CO-OPERATIVE PROGRAM IN THE ENVIRONMENTAL FIELD BETWEEN THE SWISS FEDERAL INSTITUTE OF TECHNOLOGY IN LAUSANNE (EPFL) AND SEVERAL COLOMBIAN INSTITUTIONS

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INTRODUCTION

The Colombian Association of Investigators in Switzerland (ACIS) participates in investigative and co-operative projects in the environmental field. ACIS was founded in 1992 at Lausanne, Switzerland, by a group of Colombian researchers working in diverse academic and research activities. Since its creation, among other activities, ACIS has been the Swiss node of the Red Caldas network (Network of Scientifics Colombians in the world), where it has actively participated. ACIS is a non-profit association whose members are researchers and academics of different nationalities residing in Switzerland, with a special interest in the social, technological, and scientific development of Colombia. The association's objectives are:

- To facilitate the meeting of scientists residing in Switzerland with national and international research groups. This is done by offering the scientists an opportunity to participate in research partnerships involving the North and South.
- To promote, support, and disseminate technological and scientific activities, related to the development of the nation, throughout Colombia.
- To establish and strengthen relations with national and international organizations or institutions in order to create new co-operative projects and to ensure the durability of existing ones.

The ACIS have been able to participate in different research and co-operative projects in domains such as the environment, health, and computer science, with the collaboration of Colombian institutions.

The objective of this paper is to communicate our experiences in co-operative and research activities in the environmental field. A reflection, transpiring from the daily tasks of the projects, on the key elements in the development of the scientific partnership is also presented. The study projects are: Creating a Demonstrative System for Handling the Quality of Air in the Sogamoso Valley, Colombia; Coupled Solar and Biological Systems for Water Treatment; Water Disinfection by Solar Photocatalysis; Determination of a System of Indicators to Evaluate the Main Impacts of the Oil Related Activities in a Pilot Region of Colombia, Department of the HUILA (See section 3, Summary). It must be mentioned that an atypical element of our partnerships is that the partners of the North are generally investigators pertaining to the Colombian diaspora in Switzerland.

1. CO-OPERATIVE PROGRAM IN THE ENVIRONMENTAL FIELD BETWEEN THE EPFL AND SEVERAL COLOMBIAN INSTITUTIONS

The partnership program in the environmental field between the EPFL and the University del Valle was initiated in 1994 and, with the support of the Cooperation center of the EPFL (CFRC), it has been extended recently to other Colombian institutions. The fields of research include the diagnosis and remediation of water, air and soil pollution as well as the Geographical Information Systems (GIS) applied to environmental issues.
The main objectives of the program are:

- to strengthen the scientific capacity of partner institutions through doctorate, master and undergraduate studies carried out mainly in Switzerland by Colombian students, and in part through several courses held in Colombia;
- to facilitate the launching of co-operative projects between the EPFL and Colombian institutions. In most cases these projects are initiated and lead by Colombian doctorate students at the EPFL. They contribute towards solving serious environmental problems that affect the most fragile social and economic sectors of Colombian society.
- to allow researchers and students from the EPFL and other Swiss institutions to take part in training programs and enrich themselves in the stimulating and rapidly changing academic, scientific, technical, institutional, social or cultural fields in the Colombian context.

1.1. Main results (1995-2000):

- With regards to research, the program has coordinated the commencement of 12 doctorates, 8 masters degrees, 3 undergraduate studies and 14 trainee positions. Thus far these activities have generated approximately 40 published papers in international congresses or scientific journals.
- Recently, several co-operative projects, managed by Colombian doctorate students, have been launched between the EPFL and other institutions in Colombia and Switzerland. They are dealing with environmental issues in Colombia and Latin America.
- With regards to teaching, the program has participated in the organization of 16 courses, seminars and workshops in Colombia. Furthermore, about 17 lectures have been given in different institutions.

1.2. Difficulties:

The dramatic decrease in the funds provided by COLCIENCIAS (Colombian Institution for the Promotion of Science) for overseas training of Colombian people, together with the financial crisis at Colombian universities that provided the program with important support, has constrained and jeopardized the program. Moreover, in spite of the promotional efforts of the KFPE (Swiss Commission for Scientific Partnership with Developing Countries) and some sectors of the SDC (Swiss Agency for Development and Cooperation), the political and financial aspect of scientific cooperation with the South is still under-developed.

However, the person responsible for Swiss scientific policy, Ambassador Ch. Kleiber, is currently designing a plan that will make scientific co-operation between Switzerland and the South more dynamic.

2. LESSONS FROM OUR EXPERIENCES IN RESEARCH PARTNERSHIPS

2.1. How does the context of the partners influence the preparation and development of the partnership.

Within a country such as Colombia there are many scientific and technological "Souths". On the one hand, there are, for example, institutions like CENICAFE or CINARA, which, although focusing on solving basic problems related to water supply or agriculture, are pioneers in their field at the international level. On the other hand, in the other regions of Colombia, the "South" side shows characteristics that are similar to the living conditions of the poorest countries in Africa.

In the North, in Switzerland in particular, the scientific community is more homogeneous. Our case is however atypical as most of the Northern partners involved in the above-mentioned projects are in fact expatriated Colombian scientists. It is then from our experience that we are classifying here (Table 1), based on non-hierarchical criteria, the specificities of both the Colombian and the Swiss contexts that should, in our opinion, be taken into consideration when developing partnership programs between both countries.

Table 1. Aspects to be considered for the development of scientific partnerships between Colombia and Switzerland.

Criteria	Swiss Context	Colombian Context
Size and weight of the scientific community.	Critical mass in many fields. Strong interaction with society.	Weak and highly fragmented. Little interaction among scientists, and between the scientific community and its society.
Image of the research and its actors.	Prestigious. But research becomes less prestigious when it is carried out with partners in the South.	Poorly defined, eccentric. Research in cooperation with the North is more prestigious.
Political and financial space for North-South cooperation.	Very limited, but with potential for growth. It is takes the classical orientation of "development aid".	Variable, without continuity. The recent evolution has been negative.
Motivation of the scientific community for North-South cooperation.	Weak. It is often opportunistic and circumstantial. For the diasporas it becomes something "emotional".	Very strong motivation but there is a lack of tools for its implementation.
Main feature of North-South scientific cooperation.	It is heavily influenced by the functionalist and "emergency" approach of classical technical cooperation.	There are two patterns, one that is similar to the Swiss one and the other that is discipline-based classical support (followed by Colciencias).

Development of a new vision of the North-South Cooperation.	Yes : it is being developed by Swiss Commission for Research Partnerships with Developing Countries, KFPE.	Yes : it was developed when Clemente Forero was director of Colciencias.

2.2. Key-steps in the process of preparation, negotiation and implementation of research partnerships between Switzerland and Colombian institutions

2.2.1. Identification of the partner

As the multidisciplinary problems raised by North-South cooperation are generally more complex than those arising from classical mono-disciplinary activities, it is a fundamental pre-condition to be demanding, both with ourselves, and with the partners. Because the research community in the South is still embryonic and with little critical mass, identifying a good partner in the south is not only difficult, but it is also a time-consuming step. This is all the more difficult since this first phase, most of the time, is not allocated proper funding. However, getting involved in a hurried and inadequate partnership is highly risky.

In looking for partners in countries such as Colombia, the risk is still higher as information concerning the quality of research groups based on relatively objective evaluation processes has only recently started to become available. As a result of this, until very recently, there was not always a correspondence between the "popularity" of some scientists (or research groups) and their intrinsic scientific quality. At that time it was usual to involve individuals who had never been evaluated or questioned but who were inevitable "gurus" of many of the cooperation projects.

As for the partners in Switzerland, on the other hand, it is still common that cooperation with the so-called "third world" is accessible to people with a comparatively lower degree education or people still in a learning stage. In some other cases, the Swiss partners come from a "humanitarian" or "development aid" background, which, although well intentioned, means they lack the tools to act in a real scientific partnership. When inspired by these "traditional" elements, cooperating with the South becomes frequently more of a refuge for those professions with high unemployment rates in the North. Finally, there are also completely opposite situations whereby the partners in the North, because they are too well known as individuals ("stars"), are in constant demand and thus lack the time for a real commitment to the project.

It can be thus very productive for the countries in the South to create partnerships with expatriate scientists. This is the case in our projects. This system has several assets among which the fact that the expatriates have a good knowledge of both contexts. However, the big drawback is that they, most of the time, lack a strong connection with political and financial institutions. In Switzerland for example, native Swiss generally run these institutions as the national law (principle of the 3 circles) forbids access to administrative positions by citizens of Southern countries.

2.2.2. Fitting the intervention in the South within a limited framework; strengthening already existing initiatives and potentials

In order to guaranty the depth, quality and the continuity of the partnership, we believe it is necessary to fix objectives that are limited but feasible, and thus highly motivating.

One element to be avoided is the artificial multiplication of the number of partners. When partners are integrated in the project merely for political or formal reasons, as they do not have real spaces for participation and they end up being absent for the work, but present when the benefits of the partnership are distributed. This same risk exists when creating alliances with institutions that are too different in size or in nature.

In our case, the success of some of our projects has been reinforced by the elasticity of some of the small Colombian institutions or Universities. In this same direction, it is better to support or complete already existing projects instead of starting from scratch new cooperative projects that necessitate the duplications of efforts within a context of very limited means. The strategic choice to support or to integrate already existing projects might be slower at the beginning as negotiating with the future partners takes time. However, this lost time is easily made up as experienced partners can make important contributions with their knowledge of the scientific, physical, economical, institutional and cultural context.

As North-South partnerships are most of the time multi-disciplinary and oriented towards the solution of concrete problems, there is a tendency for partners on both sides to confuse multi-disciplinarity and superficiality. In this situation, engineers, geologists, chemist, or sociologists become overnight economists, ethnologists, technicians, or even poets, without even a minimum sense of self-criticism. This breach in the rigor and in the professional ethic are not only favored by the “heady” atmosphere in the South, but also by the more concrete fact that financing institutions demand unrealistic results compared with the small funds allocated. So, when asked to carry out, within the same project, activities ranging from laboratory tests to the setting up of a productive company and including technology transfers, the researchers are then condemned either to be “genius”, or to become a real-life caricature of James Bond or Tarzan, with a slight adaptation to the scientific partnership context. One way to escape this phenomenon and to achieve a rich multi-disciplinarity without giving up the rigorous scientific and technical tools of each discipline would to create alliances with those professionals in the South who can contribute with a deep and discipline-based knowledge of the local context.

One of the aspects with more potential, although hardly used, is, precisely, to better involve the overseas scientific diasporas in the projects. In the case of the Colombian diaspora, the efforts to put to use this pool of hundreds of highly educated scientists, ready to contribute from various disciplines and regions of the world, have produced few results.

It is thus paradoxical that, precisely now, when so much is being said about the need to strengthen the research capacity of the South, no mechanisms have yet been found to salvage the enormous forces of the overseas Colombians. One suggestion would be that the Colombian government tries to negotiate, within the framework of the bilateral and multilateral agreements with the Northern countries, for the implementation of a real policy to facilitate the return of the diasporas. To complement this policy, other tools like

a system of financial support for the acquisition of research infrastructure in the fields of interest of the partners, could be envisioned. On their side, the institutions in the North could also be more active in integrating this diaspora in their activities or in looking for new partners in the South with whom to launch new projects or to use as advisers when defining policies. Finally, acknowledged institutions in the South could take charge of the management of big projects carried out in their own country or in other countries with less development in the field.

2.2.3. The role played by money and material goods within the project: vital but ambiguous

Two apparently contradictory problems coexist in the research partnerships. One is the chronic lack of financial support for many very good projects, and this represents the biggest hindrance to their realization. The other one is the incomprehensible waste of resources that exists within the other type of projects, so called "white elephant" projects. This latter type of project is, most of the time, the result of bilateral or multilateral negotiation, where, in order to respect some political or diplomatic agreement, huge sums, as compensatory returns, are disbursed for use in the short term.

The premature injection of huge sums of money in projects that are not fully prepared can have a negative effect in the building of a real partnership. First, there is the syndrome of the "lottery winner" with all its related syndromes such as distortions in the relationship among partners with the intensification of the stereotype of the "rich gringo" from the North. Together with this there is an inevitable increase of conflicts within the partners and subsequently there is a waste of money and resources. But the worst result is the development of strong networks, which are based on financial, and not on scientific criteria. A frequent corollary is that, in the rush to set things up, doors open to opportunistic partners who are not, most of the time, the most competent ones. The reason why this system has its advocates is because the economical situation can be interesting: bonuses for the partners in the South and huge salaries to the partners in the North. To make things worse, the administrator of the program (pompously called expert, counselor or advisor…) is frequently a very expensive intermediary who is not so much interested in the content of the project, but who knows well the administrative and political strings to pull to find funds.

2.2.4. Central role played by training and the dissemination of information

There is in Switzerland the vague idea that, partners, both in the North and in the South, who participate in North-South research partnerships do not need to be highly educated, and that a basic and applied level is enough.

Our experience tells us that it should not be like that as, generally, the sustainability of the projects is linked with the level of education of both partners. Even if our projects are directed to the solving of basic problems, found mainly in the environmental field, our contribution is done, first, from an academic perspective which requires highly educated actors. None of our projects could have been carried out without courses, workshops, masters and doctorates carried out before and during the projects. The main "Suisse"

input comes precisely from the Colombian doctorate students who, step by step have gone from the role of students to that of trainers and project administrators.

Training our partners from the South is very important, even when their level of education is already high. They have then a stronger impact in the local institutions and by being recognized, both in the North and the South, they become the best guarantee for the sustainability of the existing project or to play a multiplying effect for new projects. The sustainability of the projects depends indeed on the possibility to count on reliable partners for a long period.

In our projects the information is disseminated through the organization of courses, seminars and congresses. We also use networks, general or specialized, most of the time structured within larger electronic networks. In this respect, the Association of Colombian Researchers in Switzerland, ACIS, has played a major role in launching and managing for 2 year the Caldas Network (Red Caldas).

3. SUMMARY OF THE PROJECTS OF STUDY

3.1. Establishing a Demonstrative Air Quality Management System in the Valley of Sogamoso, Colombia

Partners in Switzerland: R. Jiménez, H. van den Bergh y B. Calpini
Partners in Colombia: J. Cetina, J. Morales, A. Rodríguez, F. Jaramillo, A. Martinez, M. Navarrete, E. Giraldo, R. Moreno y E. Espindola

This project is made within the framework of collaboration between the EPFL and Colombian organizations, la Corporación Autónoma Regional de Boyacá (CORPOBOYACA), Centro de Investigación en Ingeniería Ambiental (CIIA), the University of the Andes (UNIANDES), and the Mayorship of Sogamoso, Colombia.

A large number of urban and industrial areas in developing countries are, currently, threatened by serious, frequently increasing air pollution problems. Air quality degradation caused 113 thousand premature deaths in Latin America during 1996. Despite its enormous impact on human health, crop yield, tourism, patrimony and materials, decision-making toward improving air quality can be fenced by immediate social and economic needs, since in a large number of cases, emissions are generated by economic activities that provide subsistence to poor communities. This is the case of the Valley of Sogamoso, where about 600 small-scale, low technology brick and quicklime production industries generate more than 80% of the particulate matter emissions. The emission of particulate matter per square kilometer in this narrow, deep Andean valley is 20 times higher than the Swiss average and fivefold that in the San Joaquin Valley, one of the most polluted Californian air basins.

Our project is aimed at establishing a Demonstrative Air Quality Management System (AQMS) in the Valley of Sogamoso. By meeting this objective, we expect to contribute to improving the Valley of Sogamoso air quality, to show the feasibility of establishing AQMS in developing countries, to disseminate the knowledge and experience acquired in order to promote similar projects, and to gain new scientific knowledge, in particular, on the Andean atmospheric environment.

3.2. Coupled solar and biological systems for water treatment

Partners in Switzerland: S. Parra, V. Sarria, P. Péringer y C. Pulgarín
Partners in Colombia: R. Polanía, J. Olivero, W.Torres, N. Benítez, J.Fernández, M. Páez
Partners in Spain: S. Malato, J. Blanco

This work is carried out within the framework of the co-operative program, in the environmental field between the EPFL and several Colombian institutions. The support of the Colombian Institute for Science and Technology Development (COLCIENCIAS), of the Cooperation Center (CFRC), the Social Service of the EPFL, the Swiss Academy of Engineering Science (SATW), and of the concerned Swiss and Colombian institutions, have been the key for the good development of this project.

The objective of this work is to study and to develop new degradation techniques, taking advantage of the sun's irradiation for water treatment. This new technology has been developed because of the incapability of conventional biological methods to effectively remove many biorecalcitrant pollutants from water. These new degradation techniques couple solar and biological processes for the treatment of biorecalcitrant, non-biodegradable, and/or toxic organic substances present in water. An efficient chemical pre-treatment is necessary to modify the structure of the pollutants, by transforming them into less toxic and easily biodegradable intermediates, allowing then, a biological procedure to complete the degradation of the pollutant load in a shorter time and in a more economical way**.** The results obtained demonstrate that the strategy of coupling solar and biological processes is a good alternative to minimize the wastewater treatment cost. Field experiments under direct sunlight, carried out at the "Plataforma Solar de Almeria" in Spain, demonstrate the immense potential of solar detoxification technology. A remarkable advantage of this kind of technology is that it can be transferred to countries with high irradiation levels such as the developing tropical countries.

3.3. Water disinfection by solar photocatalytic treatment

Partners in Switzerland: Angela-Guiovana Rincón, P. Péringer y Cesar Pulgarin
Partners in Colombia: Janeth Sanabria, Walter Torres, Carlos Dierolf, Jorge Latorre, Norberto Benítez.

This project was initiated within the framework of a co-operative program between the EPFL and Universidad del Valle in Cali, Colombia. It aims to contribute to the development of water disinfection procedures using sunlight as an alternative to chlorination.

The control of both microbiological and chemical risk in drinking water is considered a very significant problem. The classical drinking water disinfection procedures, commonly chlorination and ozonation, can lead to the formation of disinfection by-products, some of the most important being the trihalomethanes. These compounds represent a chemical risk due to their carcinogenic and mutagenic potential. Recently, alternatives such as solar disinfection and photocatalysis have been considered because of their potential to

target both microbial and chemical risk. Solar disinfection relies on the ultraviolet portion of the solar spectrum, which destroys cell walls in bacteria and causes photo-oxidation of some organic substances. Helio-photocatalysis is based on the interaction of sunlight with solid semi-conductor particles, which produce highly oxidative species that not only destroy bacteria but also degrade a large variety of chemical compounds present in water.

Laboratory scale experiments in Lausanne, Switzerland and in Cali, Colombia have shown that photocatalytic treatment using the activating catalyst, TiO_2, effectively inactivates bacteria such as E.coli, and degrades natural organic compounds like dihydroxyphenols present in water. A drastic bacterial inactivation was observed during irradiation of distilled water spiked with a bacterial suspension. The same was observed with crude water and water containing primary and secondary effluent coming from a drinking water production plant. These results also showed the need to gain additional information concerning the different factors that can influence the solar treatment and characteristics of the phototreated water.

3.4. Developing indicators to assess the main ecological impacts of the oil industry in Colombia. Case study: Department of Huila

Partners in Switzerland: Elizabeth León, Rodolfo Schaefer
Partners in Colombia: Alejandro Martinez, Daniel Vergara G.

This project work is carried out within the frame of the cooperation program between the EPFL, in Switzerland and la Asociación colombiana del Petróleo, in Colombia.
The development of oil activities in Colombia carries, in a large number of cases, the risk of severe environmental damage and social disruption. Since potentially hydrocarbons-rich geological formation areas are highly correlated with high biodiversity, oil developments can in many cases affect sensitive ecosystems.

Over the last three years, the oil industry along with the Colombian Government has undertaken the project "Environmental Land-Use for Hydrocarbon Exploration and Exploitation", aimed at developing a whole set of environmental and socioeconomic parameters for the oil industry's new project evaluation. These parameters will also allow the definition of environmental constraints. One of the main achievements of our research is a methodology to define a set of indicators to assess the main impacts of the oil-related activities on natural ecosystems, for example, indicators to monitor and assess the quality of tropical freshwaters and forests. A region of Colombia, the Department of Huila (south East Colombia) was chosen for a case study. We have devised the following methodology for our project:
- Establish the terms of reference, including aims, participants, location and environmental assessment methods. The assessment itself then follows three stages: selection of assessment tools, information gathering and evaluation of results. This step will allow determination of the main environmental impacts of oil-related activities and to select indicators to measure them
- Ascertain the technical and economical feasibility of these indicators. The evaluation of the indicators time trends, their statistical representativeness and their integration into a geographical information system are including in this phase.

The application of this methodology would allow us to:

- Understand the environmental problems associated with the oil industry and devise practical solutions that combine scientific, technical and local indigenous knowledge.

- Determine an ecological indicator set to continuously assess the ecosystems state, which in addition would allow the Colombian Government and the oil industry to focus on, and act upon, priority environmental issues.

REFERENCES

Pulgarin, C. April 2001. Cooperation program in the environmental field between the EPFL and several Colombian Institutions.

Maselli, D.1998. Guidelines for Research in Partnership with Developing Countries. 2nd edition.

http://lslwww.epfl.ch/~acis/