

**РАЗРАБОТКА БАЗЫ ДАННЫХ ДЛЯ ОЦЕНКИ И МОДЕЛИРОВАНИЯ
СОВРЕМЕННЫХ ТЕКТОНИЧЕСКИХ ДВИЖЕНИЙ КАК ПРЕДВЕСТНИКОВ
СИЛЬНЫХ ЗЕМЛЕТРЯСЕНИЙ В ЗАПАДНОМ ТЯНЬ-ШАНЕ С ПРИМЕНЕНИЕМ
ГИС**

**DEVELOPMENT OF THE DATABASE FOR AN ASSESSMENT AND MODELING OF
MODERN TECTONIC MOVEMENTS AS PREMONITORY SYMPTOMS OF STRONG
EARTHQUAKES IN THE WESTERN TIENSHAN WITH APPLICATION OF GIS**

Орто Азия аймагы Өзбекстан сыяктуу эле өтө катуу сейсмикалык аймакта жайгашкан. Ушундан улам бул региондун сейсмогеодинамикасын фундаменталдуу мүнөздө изилдөө жана мониторинг технологиясын түзүү зор теориялык, практикалык мааниге ээ. Жүргүзүлүп жаткан изилдөөлөрдүн актуалдуулугун сейсмоактивдүү аймактардагы жер титирөөлөрдүн дайыма болуп тургандыгы шарттайт, анткени планетанын литосферасы ондогон жана жүздөгөн жылдар бою эволюция болуп жатат.

Батыш Тянь-Шандагы катуу жер титирөөлөрдөн кабар берүүчү тектоникалык кыймылдарды моделдөө жана баалоо боюнча долбоордун милдеттерин заманбап өтө так технологияларды колдонуу менен ийгиликтүү жүзөгө ашыруу үчүн анализге алынып жаткан Борбор Азия аймагында сейсмикалык абалга мониторинг жүргүзүүнү уюштуруу зарыл. Ушул максатта биз изилденип жаткан аймактагы жер титирөөлөр жана алардын параметрлери тууралуу маалыматтарды жыйнадык.

“Жер титирөөдөгү магнитуда” маалыматтар базасын башкаруу системасы (МББС – СУБД) Access тин МББСынын базасында иштелип чыккан. Алынган материалдар Батыш Тянь-Шандагы катуу жер титирөөлөрдөн кабар берүүчү тектоникалык кыймылдарды GPS и ГИС-технологиясын колдонуу менен моделдөө жана баалоо ишинде негиз болот.

***Ачкыч сөздөр:** сейсмология, инженерная геология, ГИС технологиялары, GNSS-технологиялары.*

Среднеазиатская область, как и территория Узбекистана, расположена в высокосейсмичной зоне. По этой причине создание технологий мониторинга и фундаментальных исследований сейсмогеодинамики региона имеет огромное теоретическое и практическое значение. Актуальность проводимых исследований определяется тем, что землетрясения в сейсмоактивных зонах происходят достаточно регулярно, поскольку являются результатом эволюции литосферы планеты в течение десятков и сотен миллионов лет.

Для успешной реализации поставленных в проекте задач по оценке и моделированию современных тектонических движений как предвестников сильных землетрясений в Западном Тянь-Шане с применением современных высокоточных технологий необходима организация мониторинга за сейсмической обстановкой в анализируемом Центральноазиатском регионе. С этой целью нами был организован сбор информации о землетрясениях и их параметрах на исследуемую территорию.

СУБД «Магнитуда землетрясения», разработана на базе СУБД Access. Полученные материалы будут служить основой для оценки и моделирования современных тектонических движений как предвестников сильных землетрясений в Западном Тянь-Шане с применением современных GPS и ГИС-технологий.

***Ключевые слова:** сейсмология, инженерная геология, ГИС-технологии, GNSS-технологии.*

The Central Asian region, including the territory of Uzbekistan, is located in a zone of high seismic risk. For this reason creation of the monitoring technologies and basic researches of seismic geodynamics of the region has a huge theoretical and practical value.

Relevance of the conducted researches is defined by the fact that earthquakes in the seismo-active zones occur rather regularly as are result of the lithosphere evolution of the planet during tens and hundreds of millions years.

It is necessary to organize monitoring of the seismic situation in the analyzed Central Asian region for successful realization of the tasks set by the project for assessment and modeling of modern tectonic movements as premonitory symptoms of strong earthquakes in the Western Tien Shan with application of modern high-precision technologies. For this purpose, we have organized collection of information about earthquakes and their parameters on the studied territory.

The DBMS "Magnitude of the earthquake" was developed on the basis of the DBMS Access. These materials will serve as a basis for evaluation and modeling the modern tectonic movements as the precursors of strong earthquakes in the Western Tien Shan using the advanced GPS and GIS technologies.

Keywords: *seismology, geologic engineering, GIS-technologies, GNSS-technologies.*

During a long time the applied geodetic, geological and geomorphological researches have focused on the analysis of the vertical tectonic movements which were as well more qualitative than quantitative. Only at the end of the last century, with the development and emergence of a new theory, the theory of lithospheric plates, the horizontal movements occurred in the field of view.

Lack of the adequate technical equipment hampered the large-scale measurements of the recent tectonic movements. The rapid development of the GNSS satellite global positioning systems has opened up opportunities for study of the geodynamic processes. Currently, the following satellite navigation systems are functioning or preparing for deployment: GPS belongs to the US Department of Defense; GLONASS to Russia; Beidou to China; Galileo is the European system; IRNSS is an Indian satellite navigation system under development; QZSS is a Japanese satellite navigation system under development.

The American GPS system today is the most stable functioning, and therefore received the most widespread in the world. Implementation of GPS in geodetic practice has allowed to reach new frontiers in the field of seismotectonics and evaluation of the elastic stresses, and consequently the seismic hazard. It is for this reason that our study will be carried out using GPS satellite navigation system. Such researches are conducted by the teams of researchers from a number of countries in recent years. But they are usually limited to their own territories or regions. To investigate seismo-geodynamic processes they are predominantly using the secular variations.

Currently, for processing, interpretation and integrated analysis of the geological and geophysical data on a computer, along with the extensive use of the specialized automated systems, such as GeoSoft software, a great progress has been the geographic information systems (GIS) [1-5]. The main objective of this phase of research is the development and maintenance of the information and analytical base on the potential seismic research areas according to the geological conditions, which includes:

- Main principles of the development and maintenance of the information-analytical database in an ARC-GIS environment and sorting the data on the potential seismic research area;
- Generation of data on the pleistocene geodynamics and engineering-geological basis of the Eastern part of the Western Tien Shan for introduction into the information-analytical base.
- Initial state of the compiled data on the current movements and seismic zones near the seismically active fault zones including man-made objects.
- Development of bases for the information-analytical database in the ArcGIS environment, the potential zone of seismicity studies based on the engineering-geological conditions and technological steps of its realization.

The Central Asian region, including the territory of Uzbekistan, is located in a zone of high seismic risk. For this reason creation of the monitoring technologies and basic researches of seismic geodynamics of the region has a huge theoretical and practical value.

Relevance of the conducted researches is defined by the fact that earthquakes in the seismo-active zones occur rather regularly as are result of the lithosphere evolution of the planet during tens and hundreds of millions years. The modern science and technico-technological capabilities of mankind are not able to prevent an earthquake or to reduce its force, i.e. to reduce seismic danger. The modern science has no technology of the guaranteed forecast of exact emergence time of the next underground phenomenon. Therefore further deepening of fundamental knowledge of earthquake preparation processes, improvement of the assessment technologies both potential and real seismic danger is intended to increase qualitatively efficiency of actions for protection against seismic danger. The rapid development of the global positioning systems observed in recent years, achievements of the remote sensing methods of the earth promote expansion of the researches sphere for improvement of the complex assessment methodologies of seismic danger. It is necessary to organize monitoring of the seismic situation in the analyzed Central Asian region for successful realization of the tasks set by the project for assessment and modeling of modern tectonic movements as premonitory symptoms of strong earthquakes in the Western Tien Shan with application of modern high-precision technologies. For this purpose, we have organized collection of information about earthquakes and their parameters on the studied territory. It was collected an information on the earthquakes taken place in 2013, 2014 and during January to July, 2015.

Information on earthquakes included the following parameters:

date [GMT] - date and time (by Greenwich) of the earthquake;

lat-lon - (width-longitude) - coordinates of epicenter of the last earthquake;

depth - depth of the hypocenter of the earthquake;

n sta - how many seismic stations have defined coordinates of the earthquake epicenter;

Ms - magnitude of earthquake (from latin magnitudo — importance, relevancy, fineness, greatness) — size characterizing the energy emitted during an earthquake in the form of seismic waves. It is defined on the Richter scale.

region name - name of the region in which occurred an earthquake.

At present, we are proceeding collection of information.

The received materials need to be stored in a specially developed database management systems (DMS) of the seismic information. Today, the market of the offered software products is rather wide. While choosing the DMS, first of all we need to consider that all our further researches on the project will be conducted on the basis of the modern GIS-technologies. Selection of some or other type of the DMS needs to be made taking into account both specifics of the stored information, and its further use in the environment of the GIS-systems.

The successful solution of the tasks set in the project requires to create an integrated information system with the developed infrastructure. Such information infrastructure which is based on the modern information technologies is realized in the form of the integrated geographic information systems (GIS).

At the same time, effective use of the integrated GIS is impossible without application of the scientific development and approaches to the solution of the put problems. First of all, it is experience in development of various automated cartographical systems, use of elaborations in the field of territorial planning, methods of the estimated and synthetic maps creation with use of materials of remote sensing and modern computer methods of their processing, development of digital and electronic maps, database management systems, etc.

The further work is related to the development of the expert search system (EES) for the integrated analysis of the "useful" (informative) geodetic signals in the fields of displacements which is carried out in the environment of the selected database management system (DBMS).

As noted above, we organized a gathering of information about the earthquakes and its parameters in the Central Asian region. It was collected an information about earthquakes that occurred in 2013, 2014 and in January-July 2015. The figure 1 shows the epicenters of the

earthquakes that occurred in 2013.

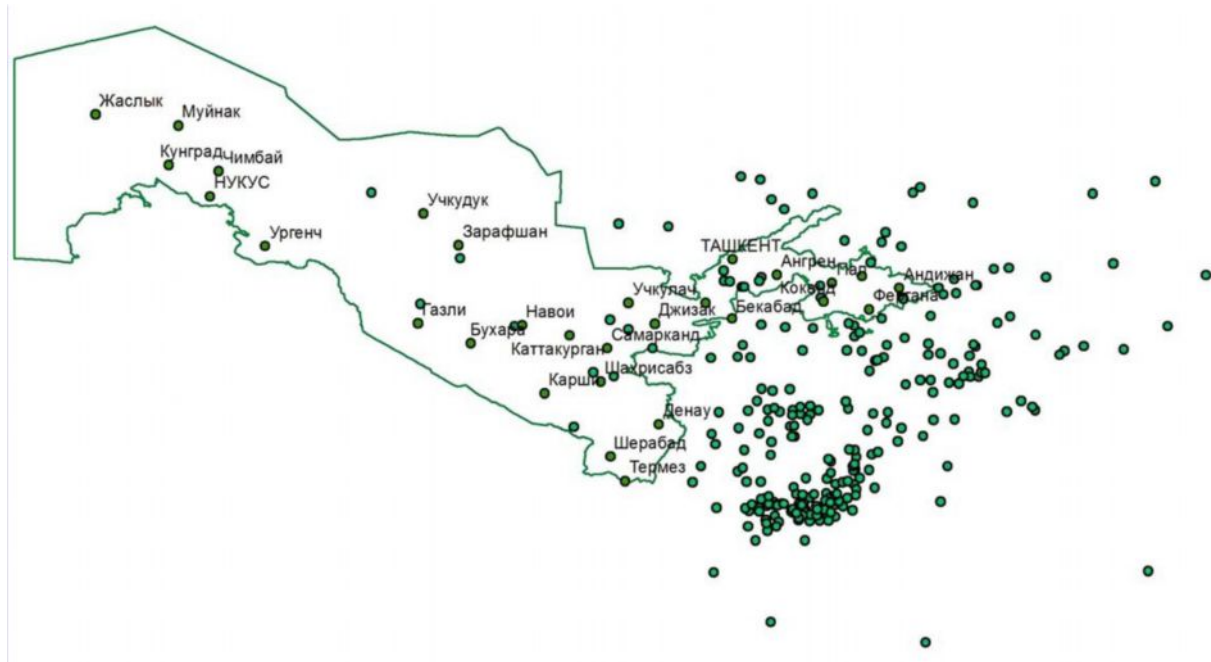


Figure 1. Map of the earthquake epicenters for 2013

The DBMS "Magnitude of the earthquake" was developed on the basis of the DBMS Access. For ease of analysis the DBMS was developed in two versions: database with a common information files for all the years and database separately for each year.

The prepared environment presents the vector and raster functions of several parameters the view of which when working in an environment is given as an example on Fig. 2-3.

In the vector format in a geodatabase are presented: surveying areas of geodetic measurements (geodez I) (276 areas objects); faulted network, including part of liniaments (faults) (active ruptures, flexures, fracture zones, etc.) - 102 linear objects, breaking stress of the fault network (stress) - 1749 linear objects; river network (waterways) - 28 linear objects; measuring points (seismic stations) - 34 point objects and GPS AP - 8 point object;

For the visual display of the territory of Uzbekistan in the geodatabase are also added the layers of the raster digital relief model made according to the radar surveying data.

The figure 2 shows a view in the GIS map window of the modern movements.

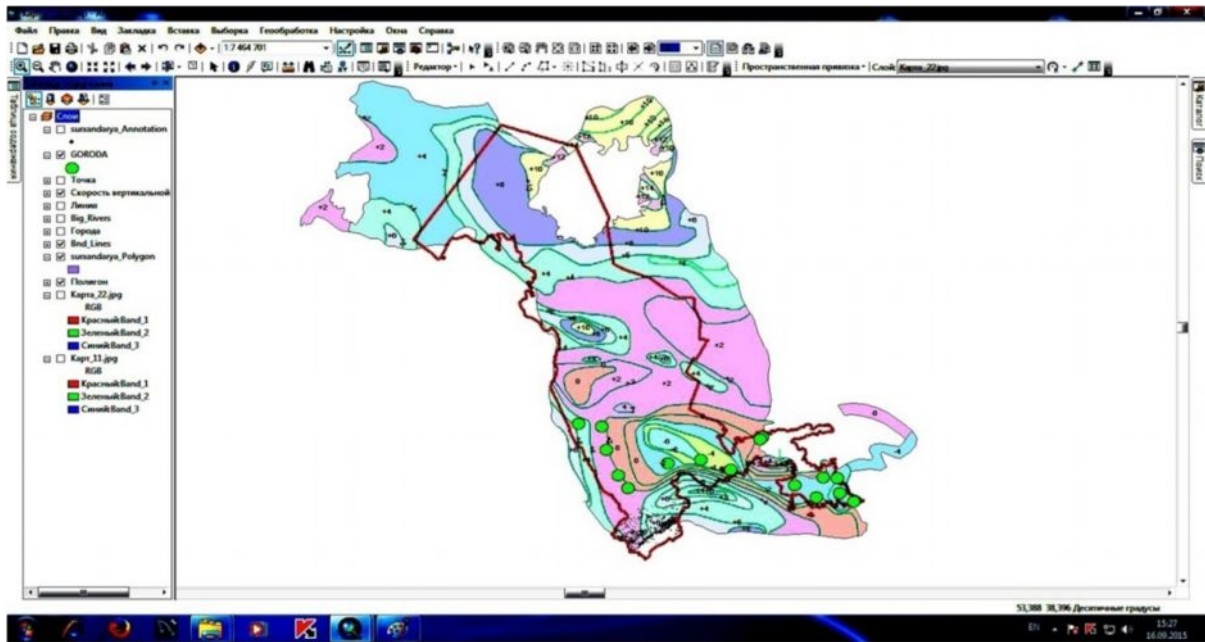


Figure 2. Map of the modern movements

In this field the distribution of earthquakes by magnitude and by the energy classes are connected after handling from the DBMS and from the main parts of the IAS architecture. The figure 3 shows the reflection on the field of this map processing and the tables of the vector displacement values.

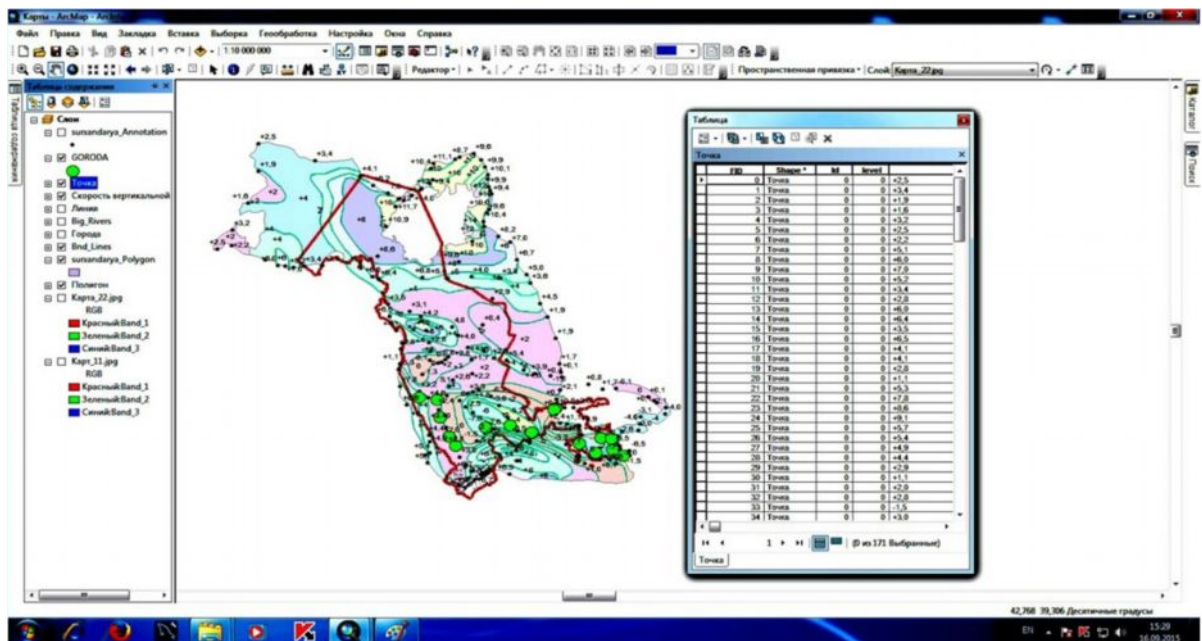


Figure 3. Modern movements and its vector values

As it was mentioned above, we organized collection of information about earthquakes and their parameters on the region of the Central Asia. It was collected an information on the earthquakes taken place in 2014-2015. While resolving the tasks of this stage set in the project we decided to use Microsoft Access DMS as it meets requirements imposed to DMS at this stage of works. In future, DMS of higher level may be applied, if necessary.

These materials will serve as a basis for evaluation and modeling the modern tectonic movements as the precursors of strong earthquakes in the Western Tien Shan using the advanced GPS and GIS technologies.

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