Application of China satellite data in geological hazards survey and evaluation: taking Baoji loess area as example

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Abstract. The development of domestic satellites has injected new vitality into the application of satellite technology in the geoscience field, and showing good application results, especially the development of high resolution satellites. This paper by using the image data of research area in 2013 and 2014 two annual Ziyuan III satellite (ZY-3), have extracted hazard-formative factors such as topography, active faults, water systems, vegetation, attempts to carry out geological hazards survey. Combined with the data of engineering geological petrofabric and rainfall in research area, to carry out susceptibility and risk assessment of the geological hazards by using the information model. It provides a demonstration for geological hazards survey, monitoring and evaluation in the loess landslide area by using domestic high resolution satellites.

1. Introduction
The eastern part of Northwest China is one of the areas where hazard seriously from geological disasters. The major cause of these disasters is landslide, collapse and mudslide from loess [1]. According to incomplete statistics, from 2002 to 2012, nearly one third of China's geological disasters occurred in the loess zone [2-3], which mainly take the form of landslide, collapse and mudslide, frequently bringing about casualties and tremendous economic losses [4-9].

Loess zone is a vast and complex terrain. Geological disasters investigation on ground alone will be time-consuming and incomplete. The rapid development of modern space technology and remote sensing technology not only opens up a broad prospect for the earth resources and environmental monitoring research, but also provides a brand new measure for the investigation and research of geological disasters. High-resolution remote sensing data are used to investigate geological disasters. It makes identification easier, covers lager area, shorten working time, and improve work efficiency.

China's high-resolution remote sensing satellite started late. So the remote sensing data from foreign satellite are often used in previous remote sensing survey for geological disasters. Over recent years, with the significant development of China's space industry and a rising demand for resources and environment exploration, China has launched a series of observation satellites such as resources and environment satellites, providing strong technical support for the investigation and monitoring of geological disasters.
2. Researched area overview and domestic satellite data used

2.1. Researched area overview
The Baoji area is located at the intersection of the Qinling-Liupanshan mountainous region, the Shanbei Loess Plateau and the Weihe Plain in northern Shaanxi Province. There are five types of landform: loess hilly, loess tableland, loess basin between mountains, valley and alluvial-proluvial plain. According to the statistics, mountainous bedrock area accounts for about 54% of the total Baoji area; loess hilly, loess tableland and loess basin account for about 42.70%. Loess area is mainly located in the central part of Baoji and most parts of Northeast China.

Baoji is in a typical semi-humid warm temperate continental monsoon climate zone. The area has more than 600mm of average rainfall in years and more than 1000mm in some years. The daily maximum rainfall reached 169.7mm/d on August 23 in 1980. Precipitation in the year is unevenly distributed in this area. Rainfall is mostly characterized by continuous rain, downpour or continuous rain plus downpour. 60 to 70% of precipitation is mostly centralized in June to September.

Landslide disaster in Baoji area is well known in China. Mountain, river and plateau are Baoji’s special geological and geomorphologic features, which are apt to cause geological disasters such as collapse, landslide and mudslide [5]. The most representative types of geological disasters in Baoji include landslide, collapse, mudslide and unstable slope and the landslides occur the most. Geological disasters are most likely to occur at edge of loess tableland (beam), in front of Qinling Mountains and along bank of large valley. Intensive fall or continuous rain is major factor to induce geological disasters in loess area of Baoji [10-11]. With non-stopping engineering activities some unreasonable human-induced activities lead to the rise of man-induced geological disasters, which threatens the lives and property safety of the masses.

2.2. Domestic satellite data used
This research is conducted mainly by means of remote sensing data from domestic resource 3rd satellite (ZY-3 for short). ZY-3, as the first self-owned civil high-resolution stereo mapping satellite in China, is equipped with four optical cameras (table 1), including a front-sight panchromatic TDI CCD camera with a ground-view resolution of 2.1m, two foresight and rear-sight panchromatic TDI CCD cameras with a ground-view resolution of 3.6m, and a front-sight multi-spectral camera with a ground-view resolution of 5.8m. Besides, its HR multi-spectral data and stereoscopic observation capacity provides the possibility of remote sensing investigation and monitoring of geological disasters and disaster-incurring environment.

### Table 1. Payloads parameters of ZY-3 satellite.

| Payload       | Band | Spectral range(μm) | spatial resolution(m) | Satellite width(km) | swing ability | revisit time(day) |
|---------------|------|--------------------|-----------------------|--------------------|---------------|------------------|
| Front view camera | -    | 0.50-0.80          | 3.5                   | 52                 | ±32°          | 3-5              |
| Rear view camera  | -    | 0.50-0.80          | 3.5                   | 52                 | ±32°          | 3-5              |
| Confront camera  | -    | 0.50-0.80          | 2.1                   | 51                 | ±32°          | 3-5              |
| Multispectral camera | 1   | 0.45-0.52          | 6                     | 51                 | ±32°          | 5                |
|               | 2    | 0.52-0.59          |                       |                    |               |                  |
|               | 3    | 0.63-0.69          |                       |                    |               |                  |
|               | 4    | 0.77-0.89          |                       |                    |               |                  |

The test data are level 1A data on Baoji area in 2013 and 2014. First, the relative elevation is extracted by means of front-sight and rear-sight data so as to obtain DEM data (based on the satellite terrain). Then panchromatic image and multispectral image are ortho-rectified respectively by means of extracted DEM. Last the basic image used for interpretation are integrated and inlaid.
3. Remote sensing interpretation for natural disaster mass
Remote sensing characteristics and differentiating marks of natural disaster mass are evident in loess area in ZY-3 true color image, which lays a foundation for remote sensing investigation in geologic hazard.

(1) Marks for differentiating landslide by remote sensing
Landslide generally consists of steep landslide walls and gentle-dip landslide mass. When slope (in figure 1) turns, the land in slope glides and forms a cambered convex tongue. There is Compete or incomplete cambered tensional valley in inner side of landslide, and two gullies from the same source come out. It is evidently presented in contour line. The contour line in rear wall of landslide comes dense and in landslide mass comes sparse (in figure 2). But in landslide which has been severely damaged naturally or artificially, the rear wall of landslide and landslide mass may be obscure even unidentified.

![Figure 1](image1.png)
Figure 1. Steep slope and gentle slope of landslide surface (S-steep slope; G-gentle slope).

![Figure 2](image2.png)
Figure 2. Contour characteristics of landslide wall and landslide body.

Generally, the edge along landslide mass is dark in tone because there is more humid there. Marsh land is distributed along the rear of landslide. Natural gully on both sides of landslide mass is cut deeper. Cambered images, including scarp, landform variation line, abnormal tonality line, are developed in rear edge of landslide mass. While slope in front edge protrudes towards valley and is often accompanied by images of landform micro-protrusions and small collapsed slide accumulation. New landslide mass shows even grey white while old landslide mass shows even dark brownish green in remote sensing image. They take the shape of dustpan, tongue, arc, and irregular shape. Characteristics such as landslide wall, landslide step, enclosed depression and landslide tongue are able to be identified by and large in image.
(2) Marks for differentiating collapse

Collapse is markedly subject to landform, structure and lithological conditions. Straight or cambered steep precipice and cliff are developed in rear edge of collapsed mass. In remote sensing image, sunny slope presents a zone in light tonality and shady slope presents a zone in shadow.Collapsed mass is often distributed consecutively along steep cliff in a large scale. Ancient collapsed mass is coarse in image and uneven in microtopography with clustered aboveground vegetation cover. Modern collapsed mass shows light and irregular spot images which often spread in groups and bands (figure 3).

![Figure 3. Remote sensing image of collapse geological hazard (ZY-3, 2013).](image)

(3) Marks for differentiating mudslide by remote sensing

Mudslide is often shaped as an asymmetric dumbbell in image. The area where mudslide occurs is often shaped like ladle, strip or branch with abundant scattered matters and is always accompanied by landslide and collapse. Gully base is straight and valley is narrow in the zone where mudslide passes. The area where mudslide is stacked is mostly located at outlet of valley with a gentle horizontal slope. It shows a fan or cone-shaped image with obvious outline in light tonality. The sector is free of fixed gully in a form of sheet-flow. Most early ravines of mudslide show a gloomy coarse strip and the stacked matters are often distributed at outlet and fan-shaped. Latest ravines of mudslide show a white line with even shadow and undeveloped vegetation (figure 4).

![Figure 4. Remote sensing image of mud slides geological hazard.](image)
(4) Marks for differentiating unstable slope by remote sensing
Unstable slopes in research area are in a large number, and are mainly distributed at artificial rock slope along highway. Their Images are white and bright. Watery area is purplish red in even shadow. Artificial excavation which shapes as arc and irregular drawing is obviously distinguished from surrounding ground. (figure 5). ZY-3 domestic satellite data in 2013 and 2014 are used to interpret a total of 973 geological disasters (582 landslides, 206 collapses, 43 mudslides and 142 unstable slopes) in a measure of 1:50000 and in combination with previous results of investigation. 53 landslides and 1 collapse (figure 6) are interpreted in a measure of 1:25000 in the north slope of Baoji.

Figure 5. Remote sensing image of unstable slope geological hazard.

Figure 6. Distribution map of Landslide in North Slope, Baoji urban area.

4. Investigation for disaster-incurring environment

4.1. Landform factor investigation
Difference of landforms is generally reflected in the development of factors which affect the incurring, occurrence and development of geological disaster. Landform factors, such as ground slope, aspect, water system (gully) density, are calculated respectively by means of extracted ZY-3 DEM data.

The slope of Ground directly affects the redistribution of substances and energies on ground. And it is a key factor to affect the occurrence of geological disasters. In loess area, the loess is relatively even in composition and less consolidated, while the flow rate of water, infiltration capacity, and volume of runoff are also influenced by the grades of the slope. As a result, ground slope area plays a crucial role in occurrence of geological disasters in losses area. When spatial neighborhood analysis is conducted with 250m in neighbor, the waviness of landform in loess area in Baoji is characterized as follows: the height of slope in the area is between 0 and 547m and there is difference among geomorphic units.
The minimum of waviness is in Weihe Basin with 72m on the average. It is 112m in the north loess hill and about 246m in the southeastern bedrock mountain area (figure 7).

![Figure 7. Slope map of Baoji area.](image1)

Slope-exposure (figure 8) directly affects the amount of solar energy on the ground, the moisture in the soil, growth of vegetation and direction of runoff on the surface. It is one of the topographical features that cannot be ignored in the mechanism of instable regional slope. The study shows the sunny slope has the climate similar to southern regions while the shadowed slope has the climate in the northern regions. The landslides in the Baoji area are mainly distributed in the sunny slope, indicating that the sunny slope is more likely to incur landslide than the shadowed slope.

The Density and distribution of Water system (gully) also affect occurrence of disasters. Erosion by river on bank slope of valley which influences the stability of slope includes down cut and lateral erosion. According to statistical analysis of a 1000m range on both banks of the main rivers in Baoji, the calculated result shows that the number of disasters is obviously decreased when the influenced area is less than 800m.

![Figure 8. Aspect map of Baoji area.](image2)
4.2. Active fault factor interpretation
It is interpreted that Neotectonic movement in the study area is intense. A series of active break at different scales and directions are formed along with the uplift of the north Qinling Mountains and the subsidence of the Weihe Basin. Active breaks which are mainly close to east-west and north-west are secondary breaks accompanied by regional ones. They play a significant role in controlling distribution of micro-topographical features, water systems and gullies. Especially, terrace of Weihu River and edge of loess plateau are cut by active breaks in the Weihe Basin. These breaks form a large-scale high steep slope and limit the distribution of landslide. It can be found in the analysis that the change of internal motive force in breaks incurs the high-density distribution of disasters in its neighborhood, and disasters are distributed the most intensively in a range of 300m away from breaks and gradually decreased beyond such range.

4.3. Water system factor extraction
There is a strong correlation between form of the water system, the topography and linear structure. Form of the water system shows obvious direction to the distribution of geological disasters. It is found through interpretation that Jinghe River system is mainly shown as branches, indicating Jinghe River system in the area is located at slightly tilted plain or relatively stable crust where lithology is uniform and dip angle of rock stratum is small. Weihe River system is feathery, indicating it is located at fault valley or linear fold area. River network density, river divergence rate, river bend coefficient and other water system factors are analyzed and calculated by means of ZY-3 DEM this time.

The calculated result shows that density of the river network in the study area is relatively high at 1.31km/km². Average divergence rate of water system is 5.27 which means the Weihe River basin is greatly affected by the geological structure (linear structure). The overall shape of Weihe River system in the study area is feathery. They consistent with the survey results.

4.4. Vegetation factor extraction
Vegetation coverage, a sensitive factor of ecological geological environment, affects all landform factors to a certain degree. For example, in area with sparse vegetation, topographical slope becomes steeper due to water and soil loss. The study result shows vegetation coverage plays a certain role in directing the distribution of geological disasters.

![Figure 9. NDVI map of Baoji area.](image)

(1-landslide, 2-collapse, 3-mud-rock flow, 4-instable slope)

In remote sensing application field, vegetation coverage is generally expressed as normalized differential vegetation index (NDVI). NDVI is the ratio of the sum to difference between near-infrared band reflectance and the infrared band reflectance; and its mathematical expression is:
NDVI = (NR − R) / (NR + R)  \hspace{1cm} (1)

Where: NR is near-infrared band reflectance and R is infrared band reflectance.

NDVI is extracted by means of multi-spectral data of ZY-3 satellite; namely, near-infrared band (B4:770nm-890nm) and infrared band (B3:630nm-690nm) of ZY-3 are used to calculate NDVI (figure 9). Negative NDVI indicates that the ground is covered by cloud, water, snow and etc. NDVI 0 indicates bare ground and bare rock. Positive NDVI indicates vegetation coverage and increases along with higher coverage. Analysis of correlation between vegetation index and disaster shows that the high-density disaster area is obviously concentrated in the area with low vegetation coverage, namely the low NDVI (0.06 ~ 0.40).

4.5. Human engineering activity
Social engineering activities of human have become a tremendous agent that cannot be neglected. They changed conditions of the geological environment to varying degrees, broken the dynamic balance formed in the nature world during the slow erosion and accumulation for thousands of years and induced or aggravated geological disasters. The main engineering activities related to geological disasters in the study area are farming, kilns building, road construction, coal cutting, gravel mining, etc. Impacts of road construction are the most extensive. Slope cutting along the road network is most related to development of geological disasters, placing many hidden hazards for the occurrence of geological disasters. ZY-3 image data are mainly used this time to extract road network information and to analyze the relation between road network and disaster location. The trunk roads in counties and cities, including expressways, national trunk highway, provincial trunk highway and other high traffic or people-flow highway, are selected to conduct correlation study for geological disasters. And the calculated result shows that geological disaster occurs frequently in the area 60m away from the highway.

5. Comprehensive assessment and analysis for geological disasters
On the basis of remote sensing interpretation for regional geological disasters and extraction of disaster-incurring factors, comprehensive assessment and analysis is performed for susceptibility to and risk of geological disaster in the studied area. Susceptibility evaluation is to analyze and assess the development level of geological disasters in loess area in Baoji by means of geology, structure, topography, river and vegetation and other types of influencing factors, and analyze the tendency of geological disasters to occur in different sections of the area in a view of space. Risk assessment is to consider disaster-incurring factors of rainfall and human engineering activity on the basis of susceptibility, and analyze and assess probability of geological disasters and their range of expansion and impact. The assessment adopt information quantity model to analyze.

5.1. Introduction to information quantity model
Information quantity model, one type of the Bayesian Probability Model (or bivariate analysis) is to perform quantitative description in a form of probability. It reflects contribution made by a different range of disaster-causing factors to occurrence of geological disasters. Information quantity \( I_{A j \rightarrow B} \) of geological disaster can be expressed as equation (2)

\[
I_{A j \rightarrow B} = \ln \frac{P(B/A_j)}{P(B)} \hspace{1cm} (j = 1, 2, L, n) \hspace{1cm} (2)
\]

Where: \( P(B/A_j) \) ——The probability of occurrence of geological disaster B corresponding to the jth range of disaster-causing factor A;
\( P(B) \) ——Regional background value of probability of occurrence of geological disaster B
\( IAj\rightarrowB \) ——Information quantity of geological disaster (unit: Nat)
\( n \) ——number of secondary ranges where disaster-causing factor A is divided

In practical operation, to make it convenient for calculation, probability in equation (2) is converted into frequency of sample so follows
\[ I_{A_{j} \rightarrow B} = \ln \frac{P(B/A_{j})}{P(B)} = \ln \frac{N_{j}/S_{j}}{N/S} \quad (j = 1, 2, L, n) \]

Where: \( I_{A_{j} \rightarrow B} \) —— information quantity of occurrence of geological disaster B corresponding to the jth range of disaster-causing factor A;  
\( N_{j} \) —— area or number of geological disasters corresponding to the jth range of disaster-causing factor A;  
\( S_{j} \) —— distribution area of the jth range of disaster-causing factor A;  
\( N \) —— total distribution area or number of regional geological disasters;  
\( S \) —— total regional area

5.2. Susceptibility assessment

**Table 2.** Calculation results of influence factor information quantity for susceptibility degree of geological hazards.

| NO | Classification | Specific elements | Element interval | Disaster point N(point) | Parameter | Information I/Nat | Order |
|----|----------------|-------------------|------------------|--------------------------|-----------|------------------|-------|
| 1  | Active fault   | 0-300             | 127              | 493.09                   | 0.98      | 4                |       |
| 2  |                | 300-600           | 91               | 489.21                   | 0.66      | 7                |       |
| 3  |                | 600-1000          | 46               | 643.92                   | -0.30     | 23               |       |
| 4  |                | moraine           | 7                | 44.25                    | 0.49      | 10               |       |
| 5  |                | gravel stratum    | 95               | 756.01                   | 0.26      | 15               |       |
| 6  |                | landslide         | 29               | 13.28                    | 3.12      | 2                |       |
| 7  |                | Q3                | 499              | 3829.05                  | 0.30      | 14               |       |
| 8  |                | Q1-Q2             | 9                | 2.77                     | 3.52      | 1                |       |
| 9  | Geology structure | Soft stratiform clasolite rock | 17 | 217.64 | -0.21 | 21 |       |
| 10 | Engineering rock group | Flaky metamorphic rock | 1 | 25.09 | -0.89 | 28 |       |
| 11 |                | solid stratified metamorphic rock | 1 | 40.60 | -1.37 | 29 |       |
| 12 |                | Stratiform clasolite rock | 11 | 78.04 | 0.38 | 12 |       |
| 13 |                | Solid stratiform clasolite rock | 80 | 1028.44 | -0.22 | 22 |       |
| 14 |                | Solid Stratiform carbonate | 39 | 446.15 | -0.10 | 20 |       |
| 15 |                | Rigid massive metamorphic rock, intruded rock | 178 | 3589.22 | -0.67 | 25 |       |
| 16 |                | 0-10              | 45               | 4289.65                  | -2.22     | 31               |       |
| 17 |                | 10-15             | 64               | 1548.56                  | -0.85     | 27               |       |
| 18 | Topography     | Slope (°)         | 15-20            | 1606.23                  | -0.52     | 24               |       |
| 19 |                | 20-25             | 132              | 1476.00                  | -0.08     | 19               |       |
| 20 |                | 25-30             | 131              | 1180.76                  | 0.14      | 17               |       |
| 21 |                | 30-44             | 509              | 1725.03                  | 1.12      | 3                |       |
| 22 |                | 0-200             | 60               | 359.65                   | 0.55      | 9                |       |
| 23 |                | 200-400           | 52               | 347.49                   | 0.44      | 11               |       |
| 24 |                | 400-600           | 61               | 338.64                   | 0.62      | 8                |       |
| 25 |                | 600-800           | 65               | 333.59                   | 0.70      | 6                |       |
| 26 |                | 800-1000          | 38               | 327.29                   | 0.18      | 16               |       |
| 27 |                | -0.392405-0.064464 | 85 | 775.957 | 0.13 | 18 |       |
| 28 |                | 0.064464-0.189456 | 362 | 1519.45 | 0.90 | 5 |       |
| 29 |                | 0.189456-0.297209 | 302 | 2147.17 | 0.38 | 13 |       |
| 30 |                | 0.297209-0.396341 | 148 | 3044.75 | -0.69 | 26 |       |
| 31 |                | 0.396341-0.499783 | 53 | 3033.87 | -1.71 | 30 |       |
| 32 |                | 0.499783-0.706667 | 23 | 2534.47 | -2.37 | 32 |       |
Assessment covers predication of susceptible conditions and potential susceptible area for spatial density of geological disaster characteristics. Major environmental influencing factors include geological structure, engineering geological rock group, type of slope structure, topography, hydro-geological condition and etc. Five influencing factors including active breaks, formation lithology, topography, river system and vegetation index, and their specific information quantities are calculated and sequenced (table 2). All factors are divided respectively into 3 to 10 ranges, a total of 35 ranges. And then calculate information quantities respectively and sequence them from high to low in order to reveal how strong the effect do different factor ranges cause to landslide, mudslide and collapse.

From a perspective of calculation results of information quantity of susceptibility influencing factors, top 5 majoring photographed factors include: old loess in engineering rock group (Q1-Q2), old landslide-accumulated mass, slope with gradient bigger than 34°, the area in a range of 300m away from active breaks, and well-vegetated region. Weight of factors are arranged in accordance with their information quantity and sequence. All single-factor layers are reclassified and assigned respectively and then factor layers are added for calculation. The results of susceptibility calculation and assessment (figure 10) thus are obtained. In a view of the evaluation results, the highly susceptible areas are distributed in watershed and tableland edge of loess hill, in front of Qinling Mountains, on the banks of Weihe River, Qianhe River, Jialing River and other large river valleys; and the medium susceptible areas are distributed in secondary branch ditches of loess ridge in north mountain, the western Longshan Mountain and southern Qinling Mountains.

![Figure 10. Geological hazards susceptibility assessment result map in Baoji loess area.](image)

5.3. Risk assessment
On the basis of the susceptibility evaluation, the risk assessment of geological disaster is carried out with priority given to considering the change of regional rainfall, the intensity of human engineering
activities incurring geological disasters, and the maximum displacement distance of geological disasters.

In recent years, extreme rainfall in Baoji has abnormally changed. Thus, the spatial distribution of average regional rainfall over recent 3 years (from 2010 to 2012) is selected as rainfall trend which may occur in subsequent several years. Impacts of human engineering activity on road network, especially trunk road, are mainly considered. A buffer is spaced at a certain distance so as to calculate information quantity (table 3).

Table 3. Calculation results of influence factor information quantity for risk of geological hazards.

| NO | Classification | Specific elements | Element interval | N_i (point) | S_i (km^2) | ln/Nat | Order |
|----|----------------|------------------|-----------------|-------------|------------|--------|-------|
| 1  | Regional rainfall | Annual rainfall | 125-150 | 364 | 3742.61 | 0.007 | 9 |
| 2  | Regional rainfall | Annual rainfall | 150-175 | 275 | 2668.74 | 0.064 | 7 |
| 3  | Regional rainfall | Annual rainfall | 175-200 | 148 | 1389.97 | 0.097 | 6 |
| 4  | Regional rainfall | Annual rainfall | >225 | 1 | 221.70 | -3.064 | 13 |
| 5  | Regional rainfall | Annual rainfall | 0-20 | 31 | 89.76 | 1.274 | 2 |
| 6  | Regional rainfall | Annual rainfall | Buffer distance | 40-60 | 34 | 86.90 | 1.399 | 1 |
| 7  | Regional rainfall | Annual rainfall | Buffer distance | 60-80 | 24 | 85.85 | 1.062 | 3 |
| 8  | Regional rainfall | Annual rainfall | Buffer distance | 80-100 | 18 | 85.06 | 0.784 | 5 |

According to the calculation results, total information quantity in a unit is 1.399 (40-60m away from the highway) as a maximum and -3.064 (rainfall is higher than 225mm) as a minimum, which generally reflects the contribution of factors to occurrence of disaster. Weights of factors are arranged in accordance with their information quantity and sequence, all single-factor layers are reclassified and assigned respectively and then factor layers are added for calculation so as to obtain results of risk calculation and assessment (figure 11). From the results of risk assessment, the highly-risk area of geological disaster in the loess of Baoji are mainly distributed in the loess plateau slope on the north bank of Weihe River, including the line along Yinwei Canal on the north bank of Weihe River, east bank of Jinling River, Changshougou, both bank of Qianhe River, and the transition zone between loess hill and tableland in front of the Qinling Mountains, and on the Shennong Town-Gaojia Town-Pingtou Town section on the south bank of Weihe River, middle and low mountainous area on both banks of Qingjiang River with Baoji-Chengdu Railway along, and both sides of trunk road in Feng County and Taibai County. The areas with a medium risk are distributed in loess hill and regional secondary eroded gully.

6. Conclusions
The following conclusion can be reached by the test for remote sensing investigation, evaluation and application

1) Domestic ZY-3 high-resolution satellite data is able to meet the remote sensing investigation for geological disaster; its interpretation mark is obvious and accurate with working scale as high as 1:25000. In this scale, overall accuracy of disaster mass remote sensing interpretation for ZY-3 data is 74.6% which effectively guarantee the remote sensing identification of large and middle-sized geological disaster mass in loess area and can serve as main data source for detailed investigation into geological disaster at 1:25000 and 1:50000 scale in place of foreign counterpart in future.

2) Domestic ZY-3 high-resolution satellite data is able to effectively extract disaster-incurring environmental factors of geological disaster. Its results of susceptibility to and risk of geological disaster are basically consistent with distribution of geological disaster locations existing in this area, which shows domestic ZY-3 satellite data is able to provide abundant information about disaster-
incurring environment for detailed investigation and assessment of geological disaster at 1:25000 to 1:50000 scale.

Figure 11. Geological hazards risk assessment results map in Baoji loess area.

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