INTERNATIONAL SCIENTIFIC COLLABORATION IN ARAB COUNTRIES

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ABSTRACT

International scientific collaboration between 9 Arab countries and with the 8 most productive countries in the world in 8 scientific fields is analysed using the MEV-MAC data base of the Laboratoire d'Evaluation et de Prospective Internationale (LEPI). An analysis of the scientific collaboration between Morocco and France during the year 1984 is also presented. The results obtained are compared with figures derived from a Moroccan data base "CONVENTION" in the field of chemistry.

RESUME

Les collaborations scientifiques internationales entre 9 pays arabes et avec les 8 pays les plus productifs dans le monde dans 8 domaines scientifiques sont analysées en utilisant la base de données MEV-MAC du Laboratoire d'Evaluation et de Prospective Internationale.(LEPI). Une étude des collaborations scientifiques entre la France et le Maroc au cours de l'année 1984 est également présentée. Les résultats précédents sont comparés avec les données contenues dans une base marocaine "CONVENTION" dans le domaine de la chimie.

INTRODUCTION

This study has been undertaken in order to observe the nature of international scientific collaborative activities in a few Arab countries and to draw conclusions about their fields of priority in research. We also attempt to evaluate the credibility of bibliometric methods by means of a study carried out on the international scientific activities of Morocco.

The study has been carried out using the methods developed at the *Laboratoire d'Evaluation et de Prospective Internationales (LEPI),* in order to facilitate the identification and evaluation of international scientific collaborations. The data for this study have been derived from analyses of the MEV-MAC database at LEPI

and the CONVENTION base at the *Centre National de Coordination et de Planification de la Recherche Scientifique et Technique (CNR-MAROC).*

I - The MEV-MAC data base (1)

Data in the Science Citation Index (SCI) base of the Institute for Scientific Information (ISI) (Philadelphia, PA, USA), classified into 8 fields in a fixed journal set by Computer Horizons, Inc, has been reclassified by LEPI into a 97-country matrix concerning the six-year period 1981-1986. The SCI database gives listings of all published scientific articles in the over 3000 mainstream journals and indicates the affiliations of all participating laboratories. This enables the identification and counting of participating countries in international scientific collaboration in each of the eight major divisions of science used by the National Science Foundation (NSF), USA: Mathematics (MAT), Physics (PHY), Chemistry (CHM), Engineering & Technology (ENT), Earth & Space (EAS), Biology (BIO), Biomedical Research (BIM), and Clinical Medicine (CLI).

The SCI is a selective data base as it only takes into account international scientific journals whose works have a high citation index. The SCI base is used for bibliographical and bibliometrical research. The CHI treatment shows the classification and distribution of articles in each of the represented countries and fields. New journals are regularly added to the listings, but stable lists are maintained over long periods for statistical analysis. Articles, reviews, and notes are included, whereas editorials, letters to the editor, and presentations of seminar's or conferences are not. Lesser-developed countries have little representation. Journals edited in such countries, publishing articles on natural resources or on technical developments, are often missing from SCI. However, even though the figures obtained from the SCI base concerning lesser-developed countries are incomplete, they indicate trends in international collaboration between lesser-developed and developed countries, the selection of preferred subjects and fields, and the laboratories involved. Moreover, it has been observed from analyses of total production that similar trends exist in lesser-developed countries in their international collaborative works and in the research within these countries. A major proportion of coauthorships between lesser-developed and developed countries stem from collaborative works resulting from prolonged stays in industrialized countries of students doing doctoral theses or postdoctoral studies.

At LEPI, the "MEV" base was initially set up as an interface between partner countries and involved procedures such as the counting of coauthorships and the registering of scientific publications produced from international collaboration. This first phase of MEV, the "MEV-MICRO" base, has, since 1986, registered all international collaborative works involving laboratories at the *Centre National de la Recherche Scientifique (CNRS)* and its partners throughout the world. MEV-MICRO, therefore, is the recording of international scientific collaboration,

by researchers, as it happens. The projet memory then becomes a subset of the total of the activities recorded by "MEV-MACRO" two or three years later, the time necessary for international data bases to register and publish their information.

Since the publications of the ISI CD-ROMs, the relationships between the "MICRO" follow-up of collaborative projects and the counting of international coauthorships have become more concrete.

II - Analysis of Scientific production carried out within the framework of international collaboration in the Arab countries which are represented the most in MEV-MAC

In this first section, we analyze the trends of production in international collaboration in the Arab countries which are the most represented in our data base. This will enable us to make comparisons between these countries, in the different scientific fields, and also to compare these countries with the most productive countries in the world.

The nine Arab countries taken into consideration are : Algeria, Saudi Arabia, Egypt, Iraq, Jordan, Kuwait, Libya, Morocco and Tunisia. In this study these countries are referred to by their ISO codes : DZA, SAU, EGY, IRQ, JOR, KWT, LBY, MAR, and TUN. For this we have two tables : (1) the table of the relation of scientific fields and international collaborative projects in the 9 Arab countries for the period from 1981-1986 (table 1); and (2) the table of the relation of scientific collaboration between the 9 Arab countries and the 8 most productive countries of the world, for the same period 1981-1986 (table 2).

TABLE 1. Relation between Scientific Fields and International Collaboration in 9 Arab Countries.

COUNTRY	MAT	PHY	CHM	ENT	EAS	BIO	BIM	CLI
ALGERIA	11	69	73	19	15	28	46	101
SAUDI ARABIA	32	101	108	135	63	60	42	163
EGYPT	27	132	283	242	59	244	145	378
IRAQ	7	20	51	41	19	42	35	64
JORDAN	3	38	37	15	14	7	16	23
KUWAIT	26	28	23	48	5	20	31	75
LIBYA	7	12	13	12	10	21	14	14
MOROCCO	11	41	105	19	26	47	29	70
TUNISIA	11	64	155	13	22	31	44	76

CNRS-LEPI MEV-MAC 1981-1986

Table 2. Relations between the 9 Arab countries and the 8 most productive countries in the World.

COUNTRY	USA	GBR	SUN	JPN	DEU	FRA	CAN	IND
ALGERIA	13	8	7	1	3	230	5	27
SAUDI ARABIA	239	149	0	5	21	22	53	14
EGYPT	469	188	11	23	156	102	61	10
IRAQ	52	82	3	7	4	7	10	23
JORDAN	67	32	1	0	19	4	0	0
KUWAIT	70	47	0	2	5	7	26	6
LIBYA	29	20	1	0	4	6	6	15
MOROCCO	38	8	0	0	10	241	4	1
TUNISIA	20	4	0	0	10	314	3	1

CNRS-LEPI MEV-MAC 1981-1986

These tables are difficult to interpret, and the histograms of the fields and of the countries are only significant of parts of these tables. In order to understand the relationships which determine the various elements in their totality, we have used a technique which has become easier to carry out due to the most recent developments in personal computers. This method is the Factorial Correspondence Analysis (FCA) (3, 4), which does not attempt to produce new information from the tables, but aims to facilitate the readings by presenting the corpus of the data in an appropriate graphic (Factorial maps).

It is a method which enables a view of large amounts of information and has the advantage of bringing about more quickly the discovery of new and better formulated questions. This technique brings about a clear extraction of the main elements of information which exist in the table but which remain blurred. Similarities which may exist between various elements of the table also become more visible.

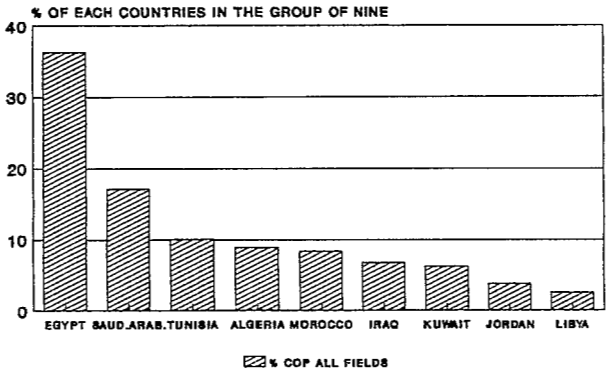
For these factorial analyses we have used a program written by us in Basic (5). In the following factorial proximity maps (6), three rules will help interpretation : 1)The relative closeness of two scientific fields corresponds to the relative similarity of the scientific positions in a group of countries. 2)The relative closeness of two points representing countries corresponds to the relative similarity of the international activities in the two countries. 3)The relative closeness of a point representing a scientific field to a point representing a country corresponds to the relative activity of the country in the scientific field.

Results

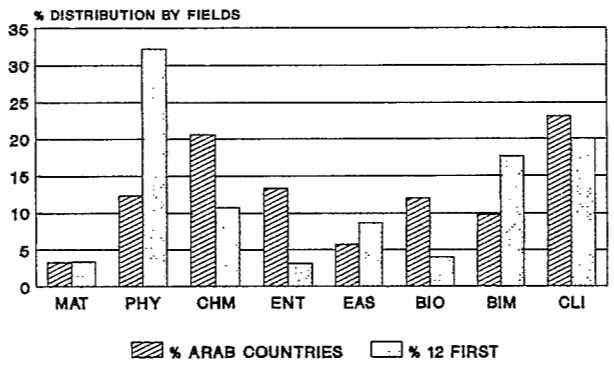
1- The scientific production of Arab countries carried out within the framework of international cooperation in each of the eight divisions or fields :

Firstly we are going to analyze the histograms drawn from the tables concerning the distribution of the nine countries in international scientific collaboration and then we shall examine the proportions in each of the scientific fields.

HISTOGRAM 1
INTERNATIONAL COLLABORATION
IN ARAB COUNTRIES



HISTOGRAM 2
INTERNATIONAL COLLABORATION
ARAB COUNTRIES & THE 12 FIRST PRODUCERS



CNRS LEPI MEV-MAC

In Histogram 1 we see that EGYPT is the most scientifically active country in international collaboration with a percentage of 36.5%. SAUDI ARABIA follows with 17.0%, then the three Maghrebian countries, TUNISIA, ALGERIA, and MOROCCO. IRAQ, KUWAIT, JORDAN, and LIBYA are in last positions.

Histogram 2 shows the relative distribution of the scientific fields. It shows that in international collaboration the scientific field most practiced in the Arab countries is Clinical Medicine (23.3%), followed by Chemistry (20.5%), Engineering (13.2%), Biology (12.1%), and Physics (12.2%). These figures can be compared with the proportions found in the international collaboration of the 12 most scientifically productive countries.

We can thereby see the specific fields of collaboration of the Arab countries. The percentages concerning Chemistry and Engineering are above the average of those of the industrialized countries. The rates in Biology demonstrate the need to exploit natural resources. Lastly, collaboration in Clinical Medicine stems from a necessity of having access to new methods.

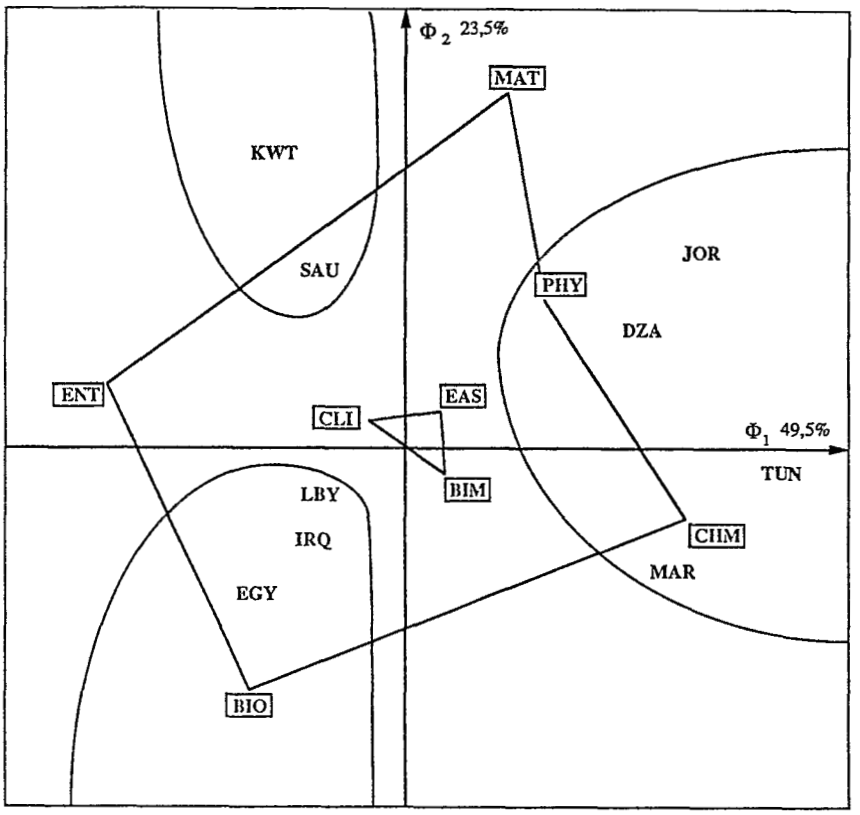
Analysis of factorial map 1 :

The correlation between the scientific fields and the Arab countries with the highest scientific international collaborations in journals selected by the SCI is presented on the factorial map n° 1. Using this 8 dimensional system the AFC brought together into the 5 first factors most of the variance of the system : 97.8%. The first two factors, which enable a plane representation of the correlation under study, alone bring together nearly 73.7% of the total variance. The first factor, Φ_1, which unites close to half of the variance (49.6%) is the preponderant element of the organization of the relationship between the Arab countries and the scientific fields.

On the cloud of scientific fields, this factor is mainly dominated by Chemistry (CHM) and Engineering & Technology (ENT). These fields cover respectively 39.6% and 37.9% of the make up of this factor (Absolute Contribution "AC"). They also have a dominant character as they are explained by this factor for 0.84% and 0.87% respectively of their variance for the first factor [Relative Contribution "RC" $\cos^2(\Phi n)$]. Physics and Chemistry, having positive coordinates on Φ_1,, are associated. They are opposed to Engineering & Technology and to Biology which have negative coordinates on this axe.

On the country cloud, the factor of Φ_1, is mainly controlled by Tunisia (AC=43.5%, RC=0.94), Morocco (AC=11.8%), Jordan (AC=7.2%), and Algeria (AC=6.4%). These different countries are projected onto Φ_1, with positive coordinates. They are therefore strongly tied to Chemistry and Physics and they are anticorrelated with research in Engineering & Technology.

The second factor Φ_2 unites more than 24% of the total variance. It is dominated by Biology (with an "AC" of 37.3% and a "RC" of 0,67), by Physics (AC=25.9%, RC=0,47), and by Mathematics (AC=22.6%, RC=0,49). Biology with its negative coordinates is opposed to Physics and to Mathematics.



Factorial Map n° 1

COLLABORATION between Arab countries
and their partners in the world
in the 8 scientific fields

CNRS - LEPI MEV - MAC 1981 - 1986

On the country plane, the second factor is concerned with Egypt (AC=30.9%, RC=0,51), Saudi Arabia (AC=27%, RC=0,48), Kuwait (AC=20.0%, RC=0,30), Iraq, and Libya. Egypt, Iraq, and Libya, with their negative coordinates on axe Φ2, are strongly tied to Biology. Kuwait and Saudi Arabia, with their positive coordinates, are strongly related and share their preferences between Engineering & Technology and Mathematics.

The scientific fields Clinical Medicine, Earth & Space, and Biomedicine are close to the origin of the axis, which means that these fields, although of a variable relative importance, are also practiced, and show a good equilibrium within the different Arab countries.

2- The correlation between 9 Arab countries and the 8 most productive countries in the world

In analyzing TABLE 3, we note that the collaboration of the group of Arab countries with each of the 8 countries is distributed as follows : 33.0% with the USA, followed by FRANCE (31.0%), UNITED-KINGDOM (17.8%), WEST GERMANY (7.6%), and CANADA (5.5%). JAPAN, INDIA, and the USSR tail behind as they collaborate little with the Arab countries.

The total participation of each of the 9 Arab countries (TABLE 4) shows that the countries are in the same order in international collaboration and in the distribution of total production for each scientific field.

Table 3. Collaboration between the group of Arab countries and each of the 8 most scientifically productive countries

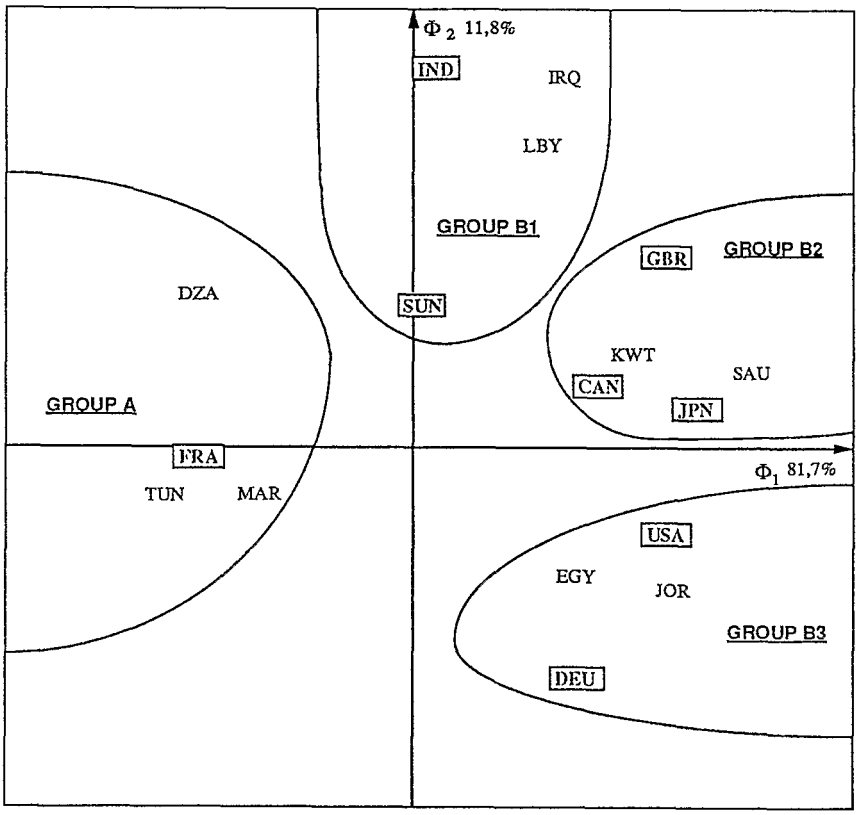
Country	Distribution in %
USA	33.0
FRA	31.0
GBR	17.8
DEU	7.6
CAN	5.5
IND	3.2
JPN	1.2
SUN	0.7
Total	100.0

Table 4. Distribution of total international collaborative production among each of the 9 Arab countries

Country	Distribution in %
EGY	36.5
SAU	17.0
TUN	10.0
MAR	8.4
DZA	8.8
IRQ	6.8
KWT	6.2
JOR	3.8
LBY	2.5
Total	100.0

Analysis of the factorial map 2 :

Group A strongly ties ALGERIA, MOROCCO, and TUNISIA to FRANCE. This result is not surprising due to the history of Franco-Maghrebian relations and also due to the role FRANCE plays in training Maghrebian researchers, who often continue in their relations and collaboration with French researchers once they return to their countries.



Factorial Map n° 2

COLLABORATION between 9 Arab countries
and the 8 first science producers in the world
All fields combined

Group B1 includes IRAQ, LIBYA, INDIA, and the USSR.

Group B2 links SAUDI ARABIA, KUWAIT, GREAT BRITAIN, CANADA, and JAPAN.

In Group B3 the USA, EGYPT, and JORDAN are brought together with specific links between Egypt and Germany.

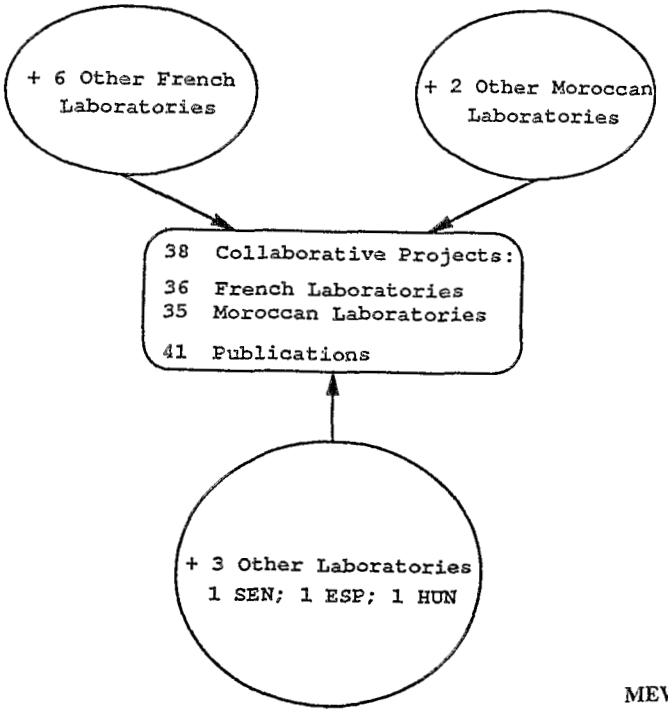
III - Analysis of the Scientific collaboration between MOROCCO and FRANCE during the year 1984

We found the collaborating laboratories by means of the co-authored articles registered in the SCI base and treated by CHI in 1984. Each publication was obtained from the INIST (l'Institut National de l'Information Scientifique et Technique, Nancy-France). These publications illustrate, in each scientific field, the collaborative projects between MOROCCO and FRANCE and the names of the researchers and laboratories involved. We catalogued the publications co-authored in 1984 between MOROCCO and FRANCE, and classified them into scientific fields and into Moroccan cities of origin (see appendix 1 for Chemistry).

Results

We see in figure 1 that MOROCCO had 38 projects with FRANCE, resulting in 41 publications. For fields such as Mathematics and Earth & Space, this collaboration was sometimes multilateral and involved other countries : SENEGAL, SPAIN, and HUNGARY also co-signed.

Figure 1
Partners in 38 collaborative projects between France and Morocco in 1984



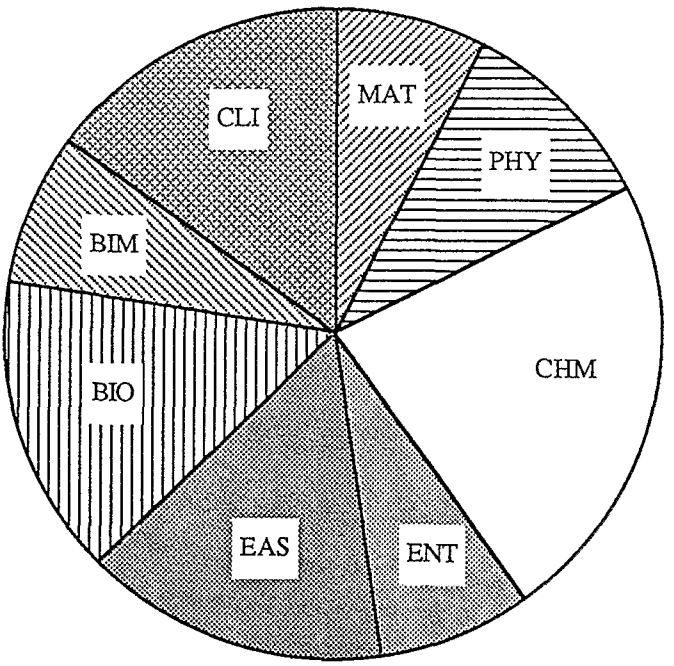
MEV-MAC 1984

In Figure 2, we note that co-publication was most important in Chemistry with a proportion of 22.5%, followed by Earth & Space, Biology, and Clinical Medicine with proportions of 15%, Physics with a proportion of 10%, and Mathematics and Biomedicine coming last with proportions of 7.5%.

Figure 2

Distribution of "COAs" co-publications between France and Morocco

MEV-MAC 1984

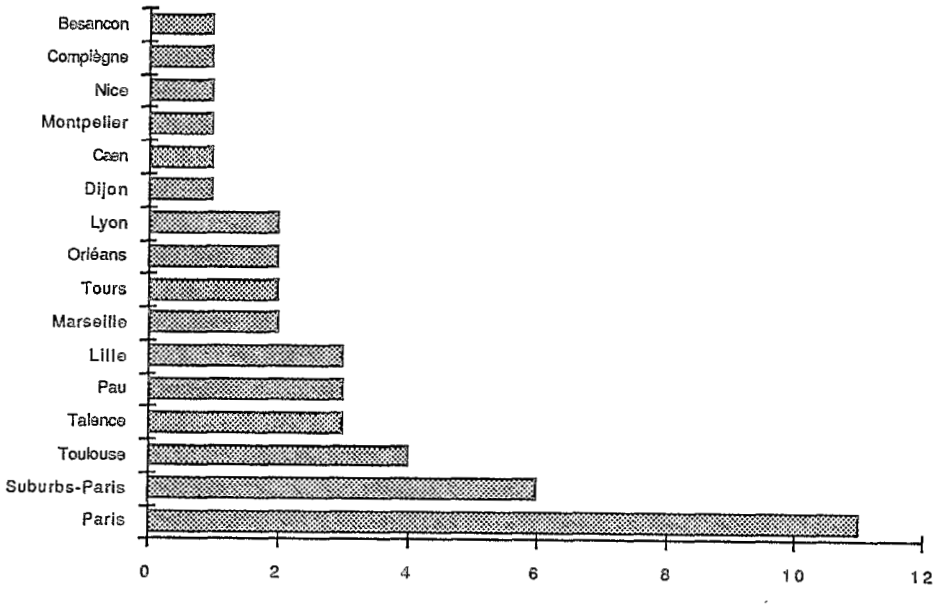


41 Publications

We also wanted to see if geographical location had an influence on the Moroccans' choices of French cities. The answer is demonstrated in Figure 3. We note that the distribution is in relation to the scientific size of the city as well as to traditions and to university relations.

Figure 3

The participation of french cities in co-publications in the "SCI" base journals between France and Morocco in 1984



IV - Comparison of the above results to data from a Moroccan data base and to a survey of Moroccan researchers

This section will show the representativity of the figures obtained from the SCI base concerning Morocco. In order to bring this about we tapped information from the Moroccan data base "CONVENTION". It lists and describes all the publications emanating from researchers having proposed research topics within the framework of the exchange agreement between the *Centre National de Coordination et de Planification de la Recherche Scientifique et Technique (CNR-MAROC)* and the *Centre National de la Recherche Scientifique et Technique (CNRS-FRANCE)*. From this base we chose Chemistry, the most active area of research in Morocco. We also chose the year 1984, the year for which we obtained publications from original articles.

Through this research we found 24 articles in Chemistry in scientific journals for the year 1984 in addition to the 9 articles listed in SCI, without considering international conferences. Following is the list of these 24 articles, classified according to whether or not the journals in which they were published are retained in the SCI base.

Articles published by Moroccans in journals in the SCI base, not identified in the 1984 listing:

1) Inorg. Chem., 2) J. Soc. Chem., 3) Tetrahedron lett., 4) Bull. Soc. Chem. Bel., 5) Phys. Stat. Sol., 6) J. Chem. Research (S), 7) An. Chim, 8) J. de Chimie Physique, 9) Journal of Heterocyclic Chem., 10) J. Solid State Chemistry, 11) Tetrahedron letters, 12) Ferroelectrics, 13) Bull. Soc. Chim. France, 14) Nucleosides and Nucleotides, 15) Ferroelectrics, 16) Organometallics, 17) Polyhedron.

Articles published by Moroccans in journals not listed in the SCI base :

1) Science and Engineering, 2) Phytotherapia, 3) Parfums Cosmétiques et Arômes, 4) Bull. Soc. Brot., 5) Revue des Sciences de l'Eau, 6) Mat. Res. Bull., 7) Le Pharmacien du Maghreb.

Survey of Moroccan researchers

In order to explain this important difference in the publications, we carried out a survey questioning the researchers involved. We were able to determine that there were two categories of researchers : those who published in SCI-listed journals and those who published in journals which they thought to be of quality, even though they were not in SCI.

In the first case, the absence of these articles in SCI in the listed "international co-authorships" results from the non-affiliation of the Moroccan laboratories. The names of the Moroccan researchers in the publication are attributed to the French laboratory followed (and not always) by the mention : 'on leave from'.

Because of the fact that the selection of collaborative works in SCI is based on the address appearing in the title of the publication, the non-mention of the affiliation of the Moroccan laboratories leads to the exclusion of these laboratories from the list of international co-authorships.

This situation should urge laboratories participating in international collaboration to identify themselves. In the above described situation both laboratories and both countries involved in a collaborative work lose the accreditation of an international publication in bibliometric studies. One recommendation could be made, that each partner identify himself by mention of the address of his laboratory.

As for the journals not listed in the SCI base, the problem is of a different nature. It is directly related to problems that have lead to this conference : the absence of a specific data base on studies concerning developing countries. The criteria of selection of articles, based on the choices by internationally represented committees of referees, should be kept. Traditional criteria for mentioning participants should not necessarily be the same in this case and could be replaced by regulations that this meeting could suggest.

We also wanted to know if Moroccan journals are represented in the 3500 journals recorded by the SCI base. Of the 153 Moroccan journals, a majority of which have an internationally normalized "ISSN" number and are therefore internationally recognized, none are taken into consideration by the SCI base. Researchers publish articles in local journals in order to facilitate distribution within Morocco.

This confirms the conclusions of a study by J. GAILLARD (7) on the misinterpretation of the representation of third world countries in world science. When observers state that science in the third world does not represent more than 5% of the international production, allusions are made to international data bases that are very selective in their choice of scientific journals. Out of seventy thousand scientific journals, only three thousand five hundred are included in the SCI base. Therefore an incomplete image of the participation of third world researchers is given.

CONCLUSION

Third world countries participate actively in international collaboration but are poorly represented in the bibliometric bases most frequently used by the large scientific countries. Bibliometric studies must be interpreted cautiously, especially when describing scientific research or when making decisions concerning third world countries. However the SCI data base may be used for the analyses of international collaboration provided that each scientist clearly mention his/her affiliation.

We recommend that: 1) When two countries work together, each partner should identify himself through his laboratory of origin when an article is published. Otherwise the collaborative work could result in wasted effort for both countries; 2) Every developing country should create its own data base, and the data in such a base should be acquired from surveys of all of the establishments concerned within the country. After being identified, the data should be registered into an international base in order to enable exchanges between countries. This last recommendation is for the development of a specific data base.

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