

Approach to environmental capacity-building in Africa by the Inter-State Colleges of Engineers and Senior Technicians in Hydraulics and Rural Infrastructure of Ouagadougou

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Introduction

In its efforts to develop its economy and raise the standard of living of its population, Africa is faced with serious environmental problems which have varied causes: climatic variations, population growth and poverty, to mention only a few. To address these problems, government policies, programs and development projects must be refocused on the goal of improving the well-being of the population and protecting the environment in accordance with the principles of sustainable development. This process of refocusing will be effective only if there are human resources that are sufficiently trained and aware of environmental concerns at all levels of the development process.

The first step in capacity-building is training. However, most training institutions in Africa, including universities and engineering institutes, still concentrate the bulk of their training programs on technical and scientific knowledge, relegating to a position of secondary importance or quite simply ignoring social, cultural, political and environmental considerations (Stocking and Perkin, 1996).

In addition to these technical skills, the engineers or technicians of today and tomorrow must develop management skills. They must be able to reconcile the technical, social, cultural, political, economic, communication and environmental aspects. Indeed, the environmental dimension is an essential component of any sustainable development project.

The Inter-State Colleges of Engineers and Senior Technicians of Ouagadougou, in their approach to the training of well-rounded rural infrastructure engineers and technicians, strive to be incubators for men and women who will be leaders in their fields of expertise. Having identified deficiencies in the way environmental protection is incorporated into their training programs and recognizing that it is essential that graduating engineers and technicians incorporate environmental concerns into their future activities, which will undoubtedly improve their employment prospects on the current labour market, the administration of the EIER-ETSHER group has reorganized its training programs in order to adapt to changing needs. In this context, the EIER and the ETSHER have been developing since 1991, with the technical assistance of the *Institut du Génie de l'Environnement* (IGE) of the *École Polytechnique Fédérale de Lausanne* (EPFL) and the financial support of the *Direction pour la Coopération et l'aide Humanitaire* (DDC) of the Swiss government, an educational approach which takes environmental concerns into account. Since the environment is a field that cuts across many different disciplines, it must be incorporated into the training curriculum not in the form of specialized courses or modules, but rather as integral parts of the various courses comprising the training of engineers and technicians. Each teacher is encouraged to develop this approach and to incorporate it as part of training and research activities. The objective was to develop, at the EIER and at the ETSHER, skills that would enable teachers to include environmental and sustainable development concerns in the teaching of their various disciplines and other activities (research and engineering), to instill in students an environmental culture, to give the scientists and technicians responsible for field work access to appropriate environmental training, and to make public authorities more aware of the need to enhance the capacity of managers in the technical ministries and the private sector to incorporate environmental concerns into their activities.

This paper outlines the strategies adopted to develop this approach, the actions taken, the main results achieved, the major obstacles encountered and the recommendations for improving the implementation of the approach.

1. Approach methodology

To attain the objective of this environmental training program, the EIER and the ETSHER have adopted a very original approach, compared to other institutions of higher education and universities in Africa and even the West. This consisted in incorporating, over the short, medium and long term, at all levels of teaching and therefore also in teacher training, knowledge about and concern for environmental protection and sustainable development. The two colleges, with the assistance of the IGE, established a coherent educational and financial program. To this end, it was necessary to identify various areas for action by the program to more effectively raise awareness of environmental concerns among the various target groups (teachers, students, professionals), identify various topics that should be covered depending on the areas for action and plan the educational tools needed to attain the desired objectives. Similarly, it was necessary to develop human resources capable of implementing the approach, and solicit and make available the financial means to carry out the program.

A number of actions were taken to translate these various requirements into reality. The first was the organization of two seminar-workshops in 1991 (May and September 1991) respectively on the topics: "Training in environmental protection" and "The interdisciplinary approach and the environment" (Erbetta and Krayenbühl, 1991; Nicod, 1991). These seminar-workshops, which were the starting point of the program, brought together a number of specialists and interested partners from the West and from various sub-regions of Africa and provided an opportunity to begin to put the approach into practice. The various areas for action by the program were identified during these two seminar-workshops. The participants selected and ranked in order of priority the main topics that should be covered in order to introduce environmental considerations into the training program of the two colleges. All of the actions taken in the context of this approach can be classified according to two strategic axes: namely institutional measures and organizational measures.

1.1. Institutional measures

The determination and commitment to implement this approach encouraged the administration of the EIER to consider, in the context of the renewal of the partnership agreement between the EIER and the EPFL, the establishment of an environmental protection program as an interdisciplinary approach in the EIER's training curriculum, with the technical assistance of the IGE and the financial assistance of the DDC.

In order to facilitate joint planning and management of the various actions in collaboration with the IGE, the EIER and the ETSHER established, under the terms of their agreement, a technical steering committee which was tasked to validate the program action plan and to coordinate, supervise and evaluate the effectiveness and efficiency of implementation of the various actions. It was also intended to stimulate strategic discussion and debate about the goals and objectives of the program. This technical committee was composed of representatives of the three parties involved in the program.

Another institutional measure was the development of a logical framework and a projected five-year budget by the technical steering committee. The funding program, negotiated on a five-year basis with the DDC, was autonomous and contained a clause whereby funding of the program will gradually be assumed by the colleges' budget. This logical framework grouped all the planned activities into six main fields: introductory and specialized training, professional training, information, advocacy and awareness-raising, intra- and inter-institutional cooperation and external relations. This framework made it possible to address

issues relating to support for teachers, professional development periods for teachers, undergraduate training of students, continuing education of professionals, awareness-raising and advocacy aimed at the general public, presentations, conferences/debates, applied research using an integrated and interdisciplinary approach, cooperation with public and private institutions operating in the environmental field, and inter-university collaboration. To incorporate these various actions into the EIER's training program, the administration of this institution adopted a new educational benchmark in 1994.

1.2. Organizational measures

To implement this program, a permanent position of environmental studies teacher was created and a teacher specializing in the environment was recruited from within the EIER in 1994. This teacher was responsible for managing and supporting the actions identified, for designing, proposing and overseeing all other actions capable of contributing to the development of an environmental culture within the colleges. During the three-year (1994-1996) experimental phase, the teacher's activities covered both colleges (EIER and ETSHER). At the end of this phase, a consolidation phase, with a five-year program (1996-2001) accompanied by an estimated budget, was developed. Given the large volume of activities to be carried out, another environmental studies teacher was recruited by the ETSHER.

All of the activities to be carried out were derived from the logical framework and were carried out in accordance with the policy guidelines set out by the administration of the EIER-ETSHER, aimed at incorporating environmental considerations into the training curriculum of both colleges. An annual action plan detailing the various activities to be carried out in each area for action identified was developed. The cost of each activity was estimated and an annual budget for all the activities was approved by the technical steering committee. The environmental studies teachers supervise the implementation of the activities approved and funded. Depending on the specialty field into which the activity falls, various teachers from the two colleges carry them out. These teachers manage the budgets associated with these activities in conjunction with the environmental studies teacher.

2. Results and discussion

The various activities carried out were analysed based on the six areas for action identified. The type of activities developed, the degree of progress achieved, the main problems encountered during implementation and the proposals for improvement were described.

2.1. Training

The activities were aimed at three types of targets: teachers, students and professionals (trainees). They covered four essential fields of activities: teaching, support for teachers, support for students' internships and practical work (engineering, job placement), supervision of dissertations and practical work for the diploma (for students from the EPFL).

2.1.1. Teaching

Undergraduate training

During the first year of training, at both the EIER and the ETSHER, the environmental studies teachers participate in an interdisciplinary team with other teachers in the "immersion excursion," which is essentially a discovery of the rural setting by the students. During this excursion, the concepts of ecology (ecosystem, dynamics of the environment, degradation, etc.), as well as the concepts of socio-economic and cultural environment, are examined with the students. Next, at the EIER, in the context of the "physical environment excursion," the concepts of physical components of the environment and their interactions are explored in somewhat greater depth.

In the second year at the EIER, during the "agrarian system excursion," farming systems and their socio-economic and environmental impacts are examined.

In the third year at the EIER and the second year at the ETSHER, the implementation of projects incorporating environmental concerns constitutes one of the activities for which the environmental studies teachers are most frequently called upon both by their colleagues who supervise these projects and by the students, for analysis and incorporation of environmental aspects (Yonkeu et al., 2000). It is also during the third year that a course entitled "Development and Environment" is regularly taught at the EIER. This 33-hour course, which focuses on incorporating environmental concerns into development projects, covers the preliminary concepts of environmental impact assessments. Also in the third year at the EIER, the final dissertation topics on environmental issues for rural infrastructure engineers are proposed to the students. For instance, from 1996 to 2001, there were ten dissertations on topics dealing with environmental concerns, seven reports are available in the EIER library and three reports are being completed (students from the class of 2000-2001).

Table 1 presents the number of engineers and senior technicians trained from 1995 to 2000 who have received training in the basic elements of incorporating environmental concerns as part of their curriculum. Every year, some 30 rural infrastructure engineers (since 1995) and some 50 senior rural infrastructure technicians (since 1997) are trained in the basic concepts of environmental concerns.

Table 1: Number of engineers at the EIER and of senior technicians at the ETSHER who have benefited from this environmental training approach in their curriculum (1995-2000)

Country	Number of engineers	Number of senior technicians
Benin	9	18
Burkina Faso	21	16
Cameroon	12	19
Central African Republic	15	4
Congo	13	14
Côte d'Ivoire	14	11
Gabon	1	13
Guinea	6	8
Mali	13	6
Mauritania	4	9
Niger	22	17
Senegal	22	16
Chad	13	13
Togo	12	18
Total	177	182

Postgraduate training

Training in five areas of specialization leading to a specialized diploma (DESS: *Diplôme d'études scientifiques supérieures*) is provided at the EIER every year: sanitary engineering (SE), agricultural hydraulics (AH), mobilization of water resources (MWR), electrical engineering and industrial refrigeration (EEIR) and information technology applied to water management systems (ITWM). The first four training programs named above follow a 27-hour common core course on environmental impact assessments. This course, although insufficient in terms of the number of course hours, gives students an opportunity to become aware of the importance of incorporating environmental issues into the engineering profession.

Table 2 presents the number of students in specialized training who took the course on environmental impact assessments from 1993-94 to 2000 for SE, from 1995-96 to 2000 for MWR and from 1996-97 to 2000 for AH and EEIR.

Table 2: Number of EIER/DESS students who have taken the environmental training

PGT\ Country	Ben- in	BF	Cam	CAR	Con- go	CI	Ga- bon	Gui- nea	Mali	Mau	Nig	Sene	Chad	Togo	Total
SE	10	6	7	1	7	7	1	2	7	1	5	10	2	4	70
AH	3	8	1	0	1	2	0	2	8	2	6	6	2	3	44
MWR	3	9	2	0	3	6	1	3	8	2	7	6	3	3	56
EEIR	6	6	2	0	3	5	1	3	5	1	1	3	5	2	43
Total	22	29	12	1	14	20	3	10	28	6	19	25	12	12	213

SE: sanitary engineering - AH: agricultural hydraulics - MWR: mobilization of water resources

EEIR: electrical engineering and industrial refrigeration

Continuing education

This has been the focus of awareness-raising efforts concerning environmental problems aimed at professionals. Continuing education sessions on environmental issues (12 in total since 1992) have been organized, including seven on environmental impact assessments, two on geographic information systems (GIS) applied to environmental management, one on land use planning and natural resource management, one on the environment and the integrated management of urban environments, and one on solid waste management. These sessions, with an average duration of two to six weeks (for EIAs), have contributed to building the environmental planning and management capacity of the member countries of the inter-state colleges.

In addition to these sessions dealing predominantly with environmental issues, activities have been organized in the context of other sessions held within the colleges at the request of the training directors of these sessions or other partners of the colleges. This fosters an ongoing and interdisciplinary network of activities and discussions.

Table 3 summarizes the number of professionals who received three to six weeks of environmental training from 1992 to April 2001.

Table 3: Number of professionals who received three to four weeks of environmental training at the EIER/ETSHER

Country	Number of professionals
Benin	17
Burkina Faso	47
Cameroon	14
Central African Republic	10
Congo	6
Côte d'Ivoire	8
Gabon	2
Guinea	19
Mali	26
Mauritania	3
Niger	24
Senegal	6
Chad	16
Togo	10
Other	4
Total	212

Some 20 professionals receive environmental training or refresher training every year, notably on environmental impact assessments. These professionals come essentially from the 14 member countries of the inter-state colleges and occasionally from other countries of Francophone Africa (Burundi, Madagascar, etc.). They come from the public and private sectors. This diversity of specialists from different backgrounds and sectors of activity lends dynamism and vitality to the training which fosters discussions and sharing of experiences. According to the evaluations provided by the trainees, this training has been a solid success.

In addition to the regular sessions held every year, customized training is provided to meet the much more specific needs of the requesting services for clearly defined target groups.

Support for teachers

In order to facilitate the integration of environmental considerations into the teaching, the environmental studies teacher, with the participation of the teachers concerned, evaluated the content of the courses given by the various teachers in 1995. Following this evaluation, a document was developed, listing the proposed environmental aspects to be included in the various courses depending on the specific objectives of the course (Mbengue, 1995). This evaluation also made it possible to identify the types of documents (reference books, journals) that should be acquired to assist the teaching staff in preparing their teaching. Today, the EIER and ETSHER documentation centres boast a collection of more than 50 reference books, magazines and journals dealing with the various environmental aspects.

In 1999, a survey of the teaching staff at the EIER and the ETSHER and an evaluation of a number of course handouts and course materials produced by the teachers showed that the teachers in the EIER/ETSHER group are all aware of the need to incorporate environmental

concerns into their courses and research activities. Furthermore, approximately 30% of the teachers have fully or partially integrated the environmental aspects pertaining to their disciplines in their course notes, while others cover these aspects directly during their lectures (Yonkeu and Mamane, 1999; Sieyadji, 2000). This relatively modest result is explained in part by the fact that certain course handouts were not yet updated at the time of this study. Some subjects lend themselves less well to such an exercise (mathematics, technical drawing, etc.). However, there are also some teachers who have difficulty integrating environmental aspects or are reluctant to take part in this exercise, since it entails a reduction in the number of hours reserved for the technical aspects and an increase in the workload required to incorporate environmental aspects into their teaching.

Others forms of support for teachers and for students and trainees have consisted in researching and making available bibliographic indices which will enable them to find basic reference documents available either in the documentation centres of the two colleges or from other libraries, as well as articles selected based on their relevance to the colleges' specialty fields. Finally, formal and informal discussions on various topics of environmental interest take place regularly between the environmental studies teachers and the other teachers and students of the colleges.

Teachers from both colleges often collaborate with the environmental studies teachers to conduct study missions on the environmental challenges facing the colleges' member states. For instance, approximately ten missions have been carried out in various states, providing an opportunity for approximately five teachers from other specialties to study environmental issues.

Support for students

In addition to the supervision that students receive during their various field excursions, integrated projects and final dissertations, a few students completing their undergraduate or postgraduate training receive research support grants to work with a teacher on a research topic taking environmental problems into account (for undergraduate training) or study-to-work grants (for postgraduate training) to work in development organizations (research departments and consulting firms, small and medium-sized enterprises, NGOs, etc.) which take environmental aspects into account in their activities.

2.1.2. Professional training

This activity concerns the professional development of teachers in the environmental aspects relating to their specialties. To this end, five professional development periods have been funded for teachers in areas other than the environment: two professional development periods on the application of geographic information systems to the environment for a mathematics/information technology teacher from the EIER, an internship on the management of mangrove swamps for an agricultural hydraulics teacher from the EIER and a water and soil management teacher from the ETSHER, and an internship on sanitation and urban waste management for a sanitation teacher from the ETSHER.

2.2. Information

To carry out this very important activity of incorporating environmental concerns into the training, the program has acquired tools for obtaining and disseminating information. For instance, various audiovisual materials have been acquired (a television, a VCR, a video camera, a number of videos dealing with various environmental topics, a camera, various slides). As mentioned earlier, a number of books, collections of reference books, journals and magazines were purchased and are made available to teachers, students and the public in the documentation centres of the two colleges.

Every year, workshops and conferences (one or two per year) are organized for teachers, students and trainees. They are often aimed at encouraging teachers to realize the importance of complementarity between disciplines in the approach to solving development problems. They inspire the teachers to take a holistic view of their specialty field as part of a coherent approach to addressing environmental and sustainable development problems.

2.3. Advocacy and awareness-raising

Field excursions to observe and reflect on particular environmental and development issues are organized regularly for teachers and students. These excursions provide an opportunity to make teachers and students more aware of the complexity of development and environmental problems and the need for a systemic and interdisciplinary approach to better understand environmental realities.

A joint EIER/ETSHER environment club was established by students at both colleges in 1998. In the course of their information and awareness-raising activities aimed at students and the public, they research information in various environment-related fields and disseminate this information through posters or through the club's newsletter established in 2000. The club also organizes conferences-debates bringing together specialists from various fields (teachers, specialists from international agencies and institutions working in the environmental field, NGOs, research departments, consulting firms). These forums provide excellent opportunities for discussions between teachers, students and professionals working in environmental fields.

The students also organize a number of film projection sessions on environmental topics. This has become a significant activity this academic year (2000-2001) with the projection of one film a week.

2.4. Intra- and extra-college cooperation

This cooperation has been encouraged through research. Indeed, the environmental protection program encourages and funds multidisciplinary research projects presented by teachers at both colleges. These projects are an excellent way of promoting an interdisciplinary approach to problems. The college's teachers of various specialties are mobilized around research topics incorporating environmental concerns such as: assessment of the environmental impacts of the paving of the Ouagadougou-Kaya highway, management of the water resources of the city of Ouagadougou, habitat improvement and sustainable urbanization in economically disadvantaged neighbourhoods (Pisy in Ouagadougou), study of landscape degradation in the upper Nakambé basin in Burkina Faso, etc. Outside contributors (University of Ouagadougou, researchers from the research departments and consulting firms, technicians from the technical ministries concerned by the various research topics) have been called on to take part in the discussion and study of these research topics. Research forums are organized by the EIER's research and engineering department to allow the various members of the research teams to present the progress of their research work and to have discussions with other teachers, students and the public. These meetings provide an opportunity, in some cases, to incorporate aspects that may have been overlooked or neglected.

2.5. External relations

In addition to the above-mentioned missions in the states carried out by the teachers, since last year, the environmental studies teachers have had an opportunity to conduct inter-institutional collaboration missions. For instance, in 2000, the teacher from the EIER visited the University of Quebec at Montreal (UQAM), the Environmental Sciences Institute (ISE) in Dakar and the Ecological Monitoring Centre (CSE) in Dakar.

The program also funds, within the limits of its capabilities, participation by teaching staff in international conferences dealing with environmental issues. Three or four teachers have already taken advantage of this opportunity. This is an opportunity for these teachers to meet with other specialists, make contacts, network and exchange information and experiences.

3. Difficulties and obstacles

Incorporating environmental concerns into the training curriculum of the inter-state colleges of engineers and technicians by integrating these concerns into the various courses and other activities (research and engineering) of the teaching staff is a methodological approach that is relatively difficult to implement because of its innovative nature. Indeed, while some teachers quickly embraced this approach, others to the contrary, while agreeing with the need to take environmental considerations into account in the training curriculum, believe that this should be done through a common core course. The difficulty arises from the fact that most of these teachers do not have the necessary skills that would allow them to take the environmental aspects of their specialty into account. Others feel that incorporating environmental aspects into their courses would mean less time available to cover the technical aspects, which they already consider insufficient to cover their program, as well as an increase in the workload to incorporate these aspects into the teaching. Moreover, since taking environmental issues into account in development policies is a relatively recent phenomenon in most African countries, there are very few instructional and educational materials relating to the ecological and environmental problems of these countries. The materials and information available deal mainly with general problems or particular situations in developed countries.

In the field of postgraduate training, while the common core course on EIAs is given regularly, the relatively limited amount of time allocated to this course (27 hours) does not make it possible to effectively address certain aspects, notably the practical aspects such as field excursions.

The major constraint concerning continuing education remains the problem of funding these sessions. In fact, less than 50% of those wishing to take part in these sessions have their own funding that would enable them to participate. The EIER/ETSHER and its donors still subsidize the majority of the participants.

In terms of information, a number of reference books and journals have been acquired, but their effective use by teachers and students continues to be less than ideal. The reasons are varied: the teachers are not sufficiently informed of the reference books available (problem of communication), they do not have enough time to consult the documents and retrieve the relevant information (problem of workload), the documents available do not always address their concerns (problem of choice of documents).

The difficulty experienced by the environment club in attracting the maximum number of students to its activities is attributable to two factors: their very busy schedule, which constitutes a major obstacle, and the inadequate awareness-raising effort aimed at first- and second-year EIER students, who have very few formal direct contacts with environmental issues and therefore are not yet convinced of the importance of these issues for their future profession as engineers.

In the field of applied research, we note that the teaching staff find it difficult to propose topics that incorporate environmental concerns. Thematic approaches continue to be predominant in the development of research projects.

4. Proposals for improvement

The integration of environmental considerations in the courses given by undergraduate teachers may be improved following the review of educational benchmarks currently under way at the EIER and already in effect at the ETSHER. In fact, the ETSHER has introduced ecology courses in the first year and EIAs in the second year of its BTS [*brevet de technicien supérieur*] diploma program 2001, while the EIER in the approach to developing its new benchmark, classifies the environment as one of its identified skill areas (which confirms that it is genuinely aware of the reality of incorporating environmental aspects into the training curriculum). This full-fledged integration of environmental aspects in the curriculum will make it possible to address aspects other than EIAs, which currently receive priority attention. Furthermore, in the six other skill areas identified, the environment is integrated as a component of teaching of general knowledge on the technical aspects. This approach will probably encourage the teaching staff to identify the environmental aspects relating to their courses and will thus foster an ongoing flow of information between them and the environmental studies teacher.

The research and development of instructional and educational materials (methodological guides, slides, videocassettes, etc.) that are adapted to the reality of the receiving environment in which this training will be applied and are appropriate to the field of expertise of the colleges are essential and will facilitate integration.

Information and training for teachers must be better targeted, adapted, organized and strengthened. To this end, it will be necessary to better identify (in conjunction with the teachers) and organize short-duration professional development training designed to provide them with the skills to incorporate environmental considerations into their specialty fields; it will be necessary to improve their access to information and self-directed learning in the environmental areas relevant to them by making available more specific references (acquisition of more targeted information sources corresponding to the needs expressed and making them available); it will be necessary to better organize the training workshops, conferences and visits aimed at teachers. The topics, dates and locations for holding these activities must be chosen in conjunction with all of the teachers at the beginning of the academic year during the back-to-school seminar so that these activities are officially taken into account in their work schedules.

To improve the students' perception of environmental issues, the research support and job placement grants accorded to the students must be better targeted, organized and adapted to allow them to gain hands-on experience, in real situations, with environmental problems and how they are taken into account in the professions of engineer and technician. To this end, it will be necessary to choose topics that better reflect environmental concerns and appropriate organizational structures.

To promote an interdisciplinary spirit in the field of research, cooperation between the colleges and other institutions should be encouraged through joint research programs. Exchanges of experience in the area of environmental teaching with universities and institutions of higher education in Africa and in the West should also be encouraged.

To more effectively implement these various improvements, increased financial and human resources will be required. Indeed, the activities of compiling information, summarizing it and making it available to teachers and students, the activities of awareness-raising (organizing visits for teachers and students, film projection sessions, etc.) and of encouraging student involvement in the environment club are very time-consuming. The environmental studies teachers at the two colleges cannot effectively carry out these various activities by themselves given their workloads for the year (courses, continuing education, supervision of field work, supervision of dissertations, administration of activities funded by the

environmental protection program), which do not necessarily take these activities into account.

Conclusion

The principle of introducing environmental considerations as an interdisciplinary approach into the training curriculum of the EIER and the ETSHER is currently strongly supported by the majority of the teaching staff at both colleges. However, effective implementation of this approach still requires more awareness-raising and encouragement of the teachers. This goal is most likely to be attained through greater involvement of the teaching staff in the selection and programming of the priority environmental topics, and in the production of appropriate educational materials. It will also be necessary to improve professional training for teachers, develop interdisciplinary research and increase exchanges with other institutions that share the same concerns.

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