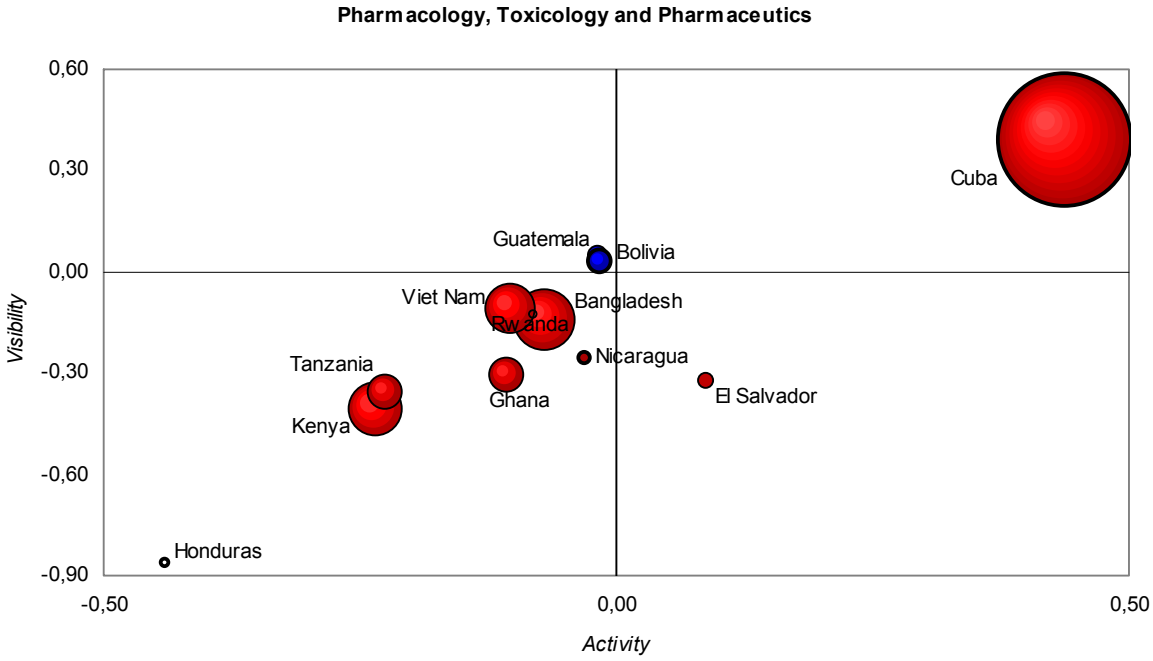
Figure 32. Activity and visibility in the context of *immunology and microbiology*.



	Doc	RAI	RVI	RI
Kenya	1 862	0.71	0.67	0.95
Cuba	1 227	0.44	0.27	0.32
Tanzania	967	0.74	0.67	0.74
Viet Nam	683	0.50	0.50	0.84
Bangladesh	618	0.35	0.39	0.63
Ghana	602	0.70	0.67	0.66
Bolivia	224	0.64	0.54	0.73
Ecuador	179	0.41	0.28	0.71
Guatemala	105	0.59	0.54	0.88
Rwanda	89	0.80	0.78	0.69
Nicaragua	68	0.61	0.62	0.94
Honduras	56	0.64	0.49	0.65
El Salvador	18	0.06	-0.27	0.39

5.15. Pharmacology, toxicology and pharmacy

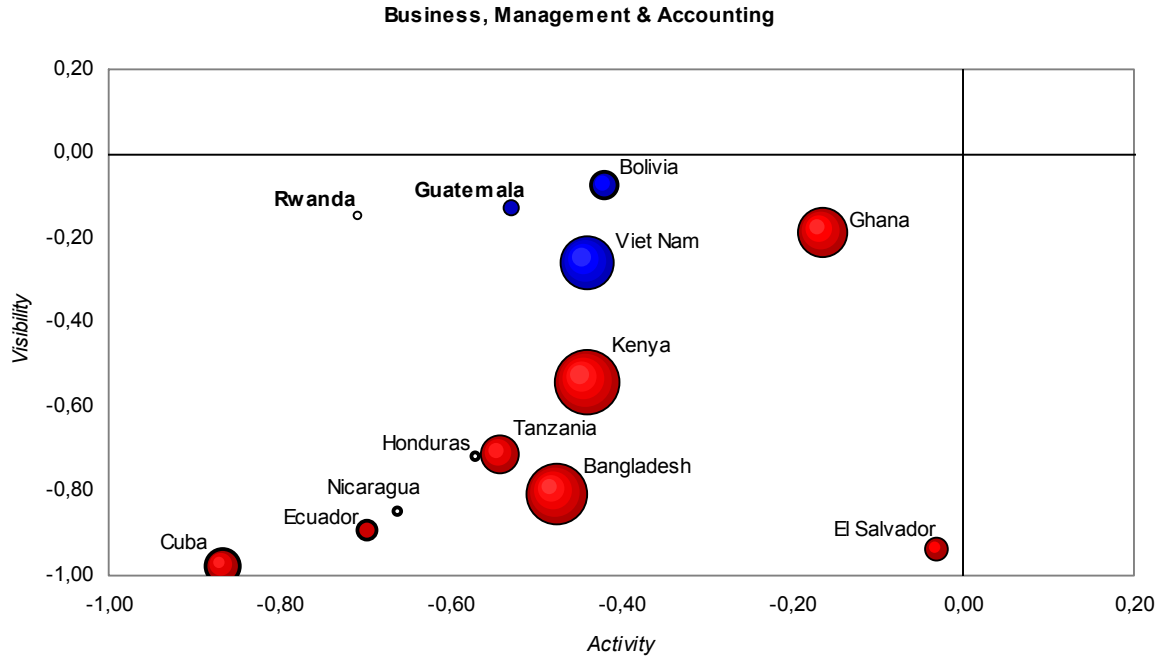
Figure 33. Activity and visibility in the context of *pharmacology, toxicology and pharmacy.*



	Doc	RAI	RVI	RI
Cuba	1 011	0.44	0.39	0.42
Bangladesh	217	-0.07	-0.14	0.49
Kenya	162	-0.23	-0.41	0.78
Viet Nam	156	-0.10	-0.11	0.83
Tanzania	75	-0.23	-0.35	0.76
Ghana	71	-0.11	-0.30	0.50
Bolivia	40	-0.02	0.03	1.10
Guatemala	22	-0.02	0.05	1.15
Ecuador	19	-0.54	-0.61	0.77
El Salvador	16	0.09	-0.32	0.33
Nicaragua	13	-0.03	-0.25	0.58
Rwanda	7	-0.08	-0.12	0.72
Honduras	4	-0.44	-0.86	0.19

5.16. Business management and accounting

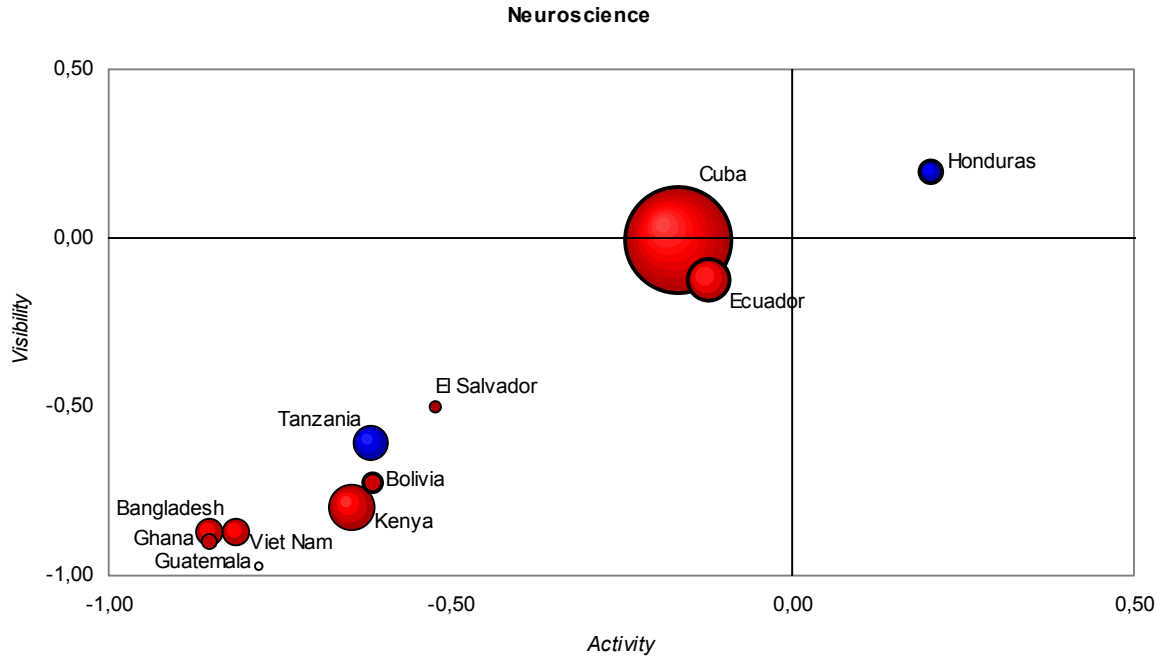
Figure 34. Activity and visibility in the context of *business management and accounting.*



	Doc	RAI	RVI	RI
Kenya	72	-0.44	-0.54	0.87
Bangladesh	63	-0.48	-0.81	0.17
Viet Nam	53	-0.44	-0.26	1.28
Ghana	45	-0.16	-0.19	0.72
Tanzania	25	-0.54	-0.71	0.57
Cuba	20	-0.87	-0.98	0.07
Bolivia	12	-0.42	-0.07	2.11
El Salvador	9	-0.03	-0.93	0.03
Ecuador	8	-0.70	-0.89	0.31
Guatemala	5	-0.53	-0.13	2.50
Nicaragua	2	-0.66	-0.85	0.37
Honduras	2	-0.57	-0.72	0.61
Rwanda	1	-0.71	-0.15	3.44

5.17. Neurosciences

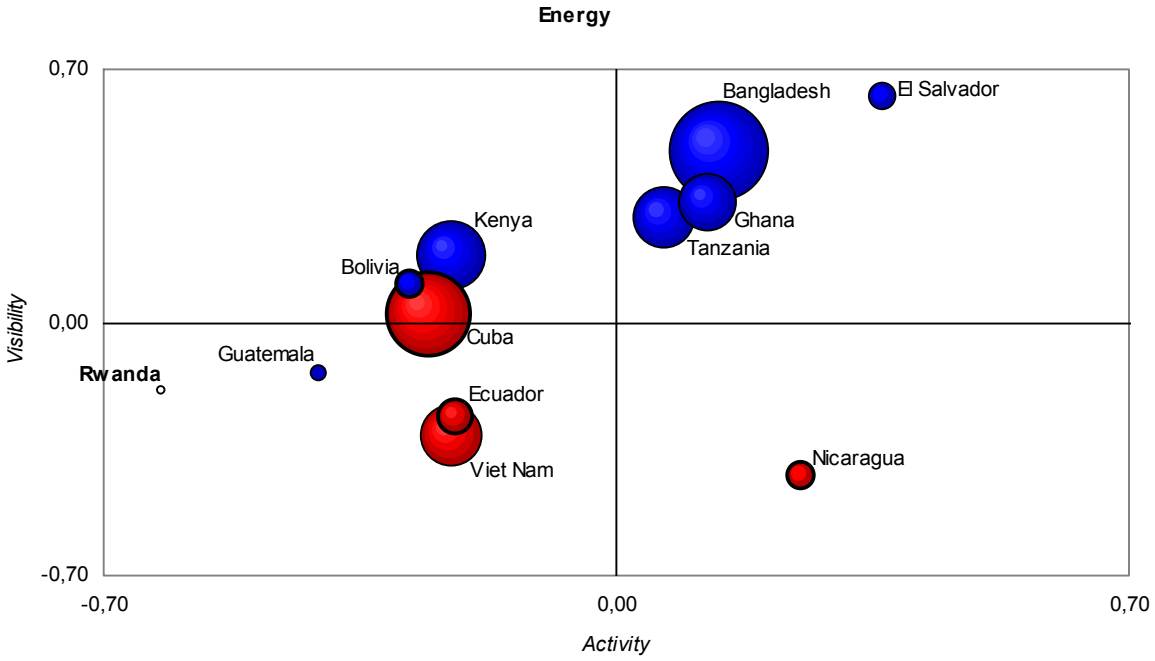
Figure 35. Activity and visibility in the context of *neurosciences.*



	Doc	RAI	RVI	RI
Cuba	200	-0.17	-0.01	0.65
Kenya	40	-0.64	-0.80	0.59
Ecuador	35	-0.12	-0.12	0.94
Tanzania	20	-0.62	-0.61	1.03
Bangladesh	14	-0.85	-0.87	0.50
Viet Nam	14	-0.81	-0.87	0.58
Honduras	11	0.20	0.20	1.01
Bolivia	7	-0.61	-0.73	0.66
Ghana	5	-0.85	-0.90	0.49
El Salvador	3	-0.52	-0.50	0.81
Guatemala	2	-0.78	-0.97	0.12
Nicaragua	0	-	-	-
Rwanda	0	-	-	-

5.18. Energy

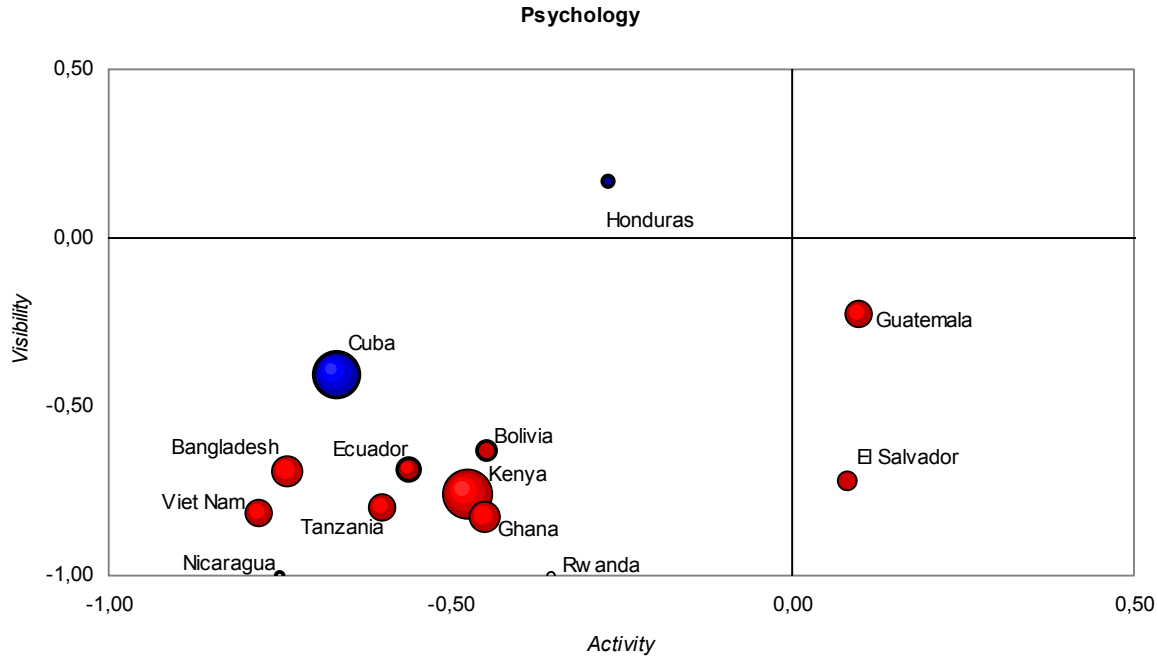
Figure 36. Activity and visibility in the context of *energy.*



	Doc	RAI	RVI	RI
Bangladesh	172	0.14	0.47	1.21
Cuba	122	-0.26	0.02	0.83
Kenya	86	-0.22	0.19	2.62
Tanzania	70	0.06	0.29	1.60
Viet Nam	63	-0.23	-0.31	0.70
Ghana	59	0.13	0.33	1.16
Ecuador	21	-0.22	-0.26	0.87
El Salvador	15	0.36	0.63	1.55
Bolivia	12	-0.28	0.11	2.21
Nicaragua	12	0.25	-0.42	0.22
Guatemala	5	-0.41	-0.14	1.79
Rwanda	1	-0.62	-0.18	2.32
Honduras	0	-	-	-

5.19. Pyschology

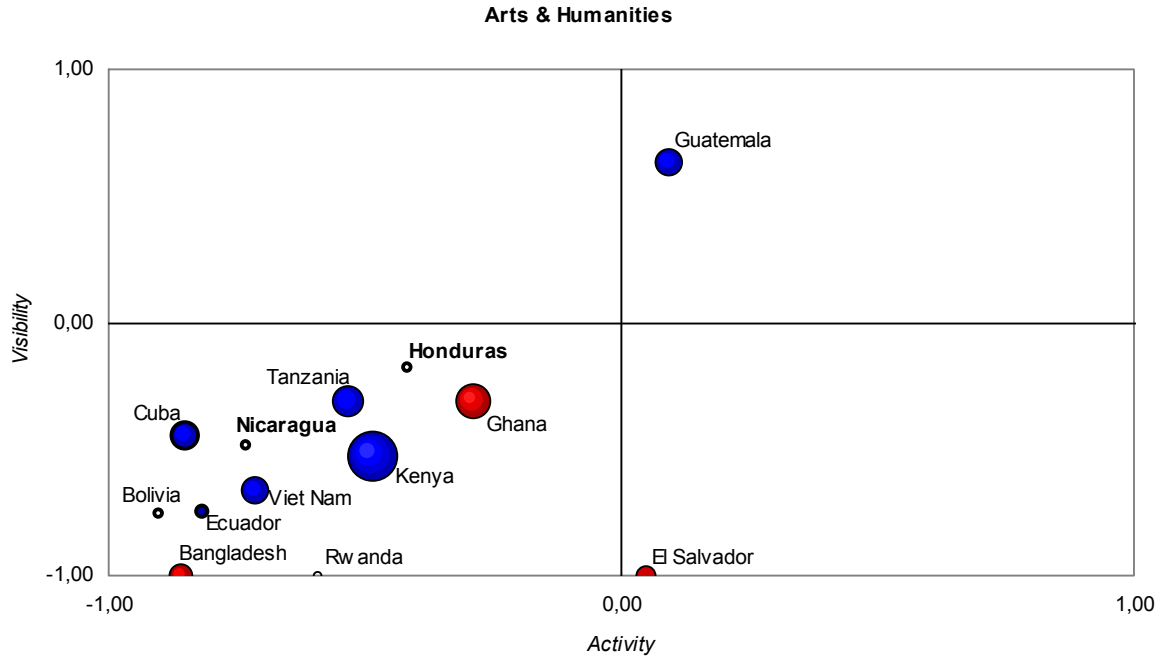
Figure 37. Activity and visibility in the context of *psychology*.



	Doc	RAI	RVI	RI
Kenya	47	-0.48	-0.76	0.44
Cuba	40	-0.67	-0.40	1.01
Bangladesh	19	-0.74	-0.69	0.70
Ghana	17	-0.45	-0.82	0.19
Tanzania	15	-0.60	-0.80	0.45
Guatemala	14	0.10	-0.22	0.52
Viet Nam	12	-0.78	-0.81	0.70
Ecuador	9	-0.56	-0.68	0.63
Bolivia	8	-0.45	-0.63	0.59
El Salvador	8	0.08	-0.72	0.10
Honduras	3	-0.27	0.17	2.48
Rwanda	2	-0.35	-1.00	0.00
Nicaragua	1	-0.75	-1.00	0.00

5.20. Arts and humanities

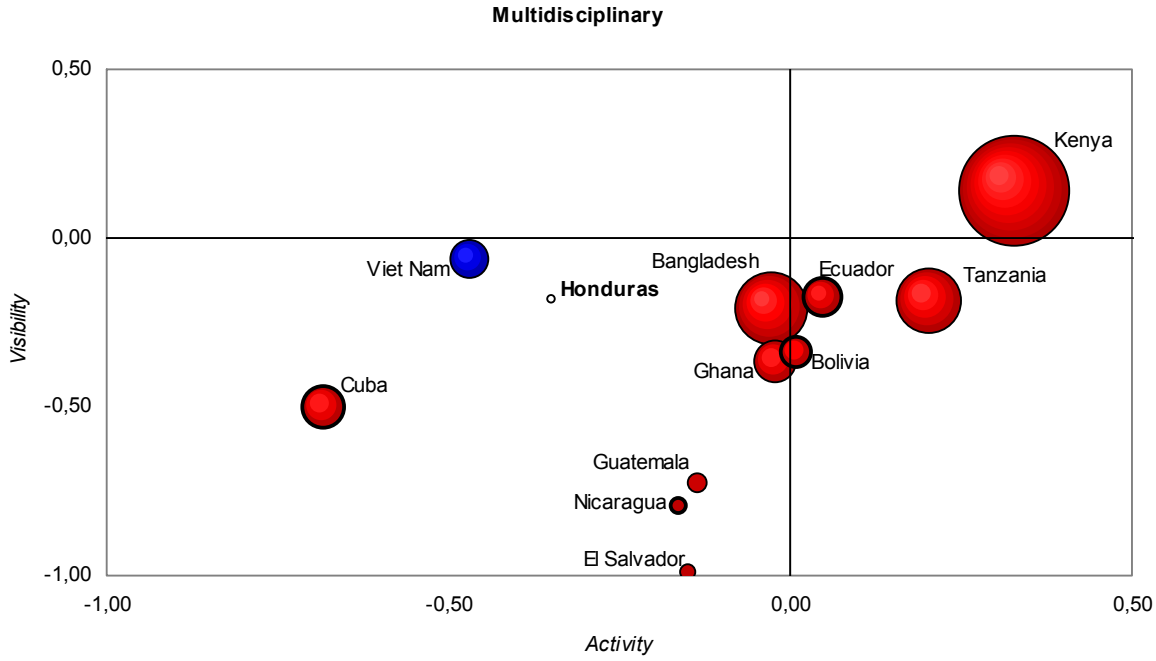
Figure 38. Activity and visibility in the context of *arts and humanities*.



	Doc	RAI	RVI	RI
Kenya	43	-0.48	-0.53	1.00
Ghana	23	-0.29	-0.31	0.72
Tanzania	17	-0.54	-0.31	1.75
Cuba	15	-0.85	-0.44	2.26
Viet Nam	15	-0.72	-0.67	1.02
Guatemala	13	0.09	0.64	3.73
Bangladesh	9	-0.86	-1.00	0.00
El Salvador	7	0.05	-1.00	0.00
Ecuador	3	-0.82	-0.74	1.39
Honduras	2	-0.42	-0.18	1.73
Bolivia	1	-0.90	-0.75	2.77
Nicaragua	1	-0.73	-0.48	2.08
Rwanda	1	-0.59	-1.00	0.00

5.21. Multidisciplinary

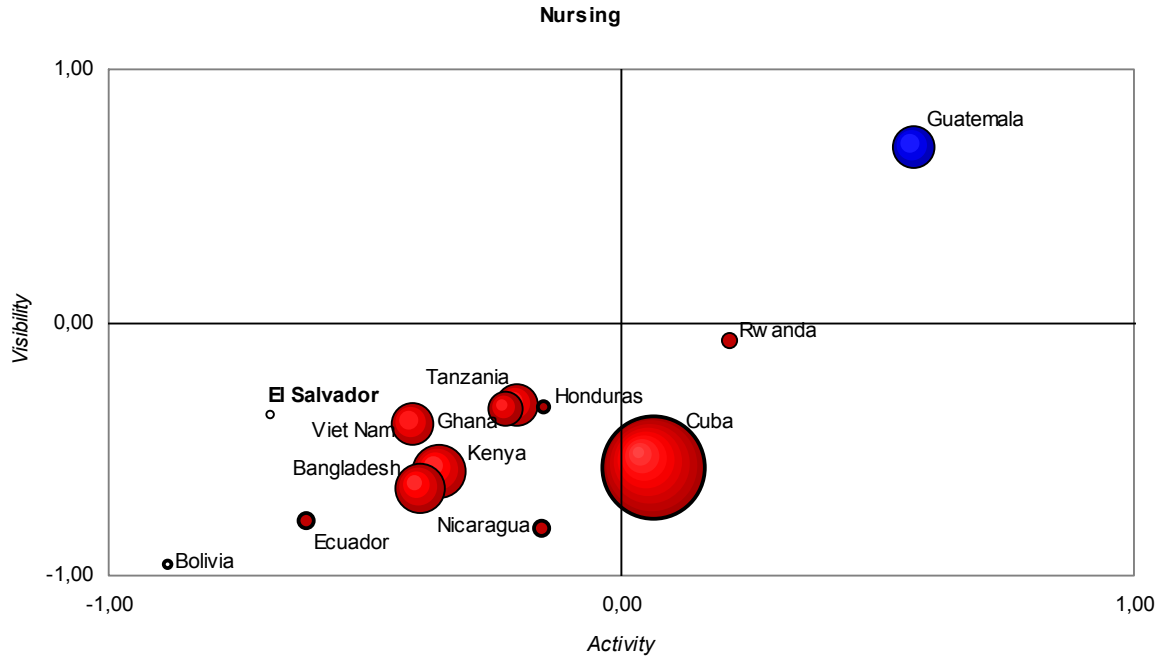
Figure 39. Activity and visibility in the context of *multidisciplinary research.*



	Doc	RAI	RVI	RI
Kenya	208	0.33	0.14	0.77
Bangladesh	95	-0.03	-0.21	0.40
Tanzania	72	0.20	-0.18	0.46
Ghana	34	-0.02	-0.37	0.36
Cuba	30	-0.68	-0.50	0.83
Ecuador	28	0.05	-0.17	0.61
Viet Nam	28	-0.47	-0.06	2.06
Bolivia	17	0.01	-0.34	0.49
Guatemala	7	-0.13	-0.73	0.21
Nicaragua	4	-0.16	-0.79	0.15
El Salvador	4	-0.15	-0.99	0.01
Honduras	2	-0.35	-0.18	1.46
Rwanda	0	-	-	-

5.22. Nursing

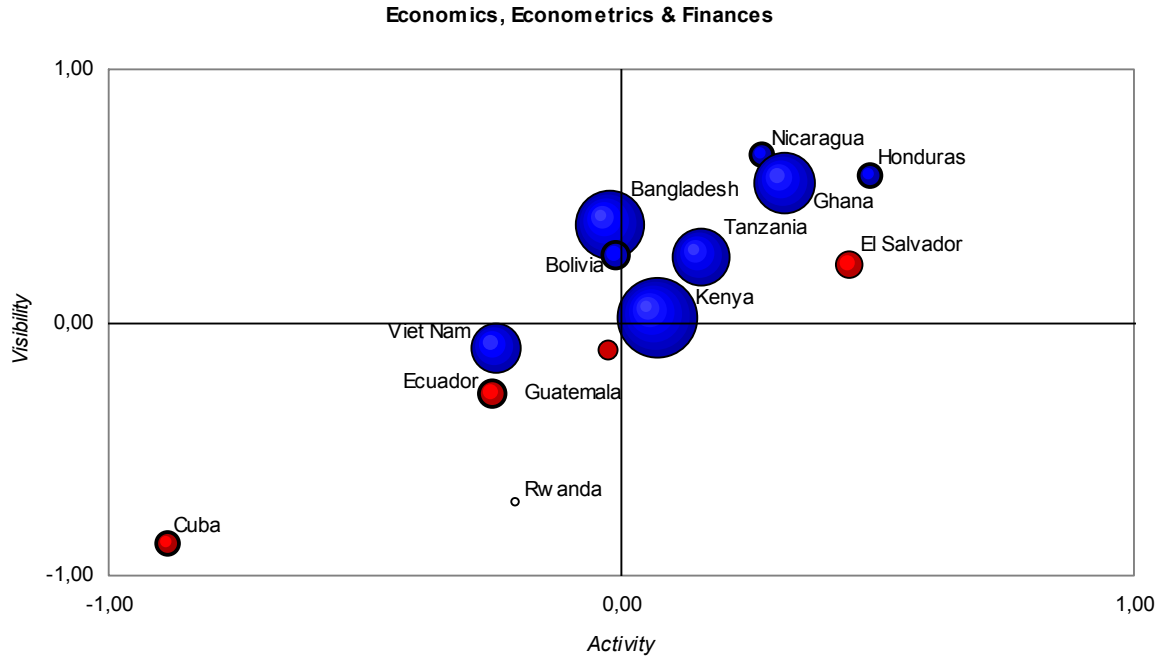
Figure 40. Activity and visibility in the context of *nursing*.



	Doc	RAI	RVI	RI
Cuba	178	0.06	-0.57	0.11
Kenya	49	-0.36	-0.59	0.62
Bangladesh	43	-0.39	-0.66	0.27
Guatemala	33	0.57	0.69	1.52
Viet Nam	32	-0.41	-0.40	0.85
Tanzania	31	-0.20	-0.32	0.78
Ghana	22	-0.23	-0.34	0.59
Ecuador	6	-0.61	-0.78	0.49
Rwanda	5	0.21	-0.07	0.45
Nicaragua	4	-0.15	-0.81	0.13
Honduras	3	-0.15	-0.34	0.69
Bolivia	1	-0.88	-0.96	0.34
El Salvador	1	-0.68	-0.36	1.89

5.23. Economy, econometrics and finance

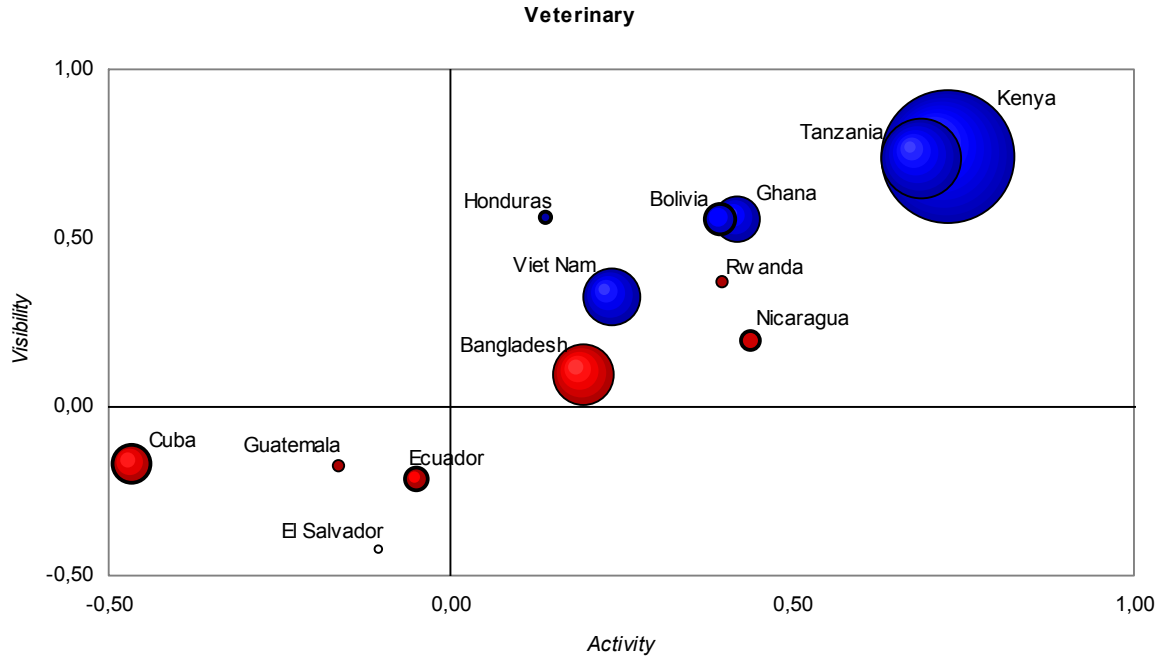
Figure 41. Activity and visibility in the context of *economy, econometrics and finance*.



	Doc	RAI	RVI	RI
Kenya	111	0.07	0.02	1.03
Bangladesh	88	-0.02	0.38	1.35
Ghana	63	0.32	0.55	1.36
Tanzania	60	0.16	0.26	1.25
Viet Nam	43	-0.25	-0.10	1.13
Bolivia	15	-0.01	0.27	1.75
Ecuador	14	-0.25	-0.28	0.89
El Salvador	13	0.45	0.23	0.47
Honduras	11	0.49	0.58	1.33
Cuba	9	-0.88	-0.87	0.51
Nicaragua	9	0.28	0.66	2.53
Guatemala	8	-0.03	-0.11	0.85
Rwanda	2	-0.21	-0.71	0.20

5.24. Veterinary

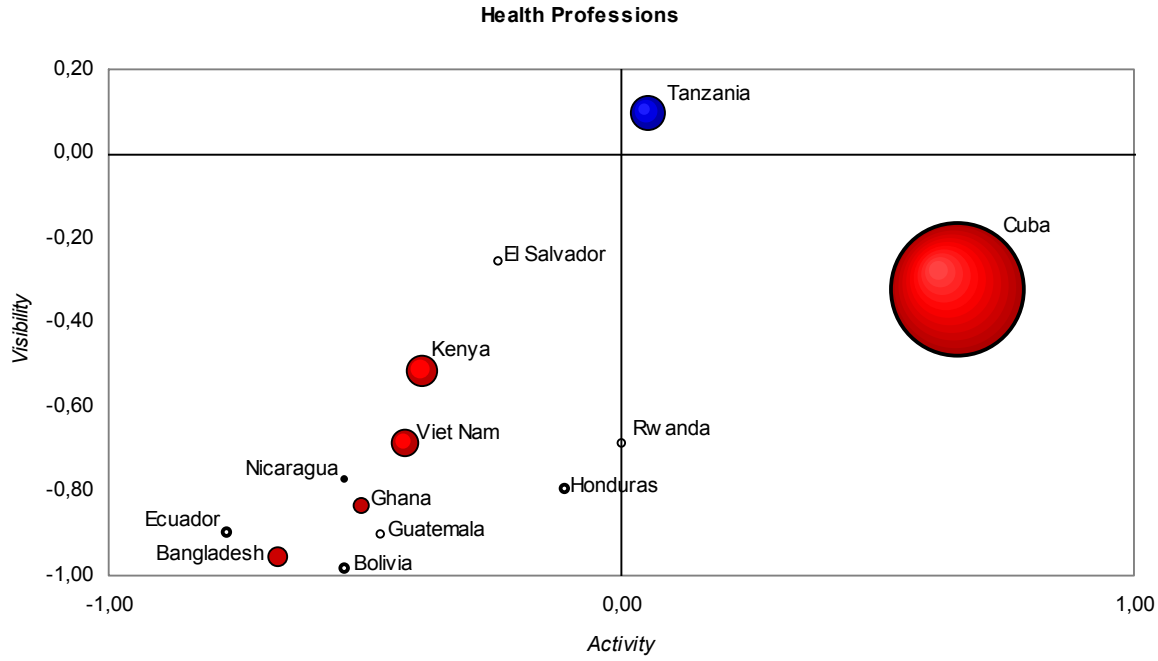
Figure 42. Activity and visibility in the context of *veterinary.*



	Doc	RAI	RVI	RI
Kenya	610	0.73	0.74	1.20
Tanzania	236	0.69	0.73	1.21
Bangladesh	136	0.20	0.10	0.47
Viet Nam	114	0.24	0.33	1.03
Ghana	79	0.42	0.56	1.09
Cuba	53	-0.47	-0.17	0.91
Bolivia	35	0.39	0.56	1.52
Ecuador	21	-0.05	-0.22	0.67
Nicaragua	13	0.44	0.20	0.53
Rwanda	7	0.40	0.37	0.74
Guatemala	6	-0.16	-0.17	0.99
Honduras	5	0.14	0.56	2.76
El Salvador	4	-0.11	-0.42	0.38

5.25. Health professions

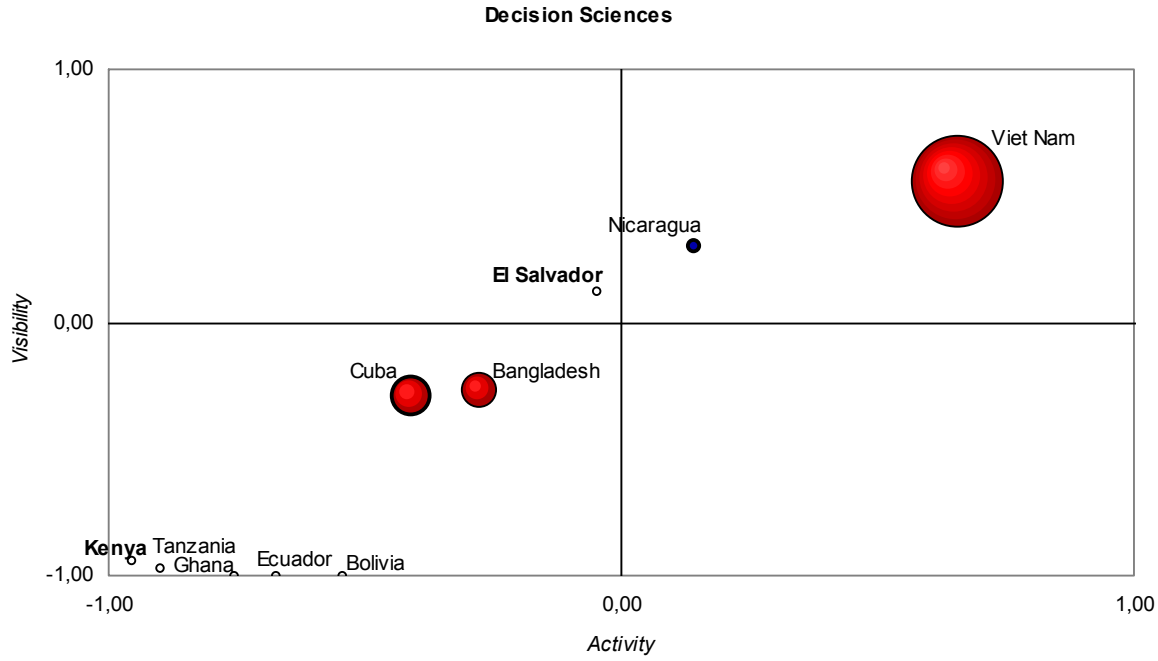
Figure 43. Activity and visibility in the context of *health professions.*



	Doc	RAI	RVI	RI
Cuba	460	0.65	-0.32	0.05
Tanzania	32	0.05	0.10	1.10
Kenya	28	-0.39	-0.51	0.83
Viet Nam	19	-0.42	-0.69	0.38
Bangladesh	12	-0.67	-0.96	0.07
Ghana	7	-0.51	-0.83	0.21
Bolivia	3	-0.54	-0.98	0.03
Ecuador	2	-0.77	-0.90	0.39
Honduras	2	-0.11	-0.79	0.15
Guatemala	2	-0.47	-0.90	0.15
El Salvador	2	-0.24	-0.26	0.74
Rwanda	2	0.00	-0.68	0.15
Nicaragua	1	-0.54	-0.77	0.39

5.26. Decision sciences

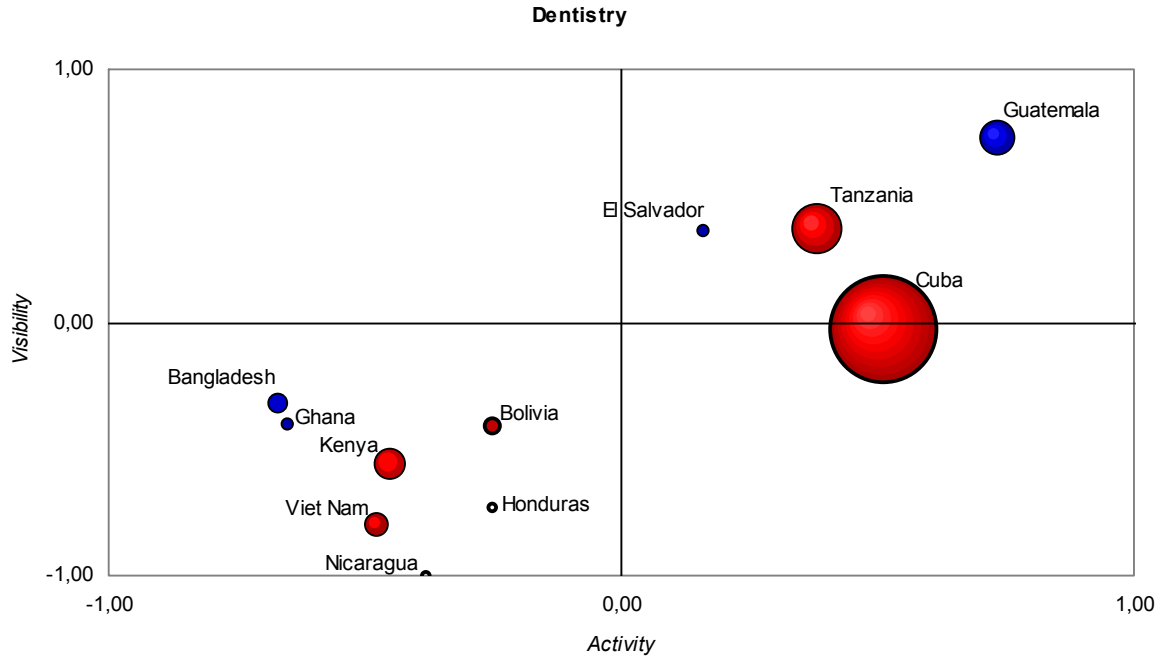
Figure 44. Activity and visibility in the context of *decision sciences.*



	Doc	RAI	RVI	RI
Viet Nam	150	0.65	0.56	0.62
Cuba	27	-0.41	-0.29	0.62
Bangladesh	23	-0.28	-0.26	0.59
Nicaragua	3	0.14	0.31	1.29
Ecuador	2	-0.68	-1.00	0.00
Bolivia	2	-0.54	-1.00	0.00
El Salvador	2	-0.05	0.13	1.08
Ghana	2	-0.76	-1.00	0.00
Kenya	1	-0.95	-0.94	1.54
Tanzania	1	-0.90	-0.97	0.31
Honduras	0	-	-	-
Guatemala	0	-	-	-
Rwanda	0	-	-	-

5.27. Dentistry

Figure 45. Activity and visibility in the context of *dentistry.*



	Doc	RAI	RVI	RI
Cuba	199	0.51	-0.03	0.14
Tanzania	43	0.38	0.37	0.97
Guatemala	24	0.73	0.73	1.00
Kenya	16	-0.45	-0.56	0.84
Viet Nam	11	-0.48	-0.80	0.27
Bangladesh	8	-0.67	-0.32	1.49
Bolivia	4	-0.25	-0.41	0.70
El Salvador	3	0.16	0.37	1.19
Ghana	3	-0.65	-0.40	1.55
Nicaragua	1	-0.38	-1.00	0.00
Honduras	1	-0.25	-0.73	0.27
Ecuador	0	-	-	-
Rwanda	0	-	-	-

5. Final considerations

This study has investigated recent changes in the scientific output of Cuba, Ecuador, Bolivia, Nicaragua and Honduras, countries that access initiatives, such as those involving INASP, working to improve knowledge dissemination in developing countries in these partner countries and others across Asia and Africa. The comparative nature of the study has enabled developments in these five Latin America to be viewed in the context not only of regional but also international trends, particularly, so that strengths and weakness can be identified to support decision-making processes.

Key findings are summarised below.

Cuba

Cuban scientific production has a clear biomedical orientation. However, the best performances according to the activity and visibility indicators are achieved in *pharmacology, toxicology and pharmacy*, *immunology and microbiology*, *agriculture and biological sciences*, *chemistry* and *biochemistry, genetics and molecular biology.* The University of Havana is the most productive institution of the country, and the core of most productive authors shows high levels of visibility. A high proportion of the scientific production is published in Cuban less-cited journals, which is probably the cause of the low impact of the country in a high number of subject areas. Spain, Mexico and Brazil, are Cuba's main scientific partners.

Ecuador

Medicine and *agriculture and biological sciences* are the two main subject areas in the Ecuadorian scientific production. The best performances are achieved in *agriculture and biological sciences*, *environmental sciences*, *earth and planetary science*, *immunology and microbiology*, and *physics and astronomy.* The University of San Francisco de Quito, and the Catholic University of Ecuador are the most productive institutions of the country. There is not a high core of Ecuadorian productive authors, which is the result of a high level of international collaboration where the leader authors are from international institutions. Although the *Revista Ecuatoriana de Neurologia* is the journal leader in the scientific production of Ecuador, a big proportion of papers is published in high visibility

journals. The United States of America, the United Kingdom and France are the Ecuador's main scientific partners.

Bolivia

Bolivian scientific production is mainly concentrated on *agriculture and biological sciences*, which shows the best bibliometric performances, too. *Environmental sciences*, *immunology and microbiology*, *earth and planetary science*, *veterinary* and *social sciences* are also located in the most active and visible position. The Major University of San Andres and the Major University of San Simon are the two most productive Bolivian institutions. The most productive authors mainly belong to these two institutions. Well known American and British journals publish a large number of Bolivian papers. The United States of America, France, Belgium and the United Kingdom are Bolivia's main scientific partners.

Nicaragua

Medicine is the most productive subject area for Nicaragua. The best performances are mainly achieved in *environmental sciences*, *immunology and microbiology*, *agriculture and biological sciences*, *earth and planetary science*, *social science* and *medicine*. *Veterinary*, *economy, econometrics and finance*, and *decision science* are also included in the positive quadrant, despite low productivity. The National Autonomous University of Nicaragua (León) is the most prolific institution. The core of the most prolific authors is specialized in medical sciences, with a high visibility. The Nicaraguan papers are essentially published in journals edited by the United States of America and the United Kingdom. The United States of America, Sweden and Costa Rica are the most important scientific partners for Nicaragua.

Honduras

In Honduras, *agriculture and biological sciences* is the most productive, active and visible research area. The quadrant of the best performers also includes the *immunology and microbiology*, *economy, econometrics and finance*, *environmental sciences*, *neuroscience*, *medicine* and *veterinary* subject areas. The National Autonomous University of Honduras is the leader institution. The core of the most prolific authors is headed by the Honduran neuroscientist Marco T. Medina, with an important research on epilepsy. Honduran papers are basically published in journals edited by the United States

of America. However, the Spanish journal *Revista de Neurología* is at the top of this ranking. The United States of America is clearly the main scientific partner for Honduras, followed by Mexico and Costa Rica.

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Impact and next steps

It is hoped that these findings will contribute to broader research into the changes in scientific output in developing countries to:

- provide data to inform future policy-making;
- create firmer links between trends in scientific output and policy decisions; and
- gauge the impact of specific policy decisions on scientific output.

Possible next steps include widening this research to incorporate all African partner countries or working with the Latin American countries featured here to extend the analysis conducted so far.

6. A brief bibliography

ARUNACHALAM, S. (2008). The science race continues in Asia. *Current Science, 94*, 848–849.

BRAUN, T., SCHUBERT, A. (1997). Dimensions of scientometric indicator datafile: world science in 1990-1994. *Scientometrics*, *38*, 175–204 .

JACSÓ, P. (2009). Errors of omission and their implications for computing scientometric measures in evaluating the publishing productivity and impact of countries. *Online Information Review, 33*, 376–385.

LEYDESDORFF, L., & WAGNER, C. (2009). Is the United States losing ground in science? A global perspective on the world science system. *Scientometrics, 78*, 23–36.

MOYA ANEGÓN, F. (2008). *Indicadores bibliométricos de la actividad científica española 2007*. Madrid: Fundación Española para la Ciencia y la Tecnología.

SCIMAGO RESEARCH GROUP. (2007). Análisis de la producción científica mundial por regiones. *El Profesional de la Información, 16*, 158–159.

SCIMAGO RESEARCH GROUP. (2008). Asia vista con el SCImago Journal &Country Rank. *El profesional de la Información, 17*, 677–678.

ZHOU, P., & LEYDESDORFF, L. (2008). China ranks second in scientific publications since 2006. *ISSI Newsletter, 13*, 7–9.