History of Steps on Establishment Space Science and Technology in Azerbaijan

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Introduction

The interest to space activities in Azerbaijan began with the two important international space events held in Baku. In October 1973, the 24th Congress of the International Astronautical Federation (IAF) was held. Two years later, a group of scientists from the former Soviet countries came together in a workshop that focused on space based Earth observation. These two events created an awareness in scientific community and the politicians towards the importance space technologies in research and continues monitoring of the natural resources in Azerbaijan. By that time, the Unites States' Landsat remote sensing satellite had proven very promising results in terms of benefits of the space based Earth observation in a wide variety of areas including natural resource management, agriculture etc.

On August 9, 1973, at a meeting held in Moscow at the Head Quarter of the Academy of Sciences of the former Soviet Union with representatives of the Academy of Sciences of Azerbaijan and space system "Meteor" and the Ministry of the Electrotechnical Industry of the former USSR. Endorsement of setting up the space related institution in Azerbaijan by these significant organizations has been created a positive environment for the successful implementation of the issue. "Meteor" was engaged at this time for constellation a variety of satellites for the needs of the former soviet union and Ministry of the Electrotechnical Industry was involved mainly for development and production of space instrumentations. Within the framework of this meeting representatives have been shared their opinions on developing a project that would investigate and monitor the environmental and natural resources in the southeast part of the former USSR and adjacent geographical areas in the neighbor countries. At the meeting, the representatives also discussed the possible ways of how to implement the project. The proposed project included the study of the Caspian and Aral seas, the flora and fauna of these lakes, land cover and land use analysis of the geographical areas surrounding the lakes, the geological structure of the region, and monitoring of petroleum pollution in the lakes, and the atmospheric chemistry of Transcaucasia and Apsheron peninsula. The meeting decided the creation of a regional center that would work under the Academy of Sciences of the Azerbaijan Named Southeast Regional Centre in Baku, the center would study the environmental and natural resources by using all the proper methods, including the space based Earth observation.

Next year, on August 1, based on the decisions concluded at the meeting, Politburo of the Central Committee of Communist Party (CCCP) of Azerbaijan presented a proposal to the Presidium of the Academy of Sciences of Azerbaijan for the establishment of the center which was renamed as the Scientific Centre Caspiy. Presidium of the Academy of Sciences of Azerbaijan approved the proposal and provided the financial, scientific and technical supports required for the establishment of the center. It also provided a building where the center was located.

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Believing economic, social and national security related values of studying natural resources using the space based technologies, the chairmen of both former USSR State Committee of Council of Ministers for Science and Engineering and the Commission of Presidium of the Cabinet of Ministries for Military-Industrial Problems have been wrote a letter to the first secretary of the Central Committee of Communist Party of Azerbaijan (CCCP) with request of considering the establishment of the Space Centre within the framework of Presidium of Academy of Science of Azerbaijan. In additional it was indicated that a regions of Caspian Sea, Middle Asia and Middle East for further activities would be essentially preferable. In the answer of the first Secretary of CCCP of Azerbaijan has emphasized that considering the results of Congress of IAF which was taken place in Baku October, 7-13, 1973, Political Bureau of CCCP of Azerbaijan has decided to call the Academy of Sciences of Republic to include for scientific activities the research of natural resources using the space technique for areas of Caspian Sea, Middle Asia and Middle East. This positive letter from CCCP of Azerbaijan has opened a door for implementation a foregoing aim of development of organization in space area in Azerbaijan.

With a view to development of experimental and design projects and also maintenance of application of theoretical development of the scientific Centre of Caspiy in practice, Cabinet Ministers of Azerbaijan from December, 16, 1974 has been permitted to set up the Special Design office with experimental manufacture (the code - Design Bureau Caspiy) since January, 1, 1975.

Prof. Dr. M. Topchibashev, the Acting President Academy of Sciences of Azerbaijan, addressed a letter to Prof. Dr. V. Katelnikov, the Acting President of the Academy of Sciences of the former Soviet in May 1975, where he expressed the benefits of placing the proposed center, Scientific Centre of Caspiy, as one of the entity of the Presidium of Academy of Sciences of Azerbaijan. The letter also specified a possible ways of solving detailed issues regarding the establishment of the Center. These includes the financial aspects required to create the Center, the equipments required for maintenance of the center, and the creation of the scientific and technical link with the appropriate organizations, including the scientific research institutes and departments existed in the former USSR.

The first step of Azerbaijan in activities of space science and technology

The Center's primary goals and tasks were determined:

- Developing remote sensing applications by using aerial and satellite remote sensing data in the following fields: agriculture, fishery, stock-breading, land improvement, water resources, geography, ecological monitoring of environment, and developing practical methods to interpret remote sensing data.
- Developing and implementing programs related to monitoring land and sea environments by satellites;
- Participating to the development of the automated ground complexes for gathering, processing, storage and distribution of remote sensing data;
- Developing and manufacturing experimental onboard and ground equipment for satellites and aerial based remote sensing systems, manufacturing experimental models and production of the small series of the experimental onboard and ground supervision equipment and data processing.

For implements these goals, the following projects have been determined by the Academy of Sciences of Azerbaijan:

- development of the monolithic memory chargers based on complex semiconductors for programmed onboard (satellite, aircraft) and ground memory systems;
- development and manufacture of the infrared (IR) sensors for high resolution remote sensing systems;
- research and development (R&D) of methods for automating the processing and interpretation of remote sensing data;
- research of regional tectonically and local structures of Azerbaijan for exploring minerals using the satellite and aerial based remote sensing data;
- study of the water pollution and soil depths of Baku archipelago area using the satellite, aerial and ground based data;
- Study of the morphology of the western coast of the Southern Caspian Sea and analyzing the changes in the coastline and the bottom shelf using the space, aerial and ground based data;
- Study of the radiation balance of the Caspian Sea;
- Study of the distribution of atmospheric particles in industrialized cities in Azerbaijan based the variety of data interpretation (water surface, aviation and space);
- Study of the different types of summer pastures in the Great Caucasus and calculating hay yields by using space and aerial based remote sensing data;
- Study and monitoring of the lake weed in the Caspian Sea using the space and aerial based remote sensing data.

Then the Center was involved in various activities for enhancing remote sensing activities in Azerbaijan and creating awareness and cooperation with other former Soviet countries. One of them was the organization of the Working Group that was formed by the former socialist countries took place in Baku starting from 1976. Representatives from the republics of the former USSR were involved and have been taken place in the events organized within the scale of the Working Group.

In a period of the progress of the capacity the following entities have been jointed to the structure of the Centre "Caspiy" which were disjoined from the other entities of the Academy of Sciences of Azerbaijan:

1. Scientific – methodical and coordination division (Development department and Shamakhi
   Astrophysical Observatory Academy of Sciences of Azerbaijan);
2. Scientific – Research division established;
3. Special Design Office of Space Instrumentation;
4. Test – experimental production.

This new status of the Centre has been allowed to create an excellent interdisciplinary interfaces between entities. The Centre "Caspiy" have had an opportunity to increase a quantity and quality of its activities and project implementations.

However, established organizational structure of the Centre did not cover the scale of activity carried out within the Centre. Significant difficulties appeared in connection with the lack or satisfaction juridical status of the Centre.

Setting up the Space Research Institute as a main scientific structure within the framework of the Academy of Science of Azerbaijan, the Centre Caspiy had significant opportunities for the further successful expansion of works in research of natural resources of the Earth using the space technology in republic as well as southeast region.

Application of space methods for investigation of natural resources of the Earth and ecological monitoring of environment have opened a wide opportunities for international cooperation in the field of geology, geography, mathematics, physics, electronics, cybernetics, agriculture, stock–breading, soil improvement etc. Results of space researches of natural resources of the Earth for maintaining defensibility of the country and ecological monitoring of environment had valuable importance.

Azerbaijan Republic had a diversified economy and specific geographical parameters which created necessary preconditions for expanding the theoretical and applied researches in the field of use of space technology for research of natural resources and ecological monitoring of environment. Geographical location of Azerbaijan, in particular – common borders and language, cultural and ethnical similarities with the adjacent countries, including Turkey and Iran,, resources and a variety of its flora and the fauna, achieved level of development in various areas of science and technology (physics, mathematics, electronics, cybernetics, geology, geography etc.) – all this created the bases in development of scientific and design works in researches of natural resources of the Earth and ecological monitoring of environment using the space technology.

Considering historical links of Azerbaijan with neighboring countries, common river, sea and overland borders, interrelation of land and underground resources and favorable geographical location of Azerbaijan it would be possible to assist countries of Near East in studying their natural resources using the opportunity of such a Centre. As far as we known some of the leading countries have a big interest to these areas in the specified aspect, focusing interested countries in use of space information received from the special sources.

This proposal has been suggested by the Cantre "Caspiy" in 1977 and submitted to the appropriate authorities of Azerbaijani government.

Proposal in consequence has been endorsed and approved by the local and former USSR officials.

Taking into account the value of works implemented within the Scientific Centre "Caspiy" and prospects of its further development were coordinated an issue with Azerbaijani authorities concerning the establishment the Space Research Institute of Natural Resources on the base of the Centre "Caspiy". The scales of tasks which are carried out in organization were not properly possible realized within the framework of the scientific Centre "Caspiy". The juridical, administrative and financial status of the Centres existed at former soviet time were not sufficient for the works with a wide scope of implementations. There was a highly needs transformation of the status of the scientific Centre "Caspiy" to the status of the scientific institute which had the more power then the Centre.

Cabinet Ministers of Azerbaijan Republic from October, 12, 1978 and Presidium of Academy of Sciences of the Azerbaijan Republic from October, 24 have been approved this proposal and Institute of Space Research of Natural Resources was established.

Scientific Production Association of Space Research as the main institution of the Earth study

In 1982 on the basis of the Institute of Space Research of Natural Resources for the first time in the system of the Academy of Sciences was established Scientific Production Association of Space Researches (SPASR) as an entity of the Academy of Sciences of Azerbaijan.

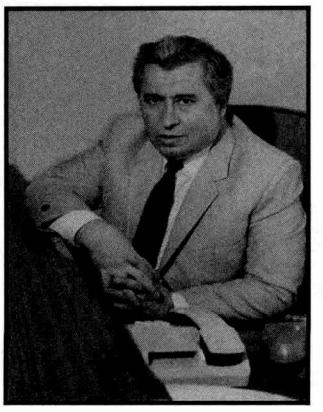

Fig. 1. Prof. Dr. Tofig K. Ismailov

Practically all space capacity of the former Soviet Union was concentrated in the Ministry of General Machine Building (MGMB) of the former USSR. Taking into account experience and the level of implemented works, in January, 1985 MGMB has been included SPASR as a separate unit of the MGMB USSR. Organization functioned in the structure of this Ministry until the collapse of the former Soviet Union.

Founder and development of space science and technology in Azerbaijan is professor, doctor of science, an academician of the International Engineering Academy Tofig K. Ismailov. (Figure 1).

Prof. Dr. Tofik K. Ismailov was the founder and the head of the Centre "Caspiy", Institute of Space Researches of Natural Resources and Research Production Association of Space Researches, which was established in the former Soviet Union as one of the largest scientific Centre in the field of aerospace studies. He is also the founder of scientific heritage of design instrumentation. It was a basis for development of the instrumentation-design industry in Azerbaijan.

Prof. Dr. Tofig K. Ismailov was an outstanding scientist in the field of scientific instrumentation-design, including development of space systems and devices. His one of the important contribution was the development of space science and technology in Azerbaijan, scientific and technical researches in the field of theory and application of development of multilevel space systems for researching environmental issues, including essentially new element - complex of the technical means of maintenance of automated management by process of undersatellite controlling of condition of environment. Application of results of these researches have resulted in development of scientific devices and complexes (aircraft, helicopter, ground and sea), research for operative solving of research and methodical problems. The last issue has been implemented Bulgaria, Hungary, Mongolia, Poland, Czechoslovakia during flights the basic and international crews on piloted space complexes "Salut-7", "Soyuz T-II".

Prof. Dr. Tofig K. Ismailov was killed by Armenian separatists and terrorists in Azerbaijani territory of Nagorniy Karabakh which has been occupied by Armenia. He was the first State Secretary of Azerbaijan Republic.

In process of establishment and development of the Scientific Centre "Caspiy", Hasan M. Abdullaev, the President of Academy of Sciences of Azerbaijan, always supported and endorsed the activities of the Centre. The science Centre "Caspiy" found an understanding and support from Presidium of the Academy of Sciences.

Fig. 2. Prof Dr. Eldar Y Salayev (in the center of the picture) is discussing details of the process of experiment

From the very beginning of SPASR's activity the idea of realization of multilevel experiments on remote sensing was actively discussed. The meaning of the idea was in the synchronous review of the same area from various levels and gathering of remote sensing data of the Earth in various scales in the identical stipulations of research such as atmospheric and weather conditions, height of the Sun etc. The purpose was to determine how scale of the image influences an opportunity of landscape elements decoding. Besides of remote sensing results of supervision should be checked up and calibrated by contact measurements in the polygons. For this reason the problem of control – calibration polygon always was taking into account of SPASR's and for this reason Council of INTERCOSMOS (intergovernmental association of the Republic of the former Soviet Union and socialist camp/Warsaw Treaty for Space affairs) of the former Soviet Union has assigned SPASR functions of head organization in performance of multilevel experiments on remote sensing.

In Sheki and Zakatala regions of Azerbaijan an international experiment of "Gunesh–84" was conducted in 1984 where representatives of some of the former socialist countries and cosmonauts of the spacecraft "Salut–7" Leonid Kizim, Vladimir Solovev, Oleg Atkovhave been participated in those experiments. SPASR was identified the main organization of experiments.

In organizations, implementation and realization of these difficult and important experiments President of the National Academy of Sciences of Azerbaijan academician, Prof. Dr. Eldar Y. Salayev took part direct participation (Figure 2). The basic purposes of experiments consist progressing the physicotechnical and scientific – methodical aspects of space researches of the Earth which would promote further intensive development of the appropriate branches of space design instrumentations. Experts of Azerbaijan, cosmonauts of the former Soviet Union and also scientists from Bulgaria, Hungary, German Democratic Republic, Cuba, Mongolia, Poland and Czechoslovakia have participated in these experiments.

The multilevel system which was developed in SPASR had a capable to operate as synchronously with integration of space vehicles and independently. It has been created a real preconditions for automation of interpretation all of the information from satellites.

Using the visual, contact and remote sensing methods on example of the selected test sites was conducted a wide scales approbation of techniques of complex studying of natural systems (geosystems) within the framework of the program "Gunesh–84". Scientific – applied problems, for example development of technique of hydro–geological interpretation of data of remote measurements received from different high–altitude levels with the help of the radiometric and spectrometer equipment, drawing up of maps of underground drain (level of subsoil waters) were solved. The success of this experiment was certainly achieved by the significant contributions of an outstanding scientist and organizer of science in Azerbaijan academician, Prof. Dr. Eldar Salayev.

Azerbaijan national aerospace agency and its space capacity

With a view of realization of the country policy in the field of development of space science and technology, implementation of national space programs, coordination and management of works in the international space projects conducted in cooperation with the other countries and international space institutions, an effective application for interests of the national economy by the Decree of President of Azerbaijan Republic from February, 21, 1992 on the base of SPASR was established Azerbaijan National Aerospace Agency (ANASA).

Today ANASA includes:

- Institute for Space Research of Natural Resources;
- Institute of the aerospace Informatics;
- Institute of Ecology;

- Special Design Office;
- Pilot plant.

In March, 1993 the Decree of President of Azerbaijan Republic ANASA was subordinated to the Committee of Special Machinebuilding and Conversion of Azerbaijan Republic.

The decree of President of Azerbaijan Republic from January, 04, 2003 ANASA again was subordinated to the National Academy of Sciences of Azerbaijan. This subordination was necessary for creation an environment for successful activities emphasizing of more attention on space scientific issues.

The main areas of activity of ANASA were the following:

- Development of scientific – methodical bases of identification of parameters natural and technogen objects using their radiating characteristics;
- Development of the monitoring system for protection of the environment of Azerbaijan based on the space science and technology;
- Methods of processing of the space information and GIS – technology;
- Measuring complexes and registration equipment of the remote sensing data.

For this period the following basic projects were carried out within the framework of the Organization:

- Development and manufacturing of a x–ray spectrometer "Pulsar X–1" for detection of local space sources x–ray and scale of radiation in range of energy from 20 kEv up to 1 300 kEv, researches of large–scale fluctuations of galactic background, definition of power of spectrum short periodical bursts scale of radiation in outside of solar origin;
- Complex research system for definition of technical shape, structure, offers and projects programme – planned documents on rocket – space technique. Development and creations of experimental sample of onboard control system for space experiment of processing and compression of received information;
- Development of complex information – measuring means for equipment control – calibrated test sides for research interests of natural resources of the Earth with the use of space system "Resurs";
- Research of methodical and organizational aspects of management scientifically – research – design works: development and application in practice of offers on improvement of working system of economic management of development difficult rocket and space complexes with a view of increase of its efficiency and concentration of resources for implementation of the main works;
- Definition of directions and development with a view of improvement of the characteristics, developed samples of space technique;
- Technique – economic researches and calculations in maintain of prospects of development of military engineering and branch industry. Development and justification of projects of documents program / branch forward planning scientifically – research and skilled – design works;
- Development, producing and installation the special equipment for conducting of experimental researches on spacecrafts "Buran" at the orbital stations;
- Development and investigation of methods and means of remote sensing of the surface of the Earth using the space systems;
- Radiolocation from the space vehicles traces, shipped submarines natural and artificial anomalies of sea surface with the purpose of gathering the data for creation of algorithms of identification of traces on background of natural anomalies;
- Creation of ground means of reception and registration of the information for operative subsystems of space system "Resurs";

- Research scientifically – technical ways of creation information – the measuring monitoring system of radiating, chemical and biological conditions in the large territories for perspective space systems;
- Development equipment for undersatellite aerospace polygons for registration of depth of undermining of products;
- Development and creation of highly effective hydroacoustic information system undersatellite aerospace polygons for detection of underwater objects in shelf zones.

The studies on thematic mapping of territory of the republic and its separate areas in various scales are a priority direction of activity of ANASA.

One of the flood zones in Azerbaijan is the southern slope of the Great Caucasus in territory of Zagatala area in Talachay pool. As a result of flood waters the channel of the river and the mountain slopes are exposed to strong changes. Therefore, monitoring of mountain areas of Azerbaijan has a great value for an effective decision making system.

Using the opportunities of GIS technology the cartographic digital bases consisting of maps in the scale 1:50,000 were created in ANASA. With this purpose, a group was established from the experts of ANASA, which have completed United Nations Food and Agriculture Organization (UN FAO) training courses. During 1.5 years together with the UN FAO experts, the group carried out the project of Land Cover/Land Use mapping of all territory of the republic in scale 1:50,000. GPS 12CX (Global Positioning System) devices for geo-registration of objects at the Earth surface were used for the control of the results of classification.

As a legend to maps of Land Cover/Land Use 38 types of classes most common for regions of Azerbaijan were selected. All procedures of GIS technology processing of the space information within the framework of the mentioned above project was implemented:

- Digital model of maps of Land Cover / Land Uses for whole territory in scale of 1:50 000;
- database of digital model of maps Land Cover/Land Use for whole in scale of 1 : 50 000;
- maps of Land Cover/Land Use for whole territory in scale of 1 : 50 000 in format A1 are printed out;
- digital model of maps of Land Cover/Land Use is coordinated to the system of qualifiers of the UN FAO (Land Cover/Land Use classification).

The results of the UN FAO project have been demonstrated within the presentation organized in cooperation UN FAO/ANASA.

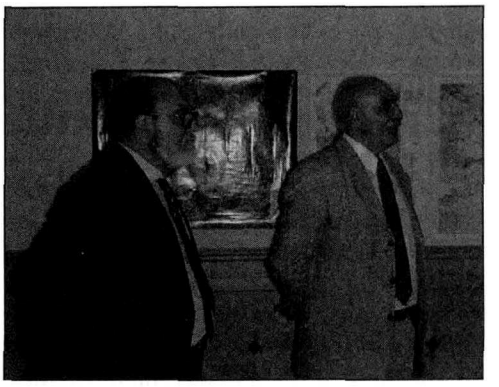

Fig. 3. Fragment from the UNFAO/ANASA presentation: UNFAO representative, left – Dr. Carlo Travaglia, ANASA representative, right – Dr. Rustam B. Rustamov

Perspectives: Establishment of Euroasian Aerospace Agency as a New Aprouch for Further Space Science and Technology Implementations

Successful development of existing capacity and application of space science and technology for the purpose of the sustainable economical development demands an international cooperation. Understanding importance and necessity of this issue the former Deputy to the Director General of ANASA on Science and International Affairs Rustam B. Rustamov since 2001 has offered an idea of establishment of the EuroAsian Aerospace Agency which is presently into consideration of the interested countries and international organizations.

Collapse of the former Soviet Union became the reason of occurrence a negative consequences in Caucasian. In consequence the whole region has remained without the control by appropriate state authorities of these republics.

This circumstance creates a necessary environment for involving of Turkey, as a strong country in the region, in processes occurring in its neighboring area. This problem is not only political issue, in the meantime there are problems of the natural and energy resources, ecological, at the same time a safety and security issues. For solving foregoing problems is necessary appropriate database which might be ensuring a guarantee for making a right decision.

For solving of these problems today Turkey can be play as a key country with a sufficient scientific and technical/technological potential and capacity. The space science and technology can take a primary place on realizations above mentioned problems. One of the important circumstances is that Turkey becomes the space country with the various purpose satellites and appropriate technique and technology. It creates a favorable environment for solving of a wide spectrum of problems for the region of the Black, Mediterranean and Caspian Seas. Within the scope of these mentioned issues are necessary:

- International cooperation between the regional countries in the field of space science and technology;
- Within the framework of indicated cooperation: setting up the center for receiving of space information, setting up the center for the control of track of space vehicles and setting up the center for processing and distribution of space information.

Necessary Steps for Implementation of the Issue

A Solution above indicated problems within one country is impossible. At the same time the use of achievements of the advance space science and technology is under the interest of many countries. Taking this point into account, any achievement in this area will have a direct influence on sustainable economical development of countries. Therefore developed European countries have been integrated a capacities in space science and technology within the framework of the European Space Agency. In the meantime many Asian-Pacific countries have been united a potentials in the same area within the framework of United Nations structures. In this connection, republics of the former USSR after collapse of the former Soviet Union did not integrate in any international structures for the use of achievements in the advance space science and technology.

The problem mentioned here can be solved with the establishment of the Eurasian Space Agency (EuASA.) At the first stage establishment of the EuASA is possible by the integration of such countries as Turkey and Azerbaijan with the following joining of countries into this institution; members of Georgia-Ukraine-Azerbaijan-Moldova (GUAM), Inter-governmental association. It is one of the opportunities.

In the initial stage of the country included in sphere of the Black, Mediterranean and Caspian Seas should consolidate efforts on establishment of cooperative mutual relations between the countries of mentioned area. It, as the first step, may serve as inquire of the joint projects representing the common interest. Productive and successful outcome of the joint projects may create a positive environment for cooperative activities and requirements for integration potential and capacities within the framework of the common institution as a similar to the European Space Agency.

Possible Achievements within the Mentioned International Structure

At first, setting up of the ground receiving station of space information (GRSSI), center of tracing of space vehicles (TSV), as well as processing and distribution of space information (CP DSI) should be considered.

GRSSI will provide the space information for creation of the necessary databases and allow member countries to control the processes occurring in their territories (Fig. 1). TSV should provide the control and necessary correction of the orbits of vehicles developed by the member countries.

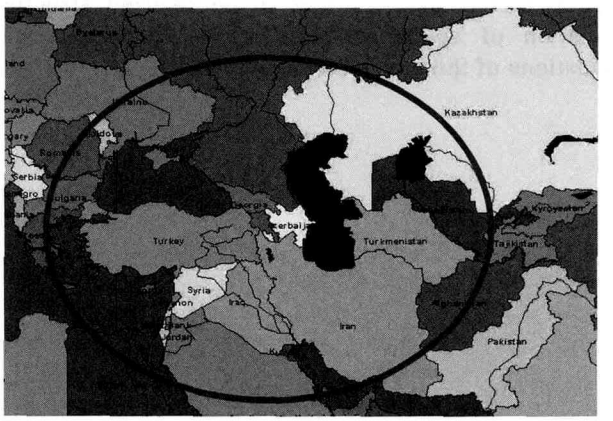

Fig.1. Illustration of the ground receiving space information

A Benefit of the Euasa for Member Countries

Proposed members of EuASA are in the sufficient status of development and financial contribution can also contribute to the created international structure with: scientific and technical potential in the field of production of rockets and satellite systems in Ukraine; achievements of Turkey in the field of air building; available scientific potential of the member countries, in particular, Azerbaijan, with its experience more than 25 years in field of remote sensing.

The increase of the member countries will be encouraged by including the East European countries to the proposed international organization. Taking into account a positive decision concerning the joining of Romania into NATO and the signed "Memorandum of Understanding between Romanian Space Agency and Azerbaijan National Aerospace Agency Concerning the Cooperation in The Exploration and Use of Outer Space For Peaceful Purposes", participation of Romania essentially will extend the opportunities of EuASA.

Signing the similar Memorandum between other Eastern Europe and above mentioned countries it may an excellent basis and will create a favorable environment for establishment of close interrelations and interactions in the sphere of space science and technology for solutions a various problems of these countries.

Conclusion

The space history of Azerbaijan began with the 24th Congress of the International Astronautical Federation, the (IAF) was held in October 1973. Actually during the Soviet Union there was a huge of reasons which eliminate a possibility to establish the institute related to the space activities in Azerbaijan. Authority of the former Soviet Union had a position for limitation of space technology in the republics of the former USSR. This kind of high technology was a prerogative of Russian Federations. Ukraine and Belarus Republics also have been engaged for a some of areas of high technology. Priority of area of space technology which Azerbaijan would be involved was study of the Earth with application of remote sensing.

For time being Azerbaijan more then 30 years of experience in space science and technology. For further success of Azerbaijan in space technology there is a highly need of cooperation within the framework of the international institutions as well as appropriate country organizations. In the meantime it has to be realized structural modifications and authority re subordination of space organization in Azerbaijan which would meet all requirements and regulations of the international standards.