7. EDUCATION

Chapter lead authors: V. G. Bondur and K. Bergen

Contributing authors: R. Heino, V.V. Kozoderov, R.G. Mamin, F.A. Surkov

7.1. Goals and Objectives

The framework of the Northern Eurasia Earth Science Partnership Initiative (NEESPI) will create opportunities for essential education and training of scientists working in the broad and dynamic arena of earth science in Northern Eurasia. Equally importantly, educational activities encompassing preparation of new scientists and continuing education and re-training of experienced scientists will be essential for meeting NEESPI scientific objectives. Education is defined broadly to include aspects such as: formal curricula, practical training and seminars; involvement of students in NEESPI research projects, development of educational and scientific materials; participation in educational expeditions, implementation of educational exchange programs and partnership programs, creation and maintenance of Internet sites, and other integrative activities. More specifically benefits include: an increase in the availability of trained scientists working on critical earth-science issues in the region; the fostering of good international relations through increased cross-cultural and collaborative opportunities; an increase in research and study opportunities for talented students; and an avenue for continuing education and re-training of experienced scientists who may have recently faced significant institutional changes. ***Therefore, NEESPI is committed to incorporating a strong education and training component into this science plan***.

The main purpose and content of this chapter is to outline how the educational component will be designed and will support NEESPI at the following levels: a) elementary and secondary school, b) undergraduate education, c) graduate professional education, d) graduate Ph.D. research and teaching education, and e) continuing education and re-training. This chapter will also discuss important programmatic aspects including a) financing, and b) administrative issues.

7.2. Financing

Core NEESPI educational activities should be financed by allocating not less than 15 % from the budget of each scientific project carried out within the framework of NEESPI. These can include (similar to the LBA program) support such as: stipend/tuition for graduate students working on NEESPI research projects to complete NEESPI-related thesis' or dissertations, individual undergraduate research involvement support, development of formal courses/curricula, development and implementation of workshops for students and/or continuing professionals, development of curricular materials for dissemination; field experiences for students; opportunities to present research results at meetings, and other educational opportunities directly related to NEESPI project goals. These should be outlined in each NEESPI project proposal and their presence and quality should be ranked as part of the review process. At the same time NEESPI should consider that an open competition specifically for financial support of student scientific research projects be organized within the NEESPI framework.

In addition to educational components funded under NEESPI auspices, other sources of financing should also be sought and used at the implementation stage of the educational activities. These sources could be 1) existing funding opportunities for students at universities and scientific institutions participating in NEESPI; each institution participating in the NEESPI program can use its own specific educational programs and procedures for implementation of an educational part of NEESPI. Scientific problems of the Research

Sections of NEESPI are already and/or can be included in curriculums of participating universities and can subsequently to become a subject of research works of teachers and students; 2) in-kind contributions such as use of laboratories, equipment, and communication facilities; 3) other existing programs of a federal level in each of the countries (for example, in the U.S., National Science Foundation (NSF) International Programs Directorate, the START Program, and private foundations with international science and cooperation programs).

7.3. Implementation of the Education Component

The purpose of the education component of NEESPI is to create opportunities for training new scientists and re-training existing scientists. These scientists should represent a diversity of international countries, of geographic regions within Northern Eurasia, of scientific interests, and of ages and genders. In developing this, quality and focus of the program are important – key organizations with existing strengths should exhibit leadership roles in their own organizations and in fostering growth in other and new organizations, and opportunities should be available for motivated new entrants in the NEESPI education program.

In Russia, the educational component will be implemented primarily by the Scientific and Educational Center of Aerospace Environmental Monitoring Problems "Aerocosmos" and Moscow State University of Geodesy and Cartography (major organizations experienced in realization of various stages of aerospace education) with the participation of Moscow State University, St. Petersburg State University, and other universities (e.g., in Rostov-on-Don, Nizhnii Novgorod, Novosibirsk, Krasnoyarsk, Irkutsk) that can demonstrate innovative educational programs which have potential for realization under NEESPI. Significant regional expertise has been accumulated in The People Republic of China (Lanchzhow Desert Institute), Uzbekistan (Uzbek State University, Tashkent), Kazakhstan (Kazhakh State University, Almaaty), The Ukraine (Kiev State University), Estonia (Tarawere Observatory, Tartu), and Finland (Helsinki University, Finnish Meteorological and Finnish Forest Research Institutes). Having important regional expertise, these Universities and Institutes will be an important part of the NEESPI educational network.

In the United States, strengths in NEESPI Education will be distributed in a diversity of universities and research organizations that demonstrate dynamic programs and an interest in NEESPI research and education activities. A number of universities and organizations currently participating in NASA-Russia research grants may be expected to contribute to planning (for example the LCLUC PI institutions). Other universities with researchers in the NASA programs interested in Northern Eurasia should be encouraged to participate in new research and educational activities. Currently NASA also supports universities to manage data and data archiving programs and these should be encouraged to participate in educational activities. Linkages to agencies and organizations with a more applied emphasis will also be fruitful. There is a considerable amount of work to be done to meet NEESPI goals, and open competitions for involvement in NEESPI education should be encouraged.

7.4. The Education Programs

As mentioned above, several stages of education and training will be implemented within the framework of NEESPI. These are outlined below at the following levels: a) elementary and secondary school, b) undergraduate education, c) graduate professional education, d) graduate Ph.D. education, and e) continuing education and re-training.

7.4.1. Elementary and Secondary School Education.

Here we include all students in school programs (in the U.S. K-12, in Russia high schools), up to their entry into a college degree program or directly into the workforce. Students not going on to college could be prepared to work in entry level jobs in a variety of agencies and

organizations related to earth sciences. Students immediately desiring to further their education would enter college or technical school undergraduate degree programs.

This elementary-secondary school level presents the ideal opportunity to link with existing NASA education programs. As an example of the international program of training and supervision over quality of environment it is feasible to adopt starting points of program GLOBE. GLOBE started in 1996 and since 2002 is carried out under NASA administration. GLOBE's international plan represents the program of partnership between the USA and more than 100 other countries. More than one million children of elementary and middle schools at more than 12000 schools take part in this program. It has more than 20000 teachers who passed training and certified under GLOBE program rules. Their numbers continue to grow. For the areas of research, procedures of gathering of the scientific data have been developed and successfully adopted on the international basis into practical activities of schoolchildren. Studies include learning about terrestrial cover, ozone, aerosols, and meteorological characteristics, characteristics of soil and many others. Data collected and accumulated by schoolchildren of GLOBE program (on the territory of NEESPI research) is the important source of in situ measurements of the NEESPI research program. These measurements include data for studying processes in ecosystems; data for identification of the Earth's surface that are frequently necessary for the analysis of pictures from the artificial satellites. The increase in number of schools actively participating in the GLOBE program on the territory of NEESPI studies is the important part of the educational unit.

7.4.2. College education

Here the students will achieve a basic college (undergraduate or Associates) degree at 2- and 4- year colleges, universities and/or professional technical schools. Graduates would expect to attain good entry level positions in agencies, science institutions, primary/secondary school teaching, other organizations and/or be prepared to go on to graduate degree programs.

Key subjects for students to concentrate on may include: geography, ecology, biology, physics, computer science, mathematics, astronomy, natural sciences. At carrying out of the basic college education stage attention should be given to the use of remote sensing, GIS, and other spatial data and methods. Introduction to such data can be established on the basis of the Internet, or with use of the basic stations of reception of the space information such as « the Earth from space » (that could be created in school laboratories).

At this stage of training a practice of performing individual tasks, course works and work contests should be employed. Thus, except the traditional forms of training a various electronic courses on remote sensing education can be adopted. For implementation of this stage of training some methodical materials, tutorials, scientific literature for teachers, working writing-books, complete sets of games and etc. should be developed. The main attention should be given to:

- Basic studies of the aerospace data processing in relation to different thematic directions: pollution (land, rivers, seas, oceans and atmosphere); detection of forest fires; studying of dynamics of a snow cover, etc.
- Bases of map creation using aerospace data.
- Development of Internet search skills of the accessible aerospace information.
- Development of skills of work with the operative aerospace information received by simple ground stations of reception.

7.4.3. Graduate Professional Education.

Here the graduate education has a strong professional and applications orientation. Graduates would expect to go on to work in agencies, institutes, and organizations, emphasizing both research and applications of the earth sciences. With their advanced training, graduates may

eventually take leadership roles in these organizations. This stage prepares experts with the profound knowledge of the following subjects:

- Bases of aerospace monitoring of an environment,
- Theoretical and practical studies of aerospace information processing on various thematic directions,
- Theory and practice of modeling processes of various natural ecosystem function,
- Modeling fields of the radiation registered by systems of remote sensing,
- Theory and practice of applications of aerospace methods and technologies in for monitoring various natural ecosystems, Studying methods of reception, processing, archiving and use of the aerospace data,
- Applications of geographical information systems data received from aerospace monitoring
- Bases of remote sensing of the Earth,
- Mechanisms of regional nature management and eco-economic regulation of economic activities,
- Applications of the newest aerospace and information technologies for regional management, quality of regional environment and bases for nature conservation decisions,
- Application of aerospace methods and technologies in forestry,
- Regional-based decisions of nature related subjects implemented by means of aerospace monitoring.

The list of guidelines for the professional training can be specified during the implementation process of NEESPI.

7.4.4. Graduate Education (Ph.D. Level)

Here the graduate education has a strong research emphasis. Graduates would expect to go on to teaching and research careers at universities and other scientific research institutes, agencies, and organizations. They should become strong international leaders in their field in terms of theory, research, and teaching. These stages will be implemented the following way:

- Professional training of the high-skilled researchers and university teachers by means of postgraduate studies and doctoral studies
- Preparation of courses and seminars to improve professional skill of the these experts

The greatest effect of a high skilled professional training will be achieved with a direct participation of aspirants in scientific researches and the projects, which are carried out with use of aerospace methods and technologies, within the framework of various thematic directions of NEESPI. At implementation stage of personnel training a special attention should be given to development of methods of remote sensing, technologies of reception, processing and storage of the aerospace information, monitoring of an environment and studying GIS technologies, etc.

These stages of educational program can be implemented on the basis of the specialized scientific-educational facilities equipped with modern means of reception, processing and long-term storage of the aerospace data.

7.4.5 Continuing Education and Re-Training

Here the participants are “students” who have been working at jobs for several to many years that have some connection to the NEESPI goals, and desire to update their skills and/or move into a new area of competence, but without pursuing further formal university degree programs. These participants will be more diverse than the above categories - they may have no college degree – or may have up to a Ph.D. This category may also include visiting

scholar programs – opportunities for scholars to both learn and share their expertise in a new international environment.

Content may include:
- New or updated skills in remote sensing data analysis and new remote sensing data,
- New or updated skills in GIS technology and methods of analysis,
- Special themes in NEESPI research: landscape ecology, land-cover change, global change, carbon cycle science, forestry, and many others

Methods and Venues may include:
- Independent short courses for professionals with continuing education credit
- Training workshops/courses associated with major conferences
- Opportunities to spend a semester at a NEESPI affiliated university participating in courses and/or research
- Internships in agencies and organizations
- Online courses for credit or updating of skills
- Opportunities to be visiting scholars – learn (sit in on workshops, courses) and share expertise (lectures)

7.5. Administrative Component

7.5.1. Applied technologies

At the preparation of curriculums the modern information technologies should be applied. They should include means of reception of the space information, technical and software methods of the satellite data processing and storage. Apart from the traditional forms of educational process Internets-technologies of online (remote) training and other modern opportunities should be used. The important place in implementation of various stages of education program is participation in the process of scientific researches and projects within the framework of NEESPI with use of space methods and technologies.

7.5.2. Grants

The list of student stipends/grants and also conditions of participation in competitions should be published and be maintained on the NEESPI website. Grant recipients should exchange ideas and present their scientific results to the leading scientists and managers of NEESPI at annual conferences.

7.5.3. Educational field trips

Educational field trips have very influential factor for increase in number and degree of interest between pupils, students, scientists and administrators of the various levels, participating in NEESPI. The main summer field trips can be organized, for example, by a means of crossing routes with NEESPI researches – the first from northwest on a southeast and the second from northeast on a southwest. Details of those trips can be subject to annual updating according to the NEESPI curriculum. Linkages to already established frameworks should be made. For example, the EarthWatch program regularly provides some funding to researchers to organize field expeditions in which students can participate (students typically pay a fee, however there are also some scholarships).

7.5.4. The Internet websites

NASA Internet Site (http: // www.nasa.gov) is a magnificent example of use of new information technologies for attraction of attention and informing of the public through World Wide Web. The NEESPI web site should become a center of achievements of high technologies. For example, with the use of geographical information system (GIS) accessible through the Internet, it will be possible in the interactive mode to model and predict dynamics

of quality of environment of the Northern Eurasia at various scenarios of anthropological activities. Links can be made to GOFC networks and websites in Northern Eurasia.

7.5.5. Partnership

Additional opportunity to increase the involvement and interest of NEESPI program among the local population is organization and support of several new programs of partnership between similar territories in the different countries. For example, Tagus-Baikal Institute (http: // www.tahoebaikal.org/projects/) include programs of educational exchange visits. Programs of exchanges play a main role in increase in a level of mutual understanding and increase of efficiency of the international projects of a similar level.

7.5.6. International Coperation

Co-operation with other international ecological educational projects will give an educational part of NEESPI program an additional impulse. Attraction in educational programs of projects of sustainable development (http: // www.unesco.org/education/tlsf/, http: // www.esdtoolkit.org/authnote.htm) is a good example of possible co-operation.