

Leading universities in environmental sciences in Latin America

Abstract

Latin America is a region that is developing a lot and currently is improving his research standards significantly. The aim of this paper is to analyze the leading universities in Latin America in environmental sciences over the last decade (2004–2013). For doing so, we use the Web of Science database and some bibliometric indicators such as the total number of papers and citations, the *h*-index and the citations per paper. The study also shows a new indicator that normalizes the indicators in $[0, 1]$ and with these results develops a weighted average. This approach is very useful to combine the data of different indicators that cannot be directly measured together. The results indicate that Brazil and Mexico are the leading countries in the region basically because they are very big countries compared to the rest. However, Chile obtains very good results per person because it is a very productive country in the region although much smaller. Some less developed countries currently publish a very low number of papers in this field and clearly needs to improve a lot in the future.

Keywords: Environmental sciences; Latin America; university analysis; bibliometrics; Web of Science.

Introduction

Latin America is a region that encompasses about twenty million squared kilometers and six hundred million people. Over the last decades, Latin America has been developing a lot under a wide range of perspectives. However, it is still below the standards of the developed nations. An important issue has been the development of the universities and the research infrastructures. In order to evaluate the development of these infrastructures one key indicator is the research production that is being developed in these institutions. In the literature there are many methodologies for carrying out this evaluation. An important one is bibliometrics which is defined as the quantitative study of the bibliographic material (Broadus, 1987). Bibliometrics has been implemented in a wide range of areas including management (Podsakoff et al. 2008) and fuzzy research (Merigó et al. 2015a).

In environmental sciences, there are also several bibliometric studies. For example, Khan and Ho (2012) studied the most cited articles in the field. Dragos and Dragos (2013) studied the factors that affected the scientific productivity in this area. Li and Zhao (2015) developed a bibliometric analysis of global environmental assessment research in a 20-year period. Ma and Stern (2006) developed a citation analysis of environmental and ecological economics. This analysis was extended by Hoepner et al. (2012). However, there is no study that has strictly focused on the Latin American region.

Therefore, the aim of this article is to analyze the research production in Latin America in environmental sciences. The main focus is at the university level in order to identify the leading institutions in the region. In order to do so, the study first considers the productivity of the Latin American countries in this area. Next, the analysis studies the leading universities in each of the countries considering a wide range of bibliometric indicators. The paper ends summarizing the main conclusions and results of the article.

Methods

The study uses the Web of Science (WoS) database in order to collect the bibliographic information. Particularly, it focuses on the results of six WoS categories that are usually considered to form the Environmental Sciences discipline (see Table 1). The analysis considers the results between 2004 and 2013 because a decade is a reasonably good period in order to obtain an updated picture of the current state of the art in the field. The search process was developed between September 2014 and March 2015. With the results obtained, this study focuses on the papers by Latin American countries.

In order to evaluate the information, this study uses a wide range of bibliometric indicators (Merigó et al. 2015b) including the number of papers (TP) and citations (TC), the citations per paper (C/P) and the *h*-index (Hirsch, 2005). Moreover, it also presents the Z-index which uses normalized results in [0, 1] in order to combine the results in the same scale and a weighted average that produces a single result for each university as follows: $Z = 0.4 \times \text{papers} [0, 1] + 0.5 \times \text{cites} [0, 1] + 0.1 \times h\text{-index} [0, 1]$.

Results

This section presents the results of the paper. The results are divided by country so we can see the leading universities in each Latin American country.

Publication structure of Latin American countries classified by categories

Before analysing the universities of each country, let us look into the total production of each country. Table 1 presents the number of papers that each country has published in environmental sciences between 2004 and 2013. The articles are divided by the six Web of Science categories that are usually referred to environmental sciences. Note that the USA is also included in order to get a general perspective of the productivity of each country.

Table 1: Publication structure of Latin American countries in Environmental Sciences

R	Country	EE	ES _t	ES	LI	BC	EC	Total
1	USA	21209	16715	82567	7425	14193	59068	150520
2	Brazil	1575	540	6732	257	2033	4055	11799
3	Mexico	835	282	3323	157	1402	2865	6767
4	Argentina	413	98	2224	208	633	2319	4520
5	Chile	301	203	1212	82	597	1697	3020
6	Colombia	202	100	616	25	162	466	1156
7	Venezuela	38	17	244	9	108	714	978
8	Panamá	11	15	128	8	136	767	874
9	Costa Rica	26	35	200	4	100	305	468
10	Ecuador	21	23	150	4	100	297	429
11	Peru	20	35	185	5	83	248	421
12	Uruguay	28	12	144	19	53	179	333
13	Bolivia	20	26	132	9	65	193	310
14	Cuba	73	13	188	8	41	74	308
15	Nicaragua	4	10	45	0	20	33	76
16	Guatemala	2	12	33	1	16	24	57
17	Honduras	5	6	20	1	10	9	34
18	El Salvador	1	2	14	0	14	14	29
19	Paraguay	0	1	5	0	7	15	19
20	Dominican Rep.	1	1	5	0	7	6	16
21	Guyana	1	2	6	0	5	8	14
22	Haiti	4	1	11	0	0	0	13

Abbreviations: R = Rank; EE = Engineering Environmental; ES_t = Environmental Studies;

ES = Environmental Sciences; LI = Limnology; BC = Biodiversity Conservation; EC =

Ecology.

Brazil is the most productive country in Latin America in environmental sciences. This is quite logical because it is by far the biggest country in the region. Mexico and Argentina obtain the second and third place, respectively. Chile appears in the fourth position and shows a higher productivity rate because it is a much smaller country than the previous one. However, if we compare it with the USA, Chile still needs to improve a lot in order to become a leading country worldwide. The rest of the countries are less productive and needs to improve a lot.

Leading universities in Latin America in environmental sciences

Next, let us look into the leading universities in each country. First, let us focus on Brazil, the most productive country in the region. Table 2 presents the Top 30 universities in Brazil in environmental sciences. Note that the universities are ranked according to the *Z*-index which makes a weighted average between papers, citations and *h*-index as explained in the methodology section.

The University of Sao Paulo is the leading university in Brazil and in Latin American in environmental sciences. It is the university with the highest number of articles and citations. The Federal University of Rio de Janeiro obtains the second position although very close to the State University of Campinas and the State University of Sao Paulo. In general, Brazil has many universities with a significant research level as it is seen in Table 2.

Mexico is the second most significant country in this research area. Table 3 shows the leading universities in this region.

The National Autonomous University of Mexico (UNAM) is the leading university in the country and far away from the rest of the universities. By looking to the number of papers, the UNAM would obtain the first position in Latin America. However, it has a lower number of citations and *h*-index than the University of Sao Paulo.

Table 2: Leading universities in Brazil

R	University	TP	TC	C/P	H	Z
1	Universidade de Sao Paulo	2219	29378	13,24	63	1
2	Universidade Federal do Rio de Janeiro	985	9990	10,14	40	0,4111
3	Universidade Estadual de Campinas	848	10301	12,15	43	0,3964
4	Universidade Estadual Paulista	851	8463	9,94	35	0,3530
5	Universidade Federal do Rio Grande do Sul	634	7459	11,76	38	0,3016
6	Instituto Nacional de Pesquisas da Amazonia	396	6825	17,23	46	0,2606
7	Universidade de Brasilia	434	6949	16,01	40	0,2600
8	Universidade Federal de Minas Gerais	548	6045	11,03	36	0,2588
9	Universidade Federal de Santa Catarina	397	3959	9,97	31	0,1882
10	Universidade Federal de Sao Carlos	398	3934	9,88	28	0,1831
11	Universidade Federal de Goias	277	4818	17,39	32	0,1827
12	Universidade Federal do Parana	430	3505	8,15	25	0,1768
13	Universidade Federal de Pernambuco	356	3061	8,6	27	0,1591
14	Instituto Nacional de Pesquisas Espaciais	230	4037	17,55	30	0,1578
15	Fundacao Universidade Federal do Rio Grande	282	3238	11,48	26	0,1472
16	Universidade Federal da Bahia	230	2862	12,44	29	0,1362
17	Universidade Federal de Vicosa	266	2530	9,51	23	0,1275
18	Universidade Federal de Santa Maria	236	2555	10,83	25	0,1257
19	Universidade Federal Fluminense	247	2408	9,75	25	0,1252
20	Universidade Federal do Para	245	2370	9,67	25	0,1242
21	Universidade Estadual de Maringa	218	2370	10,87	26	0,1209
22	Universidade do Estado do Rio de Janeiro	231	2309	10	25	0,1206
23	Fundacao Oswaldo Cruz	219	2398	10,95	24	0,1184
24	Universidade Federal de Uberlandia	174	2221	12,76	27	0,1120
25	Universidade Federal de Lavras	172	2326	13,52	26	0,1119
26	Universidade Federal do Ceara	216	2070	9,58	23	0,1107
27	Universidade Federal do Rio Grande do Norte	184	1399	7,6	20	0,0887
28	Instituto de Pesquisa Ambiental da Amazônia	48	2163	45,06	24	0,0836
29	Inst. Botânica Sao Paulo	152	1156	7,61	18	0,0756
30	Universidade Federal da Paraiba	112	1265	11,29	18	0,0703

Table 3: Leading universities in Mexico

R	University	TP	TC	C/P	H	Z
1	Universidad Nacional Autonoma de Mexico	2746	28206	10,27	59	1
2	Instituto Politecnico Nacional	599	4919	8,21	31	0,2270
3	Instituto de Ecología	388	4314	11,12	31	0,1855
4	Universidad Autonoma Metropolitana	428	3409	7,96	26	0,1668
5	Centro de Inv. De Estudios Avanzados del IPN	316	3309	10,47	29	0,1538
6	El Colegio de la Frontera Sur	258	2843	11,02	27	0,1337
7	Centro de Inv. Biológicas del Noroeste S.C	213	1902	8,93	23	0,1037
8	Universidad Autonoma de Baja California	259	1669	6,44	18	0,0978
9	Instituto Nacional de Salud Pública	78	2468	31,64	25	0,0975
10	Instituto Mexicano del Petroleo	142	1555	10,95	22	0,0855
11	Universidad Autonoma del Estado de Morelos	133	1523	11,45	21	0,0820
12	Univ. Michoacana de San Nicolas de Hidalgo	148	1401	9,47	18	0,0769
13	Centro Inv. Científ. Educ. Superior Ensenada	141	1347	9,55	18	0,0749
14	Universidad Autonoma de San Luis Potosi	132	1307	9,9	19	0,0746
15	Colegio de Postgraduados	213	889	4,17	14	0,0705
16	Universidad Autonoma del Estado de Mexico	155	985	6,35	17	0,0689
17	Universidad Veracruzana	157	903	5,75	17	0,0677
18	Universidad Autonoma del Estado de Hidalgo	150	929	6,19	16	0,0654
19	Universidad Autonoma de Nuevo Leon	157	862	5,49	16	0,0653
20	Universidad de Guadalajara	152	764	5,03	12	0,0560
21	Universidad de Sonora	100	736	7,36	14	0,0513
22	Inst. Potosino de Inv. Científica y Tecnológica	80	615	7,69	14	0,0463
23	Universidad Autonoma de Yucatan	93	598	6,43	13	0,0462
24	Universidad de Guanajuato	60	769	12,82	14	0,0461
25	Centro Inv. Alimentos y Desarrollo	102	452	4,43	11	0,0415
26	Universidad Autonoma de Queretaro	68	555	8,16	12	0,0401
27	Centro de Inv. Mejoramiento de Maiz y Trigo	28	695	24,82	13	0,0384
28	Inst. Tecnol. Estudios Superiores Monterrey	88	393	4,47	10	0,0367
29	Inst. Nacional de Ecología y Cambio Climático	39	498	12,77	13	0,0365
30	Benemerita Universidad Autonoma de Puebla	61	395	6,48	11	0,0345

Next, let us look into the leading universities in Argentina, the third most productive country in the region. Table 4 presents the results.

The University of Buenos Aires is the leading university in the country. From a general perspective, it would obtain the third position in Latin America after the University of Sao Paulo and the UNAM. Some other important universities in Argentina in this field are the National University of Cordoba, the National University of Comahue, the National University of La Plata and the National University of the Litoral.

Next, let us analyse Chile, the fourth most productive country and the most productive country per person. Table 5 shows the leading universities in the country.

Surprisingly, the University of Concepcion obtains the first position followed by the Catholic University of Chile and the University of Chile. Note that usually, the University of Chile and the Catholic University of Chile obtain the first two positions in the university rankings when considering all the research disciplines. The Austral University of Chile appears in the fourth position obtaining also remarkable results.

These four countries are the most productive ones. As it is seen in Table 1, the rest of the countries are significantly less productive so they rarely have some university in the Top 10. In this particularly study, we will see that only the University of Puerto Rico would be able to reach a remarkable position in the Latin American region. Note that currently Puerto Rico is part of the USA. However, since their population speaks Spanish, it has been included in the analysis. The fifth country in the ranking is Colombia, although far away from the previous four. Table 6 presents the ten most relevant universities in Colombia in environmental sciences between 2004 and 2013.

The National University of Colombia is the most productive and influential university. The University of the Andes and the University of Antioquia also obtain significant results for the country. However, none of them reach the Top 20 in Latin America.

Table 4: Leading universities in Argentina

R	University	TP	TC	C/P	H	Z
1	Universidad de Buenos Aires	951	12275	12,91	46	1
2	Universidad Nacional de Cordoba	449	6910	15,39	35	0,5464
3	Universidad Nacional del Comahue	276	4693	17	32	0,3768
4	Universidad Nacional de La Plata	407	3482	8,56	25	0,3674
5	Universidad Nacional del Litoral	323	3758	11,63	27	0,3476
6	Universidad Nacional de Mar del Plata	250	2403	9,61	24	0,2552
7	Universidad Nacional de San Luis	123	2300	18,7	26	0,2019
8	Universidad Nacional del Sur	203	1507	7,42	18	0,1859
9	Universidad Nacional de Tucuman	145	1827	12,6	22	0,1832
10	Instituto Nacional de Tecnologia Agropecuaria	143	1136	7,94	17	0,1434
11	Univ. Nacional de la Patagonia San Juan Bosco	100	879	8,79	19	0,1192
12	Universidad Nacional de Rio Cuarto	83	738	8,89	17	0,1019
13	Universidad Tecnologica Nacional	70	567	8,1	14	0,0830
14	Universidad Nacional de Lujan	71	617	8,69	12	0,0811
15	Univ. Nacional de San Martin, Argentina	58	632	10,9	14	0,0806
16	Universidad Nacional de Cuyo	60	583	9,72	13	0,0772
17	Universidad Nacional de La Pampa	49	400	8,16	11	0,0608
18	Universidad Nacional de Salta	41	383	9,34	12	0,0589
19	Universidad Nacional de Rosario	43	345	8,02	12	0,0582
20	Universidad Nacional de San Juan	40	319	7,97	10	0,0516

Table 5: Leading universities in Chile

R	University	TP	TC	C/P	H	Z
1	Universidad de Concepcion	785	9658	12,3	43	1
2	Pontificia Universidad Catolica de Chile	682	8692	12,74	39	0,8882
3	Universidad de Chile	603	5788	9,6	31	0,6790
4	Universidad Austral de Chile	427	4077	9,55	31	0,5007
5	Universidad Catolica del Norte	175	1529	8,74	20	0,2148
6	Universidad de Santiago de Chile	138	926	6,71	15	0,1531
7	Universidad de la Frontera	120	934	7,78	18	0,1514
8	Universidad de La Serena	109	930	8,53	18	0,1455
9	Pontificia Universidad Catolica de Valparaiso	106	721	6,8	14	0,1239
10	Univ. Catolica de la Santisima Concepcion	77	645	8,38	15	0,1075
11	Universidad de Magallanes	68	587	8,63	15	0,0999
12	Universidad de Antofagasta	60	665	11,08	12	0,0929
13	Universidad de Los Lagos	67	596	8,9	11	0,0906
14	Universidad Catolica de Temuco	48	518	10,79	11	0,0769
15	Universidad de Talca	44	409	9,3	11	0,0692
16	Universidad de Tarapaca	57	352	6,18	9	0,0682
17	Universidad de Valparaiso	44	359	8,16	10	0,0643
18	Universidad Tecnica Federico Santa Maria	42	298	7,1	10	0,0601
19	Universidad Andres Bello	35	228	6,51	9	0,0506
20	Universidad Santo Tomas	24	289	12,04	10	0,0504

Table 6: Leading universities in Colombia

R	University	TP	TC	C/P	H	Z
1	Universidad Nacional de Colombia	266	3429	12,89	29	1
2	Universidad de los Andes, Colombia	180	1671	9,28	22	0,5902
3	Universidad de Antioquia	156	1532	9,82	22	0,5338
4	Universidad del Valle	94	1110	11,81	19	0,3687
5	Pontificia Universidad Javeriana	78	748	9,59	15	0,2781
6	Universidad de Cartagena	29	908	31,31	10	0,2105
7	Universidad Industrial de Santander	35	531	15,17	13	0,1749
8	Universidad del Tolima	10	312	31,2	7	0,0847
9	Universidad de Bogota Jorge Tadeo Lozano	21	117	5,57	8	0,0762
10	Universidad del Atlantico	12	231	19,25	7	0,0759

Table 7: Leading universities in Venezuela

R	University	TP	TC	H	C/P	Z
1	Inst. Venezolano de Investigaciones Científ.	216	2320	10,74	24	0,9285
2	Universidad Central de Venezuela	263	1167	4,44	15	0,7140
3	Universidad de Los Andes	152	1648	10,84	19	0,6655
4	Universidad Simon Bolívar Venezuela	186	1137	6,11	14	0,5863
5	Universidad del Zulia	101	426	4,22	11	0,2913
6	U Nac. Exper. Llanos Occid. Ezequiel Zamora	7	940	134,29	5	0,2341
7	Universidad de Oriente	61	190	3,11	7	0,1629
8	Fundacion La Salle Ciencias Naturales	17	290	17,06	8	0,1217
9	Universidad de Carabobo	43	107	2,49	5	0,1093
10	Inst. Nacional de Investigación Agropecuaria	17	81	4,76	4	0,0600

The sixth country in the list is Venezuela. Considering that it is a bit smaller than Colombia, it presents equivalent results according to his size. Table 7 presents the Top 10 universities in this country.

The Venezuelan Institute of Scientific Research obtains the first position although the Central University of Venezuela is the most productive university. The University of the Andes in Venezuela and the Simon Bolivar University also obtain remarkable results for the country. However, none of them obtain a significant position in Latin America.

Next, let us look into the Peruvian universities. This country publishes less than half of the papers that Venezuela does although both countries have a similar number of people.

Table 8 presents the results.

Table 8: Leading universities in Perú

R	University	TP	TC	C/P	H	Z
1	Univ. Nacional San Antonio Abad del Cusco	50	1483	29,66	20	1
2	Universidad Nacional Mayor de San Marcos	39	526	13,49	13	0,5543
3	Universidad Nacional Agraria La Molina	35	370	10,57	13	0,4697
4	Universidad Nacional de la Amazonia Peruana	24	458	19,08	11	0,4014
5	Universidad Peruana Cayetano Heredia	26	255	9,81	12	0,3540
6	Pontificia Universidad Catolica del Peru	22	214	9,73	9	0,2932
7	Universidad Nacional de San Agustin	8	100	12,5	6	0,1277
8	Universidad Ricardo Palma	5	88	17,6	5	0,0947
9	Universidad de Piura	6	66	11	4	0,0903
10	Universidad Nacional de Trujillo	5	86	17,2	4	0,0890

The National University of San Antonio Abad del Cusco is the most productive and influential country in Peru. However, none of the universities have published more than one hundred papers although six universities have published more than twenty studies. By looking to these results, it is clear that Peru still needs to improve a lot in order to reach the standards of the other big countries in Latin America.

The remainder of South American countries are very small, so rarely they are able to have some university competitive at the Latin American level. However, Uruguay, Ecuador and Bolivia have some universities worth mentioning.

Table 9: Leading universities in Uruguay, Ecuador and Bolivia

R	University	TP	TC	C/P	H	Country
1	Universidad de la Republica	276	3593	13,02	29	URU
2	Pontificia Universidad Catolica del Ecuador	89	1818	20,43	22	ECU
3	Universidad Mayor de San Simon	55	684	12,44	18	BOL
4	Universidad Mayor de San Andres	61	651	10,67	14	BOL
5	Universidad San Francisco de Quito	34	332	9,76	12	ECU
6	Inst. Investig. Biológicas Clemente Estable	24	174	7,25	8	URU
7	Universidad Autonoma Gabriel Rene Moreno	14	144	10,29	8	BOL
8	Universidad de Guayaquil	8	97	12,12	5	ECU
9	Universidad Tecnica Particular de Loja	12	71	5,92	5	ECU
10	Universidad de Cuenca	10	48	4,8	5	ECU

The University of the Republic in Uruguay is the most relevant university in this country and his research production would include him in the Top 50 of Latin America. The rest of universities are less significant although the Catholic University of Ecuador is the most

influential country in Ecuador in this research discipline. The University of San Simon is the most significant university in Bolivia but very close to the University of San Andres.

Table 10: Leading universities in Central America and Caribbean (outside Mexico)

R	University	TP	TC	C/P	H	Country
1	Universidad de Puerto Rico	510	7652	15	40	PR
2	Centro Agronómico Tropical Inv. Enseñanza	88	1962	22,3	24	CR
3	Universidad de Costa Rica	139	1790	12,88	22	CR
4	Universidad Nacional de Costa Rica	69	962	13,94	18	CR
5	Instituto Tecnológico de Costa Rica	19	484	25,47	12	CR
6	Universidad del Valle de Guatemala	21	383	18,24	12	GUA
7	Universidad de La Habana	65	369	5,68	11	CUB
8	Universidad de Panamá	28	363	12,96	10	PAN
9	Universidad Central Marta Abreu de Las Villas	28	294	10,5	10	CUB
10	Universidad Centroamericana	12	251	20,92	6	NIC
11	Universidad Nacional Autónoma de Nicaragua	17	234	13,76	7	NIC
12	Universidad Quisqueya	11	155	14,09	5	HAI
13	Universidad Ciencias Médicas de La Habana	19	146	7,68	6	CUB
14	Universidad de San Carlos de Guatemala	11	131	11,91	5	GUA
15	Inst. Superior de Tecn. y Ciencias Aplicadas	17	129	7,59	5	CUB
16	Universidad de Oriente, Cuba	10	115	11,5	4	CUB
17	Universidad EARTH	15	90	6	6	CR
18	Inst. Superior Politec. Jose Antonio Echeverria	13	87	6,69	5	CUB
19	Centro de Estudios Ambientales de Cienfuegos	20	80	4	4	CUB
20	Instituto de Ecología y Sistemática	13	51	3,92	4	CUB

Finally, let us analyze the leading universities in Central America and the Caribbean excluding Mexico which has already been studied in Table 3. The results are shown in Table 10.

The University of Puerto Rico is the most relevant university in this region and far away from the rest of universities. A key explanation for this is his entrance in the USA that has improved his research facilities and partner connections. The next four universities in this region are from Costa Rica. The sixth position goes to the Valley University of Guatemala and the seventh one to the University of the Habana in Cuba.

Conclusions

This study has presented a general overview of the leading universities in Latin America in environmental sciences. The analysis has first considered the most productive countries in order to identify the leading regions where the research is being developed. Brazil, Mexico, Argentina and Chile are the most relevant countries in Latin America. Focusing on the universities, the Top 3 are the University of Sao Paulo, the National Autonomous University of Mexico and the University of Buenos Aires. From a general perspective, Latin America shows an important research production in this field but still needs to improve a lot in order to become competitive at the World level.

In future research, we will expand this analysis to other regions and considering the leading universities in environmental sciences of the World. Moreover we may consider other research areas where this university analysis could be developed distinguishing between the Latin American level and the World level.

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