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Committee on the Peaceful Uses of Outer Space

Report on the United Nations/European Space Agency Workshop on Remote Sensing Applications and Education

(Damascus, 29 June-03 July 2003)

Contents

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I. Introduction

A. Background and objectives

1. The Third United Nations Conference on the Exploration and Peaceful Uses of Outer Space (UNISPACE III), in particular through its Vienna Declaration on Space and Human Development,[1] recommended that activities of the United Nations Programme on Space Applications should promote collaborative participation among Member States at both the regional and international levels, emphasizing the development of knowledge and skills in developing countries.

2. At its forty-fifth session, in 2002, the Committee on the Peaceful Uses of Outer Space endorsed the programme of workshops, training courses, symposiums and conferences planned for 2003.[2] Subsequently, the General Assembly, in its resolution 57/116 of 11 December 2002, endorsed the United Nations Programme on Space Applications for 2003.

3. Pursuant to General Assembly resolution 57/116 and in accordance with the recommendation of UNISPACE III, the United Nations/European Space Agency (ESA) Workshop on Remote Sensing Applications and Education was organized by the United Nations, ESA and the Government of the Syrian Arab Republic at the General Organization of Remote Sensing (GORS) in Damascus from 29 June to 3 July 2003. GORS acted as the host of the workshop on behalf of the Government of the Syrian Arab Republic.

4. The main objective of the workshop was to provide a forum for discussion among engineers, educators and application scientists concerned with remote sensing applications and education. Remotely sensed data provided a view of the Earth for many studies that required synoptic or periodic observations such as inventory, surveying and monitoring in agriculture, hydrology, geology, mineralogy and the environment. Remote sensing was viewed as a discipline that was integrated with other disciplines such as photogrammetry, cartography, geodetic reference systems, global positioning systems and geographic information systems (GIS). It was a rapidly growing technology and was one of the important spin-offs of space applications and space science. Education played a critical role in ensuring the widespread application of remote sensing.

5. The workshop focused on the use of remote sensing data for various technical and educational applications, in particular in developing countries. A fundamental requirement recognized at UNISPACE III was to support sustainable development while safeguarding the Earth's environment, which required optimal management of natural resources and depended on the availability of reliable and up-to-date information at the national, regional, and international levels. Remotely sensed data played an increasingly important role as a source of reliable and timely information necessary for sustainable management of natural resources and for environmental protection.

6. The workshop also provided an opportunity to review the education curriculum for remote sensing and GIS, developed for the regional centres for space science and technology education affiliated to the United Nations and established in Africa (Morocco and Nigeria), Asia and the Pacific (India), and Latin America and

the Caribbean (Brazil and Mexico) (see ST/SPACE/18, available on the Internet at www.oosa.unvienna.org/SAP/centres/centres.html).

7. The report of the workshop has been prepared for submission to the Scientific and Technical Subcommittee of the Committee on the Peaceful Uses of Outer Space at its forty-first session, in 2004. Participants have reported on the knowledge acquired and the work conducted during the workshop to the appropriate authorities of their Governments, universities and institutions.

B. Organization and programme

8. The workshop was held at GORS, in Damascus, from 29 June to 3 July 2003. It was attended by 67 engineers, educators and application scientists from the following 14 countries: Algeria, Bangladesh, Cuba, Egypt, Iran (Islamic Republic of), Jordan, Lebanon, Libyan Arab Jamahiriya, Malaysia, Morocco, Sri Lanka, Sudan, Syrian Arab Republic and United Republic of Tanzania, as well as from the United Nations and ESA.

9. The United Nations and ESA provided financial support to defray the cost of international air travel and living expenses of 20 participants from developing countries. Room and board and local transportation for the participants, as well as meeting facilities and equipment for the workshop, were provided by GORS.

10. The programme of the workshop was developed jointly by GORS, the Office for Outer Space Affairs and ESA. Presentations made at the workshop on remote sensing applications covered topographic and thematic mapping, agriculture, hydrology, geology, mineralogy, the environment and disaster management. In relation to the use of remote sensing in education, the presentations focused on university-level teaching and curricula, data analysis and image processing, computer-assisted teaching, Internet resources, distance learning and international cooperation. Information on satellite data access, analysis, interpretation and archiving was also presented and demonstrations were made of appropriate software tools.

11. The following documents were made available to participants as preparatory material for the workshop:

(a) Report of the Third United Nations Conference on the Exploration and Peaceful Uses of Outer Space (UNISPACE III)[3] (available on the Internet at www.oosa.unvienna.org/unisp-3/index.html);

(b) Education curriculum for remote sensing and GIS (2001) (available on the Internet at www.oosa.unvienna.org/SAP/centres/centres.html);

(c) Proceedings of the International Society of Photogrammetry and Remote Sensing, Technical Commission VI, Mid Term Symposium on New Approaches for Education and Communication (2002) (available on the Internet at www.commission6.isprs.org).

12. Opening addresses were made by representatives of GORS, the Office for Outer Space Affairs and ESA.

II. Summary of workshop deliberations

A. Remote sensing applications and education

1. Background

13. Participants at the workshop were informed that the implementation in developing nations of remote sensing and GIS education programmes by the regional centres for space science and technology, affiliated to the United Nations, posed challenges owing to the limited number of experts able to cover the topics of the education curriculum in developing countries, as compared to industrialized nations. A window of opportunity existed to support local experts in teaching those topics by developing instructional materials using information technologies. The goal of teaching remote sensing and GIS focused on providing scholars with the skills and capacity to allow them to engage in active work after they had completed programmes at the regional centres. One of the most effective learning methods associated with the development of technical skills was through problem-based learning. A suggestion had been made that an ideal way to proceed would be to create a multi-layered decision-making module that provided feedback and allowed multiple final solutions. Further module development and implementation should include a first phase that would focus on assessing the regional centres' remote sensing and GIS applications and their areas of interest and cultural background and a second phase dedicated to incorporating available teaching material, software and data.

14. The remote sensing and GIS education programme that was being implemented at the regional centres would follow a pioneering and extensive curriculum. The curriculum was recently revised and updated during the United Nations Expert Meeting on the Regional Centres for Space Science and Technology Education: Status and Future Development, held in Frascati, Italy, from 3 to 7 September 2001. The curriculum formed the syllabus for a nine-month, post-graduate programme, divided into three 12-week modules: (a) fundamentals of remote sensing and GIS; (b) remote sensing and GIS applications in natural resource surveys and the environment; and (c) project work, including field data collection.

15. Many universities in developing and industrialized countries had a long tradition in both research and applications of geospatial technologies and in the development of instructional materials designed to teach principles, concepts and processes associated with spatial data generation and analysis. Such expertise and information, related in particular to aspects of science that utilized modern geo-techniques and applied especially to Earth science, environmental science and resource management, should be made available to the regional centres for space science and technology education.

16. Knowledge and use of geo-techniques would help scholars to master science concepts, including addressing numerous tasks and standards. Innovative approaches to improve the acquisition by scholars of geo-technology concepts and applications could be designed by multi-disciplinary groups of researchers and teachers working collaboratively with the regional centres. There were several distinctive features in the design of the instructional materials that highlighted their timely significance to education. The design brought together scientists from

universities with professional science educators and with curriculum, instruction and assessment consultants, all linked to practising science and geography teachers to form teams to produce cutting-edge instructional materials. The design was intended to integrate sound scientific techniques with powerful pedagogical strategies to encourage scientific investigations, resulting in a deep understanding of geospatial technologies and their application to scientific inquiry.

2. Curriculum on remote sensing and the geographic information systems

17. The history and outcome of the enduring process led by the Office for Outer Space Affairs and its collaborators in delineating and defining the curriculum on remote sensing and GIS were reviewed and commented on. The overall definition of the curriculum and the proposed course structure were considered impressive. The breadth of the science and application topics addressed, both directly and indirectly related to the target technologies, should result in scholars graduating from the programme with a deep understanding of and an ability to apply the technologies in their careers.

18. However, a concern was raised in relation to the nine-month duration of the studies. Undoubtedly, many scholars would feel overwhelmed with the amount of knowledge they would be expected to acquire in that short period of time. Evidently, the level of difficulty would depend on how deeply the topics were addressed and how thoroughly the scholars were expected to study each topic. Therefore, it was suggested that an assessment and evaluation programme should be put in place to obtain feedback from scholars and instructors on the progress achieved during programme implementation. The results of such an assessment and evaluation programme would help to identify difficulties and/or deficiencies in the programme, which could be used to guide its revision and improvement. Evaluation of instructional material would also enhance efforts to optimize the programme.

19. The workshop made the following recommendations concerning the topics included in the curriculum:

(a) The issue of classification keys for land use and land cover (LULC) and the various efforts to standardize LULC feature classification (such as the Land Cover Classification System developed by the Food and Agriculture Organization of the United Nations (FAO) and standards defined by the Federal Geographic Data Committee of the United States of America) should receive greater emphasis. Although the issue of “standards” was listed under item 1.7.8, the emphasis should be on the importance of adopting those standards instead of creating new ones. That was an important issue to address, because experts frequently found information (namely, maps or data sets) from previous projects that could be converted to fulfil an existing need, but the classification scheme, although addressing the same theme and location, did not permit reuse because of the lack of standardization. That was even more dramatic in developing nations, where the need for spatial information was much greater. The lack of emphasis on the issue, considering the way it stood in the curriculum, did not make it a priority. As a result, regional centres affiliated to the United Nations could choose not to include the topic in their programmes. An example of the problem was clearly shown in annex I of the curriculum document, where the issue was not addressed in any of the proposed lectures or practical exercises.

(b) Several types of data with a large variety of applications were presented during the programme, allowing scholars to see what was available from many different sources for use in their future activities. However, knowing what was available did not imply that they would know how to choose the right data for a specific task. Although that knowledge might be implied in several lectures and exercises relating to data types, it was suggested that a specific topic addressing that issue should be listed in the curriculum. That would improve the likelihood that scholars would be taught how to choose the right data type for the tasks they would encounter after completing the programme.

3. Pedagogic strategies

20. It was agreed that the goal behind teaching remote sensing and GIS should always be to provide scholars with the skills and capacity they needed to allow them to engage in active work after they had completed the programme. A key element in building skills was to teach the processes associated with tasks commonly used to conduct the type of work that was the focus of a training programme. By learning the processes, scholars or trainees would be able to apply the skills learned in different scenarios of vital interest to them and their home institution. An example given was that, in its most basic form, a remote sensing system essentially generated data. The data might come from different sources with different characteristics. Scholars needed to learn how to extract the necessary information from the data for a specific application for which they were responsible. They should be able to decide which technique was the most appropriate to use with the data they had access to, in order to obtain the most accurate spatial information possible that could be derived from the available data. Once the information was obtained, they should be able to analyse the various layers or components created using spatial analytical tools provided by a standard GIS environment.

21. One of the most effective ways to teach those skills was through exercises derived from problem-based learning. In a spatial reasoning context, which involved selecting data, choosing image processing techniques, extracting spatial information and analysing that information, a special set of skills needed to be acquired in order to conduct the work successfully. Behind most of those skills were the processes associated with implementing the scientific method. A multi-layered decision-making exercise that provided feedback and yet allowed multiple final solutions could teach most elements of a designated process.

22. The workshop also reviewed currently available information technology, notably multimedia and the Internet, which provided a rich material development environment where attractive and effective activities and related content could be developed and delivered in challenging and interesting ways. Many universities had developed compact disks (CD-ROMs), using state-of-the-art multimedia technology to deliver content, provide tutorials and track scholar achievements. Those CD-ROMs could be evaluated in three respects: product quality, teacher usage and scholar learning. Accordingly, they could receive marks for quality at all three testing levels. The most current products included hybrid solutions that incorporated physical media materials with Internet based updating and complementary materials. Some universities were proposing an upper scale web-based distance learning programme using web mapping technology and sophisticated multi-temporal and multi-scalar three-dimensional spatial databases.

All those experiences and technologies were available to provide a rich environment for development of materials to support the needs of the regional centres in teaching remote sensing and GIS.

23. An additional service that could be further discussed in the near future was the development of project-specific pre-processed data sets, which could be generated and provided quickly for use with facilities currently available at most of the regional centres affiliated to the United Nations.

4. Components for inclusion in the proposed modules

(a) Use of software packages in the public domain that allow extraction of information from a variety of data types and then transfer the results to a spatial database to conduct spatial analysis

24. Participants were informed that there were several powerful software packages in the public domain that could be used in an integrated manner, allowing scholars to use real data, to conduct analysis while learning how the processes were accomplished and to check the output of each process as they moved along. Examples of such packages included "MultiSpec" of the National Aeronautics and Space Administration (NASA)/Purdue Research Foundation and the Georeferenced Information Processing System (SPRING) of the National Institute for Space Research of Brazil. The use of those packages would be guided by the tutorials described below in paragraph 26.

(b) A collection of spectral data sets covering a variety of sensors, resolutions and geographic locations to provide examples that illustrate important applications included in the curriculum

25. It was agreed that a vital component of a module, such as described in the education curriculum document, was the quality and ease of use of different types of data being implemented during the programme. Scholars needed to be able to conduct field work to assess the results of their analysis and relate it to the spectral and other data sets available for comparison. The data used in technology transfer and education should be structured in such a way that the range of applications was as broad as possible. With such a structure, scholars would be able to practise a wide range of analyses, thereby illustrating the majority of applications included in the education curriculum, and were more likely to find applications that related to their career interests and/or national or regional priorities.

(c) Tutorials that are structured so as to allow scholars to have hands-on experience, which assists them in becoming competent in working with various techniques and data types

26. Such tutorials would include both basic content (concepts and principles) and practical activities (process-based) to guide scholars through the tasks necessary to conduct the various tasks of image processing and spatial analysis. The material would be structured using modern problem-based learning methods in such a manner that scholars would face a diverse range of choices at each level of instruction, where they would make decisions based on their level of skill. The system would provide the means for them to assess their progress and make corrections if needed as they progressed through the material.

(d) Preparation and delivery of data sets available locally "on demand" and that have been pre-processed to enhance applications

27. It was stated that the option to enhance and use data sets that were available locally could be a complementary service in addition to the packaged data sets delivered with the instructional material. It would include the preparation of data sets derived from data in the public domain that would be requested by a regional centre. Through such a service, a variety of data types could be made available to fulfil the needs of locally oriented projects. The scope and extent of the optional service could be explored in cooperation with the Office for Outer Space Affairs before preparation of a formal proposal.

5. Further module development

28. Participants agreed that further module development should focus initially on assessing application by the regional centres of areas of interest and cultural background. That was an important task, considering the cultural diversity of the target audience and the significant variations in the natural environment and application of remote sensing in each region (Africa, Asia and the Pacific, Latin America and the Caribbean and Western Asia). The results of the assessment should be used to guide planning of the courses and content design for the tutorials. Once portions of the content material were developed, interactive activities could be designed. Most of the teaching instruction would be conducted through such practical activities, which would provide instant feedback as the progress of the scholars was tracked. The activities would be structured on the basis of current research methods, using problem-based learning approaches. Selected components used in the activities could be linked to a web site, where information would be frequently updated. In that manner, even if the information was recorded on fixed media such as compact discs or digital videodiscs, it could still be used by the scholar in an interactive process using updated information.

29. A subsequent phase of module development would incorporate teaching material, software and data into the education curriculum. That would be a significant task, considering that most of the material contained not only text, but also figures, tables, audio and animations. Once the components were completed, they could be assembled into one application using state-of-the-art multimedia programming technology.

30. Concomitantly to the previous tasks, geospatial data could be collected to start developing spatial data sets to be distributed along with the tutorials and image processing and GIS analysis software. The data sets would allow a wide range of application alternatives in order to support most of the practical needs, as defined in the education curriculum. The final phase would include pilot testing and assessment of the materials developed in the regional centres affiliated to the United Nations, preferably including scholars who had not taken part in the programme.

31. The participants were informed that if an interest existed in establishing a service for providing on-demand data sets for the regional centres, then facilities would have to be created or adapted and personnel hired and trained to provide such a service. That was an option that would enhance the education curriculum as described above, but it would not necessarily be part of the project.

32. A web site could be developed and maintained throughout the project to exchange ideas among the development teams and the regional centres. The web site could also provide additional materials to enhance practical activities and keep an updated database for retrieval of additional information.

B. Hands-on remote sensing applications at the General Organization of Remote Sensing

33. Participants at the workshop were informed that GORS was constituted in the Syrian Arab Republic in February 1986. Located on the outskirts of Damascus, GORS cooperated with governmental bodies, countries of Western Asia and international space-related bodies. The organization carried out studies and projects on remote sensing applications for geology, hydrology, hydrogeology, agriculture, urban planning, the environment, meteorology and archaeology by utilizing images from the Landsat 7 satellite and the *Satellite pour l'observation de la terre* (SPOT) programme. GORS also published on a regular basis a space atlas of the Syrian Arab Republic, a glossary of remote-sensing terminology in various languages and journals of remote sensing. GORS worked in cooperation with the University of Damascus in providing education in remote sensing and GIS.

34. A major objective of GORS was stated to be to support sustainable development while safeguarding the country's environment. That required optimal management of natural resources, which in turn depended on the availability of reliable and timely information at the national and regional levels. Remotely sensed data played an increasingly important role as a source of the information needed for sustainable management of natural resources and for environmental protection. Through GIS, remote sensing data could be integrated with data from other sources to facilitate the efforts of resource managers, planners and policy and decision makers in obtaining the relevant information required.

35. In order to facilitate such sustainable resource management in countries of Western Asia, GORS conducted courses and symposiums in remote sensing and GIS, as applied to various Earth resource disciplines. The venue of the workshop, GORS, was a premier training institution in the region of Western Asia that had trained individuals from the Syrian Arab Republic and elsewhere over the last two decades. GORS was well equipped with state-of-the-art computing facilities, such as sophisticated personal computers and workstations with modern peripherals and software for remote sensing and GIS. It also had laboratories for ground equipment. Participants at the workshop had the opportunity to familiarize themselves with the computer hardware and software available at GORS during hands-on sessions for satellite data reduction, processing and analysis and applications.

36. In the hands-on sessions during the workshop, special attention was drawn to a recent study of groundwater exploration by remote sensing in the Syrian Arab Republic, conducted jointly by GORS, Italy and FAO. The study had indicated that the integration into GIS of data extracted from Earth observation satellites with those traditionally collected, coupled with selected field investigations and geological knowledge of the area under investigation, provided a powerful tool in the search for groundwater.

Notes

[1] *Report of the Third United Nations Conference on the Exploration and Peaceful Uses of Outer Space, Vienna, 19-30 July 1999* (United Nations publication, Sales No. E.OO.I.3), chap. I, resolution 1.

[2] *Official Records of the General Assembly, Fifty-seventh Session, Supplement No. 20* (A/57/20), para. 56.

[3] *Report of the Third United Nations Conference on the Exploration and Peaceful Uses of Outer Space, Vienna, 19-30 July 1999* (United Nations publication, Sales No. E.00.I.3).