United Nations Development Programme
UNDP

Project Completion Report

Project No. CPR/03/612

(April – November 2003)

on

Community-Based
Earthquake-Monitoring System in Xinjiang

Summary

On 24 February 2003, a strong earthquake of Ms 6.8 struck Jiashi County in southwest Xinjiang Uygur Autonomous Region, China. In response, UNDP located funds and worked with CICETE[1] and CAS[2] to complete a nine-station community-based earthquake monitoring system. This system is presently in full operation and, during its first four months, was able to see ahead for the Ms 6.1 earthquake on 1 December 2003, which struck near Bole monitoring station in northwest Xinjiang. Nearly one-third of the staff involved in this nine-station system are women. Public disaster-education drives, conducted during the project, involved 50 local government officials and over 700 schoolchildren. The total time taken, from conception to completion of this community-based earthquake monitoring system, was five months (April-September 2003).

[1] China International Center for Economic & Technical Exchanges (CICETE)
[2] Chinese Academy of Sciences (CAS)

I. Background

The Xinjiang Uygur Autonomous Region is located in northwestern China, in the interior of Central Asia. It covers more than 1.6 million square kilometers, one-sixth of the total area of China, and is larger than any other province or autonomous region in China. Its population is 12.83 million, of which 22 per cent live in the cities and 78 per cent in the farming and pastoral areas. Of its total population, 5 million are Uygur, the principal nationality in the region, 5 million are Han, and the remainder are Kazak, Mongolian, Hui, Xibe, Kirgize, Ozbek, Tajik, Russian, Manchu, Daur and Tatar.

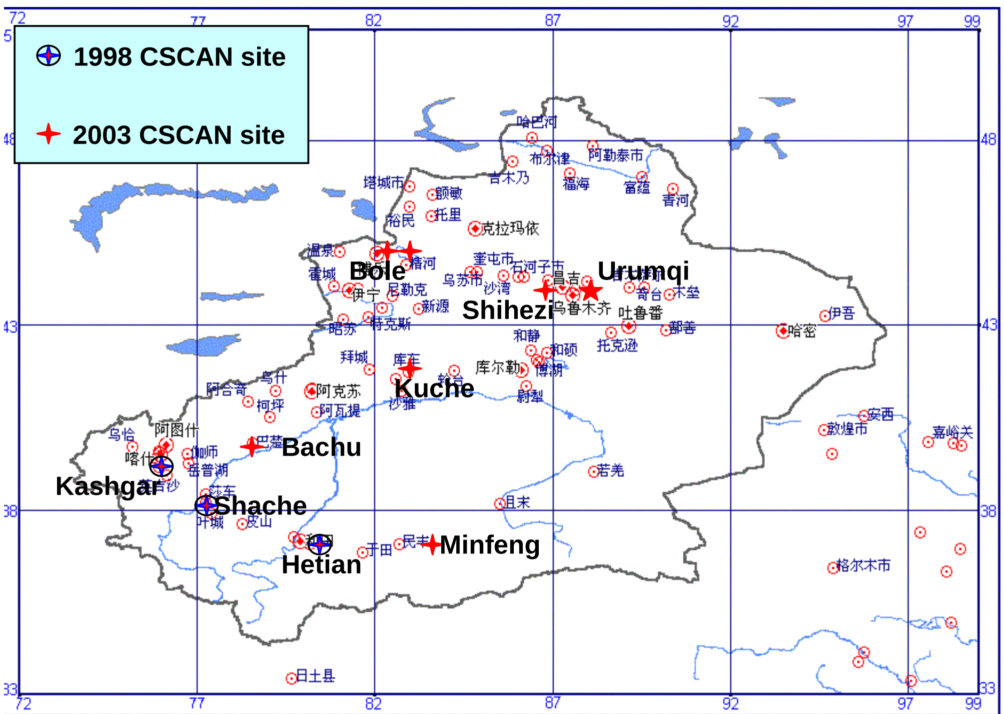

Fig. 1: Map of Xinjiang Uygur Autonomous Region and nine community-based earthquake-monitoring stations (CSCAN)

From 1985 to the present, a total of twelve earthquakes, ranging in magnitude from Ms 6.6 - 8.1 on the Richter scale, have occurred in south and southwestern Xinjiang, making this region the most active area in Asia for large and destructive earthquakes.

On 24 February 2003，a strong earthquake of Richter magnitude Ms 6.8 occurred 40 kilometers to the east of Jiashi County, Kashgar Prefecture, in the Xinjiang Uygur Autonomous Region. The earthquake epicenter was located at 39.5° N and 77.2° E. The Bureau of Civil Affairs in Xinjiang reported that the earthquake affected Bachu, Jiashi, Yuepuhu, Maigaiti, Shule, Shufu, Kashgar and Yingjisha counties/cities.

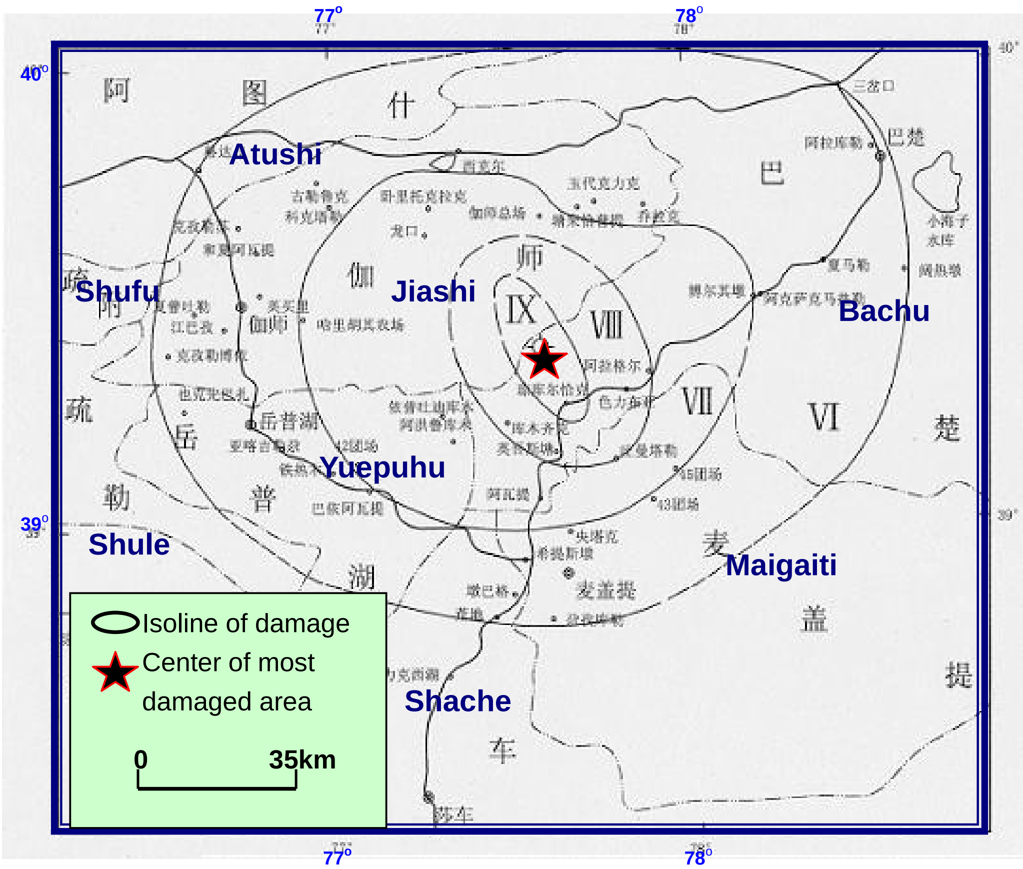

Fig. 2: Counties affected by Ms 6.8 earthquake of 24 February 2003

The March 2003 statistics of the damage / loss from this Ms 6.8 quake are:

- 268 persons dead
- More than 4,000 injured, 2,058 of them seriously – 800 still in the hospital
- 510,000 people affected, of whom 100,000 were seriously impacted
- 33,000 people without housing
- 70,000 rooms collapsed
- 10 schools, 900 class rooms collapsed
- 16 township health clinics destroyed

At epicenter of Jiashi-Bachu quake

II. Implementation Arrangements

In response to the Ms 6.8 earthquake of February 2003 in Jiashi-Bachu, UNDP provided US$50,000 to establish four stations in south and west Xinjiang, which employ a community-based approach to monitor for earthquakes. Two additional sites in northern Xinjiang were made possible through a grant of US$20,000 from the Foundation for Research and International Education relating to Natural Disasters （FRIEND）. The China International Center for Economic and Technical Exchanges (CICETE) was the executing agency, and the Chinese Academy of Sciences (CAS) implemented the project. A disaster preparedness working group, consisting of an international expert, four national experts and an administrator, completed and exceeded the planned project objectives by November 2003.

III. Major Results

The main results of the project are summarized below. They demonstrate that the Project Working Group delivered the intended results and achieved the objectives of the project in a manner that not only produced an immediate on-the-ground impact, but actually strengthened the capacity of local communities to anticipate and prepare for earthquakes on an ongoing basis.

- Raised awareness in Xinjiang of the usefulness of a community-based earthquake-monitoring system. Established **CSCAN, the Crustal Stress Community Awareness Network,** thus improving the capacity of local communities to monitor and prepare for earthquakes.

- Constructed six new crustal stress monitoring stations, exceeding by two stations (*) the original project target of four new sites (see table below and map of Fig. 1). These six new stations greatly strengthened a previously established 3-station network built by UNDP in 1998 in southwest Xinjiang. The total number of community-based earthquake-monitoring sites/stations in Xinjiang using crustal stress is now nine.

Site Name	Location in Xinjiang	Depth of Sensor
Bole *	Northwest	30.25 m
Shihezi *	North	27 m
Kuche	Central	31.89 m
Bachu	Southwest	31 m
Minfeng	Southeast	25 m
Bozhou	Northwest	30 m

- Conducted on-site training upon completion of each community-based earthquake-monitoring station. In this way, a total of twenty local community observers, *one third of them women*, were trained in recording and monitoring for earthquakes.

National expert, during Kashgar workshop, trains local communities in use of computer software to analyze their recorded data.

- Held a four-day technical workshop in Kashgar for local government officials, the staff of the local earthquake bureau/offices and the 20 recording staff from the nine community-based earthquake-monitoring CSCAN sites. This workshop presented the techniques of data reading, reporting and analysis, as well as training on earthquake mitigation and preparedness.

- Expanded the database of crustal stress observations for Xinjiang. Frequent and timely interactions between the national experts in Beijing and the local CSCAN community observers are now taking place on a regular basis to recognize and interpret abnormal signals in the data as they occur.

- Conducted public education campaigns, including presentations to local government officials and schools, emphasizing three key elements: to recognize environmental changes related to earthquakes; to build community capacity in reporting such changes to responsible officials; and to increase public awareness and knowledge of earthquake preparedness. These presentations were well-attended and reached a total of approximately 50 local government officials and 700 schoolchildren.

Schoolchildren were curious, interested and had fun finding out about earthquake preparedness

- Prepared and printed training manuals and public disaster-education materials for community leaders, residents and the recording staff at each of the nine CSCAN site locations.

- Reached agreements with local governments for long-term technical guidance to the communities on earthquake monitoring and data/information gathering, sharing, analysis and interpretation.

- Compiled the "Project Completion Report".

IV. Steps to Establish a Community-Based CSCAN

The effectiveness of this project largely depended upon good teamwork, detailed planning and preparation, attention to logistical details, and obtaining local government support to build each community-based earthquake-monitoring CSCAN station. Once the nine monitoring stations were built and the trainings completed, the CSCAN recorders chose by themselves to form regional (north and south) community monitoring teams.

The following list summarizes the steps that were taken to establish each community-based earthquake-monitoring CSCAN station:

Step1. Obtain support from the local government to build the site (1 day)

Step2. Work with local experts (2-3 days) to:

- look for a good drilling rig at a reasonable price;
- determine the location of the crustal stress site;
- select the volunteer observers/recorders.

Step3. Build the crustal stress site (3-5 days)

- drill the hole to install the crustal stress sensor;
- visit community people to present how the system is built;
- install the crustal stress sensor down the drillhole;
- provide on-site training for the observers/recorders;
- conduct earthquake awareness and preparedness campaigns.

Once the site is built, data-sharing and information flow are handled in the following manner.

- As the data is recorded, it is transmitted by email, fax, mail, or by telephone, on a weekly basis to the Beijing data-center, as well as to the provincial earthquake bureau.
- All staff at the community-based earthquake-monitoring CSCAN sites are encouraged to analyze (graph), calculate and interpret their data. A workshop is held after each network of sites is built, to train the staff recorders to conduct such tasks. In China, scientists at the national data center in Beijing (Professor Xiangning Huang's team) partner with the local sites in analyzing the data on a regular basis.
- Important conclusions and/or significant precursory signals in the data

are discussed by the experts in Beijing with the local recorders, both at the specific sites, as well as at the prefecture level.

- If the earthquake situation is of serious concern, the local recorders and the national Beijing CSCAN staff submit in writing a formal/official earthquake forecast, which they then send to alert the departments concerned to make appropriate preparations for the possible earthquake.

V. How Effective is the CSCAN Approach? What Can We See?

There are many ways to monitor for earthquakes, but only a few are widely known, accepted as mainstream and receive regular funding to develop. Seismology, which measures the shaking of the earth, is one such approach. However, it is very difficult to measure shaking before the shaking begins. Most seismologists thus strongly believe that detecting earthquakes ***before they occur*** is not yet possible.

Earthquakes result from force/pressure building up on rocks to the point that they break. It is the brittle failure (breaking) of rocks, i.e., rocks crack and move, which produces the earthquake.

If we are able to watch these forces as they build up in a region of an eventual earthquake, i.e., record changes in crustal stress (=force/area) or ‘pressure’ on the rocks, then we can learn about the process that leads to an earthquake and recognize when rocks are ready to break.

We can watch this process, i.e., the build up of stress or pressure on rocks in the Earth’s crust, by directly measuring changes in crustal stress. The crustal stress detection method is a direct measurement of stress (“force”) buildup in the Earth’s crust over a period of time, and as an earthquake forecasting technique, this method is uniquely Chinese – there is no other country that has systematically developed this approach to watch for earthquakes. This method has been further developed, in the last nine years, into a community-based earthquake-monitoring system in China and the Philippines through the support of the UNDP Country Offices.

Over 200 ‘short-term to imminent’[3] earthquake forecasts have been made since the crustal stress forecasting method went into full operation in China in the early 1970’s. At that time, the national crustal stress network consisted of about 120 professional monitoring stations. Since the mid-1990’s, a total of about seventy community-based earthquake-monitoring sites using the crustal

[3] (weeks to days beforehand)

stress method have been constructed in China and the Philippines. The success rate of the crustal stress methodology in forecasting earthquakes is 30%, i.e., of the more than 200 earthquake forecasts made officially up to present, about one third have been correct (useful in social preparedness).

A Case Study in Community-Based Earthquake-Monitoring

On 14 August 2003, Bole City in Xinjiang built its own crustal stress community-based earthquake-monitoring station. Within two months, a pronounced precursory signal appeared in the CSCAN data recorded at this station. Calculations and evaluations were conducted by both the local Bole recorders and the Beijing CSCAN staff. After more than ten phone consultations, both sides agreed on 26 November 2003 with this research result:

- between 6-14 December 2003, an earthquake Ms 5.0-5.5 would shake Bole City;
- what happened: on 1 December 2003, a magnitude Ms 6.1 earthquake actually hit the Bole region and shook Bole City significantly.

Bole recorder at Kashgar training workshop, discussing his data with a national expert

A month later, in January 2004, another clear and strong precursory signal began, which lasted 5 months up to the end of May 2004. During this time period, more than 20 phone discussions took place between the CSCAN teams in Bole and in Beijing. On 4 June 2004, both teams agreed to formally submit this research result: a Ms 6.0 earthquake could possibly take place within several hundred kilometers of Bole City in the next week or two. Bole's local environmental-monitoring team of 20 - 30 members has intensified their efforts to observe macroscopic changes in the local environment of the Bole region. The local government leadership has also been alerted and is taking appropriate steps to prepare for the possible event.

VI. Why have a Community-Based Approach for Earthquakes?

It is widely recognized that community-based disaster preparedness is one of the most important means for disaster response, management and risk reduction. There is a growing realization that many top-down approaches to disaster management fail to address the specific local needs of vulnerable communities, and do not tap the potential of local resources and capacities. The local community is the first to confront and respond immediately when any emergency arises. It is therefore important to build up the capacities of local communities to see ahead and prepare for all disasters.

With regard to earthquake disasters, what are the advantages provided by this community-based approach to earthquake monitoring (CSCAN), and how does it compare with other earthquake monitoring methods? The following list touches upon some of the major contrasts.

<u>An easy-to-operate system, at the community level, for monitoring earthquakes</u>:

- The equipment for CSCAN, while technically sophisticated, does not break down easily. It is user-friendly and very simple to use.
- A community volunteer/staff, with brief training, reads the instrument twice a day and records the crustal stress measurements. He or she can be a primary school graduate. The main requirement is that this person be someone who has a strong sense of community responsibility.
- All volunteer recorders are local community members and can be easily trained to manage the CSCAN system and to conduct preliminary analysis and interpretation of their data.
- The method is impervious to cultural noise, i.e., the impact of human activity on detecting an earthquake precursor is minimal. Wherever there are people, a crustal stress site can be built, be it in an urban metropolis or in a rural area.
- The location of a crustal stress site is straightforward and easy, as no special ground structures are required.
- The building of a site in soil sediment/strata takes only 1 day. Once set up, the site/station can begin immediate operation in forecasting an earthquake. This method is then time-sensitive in deployment and in forecasting. It can be utilized to catch earthquakes in the short-to-imminent term, i.e., months to days before the earthquake strikes.
- The environmental impact of setting up a station is minimal. Every effort is made to preserve the original environment and there is little or no environmental degradation.
- Low demand on operational resources (CNY200 or USD$25 per year): electricity, pen/pencil and paper are used twice a day for about 10-20 minutes each time.
- USD$10,000 per crustal stress equipment set

The crustal stress method employed by CSCAN was specifically designed for community use. Using this method allows local communities

to assess whether they should be concerned about their area with regard to a possible upcoming earthquake. This method can help communities determine whether macro-precursors[4] in their local environment are related to a possible earthquake in their vicinity.

Sustainability of this community-based earthquake monitoring system

- Two types of personnel typically staff a CSCAN community-based earthquake-monitoring station: a total volunteer, and/or a person receiving a small honorarium – CNY3/day. This arrangement, coupled with the low demand on electrical and recording supplies, reduces substantially the site's operational costs.

- Community members who chose to participate in CSCAN become stakeholders of the system and learn about their local environment.
  1. One exciting channel of community involvement is with schoolchildren, at both primary (from as young as 8 years old onwards) and secondary school levels. In both the Philippines and in Xinjiang, young students are participating in the actual daily recordings of CSCAN data, and can compare what they see in their instruments with what they observe with their own senses, i.e., macroscopic changes in their environment. These students, while discovering ways to measure changes in their natural environment, learn to share their observations with others nationally and internationally through the Internet, and become sensitized to the impact of their activities on their environment.
  2. The CSCAN community-based approach is founded on gender equality. This approach engages community members from all walks of life, including lobby guards, school-teachers, retirees, the disabled, farmers, and even monks and nuns at their religious centers, to participate in monitoring the environment.

- A major activity of the community-based earthquake monitoring system is to conduct public disaster-education programs, which raise the awareness of the community members on their vulnerability to natural events and what they themselves can do about reducing their vulnerabilities.

As regards further developing the CSCAN community-based earthquake-monitoring approach, one long-term goal will be to have what is happening at the community level integrated more closely professionally and in terms of policy development at the national level. The final goal is to strengthen disaster monitoring and preparedness at all levels of society, both nationally and globally.

[4] *(additional signals that are detected solely by our senses, with no equipment needed)*