ESTABLISHMENT OF ZIGUI GPS-CR LANDSLIDE MONITORING NETWORK IN THE THREE GORGE RESERVOIR AREA

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Abstract: To apply INSAR observation technique to the Three Gorge Reservoir’s landslide monitoring, we’ve installed 10 corner reflectors on the landslide within Zigui county of the Three Gorge Reservoir area, meanwhile, set up GPS observation point, preliminarily forming GPS-CR landslide monitoring network. This paper of both INSAR observation technique and GPS observation technique in landslide monitoring researches.

Key words: Three Gorge Reservoir area, landslide, INSAR, GPS-CR, monitoring network

I. Introduction

In the Three Gorge Reservoir area exist complex natural and geological condition, torrential rain and flood, with the economic development, loss and risk produced by geological calamity occur more and more, Which has become an important factor for hindering the normal economic construction and people living standard improvement.

Since 1982, on both banks of the Three Gorge Reservoir area have occurred more than 70 places landslide, collapse, debris flow, of which more than 40 places are rather large, according to statistic, 400 people died, loss was serious. At present, attention to the geological calamity problem in the Three Gorge Reservoir area of the Yangtse River has been paid by the society are very necessary, main disasters in the Three Gorge Reservoir area are landslide and collapse. Up to now, 2490 place collapses on both banks of the Three Gorge Reservoir are discovered, besides, there are still 47 ditches of debris flow, the total length of stream and tributary of the Reservoir is 5300km, bank collapse after storing water may cause new geological calamity. Developments of landslide and collapse are controlled by region stratum rock, geological structure, geomorphic and its combination relation conditions, forming obvious difference in space distribution, in Zigui bank section of the Reservoir area, the number of collapse development is the most. Its slope stability is the worst, during its development time exist same trigger factor characters including rainfall permeability, earthquake, mankind engineering activities, flood washing out and erosion, among which rainfall permeability is frequent and obvious, for example, in rainy season of 1975, in Zigui occurred landslide, collapse disaster of more than 800 places. Well-known Xin-Tan landslide used to occur more times in history, such as in 1026, 1542 and 1985 used to occur stopping navigation, due to landslide in Yangtse River, almost which stopping navigation lasted 21 years in 1026.
Jibazi landslide hindered shipping in 1982, then costing RMB 80000000 yuan to remove obstacles, strengthen bank basis, lead surface drain off water, after that navigation has been recovered again [1].

At present, nation is heavily investing in curing 200 serious collapse places of the Three Gorge Reservoir area, also launching monitoring all landslide places and monitoring of the Reservoir area, thus improving and renewal monitoring technique means, finding out a large scope, high efficient measure for monitoring landslide are needed.

II. Synthetic Aperture Radar Interferometry Method

Now, monitoring collapse method has geological prospecting, regular edge angle net and GPS measurement, which demand personal to get measuring point, next no matter what man-made observation or installing automatic device measurement dose, it-is expensive, so, observation point and observation scope are limited [2-3].

In recent years, INSAR becomes a newly large area measurement technique with high precision, INSAR technique uses synthetic aperture radar on satellite or plane carrier to get reflection complex image with high resolution, each element image information contains not only ground object, but also phase signal necessary for interference, interference technique obtains the interference phase map from covering the same region synthetic aperture radar maps, passing through image processing, some special data processing and geometric conversion to get earth’s surface three-dimensional information or measuring earth’s surface deformation, use this technical monitoring ground surface deformation to reach the highest precision (mm), utilize INSAR to monitor the crust deformation of volcano activities, city and the advantage of INSAR is able to periodically get large area data, obtaining the ground deformation observation results with high accuracy, in recent 10 years, INSAR technique is always research hot point, gradually ripe INSAR technique and new-generation satellite system launching, its image resolution and product precision need to be improved continuously, INSAR technique is able to pass through various atmosphere, obtaining all-weather, all-day, ground elevation, and deformation information [4-9].

The difference between INSAR technique and GPS is that it has high sampling density, good space continuity, unnecessary set-up ground receiving station. Owing to that INSAR technique has both excellent continuity space covering and high automation, high precision monitoring ground surface deformation, thus INSAR technique creates a new idea for crust deformation researches, it will produce important influence in seismological researches. Our country has begun applying INSAR technique to observations of crust deformation, seismological monitoring and deformation measurement after earthquake, volcano movement, ground subsidence and glacial drift, getting satisfactory fruits, no doubt, it has bright future. [10-12]

INSAR technique has been several decades development history, however its real application to topographic measurement and deformation monitoring begins only after launching ERS-1 in recent 10 years. Specially a small deformation before monitoring collapse awaits to be studied further. Nowadays, main data resource contains ERS1/2, Radarsat, Envisat etc, with various radar satellite launch, it can be applied to INSAR processing double image more and more.

III. Corner Reflector Effect in INSAR Measurement.

Since the Three Gorge project was started, domestic and foreign scholars have attempted to use INSAR to monitor the dam deformation and Reservoir area collapse, but it hasn’t been successful report yet, what is the reason? Main reason is that getting and processing the interference data are difficult, it needs higher demand in INSAR data to double image space base line (mainly vertical component), i.e. less than a dependent on wave length and critical value of incidence angle, net time difference of getting interference double image is too large. Now, the typical time difference is 35 days or 35 days multiple. The Three Gorge reservoir is located in subtropical
zone, proper water vapor condition, vegetation grows rapidly, thus in so long time interval, the vegetation coherence method to get interference striped map, for this reason, it is impossible to obtain deformation observation results.

Having directed against puzzle mentioned above, we use corner reflector interference technique to monitor landslide of the Three Gorge has become a new technique in USA and Europe, which is used for monitoring the small scope subsidence of large area and long term of the city (annual) subsidence speed is several mm). corner reflector technique utilizes scattering stability of city tall building, on SAR interference image of different time sequence, these points can be distinguished, through atmosphere effect correction, interference results are obtained, corner reflector (see Fig.1) has wide irradiation direction, large scattering section, high stability, carrying out preliminary experiment proves that corner reflector on SAR image of the three gorge reservoir area can be precisely distinguished, through proper atmosphere effect correction, the phase difference between corner reflectors can precisely show reflector will be installed in important section of landslide monitoring, regard it as more stable control point than natural PS, corner reflector plays an important role of main control network atmosphere effect correction, passing through interference phase to reckon landslide displacement, algorithm research and test-verification play a key role, certainly numeral density corner reflectors will form a landslide body monitoring control network, passing through acquiring SAR image of the Three Gorge Reservoir area to conduct interference processing, so that long term and large area monitoring with high precision will be realized, matching the landslide GIS system of the Three Gorge reservoir area, in guarantee of the reservoir area safety and people life and properly safety for the Three Gorge reservoir area, it provides data information.

IV. Establishment of GPS-CR landslide Monitoring Network

To examine the feasibility and precision of INSAR monitoring and precise image match, this project sets up INSAR, GPS synchronous observation net in landslide test region, periodically carries out GPS precise measurement, measuring seat accords with corner reflector installation (see Fig.2)

V. Discussion

To determine relative displacement of landslide, 4 stable points are chosen on stable bedrock, regarded as mimic datum of the whole experiment region deformation observation network. In June of 2005, we
carried out the first observation using 4 double frequency GPS receivers with high precision, for 10 GPS monitoring points we employed net observation mode, each side observation time didn’t be less than two hours, repeat side observation number exceeded 1/3 .Due to not exceeding 500m in distance between datum point and near monitoring point, branch line connection is used only. When doing the first observation for cover reflector center position we carried out eccentric observation of point potential, its accuracy is up to decimeter (dm), this way, absolute position of corner reflector in INSAR image is determined. Base line calculation is made by use of Pinnacle software computation, coordinate adjustment firstly employs parameter restraint adjustment method to make free net adjustment, and then transform it under coordinate frame determined by datum point, potential accuracy is 3-5mm, arriving at prediction design accuracy.

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