USING GPS TO UNDERSTAND EARTHQUAKES

Iranian Permanent GPS Network

Lying in one of the most tectonically active zones in the Alpine-Himalayan belt, Iran frequently suffers from heavy and disastrous earthquakes. To monitor surface displacement and measure velocity and strain fields, the National Cartographic Center of Iran (NCC) has established a network of one hundred GPS stations: the Iranian Permanent GPS Network for Geodynamics (IPGN). The authors introduce the design of the new geodetic network.

Iran is situated between the Eurasian plate in the north and the Arabian plate in the south, with shortening rate of 2-2.5cm per year. Many earthquakes occur in this area, causing enormous loss of life and property. Recently, for example, disastrous earthquakes took place in December 2003 and in March 2005 in Bam. Although Iranian scientists have always been aware of the damage earthquakes may cause, until early 2005 the country lacked an efficient network for geodynamic studies and continuous estimation of crustal movements and precise recording of seismic activities in tectonically active areas.

Active Zones

But now the National Cartographic Center of Iran (NCC) is completing the setting up of an Iranian Permanent GPS Network for Geodynamics (IPGN). This modern network facilitates better understanding of tectonic deformation and will enable estimation of future hazards, whilst promoting scientific knowledge. The network consists of two parts: a base network covering the entire country, and three local networks. The base network, consisting of 41 GPS stations, has been established in areas of main tectonic activity: the Zagros Mountains, Central Iran, Alborz mountains, East of Iran, Makran, Loot and Kopeh-Dagh. The remaining receivers were used to create three local networks in the most densely populated and active zones. The main task of the GPS stations is to collect and store raw GPS data and send it to Tehran processing centre on a daily basis for final processing.

Priority GPS

To properly study general tectonic movements, the 1,650,000kmÂ² area of Iran actually needed to be subdivided into cells of 900kmÂ². Such subdivision would require 1,800 GPS stations. With only just over a hundred GPS receivers available, selection of GPS station locations had to be prioritised. For this two factors were important: seismic activity and population density. Areas with high earthquake potential and high population are: Central Alborz and Tehran, north-west of Iran (Azerbaijan) and north-east of Iran (Khorasan) Local networks were established in these areas.

Local Networks

The capital Tehran, with its population of about 12 million, is located in the southern mountain foothills of Central Alborz: a highly active zone. Earthquakes in this area would heavily endanger many economic, social, cultural and industrial activities. To study the tectonic deformation, 29 permanent GPS stations, including some belonging to the Base Network, were established at an average distance of 20 to 30km from each other. The eastern and western Azerbaijan and Ardabil areas (north-east of Iran) have many active faults, such as the Tassouj, Baladan and North Tabriz faults, the last being the most active zone, with observed movement of 7mm per year. The city of Tabriz lies 100km distant from this fault. Earthquakes of magnitudes 6 to 7 on the Richter Scale have occurred in this area and recent earthquakes in Roodbar and Ardabil are witness to present fault activity. Twenty-five permanent GPS stations cover this zone. Mashhad, Neishaboor and Sabzevar, three cities with high population, have suffered from many heavy earthquakes destroying the whole area and causing many fatalities. Many active seismic faults, such as Neishaboor, Dasht-Bayaz and KopehDagh, are present in this area. Twenty-nine GPS stations cover this zone.

Concluding Remarks

The design of the network and determination of optimal locations for GPS stations was carried out with the help of Montpellier University and Josef Fourier University, both in France, the Geological Survey of Iran and the International Institute of Earthquake Engineering and Seismology.

Further Reading

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