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Journal of Life Sciences 6 (2012) 335-341

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Received: August 30, 2011 / Accepted: October 14, 2011 / Published: March 30, 2011.

Abstract: It was in 1995 that, at the end of the international project IEEY (International Equatorial Electrojet Year), African and European scientists decided to create the IRGGEA (International Group in Geophysics Europe Africa) in order to pursue the scientific work started during the IEEY project. The main objective of IRGGEA was to introduce new fields of research in Africa and built teams of African scientists recognized at an international level in these new fields. To reach this goal, we developed days after days methods to manage smoothly a large network of scientists from developed and developing countries. After a short introduction on the field of research developed in the IRGGEA, we present the organization of the work based on sharing practices and the results obtained in terms of scientific publications and socio-cultural aspects as the increase of the number of women and positions for students in their countries. Such an experience is easy to reproduce.

Key words: Scientific network, ethical rules, geophysics, sustainable research, Africa.

1. Introduction

It was at Vancouver, in 1987 that Interdivisional Commission for Developing Countries (ICDC) of International Association for Geomagnetism and Aeronomy (IAGA) planned an international campaign on the equatorial electrojet (1992-1994) [1].

In 1995 a research group (IRGGEA) involving African and European scientists was created to pursue the work. The fields of research of the IRGGEA are dynamics, electrodynamics and electromagnetism in the Earth's environment (from 50 km deep in the ground up to 1,500 km height) and the following various disciplines of external and internal geophysics: atmospheric dynamics, ionospheric studies, the Earth's magnetic field, telluric electric fields etc.We use high technology tools as radar HF (propagation of electromagnetic waves in the Earth's environment), magnetometers (measurements of the Earth's magnetic field), ionosondes (measurements of electronic densities in the Ionosphere altitude 90 km to 500 km), meteorological stations (atmospheric pressures, temperatures, winds …), satellites (various geophysical parameters), etc. [2].

Later in 2005, scientists from Vietnam and Burkina Faso joined the IRGGEA to participate to the International Heliophysical year (IHY) [3-6]. More recently, in 2010, scientists from Egypt, Congo Brazzaville and RDC joined the IRGGEA to cooperate in the framework of the International Space Weather Initiative (ISWI) [7].

This paper relates the story of this group which increased during the two last decades by a factor of 10 (20→200). Four sections composed this paper. The first one is devoted to the method used to organize the work, the second section to the scientific projects and scientific results obtained by

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the students, the third one to female scientists in the IRGGEA, and the last one gives the composition of this group in June 2010.

2. Method: Work Based on Ethical Rules and Sharing Practices

We have to take into account the fact that we are all dependent on each other (see the recent eruption of the Eyjafjöll volcano in Iceland which disturbed air flight traffic over Europe and as a consequence over the world), this fact implies that research on the Earth's environment must be developed at a planetary scale taking into account factors concerning south countries as well as north ones.

The method developed to organize the work was derived from the analysis of the situation in the African countries colonised by France, before 1960. From 1960 until 1987, French scientists were involved in geophysics studies in West Africa, and finally, in 1990, after thirty years, there is no team of African scientists working in external geophysics in West Africa. This is due to many sociological and political factors, but also to the organization of the work. If it is difficult to change quickly the sociological and political parameters, it is easier to change the organization of the scientific work through international projects.

Table 1 [8] gives the factors preventing a good development of research in the Earth's environment at the planetary scale. These factors can be overcome with sharing practices.

We have to organize the scientific world in order to help all scientists to participate in advances in knowledge.

Table 2 [8] presents the organization of the work.

Scientific teams in developing countries received instruments from scientific teams or institutions from developed countries and they share data and results (Fig. 1).

Table 1 Factors Preventing a Good Development of Research in the Earth's Environment.

Taking into account several facts concerning research in developed countries	Taking into account several facts concerning research in developing countries
• The need of observations over the whole world to do global studies ⇨ creation of observatories in the Southern hemisphere • The fact that satellite and ground observatories are complementary ⇨ creation of observatories in the Southern hemisphere • The constant increase of research fields ⇨ more researchers in the Southern hemisphere • For all disciplines the multitude of tools ⇨ sharing practices between developed and developing countries • The constant increase of data base and our impossibility to analyze all the data ⇨ sharing practices between developed and developing countries	• The impossibility to stay in their country to do research in particular fields ⇨ to develop research in developing countries • The lack of data to do research in their country ⇨ creation of observatories in the Southern hemisphere ⇨ sharing practices between developed and developing countries • The need of books, reviews, computers etc... ⇨ sharing practices between developed and developing countries • the difficulty to publish in an international scientific journals ⇨ sharing practices between developed and developing countries Etc... **A change is needed**

Table 2 Organization of the Work.

The method to maintain the project is developed day after day in accordance wither the situation
• We organize ⇨ training in several disciplines in the project ⇨ teaching in management and data base organization ⇨ teaching in history of geomagnetism and aeronomy ⇨ we follow the students and help them to enter in the international community ⇨ the students are involved in the project and can propose new development ⇨ we maintain communication with a newsletter and keep contact with all the participants
• We consider that we are in the same laboratory: " An International Laboratory without frontiers" ⇨ We share knowledge, books, financial support etc.
The IGRGEA has no direct financial support. The IGRGEA establishes and maintains connections between research teams in different laboratories in Europe and Africa. The IGRGEA organize scientific projects, data base, research, training and teaching, communication between the research teams.

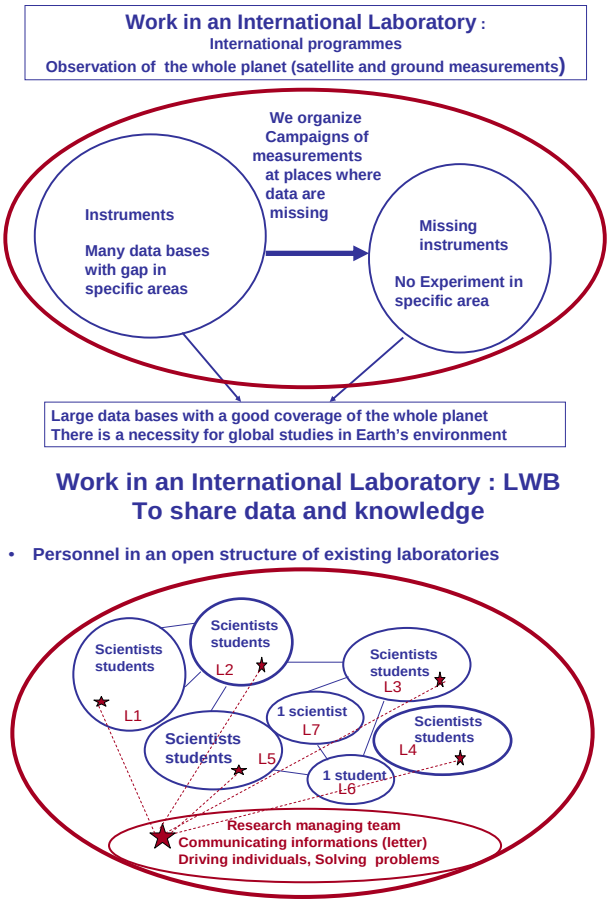

Fig. 1 Organization of the scientific network.

It is a necessity for all scientists working on the global system, to have access to large planetary data in the base of study physical processes acting in the Earth's environment at the scale of the planet. In the framework of heliophysics (introduced during the IHY) we need data base at the scale of our solar system.

Fig. 1 illustrates the network: scientists from various countries and various disciplines work together in the framework of international scientific projects. A team manages the network, solves the problems and informs (by a quarterly letter) all the participants of the development of the project.

In each country there is a leader (small star, Fig. 1) who participates with a local committee to the development of the research in his country. Sometimes there is an isolated scientist: he connects other scientists and can participate to the training of students in developing countries.

Table 3 proposes some ethical rules to apply in the framework of international scientific projects in order to balance the North and the South contribution to the world evolution.

The first objective of the IRGGEA is to develop scientific teams of research excellence in developing countries. To reach this objective, the students are trained in the framework of international project and read their Ph.D. when they have published several papers in international scientific journals.

The IRGGEA is an interdisciplinary group of scientists and the Ph.D. subjects are chosen at the frontiers of different disciplines as for example external and internal geophysics or solar and ionospheric physics etc.

3. Scientific Projects and Scientific Results

The IRGGEA was involved in two international projects and is presently participating to a third one:

3.1 IEEY: International Equatorial Electrojet Year

The first scientific project was the international Equatorial Electrojet Year (IEEY 1992-1994) [1]. The scientific topics were the study of the equatorial electrojet (electric current circulating along the Earth's magnetic equator at the altitude 100-120 km), ionospheric dynamics and ionization (spread F), ionospheric irregularities, telluric electric field, electromagnetic coupling between the pole and equator, etc.

3.2 IHY: International Heliophysical Year

The second project was the IHY (2007-2009) [4] (http://ihy2007.org).

The scientific topics were:

"* To understand the processes and drivers that affect the terrestrial environment and climate;

*To provide a global study of the Sun-heliosphere system outward to the heliopause;

* To foster international cooperation in space science now and in the future;

Table 3 Ethical rules.

This kind of human experience can be reproduced by many researchers in various countries, various disciplines by following the following proposals:
• To develop scientific projects with developing countries by campaigns of measurements in developing countries; • To create observatories in developing countries supported financially by an 'international laboratory without frontiers'; • To introduce ethical rules and sharing practices in scientific projects: as 20% of the financial support of the project for training and teaching in developing countries; • To organize research at a planetary scale by researchers including the participation of researchers from developing countries in all steps of organization; • To develop access to data base for researchers in developing countries (computer, internet ...); • Twining of Universities to share knowledge and projects; • International scientific journals free for Universities in developing countries; • Etc…
It is not necessary to change everything, just to introduce new practices.

* To communicate the unique scientific results of the IHY to the scientific community and to the public" [5, 6].

3.3 ISWI: International Space Weather Initiative

The third project is the ISWI (2010-2012) (http://www.iswi-secretariat.org).

The main objectives are [7]:

"Develop the scientific insight necessary to understand the science, and to reconstruct and forecast near-Earth space weather: instrumentation, data analysis, coordinate data products to provide input for physical modeling, coordinate data products to allow predictive relationships to be developed;

Education, training, and public outreach: university and graduate schools and public outreach"

ISWI as IHY and IEEY projects is based on ethical rules and sharing practices; the deployment of scientific tools over the world is pursued. ISWI as IHY is sponsored by United Nations Committee on the Peaceful Uses of Outer Space (http:// www.oosa.unvienna.org).

The results obtained by the IRGGEA scientists lead to the publications of 75 papers in international journals with reviewers, 19 proceedings, 18 Ph.D. concerning 16 students (two students defended two Ph.D.) and four technical reports.

Table 4 gives the contribution of the scientists from the Southern countries: they signed 32 papers as first author (42, 6%). Fourteen Ph.D. were read by scientists from the southern countries who are from seven countries (Benin, Burkina Faso, Côte d'Ivoire, Egypt, India, Senegal and Vietnam). The four Ph.D. in the Northern countries was read in France and Spain.

Table 5 gives the variations of the number of publications. It shows clearly an increase of the publications in the international journals from 12 for the period 1990-1995 to 29 for the period 2005-2010. This table also highlights that the number of publications with the first author from Northern countries is quasi the same (11, 11, 12, 9), and on the other hand the number of publications with a first author from the Southern countries increases (1, 4, 7, 20). This is explained by the fact that the training is mainly assumed by scientists from Northern countries who are introducing new fields of research in southern countries. They are helping their students to publish as

Table 4 Publications.

Type	Total: North + South	1st author South	1st author North
Paper	75	32	43
Proceeding	19	0	19
Ph.D.	18	14	4
Reports	4	0	4

Table 5 Percentage North/south (first author).

Period	North	South	North + South
1990-1995	11	1	12
1996-2000	11	4	15
2001-2005	12	7	19
2005-2010	9	20	29
Total	43	32	75

the first author. It is also important to recall here that the scientists for Northern countries are working part time in the IRGGEA.

From 1995 until 2010, 18 Ph.D. were defended by students from different countries (Benin, Burkina Faso, Côte d'Ivoire, Egypt, Spain, France, India, Senegal, and Vietnam), 16 have a position in their countries, and there are seven new positions (the other has the position during their Ph.D.). Two young scientists left geophysical research after their Ph.D. to do computer sciences. Only two female students read Ph.D., one in France and one in Egypt.

In June 2010, 17 Ph.D. were under progress, eight students have already a position in their country. The subjects covered by the Ph.D. and articles are:

* Vietnam monsoon,

* Long term variations in the equatorial ionosphere at the magnetic equator and on the tropical ionization crests in Asia,

* Long term variations in magnetic activity,

* Total electron content during maximum and minimum sunspot cycle,

* Solar action on geomagnetism,

* Equatorial electrojet,

* Regular variation of Sq magnetic field in Vietnam,

* Ionosphere disturbance dynamo,

* Terrestrial movements of the Earth's crust deduced from continuous measurements of GPS stations in South-East Asia,

* The Franco-Egyptian year, space weather,

* Use of GPS data to estimate the water vapor content of the troposphere,

* Climatology of gravity waves activity,

* Equinox transition at the magnetic equator, etc.

Six African students have been appointed as University professors in Ivory Coast, Benin and Burkina Faso. The perenniality is assured.

4. Progress of the Number of Women

By the past, from 1992 until 2009, there were two female students (12.5%) and 14 male students.

In June 2010, 17 Ph.D. were in progress in Burkina Faso (4), Côte d'Ivoire (7), Vietnam (5), and Senegal (1), and there are four female students and 13 male students i.e. 23, 5%. The female students are in Burkina Faso (1), in Senegal (1) and in Vietnam (2). The scientist women from Burkina Faso and Vietnam had already a position in their countries. The CNRS (French National Research Centre) employs 11,595 researchers in all the disciplines and 3,035 in our field department (http://www.cnrs.fr). Women scientists in geophysics are 27%. The IRGGEA was successful during the past decade to increase the number of young scientist women in geophysics and nearly reached the CNRS level.

5. Composition of the IRGGEA—June 2010

Tables 6 and 7 give an overview of the increase of

Table 6 Students in IRGGEA.

Country	Males	Females
Algeria	*1*	*1*
Benin		
Burkina Faso	**3** + **1**	**1**
Cameroon		
Egypt		
England		
France		
Gabon		
India		
Italia		
Côte d'Ivoire	**7**	
Niger		
Nigeria	*14*	*5*
RC	**10**	
RCI	**1**	
RDC	**8**	**1**
Russia		
Rwanda	*1*	
Senegal		**1**
South Africa	*4*	*1*
Spain		
Uganda		*1*
USA		
Vietnam	**3**	**2**

Bold underlined: Ph.D. in progress (17);
Bold: students who follow a training organized by the IRGGEA (21);
Italic: students who follow a training of a teacher of the IRGGEA (training not organized by the IRGGEA).

Table 7 Professors in IRGGEA.

Country	Males	Females
Algeria	*1*	*2*
Benin	**1**	
Burkina Faso	**1**	
Cameroon	*2*	
Egypt	*2*	**1**
England	**1**	
France	**14 + 1 + (1)**	**5 + (1)**
Gabon	*1*	
India	*1* + **1**	
Italia	1	
Côte d'Ivoire	**2 + 5 + (1)**	
Niger	**1**	
Nigeria	**2** + *3*	*1*
RC	**3**	
RCI		
RDC	**2**	**1**
Russia	**1**	
Rwanda		
Senegal	**1 + 1***	
South Africa	*3*	*1*
Spain	**1**	
Uganda		
USA	**3** + *15*	*5*
Vietnam	**3 + 1**	

Bold: Professors in the IRGGEA (37);
Bold underlined: student who obtained a position in research after their Ph.D. and are working now in the IRGGEA (12);
Bold, in brackets: students who left after their Ph.D. (3);
Bold with a *: student who died after the Ph.D. (1).

the IRGGEA. In 2006, the IRGGEA included nine countries [6]; today scientists from 24 countries are connected to the IRGGEA. Tables 6 and 7 give in bold the number of students and professors who are training or trained in the IRGGEA. The numbers in italic are given the number of students and professors connected to the IRGGEA in the framework of the international projects (as students trained by professors of IRGGEA or professors training students of the IRGGEA during international schools). Table 6: the bold numbers underlined correspond to Ph.D. in progress.

Table 7: the bold numbers underlined correspond to student who obtained their Ph.D. and are now working in the IRGGEA. Three students left the IRGGEA after their Ph.D. (two of them left their country). On the 16 students trained in the IRGGEA, 12 are now scientists in their countries in geophysics. Seven students obtained a new position after their Ph.D. (Benin: 1, Egypt: 1, France: 1, Côte d'Ivoire: 3, India: 1), for the other they had their positions when they did their Ph.D..

5. Conclusions

The IRGGEA created in 1995 still exists. This is due to the organization of the work. It is an open laboratory without well defined geographic and thematic borders and the projects are adapted to the request of scientists from southern countries. During the last few years, the IRGGEA increased and became planetary, this is the result of the international projects as IHY and ISWI. Indeed in the framework of these projects many workshops and schools were organized in Africa (http://kuiper.colorado.edu/, http:// ww.ihy2007.org) and isolated scientists joined the IRGGEA network. Another interest of such project is the participation of well known scientists of other groups to the training of students of the IRGGEA during workshops.

The IRGGEA was successful in the increase of scientist women in developing countries but also in the development of teams of research in Africa. Recently, at the end of 2010, the group of Space Weather of Helwan University joined the IRGGEA. In this team 75% of the students are females (13 among 17): the proportion of female students in the IRGGEA increases and approaches now the parity.

The starting country for the IRGGEA was the Côte d'Ivoire and at the present time there is a team of 13 scientists at the University of Abidjan. Then the IRGGEA extended to Vietnam (Asia) in 2005 then to Central and North Africa.

Acknowledgments

This scientific network was and is still supported by African Universities, French Foreign Agency, French

embassies of the different African countries, CNRS/DRI, United Nations, MICROSOFT, IUGG, AUF, NASA, CNES, and all the laboratories of the different participants to this scientific network see http://www.girgea.org.

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