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Around the world: In search of education and training in satellite remote sensing

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Abstract

Since the first experimental observations from satellites were made in the mid-1960s, much training, most of which stresses natural resources applications rather than satellite engineering, has been given in a number of countries throughout the world.

Most of the countries today have national remote sensing programmes set up under the auspices of various specialized institutions and government organizations, such as a space agency, science academy, research institute, university or ministry, and are already pursuing regular education and training courses in remote sensing for their own nationals. By doing so local people are trained, local problems in which remote sensing can be applied are identified and some pilot projects executed. Still, some countries organize seminars, workshops and in-house training in satellite remote sensing on an occasional basis to reach a wider spectrum of technicians, resource scientists and policy-makers and create awareness in the new technology. Some of these national remote sensing institutes, agencies, organizations or centres have already included participants from their own regions in a way playing a regional role and serving regional as well as national needs. Moreover, there are a few regional training centres serving more than one country and being financed from national sources, international organizations or by regional agreement. There are many universities or institutes in North America, Europe and elsewhere that offer undergraduate curricula in one of the resource disciplines (including remote sensing) or which give formal postgraduate studies emphasizing remote sensing techniques or applications. Some of these have an international character, offering regular and permanent training and education courses mainly in remote sensing applications.

The UN, through its various organizations such as FAO, DNRE, UNESCO, UNEP, UNDP and OSAD, organizes, supports or sponsors a varied assortment of research activities, application projects and training courses, many of which are attached to UN-sponsored projects.

The purpose of this paper is to discuss the format in which information on remote sensing education and training has to be collected, compiled and filed to be readily retrievable.

Introduction

1. Since the first experimental observations from satellites in the mid-1960s much training, most of which stresses natural resources applications rather than satellite engineering, has

been given by various agencies, centres, universities and institutions of higher education, research and technology throughout the world.

2. Most countries nowadays have national remote sensing programmes or use remotely sensed data in one way or another in projects or for resources surveys and management. Nevertheless, there is a general feeling that much more use can be made of remote sensing for the management of natural resources and monitoring of the environment. This, however, requires a considerable strengthening of national capabilities, including an intensified transfer of technology and extensive education and training programmes. Moreover, in view of the abundant but scattered information available on remote sensing materials, equipment, facilities and applications, accessibility of this information should be improved by the establishment of a properly equipped and structured information system or a network of information systems interconnected through an international clearinghouse.

3. In view of the rather general need for more education and training, such an international remote sensing information system should contain information on all existing educational facilities and available fellowship and funding support opportunities.

4. Such an information system on remote sensing training and education has to serve a dual purpose. It should guide all authorities and employers concerned in selecting the training and education facilities best suited for their personnel, taking into account prevailing national conditions and planned remote sensing applications. Furthermore, it should provide information on remote sensing educational systems and educational aids for all those organizations planning the establishment of new training facilities or the improvement of existing facilities.

5. The purpose of this paper is to discuss the format in which information on remote sensing education and training has to be collected, compiled and filed to be readily retrievable. Furthermore, the various types and levels of education and training are discussed to facilitate a definition of categories of education and training facilities and the specification of education and training requirements for specific purposes.

6. The information used for the preparation of this report stems from several different sources. It is based to a large extent on one of the Background Papers prepared for the UNISPACE 82 Conference (Document A/CONF.101/BP/9). Most of the detailed information was obtained from questionnaires mailed to institutions, organizations, government agencies, international bodies etc. as part of the data collection for die UNISPACE 82 document. For a further check, a number of questionnaires were circulated to participants in the UN seminar on Remote Sensing Applications to Land Use Planning, sponsored by the government of Japan in 1980. The many national papers prepared for the UNISPACE 82 Conference were also consulted and used as relevant. After 1981 additional information was obtained from published literature, especially on the USA, from conference and seminar papers and reports and other documents, or through correspondence.

7. The initial survey resulted in abundant data, the analysis of which required careful scrutiny. The outcome of the survey, including some updates, was compiled by Woldai (1982), which could form a first input for the new information system on remote sensing training and education. It contains a list of various institutions of higher education and research, laboratories and agencies in many countries throughout the world, providing occasional or regular remote sensing education and training. Further updating will be necessary and should become an ongoing operation, requiring a systematic data collection and from time to time additional questionnaires for updates and evaluation purposes.

Remote sensing education and training

8. Remote sensing is too powerful a tool to be ignored in terms of both its information and the logic implicit in the reasoning process employed to analyze the data. In the industrialized and developing countries alike it has nowadays become one of the most dominant methods of surveying, identifying and monitoring earth resources, both renewable and nonrenewable. Most countries have found satellite remote sensing data indispensable to monitor land use, forecast crop yields, assess damage of natural disasters, identify promising targets for mineral exploration, evaluate groundwater conditions, detect erosion and water pollution etc. Even then a number of the developing nations are still, in general, handicapped by the lack of knowledge about the nature, quantity and location of their natural resources to harness them effectively for the welfare and advancement of their people.

9. To make full use of this technology, it seems essential to develop the human resources in these countries. It is only through well-trained professionals that a country can ensure the proper adaptation of this new technology to its specialized needs. Education in remote sensing must be seen as an investment in the future. Administrative and scientific personnel should therefore be trained and given the opportunity to evaluate the economic and technological feasibility of applying this new technology to the resources and environmental problems of their region, and promote awareness with a number of other resource scientists. For this to happen, institution building is highly essential and the trend now in use in satellite remote sensing seems to emphasize this.

10. Many countries have national remote sensing programmes set up under the auspices of various specialized institutions and government organizations such as a space agency, science academy, research institute, university or ministry and are already pursuing regular education and training courses in remote sensing for their own nationals. By doing so local people are trained, local problems in which remote sensing can effectively be applied are identified and pilot projects are executed. Other countries organize seminars, workshops and in-house training in satellite remote sensing on an occasional basis to reach a wide range of technicians, resource scientists and policy-makers from their own region and promote awareness of the new technology.

11. Some national remote sensing institutes, organizations or centers have already included participants from their own regions, thereby, in a way, playing a regional role and serving

regional as well as national needs. Moreover, there are a few regional training courses serving more than one country and being financed from national sources, international organizations or by regional agreement.

12. There are also many universities in North America, Europe and elsewhere that offer undergraduate curricula in one of the resource disciplines (including remote sensing) or give formal postgraduate studies emphasizing remote sensing techniques or applications. As well, a number of semi-governmental or private organizations give customized training or on-the-job training to their clients.

13. In brief, the remote sensing facilities planned or in operation are of various types. There exist nowadays:

- International facilities, example: UN Natural Resources and Energy Division (DNRE) and UN Food and Agriculture Organization (FAO).

- Regional facilities, such as the Ouagadougou Regional Centre, Burkina Faso; the Nairobi Regional Remote Sensing Facility (RRSF) Kenya; the Asian Regional Remote Sensing Training Centre (ARRSTC) Bangkok, Thailand; etc.

- National facilities with an essentially international function, examples: the Earth Resources Observation System (EROS) Data Center, Sioux Falls, USA; Groupement pour le Developpement de la Teledetection Aerospatiale (GDTA), Toulouse, France; the International Institute for Aerospace Survey and Earth Sciences (ITC), Enschede, the Netherlands.

- National facilities with additional regional functions, examples: Centro Interamericano de Fotointerpretacion (CIAF), Colombia; the Indian Institute of Remote Sensing (IIRS), India; the Remote Sensing Technology Centre of Japan (RESTEC); and

- Purely national facilities, examples: Remote Sensing Training Centre, Beijing University, China; Centro de Levantamientos Integrados de Recursos Naturales por Sensores Remotos (CLIRSEN) , Ecuador; etc.

14. Furthermore, some facilities are: -Receiving facilities, examples: Sweden, Australia, S. Africa.

- Others combine receiving and distributing functions with or without training and user support functions, examples: National Remote Sensing Agency (NRSA), India; Instituto de Pesquisas Espaciais (INPE), Brazil; National Aeronautic and Space Administration (NASA), USA; the Canada Centre for Remote Sensing (CCRS), Canada.

- Still others are basically distribution centers: EROS Data Center, USA; or

- Training and user support centers, example: IIRS, CIAF, ITC, GDTA, ARRSTC.

15. The dimension and geographical distribution of the community involved in the application of remote sensing are determined by the characteristics of the environment in the various regions and by the type of remote sensing facilities planned or in

operation.Furthermore, various categories of personnel and various target groups are involved in education, training, research and operations.

16. The range of types and levels of training and education is equally wide. A complete listing of all facilities is not feasible nor very relevant. Instead, it is much more important to categorize the various facilities, using several different parameters.

17. We can classify the type of education in relation to the applications envisaged:

- discipline-/application (taking into consideration the natural environment of the facilities concerned, such as arid zones with rangeland management, humid tropical zones with intensive agriculture, zones rich in mineral resources, etc.)

- image analysis (taking into consideration the human environment, available financial and other resources and education and technology policy, emphasis on optical/ visual image analysis and interpretation, emphasis on digital work, or both). In the latter case it should be noted that (visual) airphoto interpretation often serves as a solid introduction to remote sensing interpretation and as an efficient way of preparing national agencies for operational remote sensing applications.

18. Another classification is by level(s) of education, type and duration of courses, methodology of education/training etc.:

- Standardized courses of short (few weeks) to long (9-12 months) duration, advanced levels (M.Sc. and Ph.D. courses, 12-30 months)
- Customer-tailored courses.
- Extra-mural courses and seminars.
- On-the-job training.

In all these cases educational methodology could be by classroom teaching (formal lectures), workshops and discussion groups, demonstration, hands-on experiments and other exercises, or use of specially designed audio-visual materials, etc.

19. Levels can be classified as:

- technician level;
- technologist and professional postgraduate level;
- advanced studies - M. Sc. level,
  - Ph. D. level;
- managers, planners and decision-makers.

20. Another classification should be discipline-/methodology-oriented:

- image processing courses - use of software and equipment;
- special software-oriented courses (specification and development of software packages);
- hardware-oriented courses (R&D, operation of equipment, maintenance);
- application-oriented courses: geology,
  agriculture,
  forestry,

mineral exploration,
water resources,
urban environment,etc.

21. For some types of education and training generally valid standards can be defined. For other types a much greater flexibility is required and type of education and standards of performance will be dictated mainly by user needs under a variety of conditions.

Funding of education and training

22. Over the years the promotion of remote sensing application and implementation of regional remote sensing programmes have received considerable support through international co-operation. Various options are available for obtaining external support for national or regional remote sensing programmes. These are facilitated by the increased emphasis given to science and technology for development since the 1979 United Nations Conference on Science and Technology for Development (UNCSTD) in Vienna. However, due to the prevailing economic and political climate, it does not increase the total amount of funds available for development co-operation (Voute, 1981). Any recipient country (i. e. developing country) or partner in development co-operation therefore who wants to fully benefit from the increased opportunities to implement science and technology in its national development efforts, has to adjust and modify its priorities in order to create the necessary financial flexibility.

23. The present worldwide education and training capacity in remote sensing for participants from the developing countries amounted to approximately 1 000 for courses exceeding six months and almost 4 000 for seminars and courses of short duration; in total about 1 800 person-years annually (UN Document A/CONF.101/BP/9, 1981). Whether this capacity will be fully used depends to a large extent on the funding of fellowships. This might involve:

- Source of funding of scholarships and fellowships including research fellows for PhD studies.

- Co-sponsoring and co-funding of courses or even of educational and training facilities.

24. Current international co-operation takes many different forms -partly on a bilateral or multilateral form, and partly through various intergovernmental and nongovernmental agencies and organizations, and others such as foundations, special funds, industries, etc. For example, a number of projects and programmes are co-funded by the United States Agency for International Development (USAID). This agency has established an Office of Science and Technology to promote the transfer of technology and applications of remote sensing to the Third World by organizing a number of seminars, both in the USA and abroad (in Third World countries). To encourage the development of local capabilities, USAID solicited a number of small-scale research and development projects from Third World scientists and provided the necessary expert assistance and materials to carry out the projects. It also supports regional remote sensing centres such as the Regional Remote Sensing Facility in Nairobi, Kenya, and the Asian Regional Remote Sensing Training Centre in Bangkok, Thailand.

25. In Canada there exist two technical assistance agencies, both of which have an interest in remote sensing. The International Development Research Centre (IDRC) assists small research and development projects (for example in Bolivia) and also has some interest in supporting regional centres, while the Canadian International Development Agency (CIDA) funds substantial projects in the development of remote sensing capabilities, such as in Peru, and in regional centres, such as the Ouagadougou Regional Remote Sensing Centre in Burkina Faso.

26. In a number of cases the European Economic Community (EEC) and the European Development Fund (EDF) also provide assistance in terms of expertise and provide fellowships and grants if the interested countries are signatories of the so-called "Lome Convention" in which many of African countries, the Caribbean and the Pacific (the "ACP" countries) are included. Similar support, more limited in extent and volume, is provided by the Organization for Economic Co-operation and Development (OECD).

27. Under a bilateral and multilateral form numerous governments in Europe are also actively involved in remote sensing programmes. The Netherlands, for example, through its Ministry for Development Co-operation supports and funds international programmes, including education and training in remote sensing. It's ongoing programmes include providing fellowships to participants from the developing countries to study at the International Institute for Aerospace Survey and Earth Sciences (ITC), the Netherlands, Centro Interamericano de Fotointerpretacion (CIAF) and the Indian Institute of Remote Sensing (IIRS), Dehra Dun, India, which are some of the active remote sensing institutes established with Netherlands assistance.

28. The main international source for support and technical assistance for national or regional remote sensing projects and programmes comes from the United Nations and the specialized agencies. Here two distinct types of functions occur:

- nonoperational secretariat functions that incorporate secretariat support to international bodies, international coordination and advice within the system, and programmes of studies, seminars and conferences directed at learning how to make best use of the potential of this new technology;

- operational functions, dealing with funding technical assistance or training (through training seminars or fellowships) for operational or field projects in developing countries.

Some UN agencies or departments combine both functions, whereas others have a mandate for only one function.

29. The main source of funding for technical assistance in the UN is the United Nations Development Programme (UNDP). Since the priorities are formulated by the recipient governments, the UNDP does not promote remote sensing or any other particular technology, but a number of governments have remote sensing projects funded through UNDP. Outer Space Affairs Division's (OSAD) objective is to create awareness of the benefits of space applications and it provides training seminars, panels and workshops. The Food and Agriculture Organization (FAO) operates an international remote sensing (user support) centre for renewable resources and provides services upon request. The Remote Sensing Unit in the Natural Resources Division (DNRE) of

the UN Department for Technical Co-operation for Development (DTCD) operates another international remote sensing centre for nonrenewable resources. UNESCO also provides support for remote sensing education and training through co-sponsoring of courses and fellowships. The World Bank (IBRD) funds large-scale operational development projects selected on the basis of expected economic return on investment. The Bank, however, does not normally directly fund training or education, although this may form part of a larger project, including the development of universities. In addition to the organizations listed, above other international agencies that support training courses for specific groups include the Interamerican Development Bank, UN Regional Commissions, Organization of American States, etc.

30. The international funding agencies, governments or non-governmental organizations and bodies contributing financial to remote sensing education and training to date are too numerous to document here. Clearly, this requires a concerted effort to update documentation of all funding available in education and training in satellite remote sensing.

Information system on educational facilities

31. The various institutions involved in remote sensing education and training have been documented by various people and organizations and it is clear that there are many more education and training facilities available locally or regionally than a few years ago and undoubtedly this trend will continue in the future. As remote sensing technology has developed, the training requirements have been varied and, at the same time, the content of the courses has become much more diversified, making it difficult for countries or individuals to decide with certainty what type of training is available and where. What is currently needed, therefore, is an efficient mechanism for making those in need of remote sensing training aware of the variety, characteristics, advantages and limitations of courses available so that they can make an educated choice as to the most appropriate courses to fulfil their needs. In other words, the need now arises for a well-documented archive information system, enumerating all training and education possibilities in satellite remote sensing.

32. The information required should be updated when the need arises and new activities should be included when necessary. The documented material could be formulated to include:

- Name and address of the institute. To facilitate action, contact person(s) (if possible), telephone and telex number should be included.
- Type of institution:
  - international/regional/national institute of higher education;
  - international/regional/national survey/production/research institute or other type of institution providing formal courses, research programmes, on-the-job training, etc.;
  - private firm or industry offering services including education/training under contract;
- Nature and content of the course given. This is a very important part, which needs elaborate treatment. Knowledge of type of courses given by the institute or centre, whether of theoretical nature or application-oriented or whether it is

mainly in aerial photo interpretation or satellite image interpretation or digital image processing using computers, whether it covers geology, geomorphology or vegetation, etc. is of prime importance for a country that would like to have its people specialized in a certain discipline;
- Strata of the people for whom the programme is offered: Teachers? Research groups? Technical support groups? Managerial groups? Decision-makers?
- Course orientation: primarily for
  - national attendance,
  - participants from own region,
  - participants from the industrialized countries,
  - participants from the developing countries,
  - participants from all countries.
- Number of participants per year or per course (annual capacity) duration and frequency of courses, planned number of participants.
- Qualifications required of the participants (entry requirement)
- Language(s) of instruction.
- Sources for funding of fellowship, example: sponsored by own institution, national fellowship programme, donor countries, international agencies, etc.
- Type of degree, diploma or certificate offered.
- Additional information:
  - involvement of the institution in seminars, workshops, symposia, conferences, etc.
  - other activities such as research, consultancy, etc.
  - facilities or equipment available.

33. The name of institution actively involved in satellite remote sensing education and training have been documented in a number of publications; to list a few: by the Department of Industry, London (1979), Tessar et al. (1981) CORSE-81 (1981), UN Document E/ECA/NRD/ARSC/1 (1982), Woldai (1982) and EARSeL Directory (1983). The number of institutions given below, by no means exhaustive, covers only a fraction of the total education and training opportunities available throughout the world. The institutions described occupy no priority listing in the author's mind but are selected to fit the proposal formula above regarding preferable format and information required on education and training opportunities in satellite remote sensing.

34. Institution:

Centro Interamericano de Fotointerpretacion (CIAF),
Apartado Aero 53754, Carrera 30 No. 47 A-57,
Bogota 2, Colombia, South America.
Tel. 2 68 01 90-2 69 48 11. Telex 45656 OMOPT.

CIAF, an institute of the Colombian government, started in 1968 and is one of the best known and largest training and user-assistance centres in remote sensing in Latin America.

Nature and content of the courses:
The institute offers regular courses in civil engineering, geology, forestry and soils, in which aerial photo interpretation and remote sensing form an integral part. Apart from this, CIAF also offers a special course for professionals and technicians in the application of remote sensing to a variety of disciplines. The courses are mainly oriented for Colombian nationals and participants from the Latin American countries. In this respect CIAF fulfils the task of a national centre with a regional function in Latin America.

Number of participants:
Normal yearly number of participants accepted ranges between 250 and 300.

Frequency/duration of course:
Normal course once per year, duration 40 weeks; special course once per year, duration 2-16 weeks.

Qualification required:
Participants should have training in or have thorough experience with aerial photo interpretation in their field of specialization. A university degree or its equivalent is a prerequisite for admission.

Language of instruction:
Spanish.

Degree/diploma/certificate awarded:
Upon successful finishing of the course the student is awarded a diploma or certificate.

Source of funding:
Students are advised to find their own means of funding. List of national or international organizations offering fellowships can be obtained from CIAF.
CIAF is active in participating and collaborating with national and international organizations, UN bodies and international institutes such as ITC in organizing symposia and seminars, the most recent one being "El primer Simposio Sobre Sensores Remotos" in 1981. It also carries out research in many fields and provides consultancy to national authorities and organizations in neighbouring countries.

35. Institution:

Indian Institute of Remote Sensing (IIRS),
National Remote Sensing Agency (NRSA), Kalidas Road, P. O. Box 135, Dehra Dun (U. P.),248 001 India, Asia.
Tel. 45 83, Cables REMOTIPI. Telex 0595 224 NRSA IN.

The IIRS (formerly Indian Institute of Photo Interpretation - IPI) was established in 1966 and is part of the NRSA. With a total number of over 1 000 alumni to date it is by far the most important remote sensing training institute in the Economic and Social Commission for Asia and the Pacific Regions (ESCAP regions).

Nature and content of the courses:
The institute offers a range of regular courses (short and long) in airphoto interpretation (techniques), applied photogrammetry, geology, soil survey, forestry and geomorphology. Elements of remote sensing using satellites imagery are also included in its syllabus. The IIRS courses, although primarily for national attendance, are also open for participants from the ESCAP region.

Number of participants:
Yearly number of participants ranges between 70 and 80.

Frequency/duration of courses:
Duration of regular training courses ranges from 3 to 12 months. Special orientation courses of approximately 2 weeks are also conducted every year for middle management staff.

Qualification required:
Applicants for admission to various disciplines must have a basic (preferably an M. Sc.) degree in their respective disciplines. In addition, at least one year of practical experience in the subject concerned is required.

Language of instruction:
English.

Degree/diploma/certificate awarded:
Successful completion warrants a postgraduate diploma or certificate.

Source of funding:
For Indian participants the source of funding involves either sponsorship from their own institution, national fellowship programme, by donor countries or from international agencies. Foreign participants, however, should bear their own expenses for tuition, travel, etc.
IIRS is well equipped with analogue photo interpretation instruments and provides consultancy in the techniques related to the above activities. It also organizes and participates in international seminars, symposia and conferences.

36. Institution:

Regional Remote Sensing Facility (RRSF),
P. O. Box 18332 or 18118, Nairobi, Kenya, Africa.
Tel. 55 64 00. Cables Landsat Nairobi. Telex 22 972 KAELER.

A division of the Regional Centre for Services in Surveying and Mapping (RCSSM), the facility is designed to support and assist users of remote sensing data. It is also designated as one of the Regional Remote Sensing Centres in Africa.

Nature and content of the courses:
The facility offers short courses, information seminars and on-the-job training in remote sensing. The short courses are designed to introduce remote sensing techniques and so far courses have dealt with hydrology, forestry and range resources,
cartography, agriculture, geology and regional planning. Extended training courses have been introduced to provide greater exposure to the technology and to link the facility directly to ongoing resource development projects. Information seminars and on-the-job training are offered, usually upon request and mostly in the requesting country.

Number of participants:
Approximately 100 - 120 per year in total.

Frequency/duration of courses:
Short courses 3 weeks and 4-6 times per year. The information seminars and on-the-job training last normally 2-3 days and depend on request.

Qualification required:
Practical experience in the subject concerned and a minimum of a B. Sc. degree or equivalent is required for the shorter and extended training courses.

Language of instruction:
English.

Degree/diploma/certificate awarded:
Diploma or certificate.

Source of funding:
International organization or donor countries.

The facility undertakes a number of technical assistance activities both in imagery interpretation, the distribution of remote sensing data products and image review facilities from a browse file covering the whole of Africa. It publishes "Earth Resources Mapping in Africa" newsletter and maintains working relations with survey departments in the sub-region. It also participates in and organizes workshops, seminars and conferences directly related to remote sensing activities in the region.

37. Institution:

EROS Data Center (EDC),
Sioux Falls, South Dakota 57198, USA, North America.
Tel. (605) 594-6114/6511, ext. 1 14.

EDC, an agency of the United States Geological Survey (USGS), offers a variety of international training programmes.

Nature and content of the courses:
International remote sensing workshop series. This is an introductory in nature and is mainly designed to familiarize the participants with different remote sensing systems, their characteristics, limitations, advantages, applications and to provide analyzing experience on various remote sensing imagery. The whole programme involves a combination of classroom lectures, workshop exercises, homework and fieldwork. Most emphasis is put on the analysis of LANDSAT data, including aerial photographs, thermal infrared and radar. The May workshop concentrates on geologic and hydrologic implications while the September one deals with vegetation assessment and land use planning. The workshop does not include advanced theoretical works or computer-aided image analysis.

Number of participants:
More than 30 students for each of the two workshops per year.

Frequency/duration of courses:
Two courses per year, each of four weeks duration.

Qualifications required:
The participants should have background or assignment in one or more of the following disciplines: agriculture, engineering site selection and evaluation, geology, hydrology, forestry, range management and soil sciences.

Language of instruction:
English.

Degree/diploma/certificate awarded:
Upon successful completion of the course the participants are awarded a diploma or certificate.

Source of funding:
No scholarships are available from the USGS and as a result the cost for training is borne by the participant or his supporting agency.

EDC conducts courses sponsored by specific foreign governments or international organizations. It is active in organizing seminars, symposia and participates together with other international, national or foreign governments in the preparation of conferences.

38. Institution:

International Institute for Aerospace Survey and Earth Sciences (ITC), P. O. Box 6, 7500 AA Enschede, Netherlands, Europe. Tel. (053) 320330. Cables EARSUR, Enschede, Netherlands. Telex 44 525.

ITC is an international institute. Since its creation in 1950 it has provided training to more than 6 000 students from all over the world.

Nature and content of the course:

The ITC offers courses in a variety of disciplines, primarily at the postgraduate level, in which remote sensing applications form an integral part. Courses given include geology (including hydrogeology and engineering geology), geography and geomorphology, soil survey, forest survey, rural and urban survey, photogrammetry, aerial photography, cartography, mining exploration, geophysics and integrated surveys. A few courses are given also at the technician level. In addition, short courses in the applications of remote sensing (LANDSAT, side-looking radar, multispectral and false colour photography, thermal infrared scanning) in geology, water resources, geomorphology, soil survey and terrain classification aimed at deepening and updating the knowledge of those involved in natural resources are given every year. Beginning this year a 3 month-course in digital image processing and pattern recognition has been incorporated in the ITC courses separately.

Number of participants:

The total number of participants per year amounts to 500.

Frequency/duration of course:

Standard courses 1 year, advanced courses leading to an M. Sc. degree 18 months (given only after successful completion of the course), short remote sensing course 3 months/year mainly beginning October, and digital image processing and pattern recognition 3 months/year beginning February.

Qualification required:

Most of the courses require a B. Sc. degree for admission and many provide the possibility for the successful participant to obtain an M. Sc. degree. Courses at the technician level are also given in photogrammetry, cartography and aerial photography.

Language and instruction:

Mainly English. The Photogrammetry Department gives courses in French.

Degree/diploma/certificate awarded:

Advanced diploma, certificate or M. Sc. degree.

Source of funding:

The Netherlands government grants annual fellowships covering tuition and all other expenses to about half of ITC students (from developing countries). A list of international bodies which can grant fellowships can be obtained from the Dean of Students of the ITC. Participants from the industrialized countries must find their own means of funding. ITC itself has no funds available for scholarships.

ITC occasionally organizes special courses at the request of specific governments or international organizations and regularly provides guest lectures to training seminars organized by the United Nations. It provides support to the Indian Institute of Photo Interpretation in Dehru Dun, India, the Regional Centre of Training in Aerial Surveys in Ile-Ife, Nigeria, the Centro Interamericano de Fotointerpretacion (CIAF) in Bogota, Colombia, and the School for Photogrammetry and Cartography Operators in Bandung, Indonesia. It actively

organizes seminars in different parts of the world, participates in symposia and gives consultancy in aerial survey and remote sensing applications. The ITC Journal is circulated to all its former alumni throughout the world.

Conclusion

39. Education and training in remote sensing are receiving increasing attention and the trend seems favourable. Many educational facilities prevail, some on a permanent continous basis and some on occasional basis. Different facilities have different specializations and are oriented for specific strata of people. The costs and fees for attending the various courses in satellite remote sensing differ widely. Available documentation regarding the facilities in education and training in remote sensing in the world is not fully comprehensive and does not seem to include full-time university/college courses in earth science fields. The questions often asked are "what type of training is available?, where?, and when?, what type of funding is available for promoting education and training in this field?, where can one look for fellowships?, what is the cost involved in attending the course?, what requirement is needed?", etc. It is the purpose of this paper to stress the need for such kinds of information and it is hoped that the UN will recommend specific actions and measures in this respect.

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