Safer World: seismic hazard assessment to decrease the level of seismic disaster

Seismic network expansion in Caucasus and Central Asia (SNECCA)

Funded by the USA

- Lawrence Livermore National Laboratory (LLNL), EarthScope, USA

SDGs

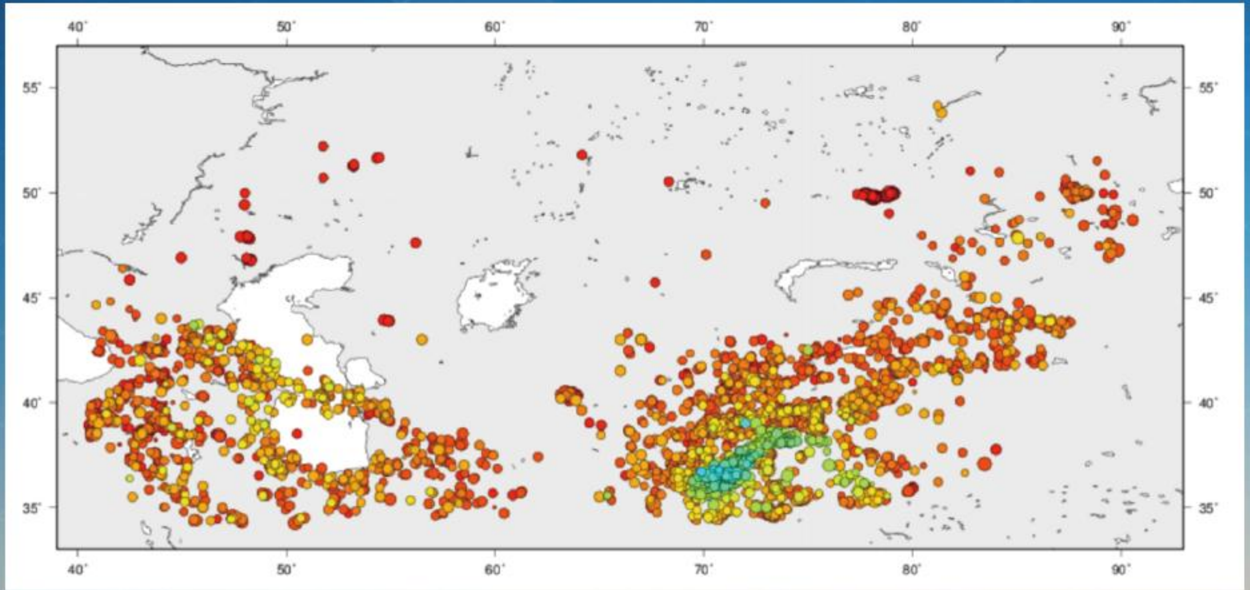
- Republican Center of Seismological Survey under the National Academy of Sciences of Azerbaijan
- Institute of Earth Sciences and National Seismic Monitoring Centre, Georgia
- Institute of Geological Sciences, National Academy of Sciences of Republic of Armenia

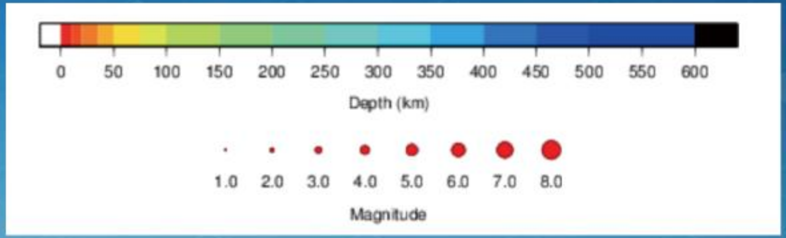
- National Scientific Center for Seismological Observations and Research, Ministry of Emergency Situations of the Republic of Kazakhstan
- Institute of Seismology, National Academy of Sciences of Kyrgyz Republic
- Geophysical Survey, National Academy of Sciences of the Republic of Tajikistan

PROJECT KR2452

Central Asia and Caucasus –one of the world’s most active earthquake zones

- The countries of Central Asia and Caucasus are located in one of the world’s most seismically active tectonic zones (Alpine-Himalayan orogeny). Between 1900-2024, more than 5,000 with magnitude 5.0 or larger earthquakes occurred between eastern Turkey and the western Himalayas. Earthquakes and their impacts, along with most other regional natural hazards, are trans-border phenomena and require trans-border cooperation to effectively study and assess these risks as means of developing strategies for risk reduction and response.





A map seismicity for M > 5.0 (1900-2024) obtained from reviewed International Seismological Center (ISC) catalog

The need for a coordinated approach to earthquake monitoring and risk assessment

Faced with the common threat of devastating earthquakes in Central Asia and the Caucasus, it was essential to develop a coordinated approach to earthquake monitoring and risk assessment to reduce the vulnerability of communities to earthquakes. This coordination requires a basic level of seismic infrastructure (principally instrumentation and communications) across the Caucasus and Central Asia.

Earthquake's consequences

Turkey- Syria earthquake (Mw=7.8), February 6, 2023

Nura earthquake (Mw=6.6), October 5, 2008, Kyrgyzstan

Expand national seismic networks in the Caucasus and Central Asia through the installation of permanent broadband seismic stations.

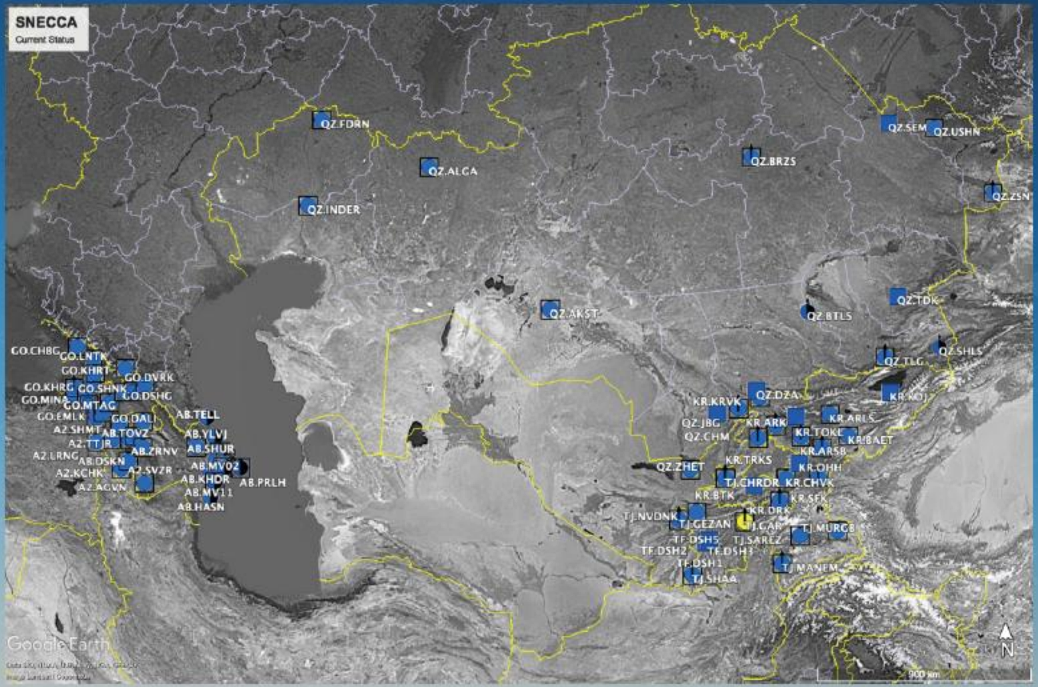
ISTC
INTERNATIONAL SCIENCE AND TECHNOLOGY CENTER

Improve

- In-country and regional station coverage.
- Data quality (modern installation practices and equipment upgrades).
- National data centers' capabilities.
- Open access to real-time data processing and archiving.

Provide

- Seamless data sharing and exchange between countries
- Data that can be used to high quality data products (seismic bulletins, earthquake's catalogue, etc.).
- Data to meet multiple civil and scientific needs(earthquake monitoring, earth research, seismic hazard assessments)



▲ A map of location of the SNECCA seismic stations

Seismic station installation

Within the frame of the KR2452 (SNECCA) project, all new seismic stations have been installed in postholes with a minimum depth of 2 m to reduce seismic noise and improve data quality. The picture shows a truck mounted / transportable drill rig capable for hammer-drilling or auguring a hole. Hammer drilling can be used in all ground conditions, streamlining logistics even when exact site conditions may vary from location to location. After drilling the seismic equipment is installed.

- a minimum depth of 2 m
- all ground conditions

- truck mounted / transportable drill rig
- hammer-drilling or auguring

Example conducted drilling jobs in purpose of seismic station installation.

Stages of seismic station installation.

A
- Equipment Installation
  seismic equipment mounting into posthole

B
- Power Supply
  solar panels mounting for power supply ensuring in the high-mountain regions

C
- Data Transmission
  real-time data transmission system installation using the cell-internet

D
- Completed Station
  example of installed seismic station

National data centers for processing the data transmitted from the seismic stations

Powerful generators for ensuring uninterrupted power supply of the servers

Example of the powerful server, installed for storage of seismic waveforms and results of its analysis.

- The data (transmitted from the seismic stations) flows into national data centers running on modern, state-of-the-art hardware, such as powerful servers procured and installed as part of this project. The telemetry is managed by a cutting-edge open-source software called SeisComp3 that receives and processes the data. Standard data products are created instantly and automatically, but are subject to human review. Human analysts manually process the data to produce more sophisticated data products. Network status, associated data products and data are displayed in real time on large wall-mounted monitors so that analysts, managers and visiting officials can quickly understand the operational status of the system.

Data transmission from the national data centers to the FDSN

Seismic data (waveforms) is transmitted in real-time mode to the national data centers, using cell-internet, and after to the FDSN (International Federation of Digital Seismograph Networks), using the high-speed internet . As a result, within the frame of the project in total 88 sites have been installed (https://ds.iris.edu/mda/_SNECCA/)

Newly installed station in the countries of Caucasus and Central Asia

- Azerbaijan - 22 new stations 10 stations added to fill gaps in their existing network: 3 postholes (co-located accelerometers) and 7 semi-broadbands; 12 semi-broadbands for mud volcano monitoring.

- Armenia - 8 new posthole stations co-located accelerometers; 2 standalone accelerometers in Yerevan.

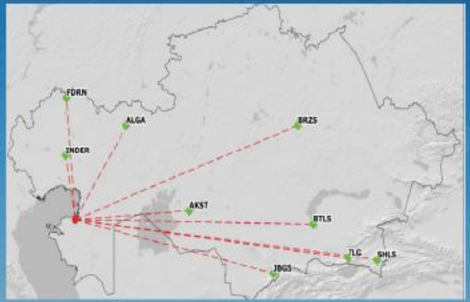
- Georgia - 14 new sites to improve coverage of existing network: 10 postholes and 4 vault sites, co-located accelerometers.

- Kazakhstan - 12 new sites to improve coverage of existing network 9 postholes (co-located accelerometers) and 3 semi-broadbands; 4 strong motions (co-located with existing seismometers).

- Kyrgyzstan - 10 new postholes sites (co-located accelerometers) to improve coverage of existing network; 4 strong motions (co-located with existing seismometers).

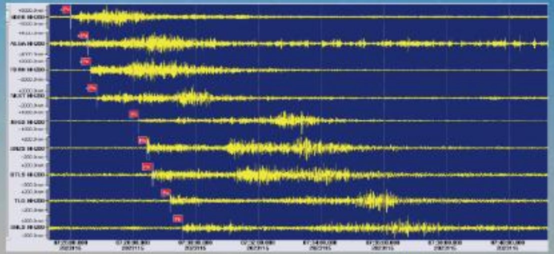
- Tajikistan - 8 new posthole stations co-located accelerometers; 4 strong motion stations in Dushanbe.

Earthquake location using new data



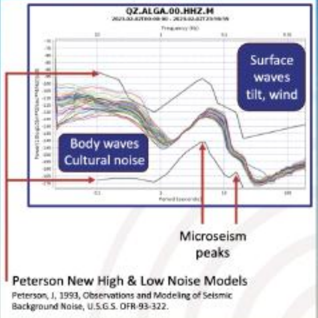
04/25/2023 (mb 4.6), Mangistay region, Western Kazakhstan

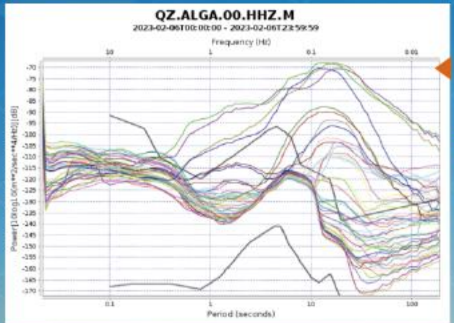
Waveform Recordings

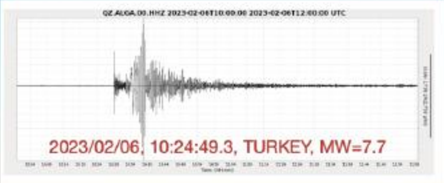


Achievements - Improved seismic monitoring systems and seismic hazard assessments

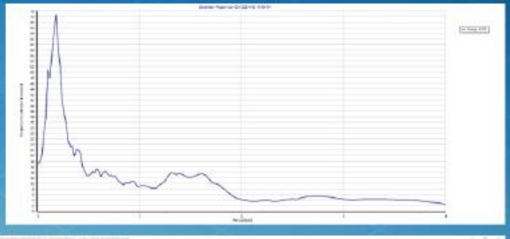
- The implementation of this project led to significant improvements in seismic monitoring systems and regional data processing to obtain high-quality datasets for earthquake studies.
- Based on national needs, each country installed between twelve to sixteen broadband and strong motion stations distributed evenly throughout their countries and the region.
- The seismic monitoring systems established in the project has both scientific and applied significance, since correct analysis of the data obtained is the basis for adequate seismic hazard assessment of the territory and, consequently, for the planning of appropriate preventive measures that can save human lives and reduce the level of various damages and destructions.

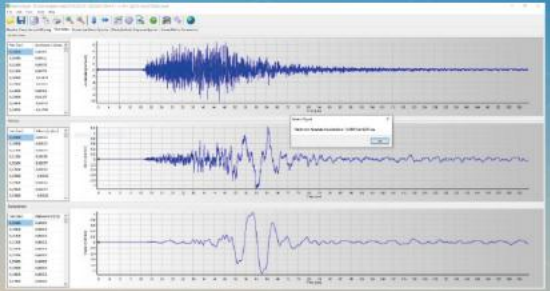






Example of an installed seismic station, each of these ones is equipped with an alternative power supply system and system of data transmission in the real time mode.





Example of strong motion record (22.01.2024, Mw=7.0) and corresponding spectrum.

TEAMS

KR2452 TEAMS

Meeting of project's participants, Georgia, 2023

Meeting of project's participants, Georgia, 2023

Meeting of project's participants, Turkey, 2022

Discussions on project implementation stages

International conference «From Science to Safety: Meeting Engineering Needs with Earth Science», Georgia, 2024