PROGRAMME ON
ENVIRONMENT INFORMATION SYSTEMS IN SUB-SAHARAN AFRICA

GUIDELINES FOR EDUCATION AND TRAINING
IN ENVIRONMENTAL INFORMATION SYSTEMS
IN SUB-SAHARAN AFRICA:
SOME KEY ISSUES

by

Professor John L. van Genderen

Guideline Series, No. 1
February 1992
This paper was prepared by:

Professor John van Genderen,
I.T.C., International Institute for Aerospace Survey and Earth Sciences,
Enschede, The Netherlands

Programme on Environment Information Systems in Sub-Saharan Africa
International Advisory Committee Member

In conjunction with:

The International Advisory Committee for
the Programme on Environment Information Systems in Sub-Saharan Africa

and

The Environment Division
Technical Department, Africa Region
The World Bank

This paper is an informational document prepared in connection with the Program on Environment Information Systems in Sub-Saharan Africa. The views expressed herein should not be attributed to the World Bank or any of its affiliated organizations.

February 1992
Cover illustration by Valerie Falloux
PREFACE

There is a crucial need for environmental data in Sub-Saharan Africa. Environmental problems have complex causes, involving both physical and human factors. It is easier to deal with these causes if the required data can be collected, managed and used in a systematic way.

The Programme on Environment Information Systems (EIS) in Sub-Saharan Africa was established in 1990 to help set up operational EIS (see "Programme Presentation"). The term "environmental information system" is used to describe any organized system for environmental data management, including geographic information systems (GIS).

For a country to have an effective environment information system, it must have policy makers and administrators capable of appreciating the applications and implications of the information, and scientists, engineers, technicians and teachers capable of developing, adapting, applying and teaching the technologies. Education and training are essential to build up these skills.

The Programme’s International Advisory Committee would like to promote the publication and circulation of clear and concise documentation on EIS issues; this paper represents the first in a series of guidelines. It is intended to produce a range of guidelines and notes for the establishment of national EIS; for international agencies interested in supporting EIS work; on country case studies; on the impact of environment information on the decision-making process; and an EIS "directory" with information on current training options, on documentation sources and on relevant software.

This publication recognizes the increasing importance of environment information-related training in Africa. It discusses many of the issues involved, and contains a variety of valuable proposals regarding the contents of EIS education programmes, and the required teaching methods and tools.

Leif E. Christoffersen
Division Chief
Environment Division
Technical Department, Africa Region
World Bank
PROGRAMME PRESENTATION

PROGRAMME ON
ENVIRONMENT INFORMATION SYSTEMS
IN SUB-SAHARAN AFRICA

The World Bank, with other donors and international agencies, initiated this programme in early 1990. The aim is to help Sub-Saharan countries set up operational environmental information systems, to meet the priority demands of resource users, planners and decision makers for better renewable resource management. Such systems are a key element for National Environment Action Plans (NEAPs), which are being prepared in an increasing number of countries in Africa. Work on programme falls under the auspices of NEAP processes where these are in progress.

The programme supports African countries as they assess their priority needs in terms of environment and land information and analyze the technical, institutional, legal and economic issues hampering their possibilities of meeting these needs. It assists them in finding adequate, sustainable and long-term solutions to deal with these issues.

Among the countries which are interested in the programme, and have participated by sharing relevant information, are Benin, Botswana, Burkina Faso, Côte d'Ivoire, Kenya, Lesotho, Madagascar, Senegal, Uganda, and Zimbabwe. Involvement depends on both the interest expressed by the countries and the capacity of the international community to provide the necessary funds. Several bilateral and multilateral agencies, including the Bank, are supporting the programme, and others are expected to join in.
# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>PREFACE</td>
<td>i</td>
</tr>
<tr>
<td>PROGRAMME PRESENTATION</td>
<td>ii</td>
</tr>
<tr>
<td>INTRODUCTION</td>
<td>1</td>
</tr>
<tr>
<td>ISSUE 1: Who needs to be trained and why?</td>
<td>2</td>
</tr>
<tr>
<td>ISSUE 2: Where should the training take place?</td>
<td>7</td>
</tr>
<tr>
<td>ISSUE 3: How many people need to be trained?</td>
<td>10</td>
</tr>
<tr>
<td>ISSUE 4: How long should the training be?</td>
<td>13</td>
</tr>
<tr>
<td>ISSUE 5: What should be taught, and how?</td>
<td>14</td>
</tr>
<tr>
<td>ISSUE 6: Who should do the training?</td>
<td>17</td>
</tr>
<tr>
<td>ISSUE 7: Who pays for the training?</td>
<td>18</td>
</tr>
<tr>
<td>CONCLUSIONS AND RECOMMENDATIONS</td>
<td>20</td>
</tr>
<tr>
<td>ACKNOWLEDGEMENTS</td>
<td>29</td>
</tr>
<tr>
<td>REFERENCES</td>
<td>31</td>
</tr>
<tr>
<td>ACRONYMS</td>
<td>34</td>
</tr>
</tbody>
</table>
INTRODUCTION

1. An effective system of education is considered essential for all nations. Within this system, training programmes are provided to develop specific skills. If a country is to use Geographic Information Systems (GIS) technology effectively as a tool in environmental information systems (EIS), it must have policy makers and administrators capable of assessing the political, social and economic implications of the technology, and how it should be introduced and managed to be most efficient and to gain the greatest benefit; scientists capable of developing and adapting the technology; engineers to design applications systems; technicians to construct, operate and maintain the systems; and teachers to teach the technology. A variety of education and training programmes will be required, at various levels and with various orientations or specializations. It is important here to make a distinction between the terms "education" and "training" as used in this paper.

2. The objectives of education are to bring the individual to an understanding of a subject, so that he or she may form independent opinions, establish priorities, understand and discuss the methodology, the techniques used and their applications. Education is concerned with the development of mental ability and of mental power, and thus with the attitude of persons.

3. The objectives of training are to teach individuals to carry out specific tasks based upon an accepted methodology and for which known techniques are available. Understanding of the context is not always required; often only the ability to apply the technique is needed. Knowledge of the subject as a whole, may not be necessary. Training brings the individual to a desired standard of efficiency. This is achieved by instruction and practice.

   Specific differences between training and education are listed below (Burns and Hendersen, 1989):

<table>
<thead>
<tr>
<th>Training</th>
<th>Education</th>
</tr>
</thead>
<tbody>
<tr>
<td>* specialized instruction</td>
<td>* general instruction</td>
</tr>
<tr>
<td>* short time frame</td>
<td>* long time frame</td>
</tr>
<tr>
<td>* concentrated attention</td>
<td>* dispersed attention</td>
</tr>
<tr>
<td>* intense delivery</td>
<td>* measured delivery</td>
</tr>
<tr>
<td>* practical emphasis</td>
<td>* theoretical emphasis</td>
</tr>
<tr>
<td>* performance skills</td>
<td>* knowledge acquisition</td>
</tr>
<tr>
<td>* behavioral change</td>
<td>* synthesis of ideas</td>
</tr>
</tbody>
</table>

4. To create the awareness, flexibility and motivation necessary to adjust to rapidly changing conditions, education and "continuing education" programmes to keep pace with changing environmental information technologies are likely to be more effective than training for tasks which, because of the very nature of the new technologies, will alter quickly.
5. This paper raises various key issues related to education and training in EIS in Sub-Saharan Africa such as who needs to be trained, and for each of the groups identified, raises issues relating to how many need to be trained, where the training should take place, how long the training should be, who should do the training, what should be taught, how should it be taught, who will pay for the training, what facilities are required, etc.

6. The paper concludes with a number of observations and recommendations on some "ways and means" to improve the education and training of EIS personnel in Sub-Saharan Africa. Numerous literature references are provided for those wishing to delve further into the issues raised.

ISSUE 1: WHO NEEDS TO BE TRAINED AND WHY?

1. Most African countries are still at various stages of institutional development in which a relatively large number of personnel at various levels and in different categories are to be trained for specific skills in a short period of time. In addition, education is required to establish or modify professional infrastructures. Marked differences in the level of socio-economic and institutional development occur between regions and countries in Africa. This is reflected in the number of personnel needed for the various categories and the levels of functions requiring education and training. It is also reflected in the degree of dependence on outside educational or training facilities such as those of the International Institute for Aerospace Survey and Earth Sciences (ITC).

2. EIS educational and training programmes are required for at least the following categories of persons. These categories are discussed in the subsequent paragraphs:

(a) Decision-makers and planners, including politicians and senior officials, who should have a general awareness of EIS and their practical and policy aspects;
(b) Opinion leaders (individuals such as leading scientists and directors of government environment programmes), who are influential in approving or disapproving such new methods as EIS;
(c) Managerial persons in institutions, agencies and private enterprises, who should have sufficient technical background to coordinate activities regarding specific applications of EIS;
(d) Personnel carrying out resource surveying tasks at various levels, who should receive instructions for interpretation of imagery and digital data for mapping and monitoring in various disciplines and environments and the manipulation of the data in a EIS;
Technical support staff, from engineers to technicians, who should be responsible for construction, operation and maintenance of facilities and equipment and which need manuals with instructions for performing technical tasks;

Research workers, who should develop interdisciplinary approaches in their work and possess in-depth knowledge on several aspects of EIS;

Teachers, responsible for the education and training of the various groups of personnel, who should have an insight in technical matters and in environmental sciences, and experience in educational technology and curriculum development;

Students at schools, colleges, universities, etc.;

The general public.

3. DECISION MAKERS

Often the real players in EIS technology are overlooked. Senior decision makers in government, private industry, in donor organizations, etc. make decisions about future direction, infrastructure and staffing needs. While the GIS community has been relatively successful in capturing the imagination of technical and middle management personnel, it has not been as successful in conveying to top management the potential benefits of the technology. At this level arranged appointments, one-to-one interviews, luncheons, and short demonstrations matched to the specific needs of the client organization may be better avenues for communication than short courses, workshops and lectures, which are more appropriate strategies for capturing the commitment of those who will undertake the actual implementation of the technology, namely, the professional, para-professional and technician groups.

Strategies have to be developed that will target particular user and management groups and provide them with specific information relevant to their needs in addition to maintaining a high profile for EIS in the general workplace. Thus this first category consists of decision-makers and planners, including politicians, preparers of decisions (planners, etc.) and senior officials responsible for briefing (political) decision-makers. Seminars for decision makers of 2-5 days duration to discuss EIS issues so that they can prepare EIS policy proposals, have shown to be very successful educational tools.

4. OPINION LEADERS

Some EIS adopters in Africa are "active" in influencing other individuals or organizations to also adopt the new methodology. Others who have adopted the innovation provided by EIS do not attempt to influence others to do so. Similarly there are active rejecters of new approaches who also may or may not influence others, this discouraging change. Thus it is important to reach and train these opinion leaders, as they can exert personal influence upon a certain number of other people. This is especially important at the evaluation stage in the process of adoption of new technology such as provided by EIS. Once these opinion leaders have become informed on the benefits of EIS, training this group has a marked "snowball effect",
i.e., the number of new individuals adopting EIS in each time period increased in proportion to those individuals already converted.

5. MANAGERS

Managerial persons in institutions, agencies and private enterprise constitute a second category. They should have sufficient technical background to coordinate activities regarding specific applications and to establish facilities for GIS.

6. PROFESSIONALS

A total training programme in EIS technologies should be structured so as to match the existing experience and employment levels of those seeking training. Training for professional and para-professional personnel should be aimed at providing experience in the design and implementation of projects using remotely sensed data and other information sources in the procedure associated with EIS analysis. Not all participants at this level, however, need to be proficient in the technical skills related to image processing, GIS manipulation, ground data collection, etc. as this would be the task of the next category, the technicians. The high demand for short courses in EIS in Africa stems from the fact that many professionals currently occupying leadership roles in African user agencies were trained before the advent of GIS.

7. TECHNICIANS

A fourth, equally important, category consists of technical support staff, from engineers to technicians, who should be responsible for the construction, operation and maintenance of facilities and equipment and who need manuals with instructions for performing technical tasks. Technician-level training may require instruction in the methods of collecting relevant ground data, conducting field measurement and undertaking image analysis, entering the data into a GIS, and processing and presenting the data in suitable formats. Clearly, theoretical considerations or instruction in the principles of environmental information management may be inappropriate at this level.

Support staff members are frequently not trained at all. They should be treated as valued employees, and they will benefit from an overview of changes in operational organizational restructuring plans resulting from the introduction of new digital EIS technology.

8. RESEARCHERS

Further progress is impossible without a fifth category, that of the research workers, who should develop interdisciplinary approaches in their work and possess in-depth knowledge on several aspects of EIS specifically related to the local environmental conditions in Africa and to local needs.
9. **Teachers**

The sixth category consists of teachers responsible for the education and training of the various groups of personnel. They should have insight into technical matters and environmental sciences, and experience in educational technology and curriculum development. This is the category which benefits most from training as it has the highest multiplier effect and spin-off benefits, as each teacher trained in the use of EIS in turn trains tens of people each year in the principles of GIS and how it can be used for establishing EIS in Africa.

Many alumni of courses in the west possess adequate knowledge to teach and train personnel in their own country. However, the lack of teaching aids, demonstration equipment and learning packages are hampering the educational activities to some degree. When these shortcomings can be removed, the potential resources of national instructors, teachers and professors can be better exploited. The introduction of new media and method should then also be possible and may well act as a multiplication factor.

In order to train the teachers, therefore, a number of pertinent issues need to be resolved:

- structure of education and training programmes, including their contents, language, scope, cost and duration;
- scope of programmes (intensive and comprehensive);
- means of keeping programmes current so that participating personnel can be kept abreast of developments in their disciplines;
- source and manner of acquiring/developing teaching materials and equipment;
- compensating for the absence of relevant materials and appropriate equipment at the local level;
- assuring control of quality and effectiveness of what is being taught;
- identification of specific institutions capable of housing the teacher education programmes;
- determination of the minimum basic background to be required of potential participants so that upon the conclusion of their education they would be capable of effectively using the newly acquired knowledge.

A further issue to be faced is that many African university staff who already have appropriate qualifications such as PhDs and who are reluctant to consider undertaking additional periods of long-term training in EIS, may be able to obtain the necessary skills through sabbaticals, occupational leave programs, short courses and the like.

Academic staff with bachelor and masters qualifications, however, are more keen to explore the possibility of extended training in EIS and should be enabled to do so by their institutions.
10. STUDENTS

While there will always be a market for the specialist short courses, in particular those dealing with new and advanced procedures, long term benefits are most likely to accrue from programmes aimed at training occupational student personnel about to enter the work force in EIS. This requires setting up an appropriate infrastructure at the university and technical college level of instruction and will be discussed later in this paper. Consideration should also be given to including secondary school level of education for the transfer of technology programmes.

11. THE GENERAL PUBLIC

All sections of society need to be informed on how knowledge is acquired and used to make decisions which affect living standards and life styles. Indeed, the cause of technology transfer would be greatly enhanced if the general public were kept more aware of the value of remote sensing and GIS technologies in solving environmental problems related to the rational management of earth resources. Environmental problem solving is by no means the sole realm of politicians and bureaucratic heads; community groups and individuals also have a fundamental, vital role to play. By bringing environmental situations to people's attention in a manner that illustrates how their own daily patterns may affect their environment they can become motivated to understand and act upon environmental issues in a positive manner.

Information seminars, public demonstrations, interviews, newspaper articles and TV clips should therefore assume an importance equal to some of the more deliberate strategies, such as the targeting of political leaders, funding agencies and potential user groups in order to promote the use and implementation of EIS in Africa.

12. Additional concerns regarding who needs to be trained and why include: aspects such as where do the trainees come from, and how should they be selected? As Hastings and Clark have pointed out, one has to be very careful to train the right groups of people. Whilst staff of research institutes, universities and those in the private industries are usually better paid, have better benefits, equipment and therefore often more talented, motivated and better trained people, it is the traditional civil service that has the operational mandates for gathering and providing information on the environment. Thus functionally they are the most logical "home" for EIS, even if they are severely limited in their ability to support a highly technical programme requiring continuity of personnel and activities. EIS programmes and training must therefore address the issue of ensuring sufficient infrastructure support to keep the EIS effective long after the initial training and implementation.
ISSUE 2: WHERE SHOULD THE TRAINING TAKE PLACE?

1. Here there are basically two options, each with various subcategories:

   Option 1: in Africa
   Option 2: overseas

2. **OPTION 1: IN AFRICA**

   One can distinguish the following locations:

   * regional (international);
   * national;
   * sub-national;
   * on-the-job.

   The largest number of personnel need specific types of training at rather low levels; the required training facilities should be available in every country and can even be located at provincial or local centres. A smaller number need medium-level training, preferably with multi-disciplinary input; the required educational facilities could be national, or regional when this offers advantages. The smallest number need high-level education aiming at both specialization and integration, with emphasis on the consequences of technological innovations. The required educational facilities should, for reasons of efficiency, be regional or international, in particular for those African countries with relatively small populations.

   In Africa there are a number of regional centres such as the ITC sister institute, the Regional Centre for Training in Aerospace Surveys (RECTAS), Ile Ife, Nigeria; the Regional Centre for Services in Surveying, Mapping and Remote Sensing (RCSSMRS) in Nairobi, Kenya; and the Centre Régional de Télédétection de Ouagadougou (CRTO) in Burkina Faso. In addition, the United Nations Environment Programme (UNEP), FAO, ITC, GDTA (Groupement pour le Développement de la Télédétection Aérospatiale) and others organize regional training programmes in Africa.

   At the national level, national remote sensing centres and EIS centres are in place in but a few African countries, but this situation is rapidly improving. At the sub-national level there are universities, regional/provincial training institutes, but these all require infrastructure, equipment, personnel etc. in order for them to be able to assist in meeting the training requirements.

   On-the-job training during transfer of technology projects, pilot projects or other low-cost interventions are useful training mechanisms. In-service training courses have the added advantages in that the teaching materials are specifically related to the local conditions and needs, larger groups can be trained in order to reach a critical mass, costs are relatively low, the teaching can be done in the local language, etc.
3. **OPTION 2: OVERSEAS**

Sending African staff overseas for training has both benefits and disadvantages. The benefits include the following:

* well-equipped training centres available;
* highly qualified/experienced teachers;
* wide variety of technologies and types of equipment available in order to select relevant ones;
* multi-disciplinary, interrelated programmes available linking remote sensing, GIS, environment, cartography, photogrammetry, cadastre, etc.;
* benefits of international contacts and exchange of problems, issues, etc. with fellow students from other countries;
* efficiency of scale, costs, etc.

Some disadvantages include:

* only a few per country can be trained abroad each year;
* on return (if they return) they are often promoted to positions where they no longer benefit from their training;
* training materials sometimes less relevant to participants local conditions;
* usually restricted to availability of fellowships;
* courses can focus too much on technology to the exclusion of necessary social and political conditions for effective use of EIS.

4. GIS hardware and software are useless in Africa without a long-term commitment of recipients, vendors, and donors to system support, maintenance and hands-on training. This type of equipment should be local, should deal with local data and must survive the initial period of enthusiasm over the new system. Local African EIS training should include:

* applications training for local scientists and technicians on local information needs;
* hardware system support training for local technician including basic diagnostics, and minor repairs-replacing graphics boards, for example; and
* orientation for managers and resource scientists so that they may know the potential of the tools available to them through their staff and colleagues.

5. A series of mobile/roving courses can be very effective, e.g., a five day seminar/course/workshop training for decision makers can be given in each region or country of Africa. Once the contents are established, only minor changes are required to adapt it to local circumstances. Such in-house courses can be devised for each of the ten categories of people needed to be trained in Africa - each with its own time span (from a few days for senior decision makers to several months or a year for technician level training - see issue 4) and with its syllabus designed to the particular user needs of the local client (Issue 5).
6. **On-the-Job Training**

On-the-job training in EIS is an essential component of every training programme. It provides the "finishing" stage of classroom and laboratory training which is necessarily isolated from the real conditions of the workplace, since many real problems cannot be easily simulated in the training laboratory. It is the time when the trainee learns to apply the formally-acquired skills in the wide variety of tasks and problems which confront the specialist. All skills are learnt best by exercising them.

On-the-job training uses available personnel and equipment resources and does not require special training staff or accommodation, is specific to the local needs and the trainee is productive on the job. It is particularly relevant where practical training far outweighs theoretical study, as in the training of "data entry" techniques, digitizing maps for input in the EIS.

The dangers are that on-the-job training may be used by default as the "natural" training method where more structured training with a sound theoretical component is really required to produce fully rounded specialists, that supervisors with indifferent abilities may be used, that training may be too narrow and have significant gaps in skill or knowledge, and that the effectiveness of training may not be objectively measured.

To summarize, the advantages are:

* low cost (no travel or daily expenses, etc.);
* resources are generally available;
* highly relevant to the job;
* skills learnt by doing;
* productive.

The disadvantages are:

* very subject to quality of supervision;
* limited by available work content;
* too specific or narrow;
* may miss theoretical understanding;
* training effectiveness may not be measured.

The conditions necessary for successful on-the-job training are:

(a) a training plan which defines the skills to be learnt;
(b) an objective measure of successfully acquired skills (by observation or test);
(c) work content covering the required field;
(d) a work supervisor who is a good trainer - skilled in the topic, with good teaching method, patient, and encouraging;
(e) adequate theoretical understanding to support the practical training.
ISSUE 3: HOW MANY PEOPLE NEED TO BE TRAINED?

1. Most developing countries are still at various stages of institutional development in which a relatively large number of personnel at various levels and in different categories are to be trained for specific skills in a short period of time. In addition, education and training is required to establish or modify professional infrastructures. Marked differences in the level of socio-economic and institutional development occur between African regions and countries. This in turn is reflected in the number of personnel needed for the various categories and levels of functions requiring education and training. It is also reflected in the degree of dependence on outside educational or training facilities.

2. Hard figures on personnel requirements for the 1990s are difficult to give but three principles can be used by individual countries or groups of countries to determine a number or at least to make an educated guess about it. The principles are based on:

   * the idea of critical mass;
   * cross-border co-operation;
   * comparison with existing infrastructures in surveying.

3. "Critical mass" as an idea originated in nuclear physics where a chain-reaction will only occur if the mass of the fissile atoms is above a certain value: the critical mass. The idea applies here in particular to the creation of a small team of experts, engineers and technicians for EIS applications in an African country. Two or three persons are usually insufficient to really have an impact on a new field or on a new technology in an established department or institute. Based on experiences gained in India, teams of about 20 to 30 persons at different levels and in diverse disciplines are required for local centres to support surveying departments in each of the federal states of that large country.

4. Many developing countries in Africa are too small to adhere to the idea of critical mass in each of the survey organizations in their countries. In such cases, multinational co-operation may offer a solution, for example:

   (a) a regional centre providing all necessary functions for a group of nations (the regional remote sensing centres in Africa), or an international centre providing functions in certain fields of application, such as ITC, the Netherlands;

   (b) a combination of a number of small national facilities serviced by a regional support facility (the Regional Centre for Services in Surveying and Mapping in Nairobi, Kenya);

   (c) national teams strengthened by cross-border exchange of experience (under programmes for bilateral or multilateral co-operation) such as the EIS programme.
5. A comparison with the infrastructure in surveying can be made on the basis of a United Nations-sponsored study, "Inventory of needs in surveying and mapping: a global inventory" (ref. 1). In this study, the number of professional cartographers and topographic surveyors, including photogrammetrists, was found to correlate with the number of inhabitants of a country. Countries with a well-established infrastructure in this domain of surveying employ on the average 5.2 "cartographers" per 10,000 inhabitants. If one includes all surveyors in earth science disciplines, the proportion becomes 1 surveyor per 1,000 inhabitants. It appears that per survey-discipline, 1 professional per 10,000 inhabitants is reasonable for a surveying infrastructure serving the national authorities of a well-developed country.

6. Tempting as it may be to apply these numbers to determine the amount of personnel any country region or the continent of Africa might need for surveying activities within the domain of mapping and inventory, it is advisable to consider three additional factors:

   (a) the first is the structural change that the new technology of satellite remote sensing and GIS will have on established survey organizations, methods and products;

   (b) the second is the relation between the total population of a country and the critical mass idea. Several European countries, Japan and the United States fall in the population range of 300 to 30 million. However, half the African countries fall in the 30 to 3 million, and many in the 3 to 0.3 million range, while several have less than 300,000 inhabitants. It is clear that the ratios derived therefrom should be applied with the greatest care;

   (c) the third factor is the difference in the population structure (population pyramid): the developed countries for which the rule holds have a low percentage of young people, whereas in many African countries, 45 per cent of the population are under the age of 16 years.

7. On the basis of the above approach for estimating personnel, it should be possible to estimate the required capacity and the programmes for education and training in EIS for the short-term and long-term environmental surveying and monitoring activities for mapping and monitoring for EIS in Africa.

8. Three rules of thumb can be used in this context. The first rule is that, in case of an established department or organization with a constant number of employees, the educational programme, including refresher and updating courses ("recurrent education"), should be sufficient to cope with at least 10 per cent of the personnel annually in order to compensate for attrition due to departure, retirement or transfer.

9. The second rule is that, in order to establish a new department or organization, the annual educational programme should be large enough to cope with about 30 per cent of the personnel to be employed for full operation, depending, to some extent, on the number of years (5, 7, 10?) it will take to arrive at this stage. The effective capacity needs to be large due to the fact that not all trained persons will eventually be holding jobs involving their subject of study. Moreover, as long as the
critical mass has not been reached, the number of drop-outs is relatively large and the percentage may even have to be raised to 40 in certain situations.

10. The third rule refers to cases which lie between the situations described above: the rapid introduction of a promising technological innovation in an existing department or organization by means of educational programme should allow for an annual throughput of about 20 per cent of the number of employees who will ultimately apply the innovative technology in their conventional work. The introduction of remote sensing and EIS in a mapping and inventory organization forms such a case. It affects in total 1 person per 10,000 inhabitants, and consequently the annual number of persons to be trained is 1 per 50,000 inhabitants.

11. For a correct appreciation of the last figure (1:50,000) it is illustrative to apply it to a country with five million inhabitants (i.e., halfway on the world list of population per country; 50 per cent of the world's nations have a smaller population). If such a model country had a topographic survey department and mapping departments for all of the conventional earth science disciplines, 100 persons would need to be educated or trained annually. The required capacity depends directly on the duration of training per person. Assuming that the use of satellite imagery and digital data for mapping and GIS for updating requires an average training of three months, then the educational capacity should be 300 man-months or 30 man-years annually, and the facility should have 30 trainees at a time for the first five years.

12. Personnel must not only be trained to do a job, but must also be motivated to perform it to the highest standards. A few factors likely to have a major influence on staff motivation are listed below:

(a) perceived status of job. This may depend on many factors, including the salary level when compared to other opportunities, the level of technology used, the physical conditions of the work, any publicity given to the job location, a smooth organization, etc.;
(b) perceived career opportunity;
(c) feedback on performance. The staff member should receive clear indications on the difference between a good and a poor performance, and on the value that is attached to the highest work standards;
(d) opportunity for self-achievement. If the administration aims at high interest among its most promising staff members, it should provide opportunities for further individual study and discussions with national and international specialists.

13. It should be recognized that the labour market in GIS is highly competitive; skilled staff who are dissatisfied with their employment conditions are very likely to find better opportunities in some other organization or country. International co-operation, leading to more uniformity in skill levels and employment conditions, could result in more staff stability and improvement performance.

14. In many cases, maintenance deficiencies can be traced to the lack of proper tools, measuring instruments, materials or equipment. It should be stressed here that
training is only one condition for proper operation and maintenance in any technical organization. It should be complemented with proper management procedures ensuring that the necessary means for carrying out each job are continuously available. With respect to the continuity of service, the management of spare parts also plays a critical role. Proper attention has to be given to these aspects at an early stage during the planning phase of any EIS installation.

ISSUE 4: HOW LONG SHOULD THE TRAINING BE?

1. The type and level of training requirements should be specified in accordance with short-term and long-term objectives. For most categories of personnel, in-depth education and training is required. The objectives should be to provide scientists and the technical support groups with the necessary background knowledge and skills required to enter, process, interpret and analyze environmental data. Under the prevailing conditions, developing countries on the whole need both short-term and long-term programmes to fulfill their various requirements. Actually, most international, regional and bilateral technical cooperation programmes, despite providing large sums of money, are geared to short-term objectives. This attitude is officially criticized by only a few agencies.

2. Developing a viable national or regional capability in EIS requires a commitment to provide on-going training together with the establishment of facilities to acquire, process and analyse environmental data. So much of the aid-sponsored training programs and in particular the on-off type short courses, suffer from the inability of both the contributing and participating agencies to follow-up, reinforce and extend the training of those involved in the initial courses. So much of the learning is dissipated and the momentum for using EIS is lost because the participants from these courses return to their own organizations without any real opportunity for implementing the methodology or for continuing their training in EIS.

3. Once agreement has been reached on how to tackle issues 1 to 3, one can tackle issues 4 and 5. In general, one can identify the following types of EIS courses in Africa:

(a) short (five days) courses/seminars/workshops for senior decision makers, such as organized by ITC, FAO, the UN Economic Commission for Africa (ECA) etc.;
(b) two-four weeks introductory EIS courses to professionals;
(c) two to four months courses to professionals;
(d) six-twelve months courses to professionals and technicians;
(e) one to two years: MScs in EIS;
(f) two to four years: PhDs in EIS.
ISSUE 5: WHAT SHOULD BE TAUGHT, AND HOW?

1. Principles and procedures; applications; integration with other information technologies are some of the key issues needed to be taught. This can be done by lectures, laboratory exercises, simulations, hands-on experience, project applications, handbooks, programmed learning packages, audio-visual aids and a wide variety of other teaching tools available today.

2. Training needs cannot be expressed in numbers alone. Consideration must also be given to the required job performance level, the entry level of the trainees and the training facilities required. The educational system must train large numbers of trainees, with wide variations in socio-cultural background and experience and train them in a field where very few organizations have the required know-how and experience.

3. In order to plan a training programme, it is necessary to carry out the following activities:

   (a) review or prepare the organization chart;
   (b) review the existing and planned technical systems;
   (c) prepare a list of jobs for which training is required;
   (d) determine the numbers of staff in each job;
   (e) conduct a personnel survey; determine likely sources for recruitment, education and training received, experience and language ability in order to identify any required remedial training;
   (f) conduct a job analysis for each of the jobs identified above. For this critical step, the co-operation of equipment manufacturers, administrators and experts in task analysis is usually required; international co-operation can be extremely useful since the experience of other administrations in the operation and maintenance of similar equipment can be taken into account.

4. The organization of the training programme will depend on the job analysis carried out as indicated above, and on the entry level of the trainees.

5. Training methods can be many, including lecturing, self-study, tutoring and laboratory exercises with model equipment. However, training cannot be complete without practical on-the-job training under close supervision by experienced staff. This requirement, and the low numbers of staff to be trained for any one location (no more than a few per year after the first staff group has been trained) make specific demands on the training programme. Individualized training, but with group support is highly desirable, including programmed learning, audio-visual learning aids and simulated practice. Experience with distance learning approaches based upon structured reading, tasks and case studies with tutorial feedback show that the process can be very effective. It is a direction Africa should take. ITC experience has shown that publication of the teaching materials forces the educators and trainers to increase the quality of the lecture notes, exercises and case studies. Commonly used training methods used by the major training centres include:
IN-HOUSE TRAINING

In-house training offers timely instruction, which may be presented to offer the highest level of insight into work related problems. However, this type of training may threaten the production capabilities of the organization, by trying up valuable employee resources while the training is being conducted.

VENDOR TRAINING

The vendor is the most qualified to provide training for a vendor-supplied EIS product. Most major vendors have an experienced training staff, good facilities, and the ability to accommodate special group requirements. Unfortunately, the vendor is often not familiar with the employee work environment and cannot offer work related examples. Large automation programs resulting in the acquisition of numerous, multi-vendor products may result in the need for many separate vendor training classes. This approach may be cost prohibitive and will lack a cohesive training focus. Alternatively, a contractor may be sought who can provide a complete training plan for all vendor equipment with greater focus on project goals and procedures rather than specific components.

FORMAL EDUCATION

Formal education is the only method resulting in a recognized achievement level, attained in the form of degrees or certificates. Frequently a firm’s credentials must stand on the number of professionals with degrees and their fields of expertise. Formal education does not always provide the specific training required by a new system or technology and may not be timely. Additionally, colleges and universities may not be conveniently located to employees or offer schedules conductive to employee work schedules.

SELF-TAUGHT TRAINING

Self-paced training warrants serious consideration. In this type of training several things must be present from the start: the student must have some degree of proficiency either in the area to be mastered or in an associated discipline, and, most importantly, the student must have a sincere desire to learn. Many employees find self-paced training useful, using some of the distance-learning techniques described above.

Although each of the methods is satisfactory, the appropriate training method must be determined on the basis of individual employee requirements.

6. Curricula and teaching aids have to be developed for EIS personnel, from planners and managers to research workers and teachers, production personnel and the technical support staff. The wide spectrum of these groups makes it impossible to design standard curricula. Curricula for the principal surveying and mapping questions have been developed in one form or another in the facilities which at present provide courses in satellite remote sensing. It is most effective to continue
using existing programmes, which prove to have a rather great similarity. However, changes in the course contents and in the aims of educational and training programmes are urgently needed.

7. Monitoring the environment calls for a curricula different from that of classical inventory and mapping. Initially, politicians and planners should be reached; later, research workers in institutes and departments have to get involved. Teachers have to be taught, and learning methods and teaching aids should be prepared in order to reach the lower strata of the personnel pyramid. Penetration down to the "grass-root" level and training of "bare-foot surveyors" require a different approach from educating post-graduate students in sophisticated EIS technology.

8. Demonstration packages/reference manuals/handbooks and case studies form some of the most powerful training tools. A very good example of such a core curriculum on GIS is that produced by the National Centre for Geographic Information and Analysis, University of California, Santa Barbara, USA.

   Few users adopt GIS without serious evaluation of the technology. Hence the initial contact and continued liaison between the innovator and potential adopter of the technology is very important, particularly in the early stages of the transfer process to set up an EIS in Africa. The ability to clearly explain the utility of EIS in an operational environment and to provide examples of turn-key applications with the generation of usable products along with advice on possible system configurations and staffing needs, are essential components of any package designed to demonstrate the worth of the technology.

   For the potential benefits of EIS technology to be fully realized requires the existence of operational procedures producing credible results. Potential users within the public or private sectors are not interested in risk taking or in using experimental or untried routines. A major factor responsible for user adoption is the availability of clear examples of successful applications and, in particular, ones which contain repeatable methodologies.

9. The linkages between remote sensing, GIS and other mapping sciences such as cartography, photogrammetry and cadastre need to be clearly indicated and promoted. EIS is inherently a multi-disciplinary technology, a fact which must be recognized, accepted and dealt with in teaching as well as in developing and applying the technology.
ISSUE 6:  WHO SHOULD DO THE TRAINING?

1. The success of short course programmes in the past twenty years is a clear indication of the need for a more formalized approach to training in GIS. It is also necessary because the innovators of a new technology are not always the best teachers or perpetrators of that technology.

2. The instructor must have a solid grounding in the fundamentals he or she is trying to teach. Now, it is no easier for a computer scientist or an electrical engineer to learn, say, the physics of environmental pollution than it is for an agronomist to learn the principles of digital database management. But it can be done and it is done regularly in the multi-disciplinary research and education programmes which have grown up with the technology. An apprenticeship with such a programme is probably the most effective way to prepare oneself to be an effective educator in the field of modern GIS technology and its applications.

3. The present training activities for EIS consist of the following:

   (a) universities and other educational institutions provide education as part of standard curricula or as separate programmes;
   (b) remote sensing centres, established for applied research in remote sensing and for its introduction to user agencies, often offer courses in GIS;
   (c) user agencies are conducting short courses in the application of GIS;
   (d) countries are organizing irregular ad hoc training courses in GIS on their own or in co-operation with other countries;
   (e) private enterprises, independent research laboratories and institutes are occasionally organizing workshops, seminars and on-the-job training on a contract basis, often as part of a development project;

4. The total training effort is of great value to countries which are in the position to have their people educated/trained, but the current situation has some disadvantages:

   (a) the various training programmes lack coordination;
   (b) developing countries may have problems due to temporary over-supply of educational opportunities offered in an incoherent manner;
   (c) educational and training efforts tend to be directed to the top strata of the professional pyramid. More needs to be done to inform the opinion leaders and decision makers as well;
   (d) current training programmes respond often solely to immediate needs, or are too strongly based on past experiences, instead of forming part of a long-term educational strategy or personnel development plan.

5. This implies need for better coordination by the major institutes/agencies providing the training (e.g. UNEP, the regional centres in Nairobi (RCSSMRS) and Ile Ife (RECTAS), UNITAR, FAO, ITC, GDTA, etc.). In addition, engineering consultants, western universities, and donors give occasional courses in EIS to
Africans. This group is difficult or impossible to coordinate. Most do not know what the others are doing.

6. Much is to be said for further strengthening the South-South links. That is to say, for those African organizations relatively far advanced with the introduction of EIS to pass on their knowledge by training surrounding countries. For example, the Remote Sensing Centre in Abidjan, Côte d'Ivoire, which has one of the largest operational digital processing facilities in Africa, should be assisted in its efforts to provide training in EIS to the surrounding francophone countries. At present only the regional training centres RECTAS and RCSSMRS provide this South-South training. There is a demand for more such regional or sub-regional local training in EIS in Africa.

ISSUE 7: WHO PAYS FOR THE TRAINING?

1. On the whole, EIS education and training is poorly organized, fragmentary and geographically restricted. As a proportion of the total annual budget contributed to training worldwide, very little is actually spent on EIS education and training in Africa.

   Few University institutions in Africa have been able to finance the establishment of adequate EIS facilities in order to cater to student needs, nor have they designed programmes in EIS that provide comprehensive training at both the undergraduate and post-graduate level. Attempts by individual faculties or schools are often less than successful because neither the time nor the resources are available for meaningful training in EIS to occur.

2. Financial commitment to EIS education and training, however, has been limited in the past, lacking any overall strategy at either the government, industry or institution level. Few governments, be they national or regional, have committed sufficient funds to allow remote sensing and EIS technologies to become fully operational, let alone provide sufficient money for the necessary training of personnel. As most agencies associated with the management of renewable resources like agriculture, forestry and hydrology are government funded, these organizations also have found it difficult to commit sufficient funds to provide adequate training for their personnel.

   Private industry groups, such as those in the geological and mining sector in Africa, have committed substantial amounts to implementing remote sensing and GIS technology and to the training of their personnel. Much of this training, however, has been in-house or else "within" the industry and has not necessarily benefited other training institutes and the general user community.
3. Severe financial constraints on university expenditures over the last ten years (and at the regional centres) has meant that few institutions have committed sufficient funds to establish adequate facilities to meet the growing demands of both undergraduate and graduate education. One-off grants or the purchase of single workstations by individual departments together with the failure to appoint academic staff with qualifications in EIS, all point to the lack of any overall strategy to promote teaching and research in EIS and related technologies. Thus training is heavily dependent on outside training centres such as ITC, FAO, GDTA, etc.

4. Until such time as sufficient potential users become actual adopters of the technology and thereby create a demand for trained and capable personnel, the developers of that technology and agencies committed to technology transfer may be required to support and fund the establishment and maintenance of training programmes in remote sensing.

5. Costs and fees for attending the various courses on environmental issues, and training seminars abroad vary widely. In some cases, participants or their sponsors have to provide only travel to and from the location of a course or seminar; in other cases low (nominal) to high fees (to cover operating costs for the courses concerned) are charged. In general, the costs for the educational infrastructure, including investments and overhead charges, are covered by the institutes themselves or are supported by subsidies from national/international agencies.

6. Under these conditions, it is difficult to estimate the real costs involved in education and training in EIS. It is therefore equally difficult to estimate the financial consequences of the recommended expansion of education and training capacities to conform better with the high demand for training in EIS in Africa.

7. It is equally difficult to estimate the economic/social benefits to be derived from the financial resources provided for education and training in EIS. No published data are available to permit a comparison of costs and benefits for an average academic education and an intensive post-graduate studies which are often attended by mid-career personnel. An unpublished study in the Netherlands shows that investments in special post-graduate education and training for personnel from developing countries compare favourably with normal university education in an industrialized country, in terms of expenditure and economic rate of return. They also compare favourably with the costs of providing expatriate experts for implementing a remote sensing application job in a developing country, even if one does not take into account that education and training of nationals contribute to self-reliance.

8. Development of an EIS facility involves competing pressures on limited budgets to maximize hardware and software capability, hire the best people, provide adequate training and support operations. Training is often one of the worst-hit parts of this process when budgets need to be met. As most GIS vendors tout their hardware and software as "easy-to-use and maintain", why should one need a long term training commitment and maintenance contracts? Those responsible for successful implementations of EIS in Africa know that sophisticated GIS technology needs considerable training time.
CONCLUSIONS AND RECOMMENDATIONS

1. National policies on education and training in EIS in Africa should be part of an over-all educational policy. Education should be regarded as a productive investment in human resources, resulting in personal growth and development, in improved social satisfaction, higher efficiency and better public services. Education and training are the indispensable complements of any investment in new technology and in expanded public services, and such investments are prime catalysts in socio-economic development.

2. The EIS Programme could organize a seminar of the major providers of training/education in Africa in EIS to ensure exchange of information on who is doing what, minimize duplication, ensure more coherent framework, and to identify gaps in training requirements.

3. There are many activities that can be undertaken immediately by national and international administrations to start the development of the education and training programmes that are required.
   (a) existing training centres and facilities should be supported in their operations and their development;
   (b) the national educational infrastructure should be developed in each country in a way that best meets that country's social and educational applications and technological needs;
   (c) coordination between training programmes should be maintained and improved to ensure the widest availability of new knowledge in the rapidly developing field of EIS;
   (d) long-term planning of EIS education should be supported within an over-all development strategy;
   (e) training systems for the lower strata of professions will need to be developed using modern educational methods, instructional material and instructor training;
   (f) more training packages of instructional material should be prepared and distributed widely.

4. Training in the developing countries is either second hand by indigenous staff who are trained abroad and who remain isolated from the centres and institutions in the developed countries where new developments are constantly taking place, or first hand through the medium of specially organized events in the developing countries utilizing overseas expertise. Training is available abroad, but it is almost entirely dependent on the availability of fellowship awards from one source or another. Together, these three avenues of training are unable to cope with the training needs of the developing countries in the EIS field. This situation is becoming even more adverse as a result of the rapid rate of development in relevant technology and the slow rate of transfer of this technology to the developing countries.
5. Appropriate human resources development and utilization is the cornerstone of a country's participation in any technology - new or old; it is the single most important infrastructure that needs to be built and continuously strengthened. It is in this context that the EIS Programme should be directing its attention to the provision of relevant training for educators in their own environment. This step should be taken in the belief that appropriate education is an essential precondition to preparing for the development and utilization of any new technology such as EIS.

6. At present, Sub-Saharan Africa is nowhere near reaching the critical mass in trained EIS staff required to ensure sustainability of EIS.

7. Until very recently GIS education has been supported largely by the innovators of the technology. With the increasing maturity of EIS, however, the demand for training is and must become more user oriented and supported. Unfortunately those institutions responsible for the provision of formal education and training services have been slow to respond to the demand. Strategies need to be developed and implemented at the national, regional, institution and user group levels that will increase the number of training opportunities available and establish the necessary infrastructure to ensure the continued development of EIS education and training in Africa.

8. The success of any technology transfer program such as EIS depends on the provision of trained personnel. Failure to give due attention to the education and training needs that accompany the adoption of this technology could well become the major limiting factor to the successful adoption and increased use of GIS in Sub-Saharan Africa in the future.

   The need for a comprehensive and coordinated approach to EIS education and training has become critical. The incorporation of this technology and its routine use in deriving information for resource related analysis and management, depends on the provision of trained operators who understand its capabilities and who are proficient in its operation.

9. An in-depth survey should be made of who in Africa is offering training, who is twinned with whom, and which overseas training centres/universities are, or would be interested in twinning arrangements with African universities and training centres.

10. All EIS training programmes should be regarded as a partnership with the overall objective of improving EIS in Sub-Saharan Africa. Some partners can contribute personnel and local knowledge, whilst other partners can provide teaching skills, EIS technologies, educational materials and financial resources to share.

11. There should be a means of feedback and monitoring to ensure that the educational and training programmes are administered in the spirit of the guidelines above, and so that the EIS training programmes can be continuously modified and improved.
Instead of continuing the present uncoordinated, and often ad-hoc training programmes in EIS taking place in Africa, a comprehensive training plan should be drawn up. Properly established and equipped EIS training centres in Africa are considered to be valuable resources of expertise and equipment for the sound and efficient training of all the various target groups described in this paper.

A comprehensive training plan such as mentioned above, should incorporate at least the following elements:

12.1 Goals and Objectives

(a) to improve and maintain the quality of information in all EIS programmes;
(b) to fully realize the value of capital invested in EIS instrumentation systems over their optimum economic life;
(c) to provide effective knowledge transfer and skill enhancement by using appropriately qualified tutors, excellent training aids and facilities, and modern learning methods;
(d) to design courses, select trainees, adopt procedures and run courses of instruction including follow-up work, which will provide self-sustaining knowledge and skills in the EIS service of the trainees' country;
(e) to be a centre of expertise and resources, and to co-operate with other similar centres in Africa, in order to share resources and give assistance and advice on a wide range of EIS procedures and problems;
(f) to provide balanced programmes of training which meet the clearly defined needs of the member country or members within each region for skills at graded levels;
(g) to monitor the effectiveness of training by appropriate assessment and reporting procedures; and
(h) to make freely available to members through technical reports and presentations the findings on EIS comparisons and other investigations, by means of liaison with other centres.

12.2 Justification for EIS Training Centres

(a) national needs;
(b) regional needs;
(c) geographic location to meet country and regional requirements;
(d) long-term need;
(e) potential numbers of students by target group;
(f) enhancement of existing facilities.
12.3 OBLIGATIONS

12.3.1 Role and obligations of EIS Program International Advisory Committee

(a) agreement on purpose and scope;
(b) monitoring and modification of syllabi and courses;
(c) coordinating financial support.

12.3.2 Obligations of the government of the host country in Africa

(a) purpose and functions of Centre;
(b) open to students from all countries in Sub-Saharan region;
(c) adequate personnel and material resources;
(d) financial support.

12.3.3 Obligations of the training centre

(a) administrative arrangements;
(b) annual report and financial balance sheet;
(c) syllabi and courses consistent with EIS International Advisory Committee guidance;
(d) adequate resources;
(e) student assessment and examination standards;
(f) student welfare.

12.4 RELATIONSHIPS WITH OTHER INSTITUTIONS

(a) ITC, UNEP-GEMS, FAO, GDTA, UNITAR, etc.;
(b) regional remote sensing training centres in Nairobi and Ile-Ife;
(c) other Regional or sub-regional training centres.

12.5 COSTS, FUNDING & FINANCIAL CONTROL

12.5.1 Establishment costs (also serving as a list of necessary and desirable items)

(a) classroom and laboratory space;
(b) staff recruitment;
(c) office equipment;
(d) instruments for teaching;
(e) classroom audio-visual equipment;
(f) library texts, periodicals and audio-visual media;
(g) computer-assisted learning equipment and software;
(h) initial stocks of stationery and other supplies;
(i) motor transport for field data collection.
12.5.2 Annual operating costs

(a) staff salaries;
(b) rental of accommodation and equipment;
(c) electricity, gas and water supplies;
(d) telephone, fax and telex charges;
(e) maintenance on buildings and plant;
(f) laboratory materials and components;
(g) stationery and office supplies;
(h) periodical subscriptions;
(i) new and replacement instruments and equipment;
(j) motor vehicle running costs and maintenance;
(k) allowance for depreciation of all plant;
(l) insurance;
(m) travel;
(n) student accommodation.

12.5.3 Financial control

(a) the budget (on a several year cycle);
(b) approvals for expenditure;
(c) coding income and expenditure;
(d) bookkeeping;
(e) monthly statement of income and expenditure;
(f) annual balance sheet;
(g) annual statement of assets and liabilities.

12.5.4 Sources of funding

(a) for establishment;
(b) for annual operating costs;
(c) for tutor salaries;
(d) for tutor training;
(e) for equipment;
(f) for library resources;
(g) for student fellowships;
(h) budget of national environmental management;
(i) UN Development Programme, UNEP, etc.;
(j) bilateral and multilateral funding;
(k) commercial sponsorship;
(l) course fees;
(m) fees for calibration and special investigations.
12.6 RESOURCES

12.6.1 Administration

(a) direction and management;
(b) policy and planning;
(c) advisory services through international experts;
(d) accounting and financial control;
(e) applications for funding;
(f) clerical support;
(g) student liaison and induction;
(h) student travel and accommodation;
(i) storekeeping and inventory;
(j) purchase of equipment and supplies;
(k) equipment maintenance;
(l) liaison with external agencies and institutions.

12.6.2 Tutors

(a) qualifications, experience and grading;
(b) competence in communication, teaching and technical skills;
(c) student/staff ratio;
(d) full-time, part-time, seconded and visiting;
(e) specializations;
(f) refresher courses and liaison visits;
(g) availability as travelling experts;
(h) supporting technical staff.

12.6.3 Accommodation

(a) classrooms;
(b) laboratories;
(c) library;
(d) common rooms and utilities for students and staff;
(e) storage for equipment and materials;
(f) field test site;
(g) lighting;
(h) heating and ventilation;
(i) student accommodation alternatives.

12.6.4 Library

(a) professional management;
(b) special extension of environmental information;
(c) interloans with similar libraries abroad;
(d) curricula and syllabi;
(e) compendia of lecture notes from other institutes from abroad;
(f) technical texts and periodicals;
(g) audio-visual media;
(h) computer-assisted learning materials;
(i) bibliographies, data bases and information services.

12.6.5 Equipment

(a) representative EIS equipment;
(b) classroom audio-visual equipment;
(c) computer-assisted learning equipment;

12.7 Students (with particular reference to the welfare of foreign students)

(a) competence in working language;
(b) immigration requirements: visas and work permits;
(c) dossier of helpful information;
(d) laws and regulations;
(e) religious observances;
(f) dietary requirements;
(g) accommodation;
(h) living expenses (fellowships);
(i) health: medical and dental services;
(j) insurance: health, travel, personal effects, motor vehicle;
(k) requirements for driving a motor vehicle;
(l) grievances;
(m) travel;
(n) leisure and cultural activities;
(o) student evaluation and suggestions.

12.8 Programmes

12.8.1 Programme administration

(a) planning annual and triennial programmes;
(b) consideration of regional requirements;
(c) working languages;
(d) estimating student numbers;
(e) duration and frequency of courses;
(f) use of ITC curricula and syllabi;
(g) use of other syllabi (e.g., UNITAR, GDTA, FAO, UNEP, etc.);
(h) course design and methodologies;
(i) concurrent courses: resources required;
(j) tutor performance assessment;
(k) moderation of syllabi, courses and standards of assessment;
(l) syllabus and course revision.
12.8.2 Courses

(a) general;
(b) special;
(c) refresher;
(d) correspondence;
(e) on-the-job training placements;
(f) travelling workshops;
(g) classification and level of courses;
(h) training techniques;
(i) class/practical work ratio;
(j) practical work assignments;
(k) prepared notes and background papers;
(l) student evaluation of course benefit;
(m) tutor evaluation of courses.

12.8.3 Student performance assessment

(a) assignment;
(b) essays and reports;
(c) projects;
(d) periodic tests;
(e) on-the-job work assessment;
(f) self-assessment;
(g) formal examination;
(h) certificate of attainment;
(i) report on students by Training Centre;
(j) report from "home" service 6 months after course.

Such a plan, once prepared, and revised and agreed by all concerned, could form the basis of a coordinated effort by all multi and bilateral donor agencies to improve the manpower development in the field of EIS dramatically.

13. Programme Evaluation

Maintenance of effective EIS training programmes requires a continuing measure of effectiveness against observable criteria, e.g. the attainment of certain skills to a defined standard. Programme evaluation should occur at several levels. Each training activity should be evaluated as it is completed. Various parties involved in the programme (e.g. trainee, tutor, employer) may have divergent views. It will probably be informative if they all make independent assessments which are then compared and reconciled. A check on skill retention about six months after a course will give some measure of the effectiveness of the training method.
Of course, all EIS project proposals involving education and training should include the ethic or stated objective of:

* inherent respect for culture, language, sexual difference, environmental and political considerations;
* long-term commitment to promoting the self-reliance and independence of the recipient partner agency;
* including maximum partner consultation, priority-setting, decision-making and management in cooperative programmes;
* full sharing of information and plans; and mutual accountability for the outcomes of programmes;
* improving the role of women and young people in participation and decision-making;
* ensuring the proper mix of human input and labour, and technology appropriate to the local economy, skills and staffing policies;
* working toward the goal of self-sustenance in training programmes whereby the knowledge and skills can be retained and effectively propagated in the recipient partner country;
* where equipment and systems are to be installed in the recipient partner country, providing for the long-term transfer of knowledge, personnel skills and adequate material resources for the continued successful operation and maintenance of the equipment and systems;
* ensuring that recipient partners are able to make free choices as to the future provision of materials, equipment and services;
* effective coordination with other programmes and with all partners in multi-lateral programmes to avoid misunderstandings, inefficiency and waste;
* evaluation by the partners of the medium and long-term success of each programme.

Production or supply of the following EIS learning resources (subject to consultation, local need, adequate specification of requirements and coordination with other donors):

* planning and building training classrooms, laboratories and workshops at regional and national training centres (N.B. local labour and materials should be used as far as possible);
* supply of classroom, laboratory and workshop furniture, equipment and consumable supplies (continuing annual basis);
* class sets of stationery, textbooks, lecture notes, correspondence courses, wall charts, commercial component data books and application notes, EIS case studies, tutorials, etc.;
* training films, projector transparencies and slides, audio tapes, video tapes, computer-aided learning software;
* 16 mm film projectors, overhead transparency projectors (with materials), slide projectors;
* microcomputer class sets and computer-aided learning software;
* teaching samples of EIS for regional and national training centres;
* photocopiers (with paper and chemical supplies).
ACKNOWLEDGEMENTS

The author wishes to credit various African educators and active institutions for many of the ideas brought forward in this paper, whereas most others are his own. The paper is based on an invited address of similar title given by the author to the third meeting of the International Advisory Committee for the EIS Programme in Sub-Saharan Africa, held in Heidelberg, Germany, in April 1991.

The views expressed by the author do not imply endorsement by the World Bank, the ITC, or any other organization. As a result of the Heidelberg meeting, subsequent versions of the text were circulated to most major international training centres for their views. Particular thanks are due to Dr. A. Harding of ITC's Educational Development Centre for his advice, as well as to constructive improvements recommended by M. Norton-Griffith of UNEP-GEMS, Nairobi, and Dr. Christine Specter, Florida International University. The attached literature also provided many concepts to add to the author's own views and experience of some of the issues involved in education and training in EIS in Sub-Saharan Africa.
REFERENCES

1. Abiodun, A.A. et.al. (1988)
   "Development of indigenous capability in remote sensing", Space Policy, May 1988, pp 121-130.

   "In-depth long-term education: a vehicle for technology development", UN Outer Space Affairs Division Paper, 4 pages.

3. Anon (1987)


   "Education and Training in GIS: ESRI", Technical Papers, ACSM-ASPRS, Annual Convention, volume 1, Cartography and Education.

   "Education in Land, Information and Management", Conference of Commonwealth Surveyors, paper no. 12, 17 pages.

   "Geographic Information System teaching at ITC", Technical Papers, 1986 ACSM-ASPRS Annual Convention, volume 1 Cartography and Education.

   "GIS Training and research methods for resource management in developing countries", paper presented March 1991 at ASPRS Symposium, Baltimore, USA.


13. ISRIC (1991)  

14. ITC  


16. Linden, G.J. (1989a)  

17. Linden, G.J. (1989b)  

18. Linden, G.J. (1989c)  

19. Meijere, J.C. de  


21. NCGIA (1990)  
"Introduction to GIS: Core Curriculum" (3 volumes).

23. Nossin, J.J. "Keeping educational curricula in pace with technological developments and with user needs", invited paper, United Nations Int'l Meeting of experts on the development of remote sensing skills and knowledge, Dundee, UK, June.


33. UN (1981)
"Training and Education of Users of Space Technology", UNISPACE 82, Background paper, A/Conf. 101/BP/9, 44 pages.

34. UNESCO-UNEP (1975-83)


36. WMO (1991)
"Guidelines for the education and training of personnel in meteorology and operational hydrology", World Meteorological Organization Publication no. 258, Geneva, Switzerland.

* * *
ACRONYMS USED IN THE TEXT

<table>
<thead>
<tr>
<th>ACRONYM</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>CRTO</td>
<td>Centre Régional de Télédétection de Ouagadougou, Burkina Faso</td>
</tr>
<tr>
<td>ECA</td>
<td>Economic Commission for Africa of the UN</td>
</tr>
<tr>
<td>EIS</td>
<td>environment information system</td>
</tr>
<tr>
<td>FAO</td>
<td>Food and Agriculture Organization of the United Nations</td>
</tr>
<tr>
<td>GDTA</td>
<td>Groupement pour le Développement de la Télédétection Aérospatiale, France</td>
</tr>
<tr>
<td>GEMS</td>
<td>Global Environment Monitoring System (UNEP)</td>
</tr>
<tr>
<td>GIS</td>
<td>geographic information system</td>
</tr>
<tr>
<td>GRID</td>
<td>Global Resources Information Database (UNEP)</td>
</tr>
<tr>
<td>ITC</td>
<td>International Institute for Aerospace Survey and Earth Sciences</td>
</tr>
<tr>
<td>NEAP</td>
<td>National Environmental Action Plan</td>
</tr>
<tr>
<td>RCSSMRS</td>
<td>Regional Centre for Services in Surveying, Mapping and Remote Sensing, Nairobi, Kenya</td>
</tr>
<tr>
<td>RECTAS</td>
<td>Regional Centre for Training in Aerospace Surveys, Ile Ife, Nigeria</td>
</tr>
<tr>
<td>UN</td>
<td>United Nations</td>
</tr>
<tr>
<td>UNDP</td>
<td>United Nations Development Programme</td>
</tr>
<tr>
<td>UNEP</td>
<td>United Nations Environment Programme</td>
</tr>
<tr>
<td>UNITAR</td>
<td>United Nations Institute for Training and Research</td>
</tr>
<tr>
<td>UNSO</td>
<td>United Nations Sudano-Saharan Office</td>
</tr>
</tbody>
</table>

* * *