Available online at www.sciencedirect.com

SciVerse ScienceDirect

Procedia Engineering 21 (2011) 368 – 375

Procedia Engineering

www.elsevier.com/locate/procedia

2011 International Conference on Green Buildings and Sustainable Cities

Coastal urban road geo-disaster monitoring problems of Laoshan District

JU Chunyan[a], JIA Yonggang [a*], SHAN Hongxian[a], TAN Changwei[b], JIAO Fanghui[a], YANG Zhongnian[a]

[a] *College of Environmental Science and Engineering, Ocean University of China, Qingdao*
[b] *Qingdao Geotechnical Investigation and Surveying Research Institute, Qingdao*

Abstract

Laoshan District is located in the southeast of Qingdao city which has a special geological and geographical environment. Many kinds of geological disasters have been appeared, especially surrounding the road nets, such as, slope disaster, landslides, collapse and unstable slopes. Laoshan District is National Grading-AAAA Tourist Districts which attracted lots of tourists from everywhere, however, geological disasters composed huge threaten to tourists. The purpose of this paper is to provide reliable, consistent and transient data for local disaster research on potential hazard points to maximize public safety. This paper presents the criteria currently used to judge an event's significance, the duties, responsibilities, and conditions which operate for responders, and the capabilities that can be called upon in responding.

Selection and/or peer-review under responsibility of APAAS

Keywords: Geo-disaster；Disaster monitoring problem；Coastal urban；Road net

1. INTRODUCTION

In developing countries, urban urbanization brings about development problems with rapid economic development; one of these problems is increased geo-disasters. There are many geo-disasters were initiated by tourism urban modernization development in coastal urban. Meanwhile appearing an amount of potential geo-disasters are severe results especially beside mountainous roads, which have potential effect. Most of potential geo-disasters are result of human activities to the environment [1, 2], especially the engineering activity on coastal environment（Filatova et al., 2011； Beukes et al., 2011）. For

* Corresponding author. Tel.: +86-1390-532-4116
E-mail addresses: yonggang@ouc.edu.cn

doi:10.1016/j.proeng.2011.11.2028

potential geo-disasters different cities have various characteristics of environment, because the different of the conditions of physical geography, hydrogeology, geological structure, rock, i.e.

A large number of studies have been carried out to examine disasters in rapidly urbanizing areas. The extent of disaster damage depends on spatial patterns of residential and people activity areas and their values. Due to several reasons tourism developments occur in proximity to mountainous areas, which originated close to the steep hillside. First, tourism benefits from spectacle especially steep zone**.** Second, households are attracted to economically developed areas because of tourism opportunities. Third, in addition to these economic factors coastal zones provide important environmental amenities, which are highly valued by households [3] (Bin et al., 2008). Thus, all these forces work to promote growth of potential disaster areas.

In coastal zones another vital factor in the growth of potential disasters is road planning. With tourist increase, road planning need to preplanning and reconstruction for highway communication related to traffic factors, such as vehicle speeds and volumes. Road construction is sure to increase the disasters, such as excavated roadbed and basalslope**,** excavation, etc. This paper determines potential geo-disaster dispersed wayside at different areas to monitoring disaster. Manager and planner may assess the impact of disaster loss on sustainable local development from the disaster monitoring system and proposes a GIS based method that relies on a spatial multiple criteria evaluation to include geological factors in the planning process.

2. MAIN GEOLOGICAL ENVIRONMENT BACKGROUND OF LAOSHAN DISTRICT

Laoshan District is located in Qingdao City, Shandong Province, China, at the foot of the Laoshan Mountain, 36°03′~36°23′ and 120°24′33″~120°43′E, with 389.64km^2, as shown in Fig. 1. Topography of Laoshan District is higher in middle and lowers around. The highest peak is Mt. Laoshan (36°05′–36°19′N, 120°24′–120°42′E) with an reaching an elevation of 1133 m above sea level. Mt. Laoshan is the second highest mountain in Shandong Province following Mt. Taishan (which reaches 1545 m) and is the highest mountain along the 18,000 km long coast line of China. Mountain ridges develop several streams which are controlled mainly by topography and geomorphology. Most land area in study area is mountainous.

The exposure strata of Laoshan District are Proterozoic metamorphic rocks, Mesozoic cretaceous clastic rocks and Cenozoic quaternary loose deposit. The lithological characters are mostly Granite Region. The structural pattern is mainly with the strike in the north-east and north-west. Under the control of geological structure, stratum lithology, and exogenic geological processes, different geomorphic types are formed in Laoshan District. The main geomorphic features are fluvial landform terraces and sea landform; diluvial fans are developed along the river.

Groundwater distribution is strictly controlled by geological structure, stratum lithology and landform. At Laoshan District there is the Quaternary accumulated area. There are some ranges of accumulated material of varied thicknesses since the Cenozoic in the area[4] (Kusky et al.2011).

3. MAIN GEOLOGICAL ENVIRONMENT PROBLEMS OF LAOSHAN DISTRICT

Due to the specific geological and geographical environment of Laoshan District, some geo-environmental problems have appeared in this area. Many types of geological disasters have been recorded, mostly slope geological disasters. So some of main problems of slope geological disasters are introduced as follows (Fig.2):

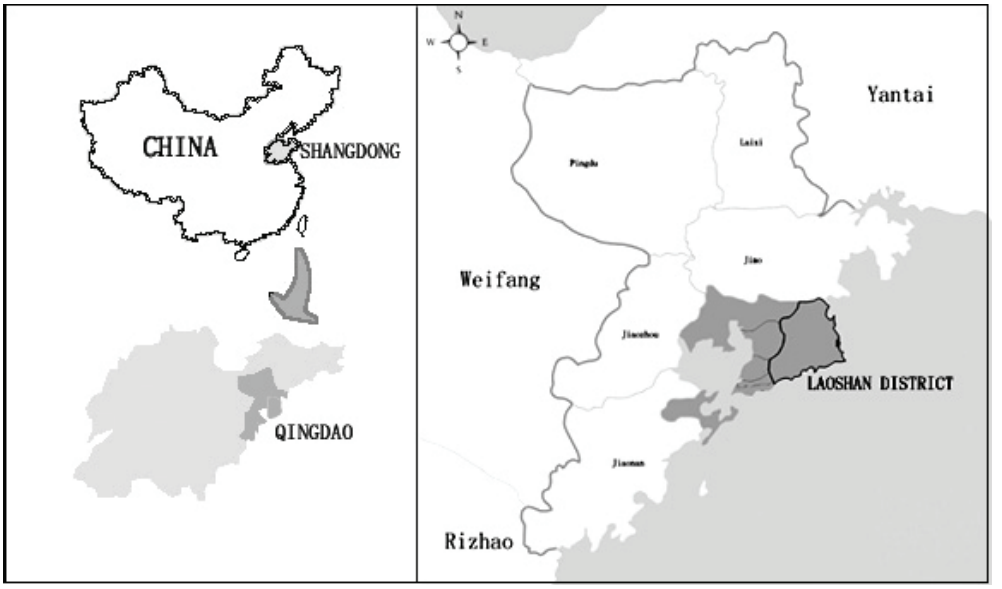


Fig.1 The location of research area

3.1. Landslides

Laoshan District is in the coastal area of low mountains and hills, which are composed of different rock masses. Under local geological circumstance, high ground stress is stored in rock slopes and this gives rise to deformation of slopes universally in this area. There are more than there landslides recorded around the urban area according to the records until 2009, and potential hazard points are fifteen at tourist area next to a highway, most of the landslides are small scale, and few of them are middle scale. But this still shows than landslides can't be ignored. According to records are due to human activity, particularly beside the road.

3.2. Unstable slope and Collapse

The phenomenon of Unstable slope and Collapse records shows that eight collapses have happened around Laoshan District, and potential hazard points are one hundred eighteen by the roadside at tourism area. Most slope collapse was triggered by excavation. The condition of the geomorphology, lithology and structure of rock slope provided may cause slope collapse.

Unstable slopes have been found with tensile fissures, some of them have caused damage to houses. In addition, a lot of limestone is randomly excavated around urban areas, particularly roadside, which has also caused some unstable slopes. This unstable slope threatens the safety of inhabitants and passer by.

Excavation scars the natural landscape and changes the stress distribution of the slope in a short period, which sometimes gives rise to landslides, collapses and debris flows. Furthermore, excavation causes floating dust that pollutes the air, destroys vegetation and causes water loss and soil erosion

3.3. Debris flows

There are about two debris flows recorded, and potential hazard points are five. The heavy rainfall and loosened solid materials are mainly reasons to initiate debris flow.

.

Fig.2 The photos of landslide, debris flows, unstable slope and collapse

4. MONITORING GEO-ENVIRONMENTAL DISASTER SYSTEM

Because of the special topography, landforms, long-term geologic agent, and human engineering geological activity, the damage extent of geological environment and the negative influence were also increasing. Recently the current prevention and control is mainly post-disaster emergency rescue and removal or reinforcement of small dangerous rock mass. It is lack of the necessary monitoring of the dynamic changes of major disasters [5] (P. Potherat & J.P. Duranthon, 2010).

According to this shortcoming, our study teams designed and developed the remote monitoring and early warning system. Through installing the automatic monitoring devices on site, and transmitting data to the monitoring and early warning center by the wireless technology, it realizes web publishing of the monitoring and early warning information to serve geological disaster management.

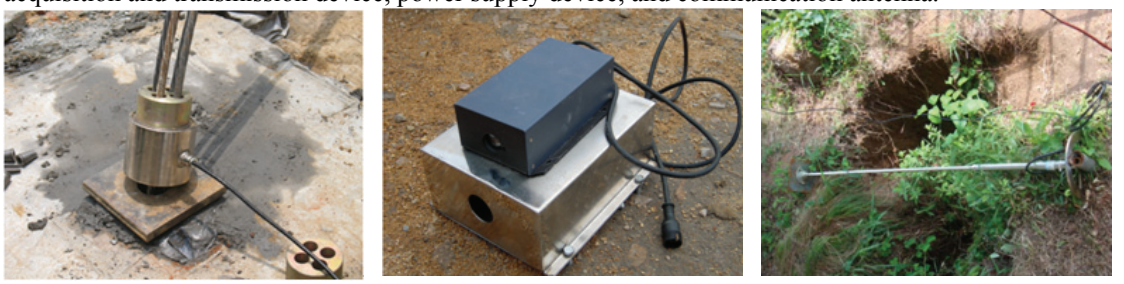
Several sites have been studied and monitored for years, which has been concerned by a crisis followed by an important collapse or rock fall. Typical site chosen among other ones, gave us the opportunity, thanks to data analysis combined with the structural context knowledge and with field

observations, to acquire a better understanding of the phenomenon in term of change of rate of displacement before rupture.

Fig.3 Location map of the test case study: the gray point is the monitoring points

4.1. Installation of monitoring devices

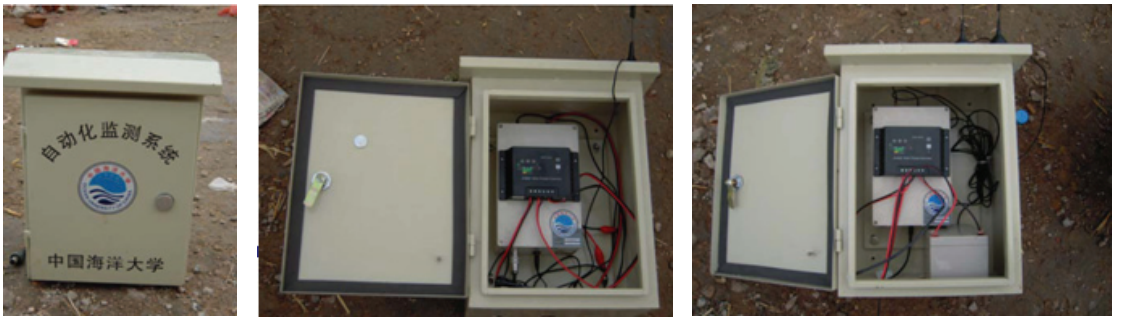
Automatic monitoring devices include force sensor, laser sensor, crack deformation sensor, data acquisition and transmission device, power supply device, and communication antenna.



(a) (b) (c)

Fig.4 Monitoring devices：(a)Force sensor; (b) Laser sensor Crack sensor; (c) Crack sensor

Data acquisition devices include acquisition module, radio module, and power module. Acquisition module is used to connect sensors and collect monitoring data; wireless module is used to set up LAN and send data together; power module is the chargeable battery using solar energy. Data transmission devices include wireless module, GPRS module, and power module.



(a) (b) (c)

Fig.5 automatic acquisition device: (a) appearance of device; (b) Data acquisition; (c) Data transmission

4.2. Network transmission of monitoring data

Among its disaster monitoring capabilities, system maintains an all-hours readiness to respond on-site within 24 hours to major objects in Laoshan District. The role of the rapid-response team is to: 1) provides expert advice to ensure public safety, 2) collect reliable, consistent disaster information of temporary nature, and 3) provide relevant freely available documentation and scientific data. According to the monitoring conditions, GPRS wireless network is selected for data transmission.

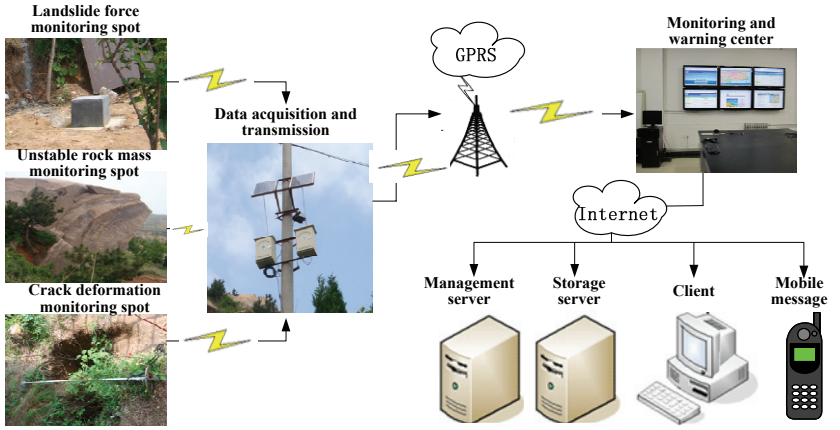


Fig.6 Network transmission of monitoring data

4.3. Data analysis

We can see on the long-term evolution graph, important seasonal variations and a small acceleration of the displacement rate. Detailed curve analysis, for the data monitoring period, show the subtle variation of monitored object. Taking into account the overstepping of the threshold alarm value, a crisis experts had been set up, which have volunteered their time and can be called upon on behalf of local authorities in charge of public safety throughout Laoshan District. Experts may response the professional advice on changed curve, then expertise appropriate to the data analysis, on-site within 24 hours of the occurrence

of a major event. A threshold alarm value leading to moving had been estimated. An exponential divergence model, based on the mean velocity of the previous 24 hours, was used to forecast the time of happening hazard.

5. DISUSSIONAND

A goal of the research team is to develop quantitative monitoring system in a local geo-disasters crisis and to advice on expected outcomes in real time as the crisis develops. The reason for this goal is based on a long-passed precedent failure in geo-disasters raised over months in hazard developed setting, but people were still in residence on the disaster area despite it is very dangerous area; A major difficult problem of geo-disasters monitoring failure was that analysis of the monitoring data did not keep pace with the developing event. Today, experts have sufficient data in hand to have successfully managed the situation, but lacked the capacity to evaluate it fast enough to be of use. The major advance contributed by the team is to rectify this lack of capacity [6](M.et,al.2010).

Nowadays, the monitoring at the Laoshan District's potential disaster points shows that current motion trends pose no threat to public safety, even though it causes property damage. The displacement monitoring to date shows that measurements can provide warning to the owners when the monitoring object is moving, and warning when line displacements are sufficient to require realignment.

The potential disaster points monitoring improves the comprehensive response capability of the relevant departments, and minimizes the harm caused by geological disasters provides the scientific basis for the prevention of the geological disasters in coastal urban by the road. This study improved knowledge of the potential disaster points monitoring to Laoshan District of Qingdao from geological hazards has led to substantial reductions in economic loss and life-threatening.

6. CONCLUSIONS

With respect to Laoshan District's potential disaster points, the monitoring system has enabled:

- 1. Maintenance of 24-hour-a-day capability to provide expert potential disaster points advice to ensure public safety;
- 2. Capacity to obtain consistent and often ephemeral potential disaster points data for research;
- 3. Capacity to provide near-real time advice on developing potential disaster points crises;

7. Copyright

References

[1] Filatova, T., J.P.M. Mulder and A. van der Veen, Coastal risk management: How to motivate individual economic decisions to lower flood risk?. *Ocean & Coastal Management* 2011; **54(2)**: 164-172.

[2]Beukes, E.A., M.J.W.A. Vanderschuren and M.H.P. Zuidgeest, Context sensitive multimodal road planning: A case study in Cape Town, South Africa. *Journal of Transport Geography*. In Press, Corrected Proof.

[3]Bin O, Kruse J, Landry CE. Flood hazards, insurance rates, and amenities:evidence from the coastal housing market. *The Journal of Risk and Insurance* 2008; **75(1):**63-82.

[4]Kusky T et al. A critical examination of evidence for a Quaternary glaciation in Mt. Laoshan, Eastern China. *Journal of Asian Earth Sciences* 2011; **40(1)**: 403-416.

[5]P. Potherat JP Duranthon. The monitoring of unstable rock masses applied to risk management. Geologically Active, *Proceedings And Monographs In Engineering, Water And Earth Sciences*. Newzealand: CRC PRESS / BALKEMA;2010.

[6]M.J. McSaveney CI Massey1 & GD Dellow. Landslide response and monitoring—the New Zealand GeoNet experience. Geologically Active,*Proceedings And Monographs In Engineering, Water And Earth Sciences*. Newzealand: CRC PRESS / BALKEMA;2010.