

Presented at the FIG Working Week 2016,  
May 2-6, 2016 in Christchurch, New Zealand

# Research on Reclamation and Implementation effect of abandoned cave dwelling in Loess area of Northwest China— Taking Xifeng District of Gansu Province for Example

## 黄土高原区废弃窑洞复垦与实施效应研究 ——以甘肃省西峰区为例



Feng YOU  
2016.5.5



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Recovery

from disaster

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**01 Where are we from ?**

**02 What is cave dwelling ?**

**03 What methods we use?**

**04 How about the effect?**



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## 区域位置 Regional location

甘肃省位于青藏高原、内蒙古高原、黄土高原交界处,东接陕西,西连新疆,南邻四川,北与宁夏、内蒙古毗邻,并与蒙古国接壤。

Gansu is situated at the juncture of three Plateau: Qinghai-Tibetan Plateau, the Inner-Mongolia Plateau and the Loess Plateau, it borders Shanxi to the east, Xinjiang to the west, Sichuan to the south, Inner-Mongolia, Ningxia and Mongolia to the north.





## 区域位置 Regional location

- 古丝绸之路的要冲
- 新欧亚大陆桥的通道
- 我国现代化建设的战略要地之一

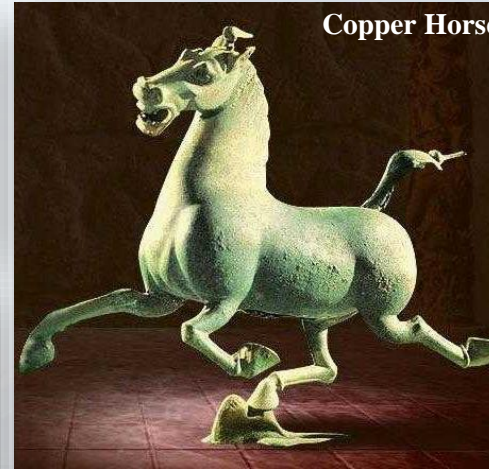
Gansu province was one of communications centers of The ancient Silk Road . Now it is not only the throat of the new Eurasian Continental Bridge, but also is one of the strategic points in the modernization construction.



QiShe figure



station to make



Copper Horse



Dunhuang Feitian



The Silk Road

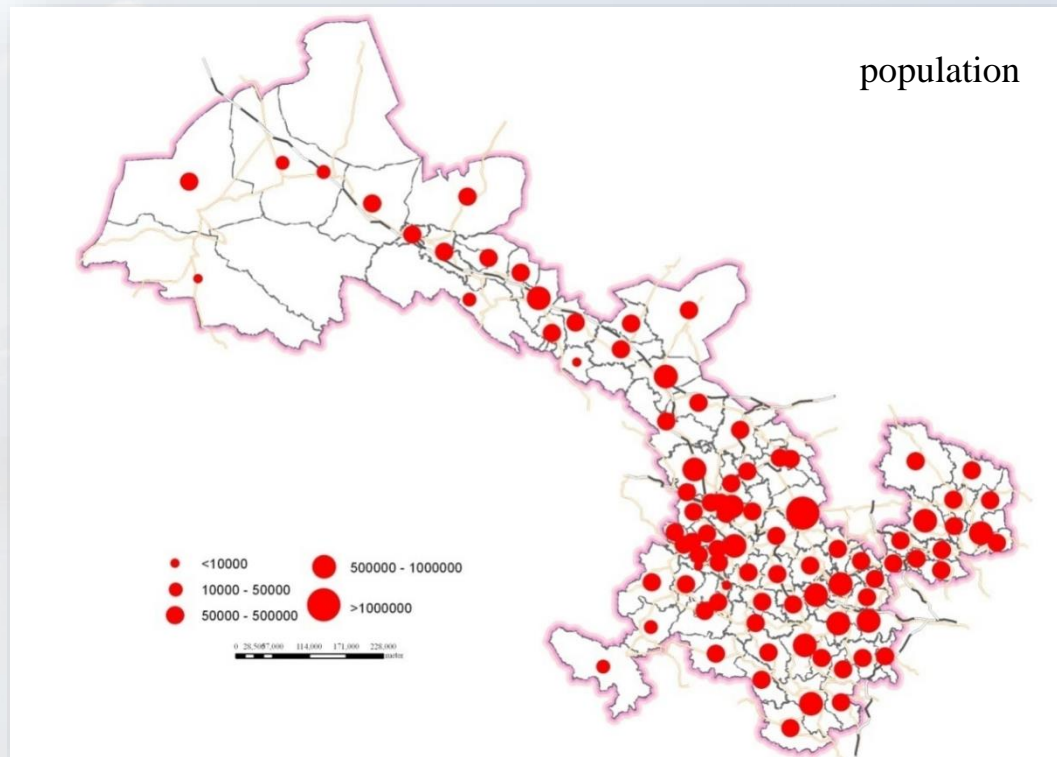


## 区域位置 Regional location

甘肃全省土地总面积42.58万平方公里。现辖12个地级市、临夏、甘南2个自治州；共有4个县级市、58个县、7个民族自治县、17个市辖区，总人口2594万人。

Gansu province covers an area of 425,800 square kilometers. It has 12 municipalities and 2 autonomous prefectures.

There are 4 county-level cities, 58 counties, 7 national autonomous counties, and 17 districts. It has a population of 25.94 million.



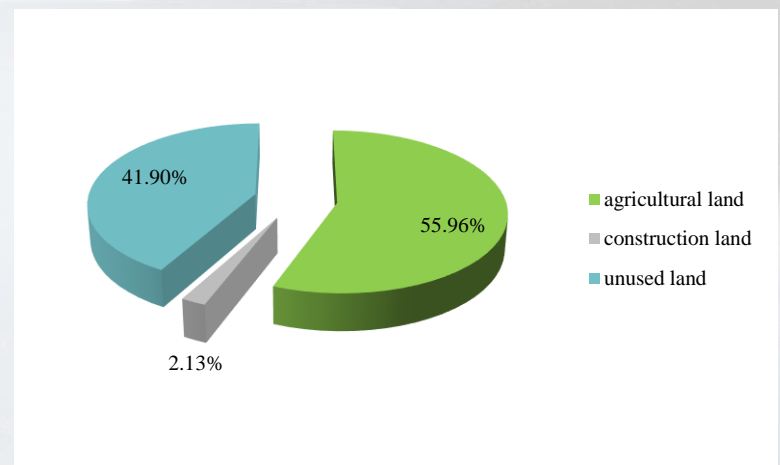
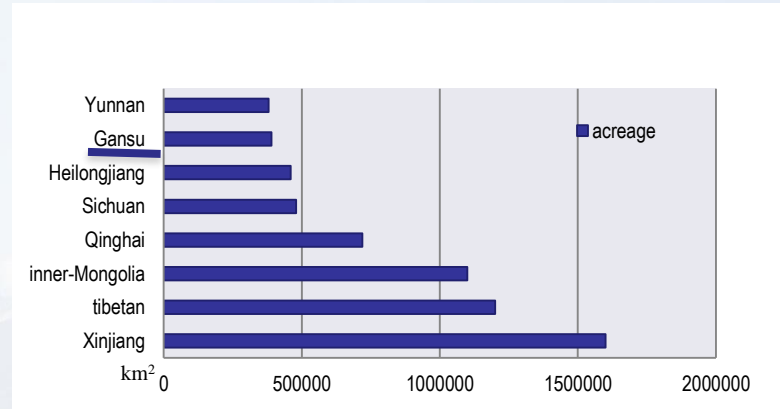


## 土地利用特征 Characteristics of land use

### 1.土地资源总量大，土地质量差

### 1. Large land resources amount, poor land quality

Total land area of Gansu ranks the seventh in China, with per capita of land is 1.75 hectares, and there are the average 57 people per square kilometer. But the unused land area is large. The land hard to use accounts for 40.62% of the total land area ,such as desert,gobi, saline-alkali soil, wetlands,etc



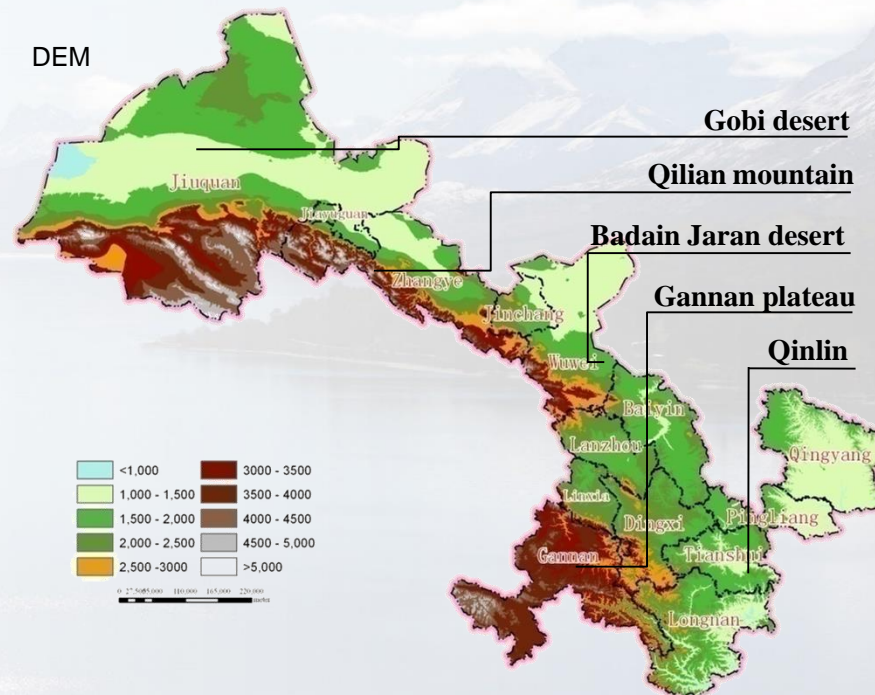


## 土地利用特征 Characteristics of land use

### 2.自然环境条件差异大，土地利用地域间差异明显

### 2. Marked differences of the natural environment conditions, and obvious differences of the land-use

Gansu is long and narrow, which is 1655 kilometers from east to west, 530 kilometers from north to south, and the narrowest place is only 50 kilometers. Gansu has mountains, plateaus, hills, gobi deserts with complicated and varied landforms.







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## 土地利用特征 Characteristics of land use



Gobi desert



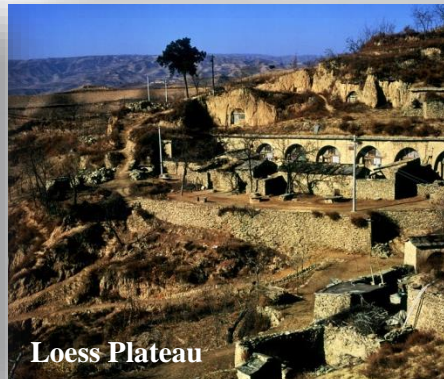
Qilian mountain



Badain Jaran desert



Gannan plateau



Loess Plateau



Qin lin



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## 土地利用特征 Characteristics of land use

### 3. 土地生态环境脆弱，农业生产抗御自然灾害的能力较差

### 3. Fragile ecological environment of land, poor ability of agricultural production to resist natural disaster

甘肃是我国西北地区自然条件最严酷的地区之一，也是区域性水土流失严重的地区。全省干旱半干旱地区占总面积的三分之二以上，严酷的自然环境条件使全省各地每年都有不同程度的各种自然灾害的侵袭。

Gansu is one of regions which have the severe natural conditions in northwest China. And the soil erosion is serious. The arid and semi-arid area accounts for two-thirds of the total area. The natural environment is so harsh that there are many kinds of natural disasters every year.





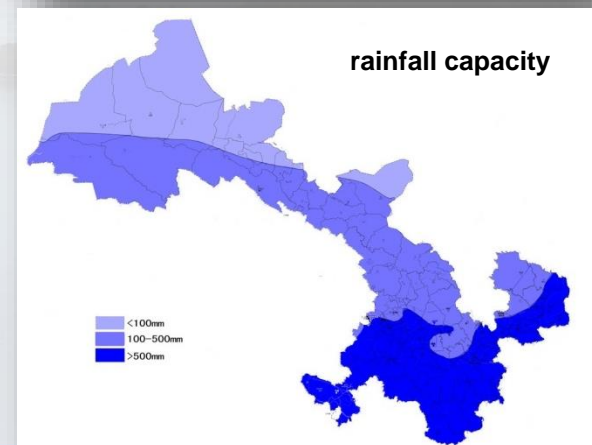
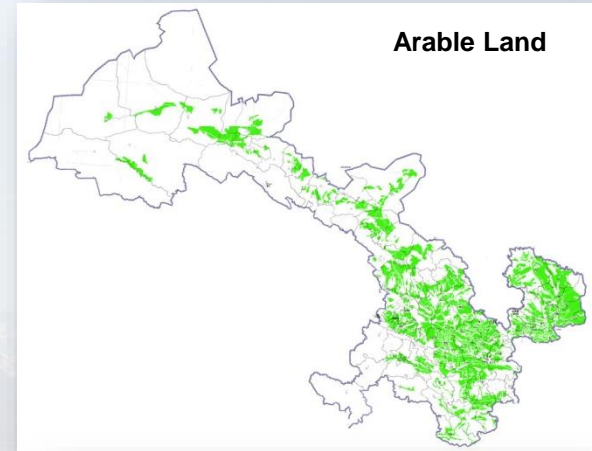
## 土地利用特征 Characteristics of land use

### 4.土地资源开发利用潜力较大，但水土资源匹配不协调

### 4. Large potential in developing and utilizing of land resources, while disharmony in the water and soil resources matching

甘肃土地资源面积较大，但耕地不足总土地面积的10%，后备土地资源也有很大潜力，但由于水土资源匹配不协调，致使土地资源的经济效益得不到充分发挥，生产力水平不高。

Land resources area is large, but the cultivated land accounts for less than 10% of the total land. There are a large number of the potential land resources in Gansu. Because the water and soil resources aren't matched harmoniously, economic performance of land resources cannot play well and productive forces are also on a low level.





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### 窑洞 Cave dwelling

窑洞：在土山山崖挖成的用作居住的山洞或土屋

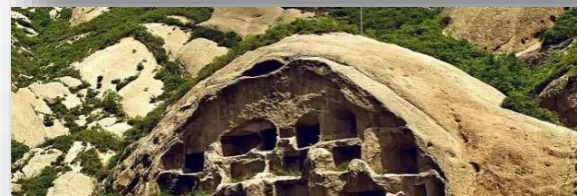
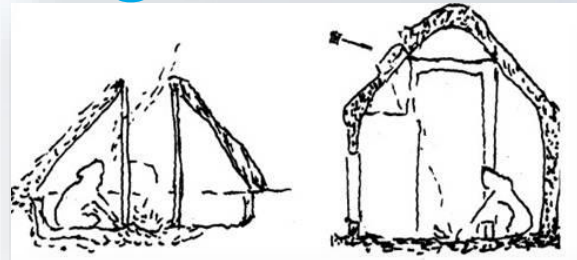
Cave is digging holes used to living in the mountains.

采光较差、通风不良、潮湿易霉  
Disadvantages: poor day lighting, poor ventilation, wet easy to mold

□观光 tourism landscape



□废弃 abandoned





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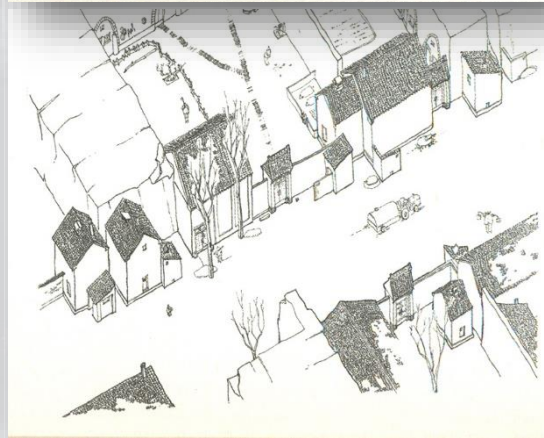
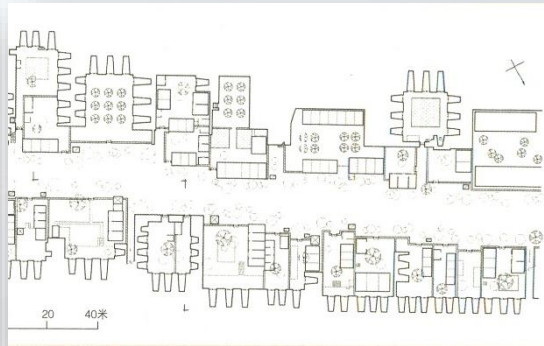
## 窑洞 Cave dwelling

- 靠崖式
- Cliff Cave

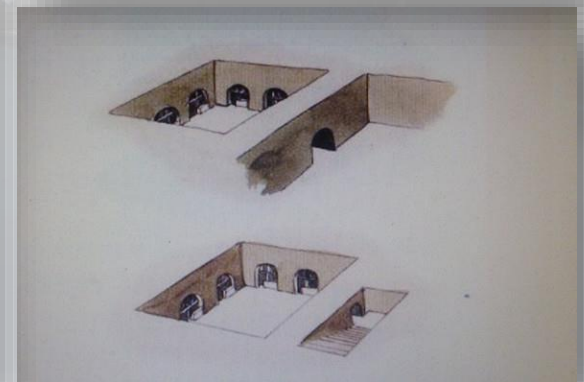


24/07/2010

- 胡同式
- Alley Cave



- 地坑院
- Underground Cave





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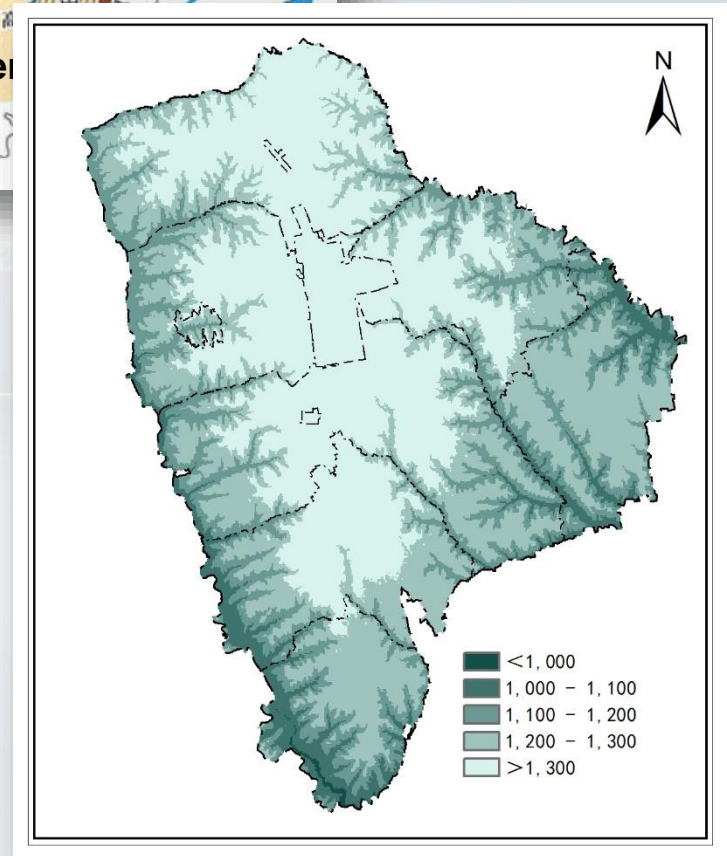
Recovery

from disaster

西峰区位于甘肃省东部庆阳市中部，座落在“北控河套、南屏关中”的董志塬腹地，地势平坦，土壤肥沃



Study area is located in Xifeng District, Gansu Province. Xifeng is in the middle east of Qingyang City, Gansu Province, located in the Dongzhiyuan hinterland. The land is flat and fertile.







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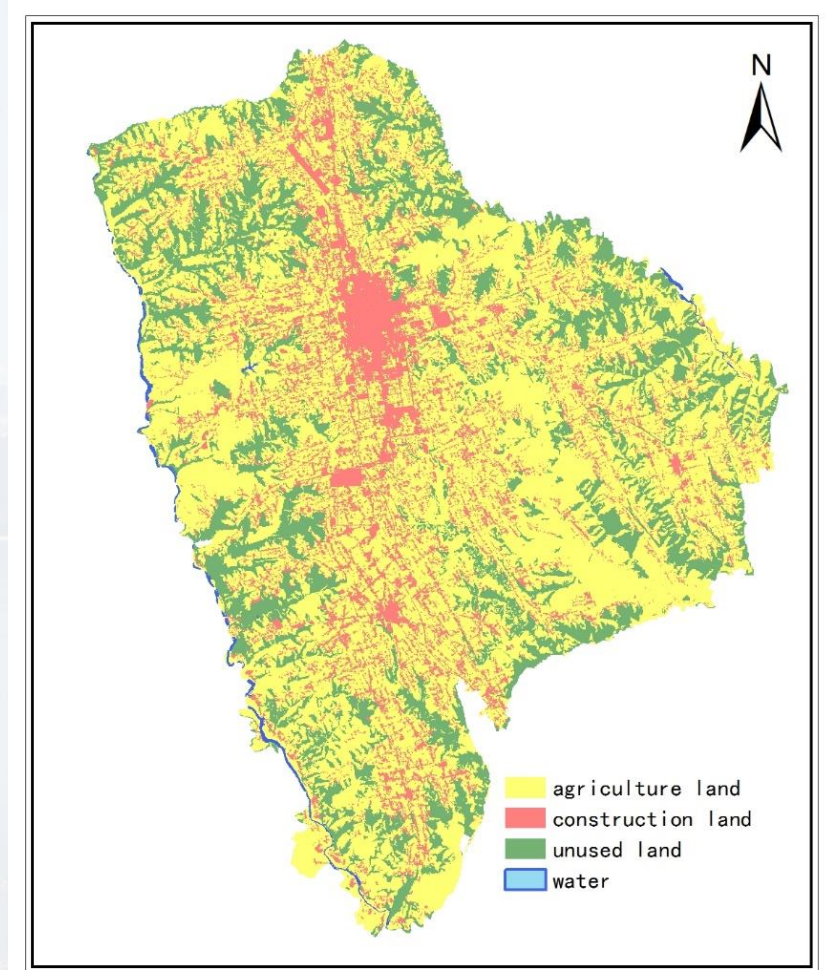
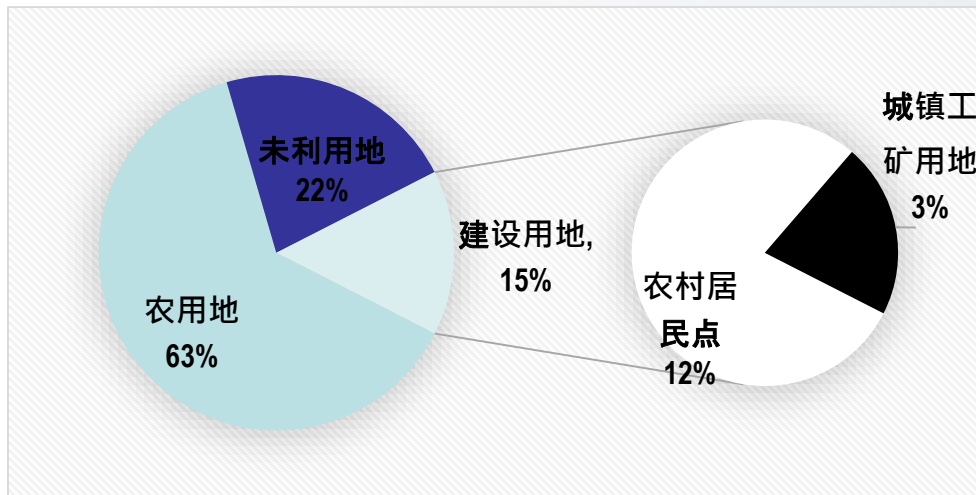
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## Recovery

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2013年全区土地面积99901公顷，其中农用地面积为62918公顷，建设用地面积为14998公顷，其他土地面积为21984公顷。

In 2013, the total land area is 99,901hm<sup>2</sup>, including the agricultural land area of 62918 hm<sup>2</sup>、construction land area of 14998 hm<sup>2</sup>and other land of 21984 hm<sup>2</sup>.





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from disaster

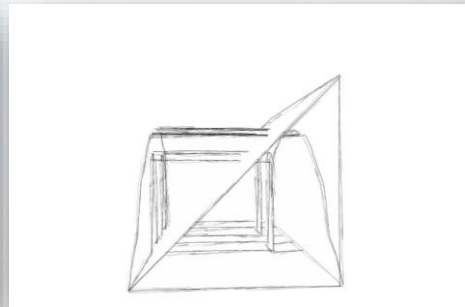
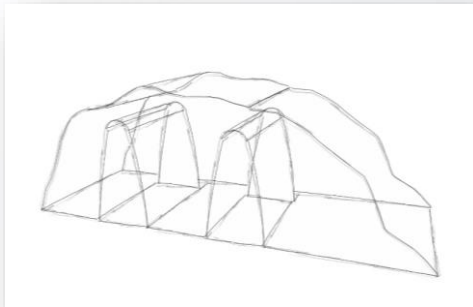
**A area**

**靠崖式窑洞 245.62公顷 1310人**

**Cliff Cave 245.62hm<sup>2</sup> 1310p**

该类窑洞依山而建，复垦时采用“挖一半，填一半”的技术，重点在于根据上层塬面与窑洞底面高差合理确定梯田高度和后退宽度，将其整理为阶梯型，配套相应的田坎、生产道路和沟头防护，以防止水土流失，提高田块蓄水能力，便于农民耕种。

This type of cave is built on hillside, and using "dig in half, fill in half" reclamation technology with emphasis on reasonably determine the height and back terraces width based on the upper plateau surface and the bottom surface elevation cave, which was sort of ladder-type, complete the appropriate the ridge, the production of road and ditch head protection to prevent soil erosion, improve water storage capacity plots, for farmers to cultivate.





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**B area**

胡同式窑洞 174.34公顷 1310人  
**Alley Cave 174.34hm<sup>2</sup> 1310p**

窑洞拆除时，用推土机把旧宅基地房前屋后、老墙、窑背有机土分片集中堆放，再用推土机、装载机拆除项目区内的旧宅，清理旧建筑中的砖块等废弃物，拆除后结合土地平整综合利用。配套相应的生产道路和田间防护林，以防止水土流失，提高田块蓄水能力，便于农民耕种。

The type of alley caves are usually closed one by one. In the process of reclamation, the technology should be combined with different topography, and original terrain, according to local conditions to design different elevation plots. When the cave is demolished, the workers used bulldozers to pile up the organic slice from the front and back of old house, old walls, then used bulldozers, loaders removal project in the old house, after removal of combined land leveling utilization.





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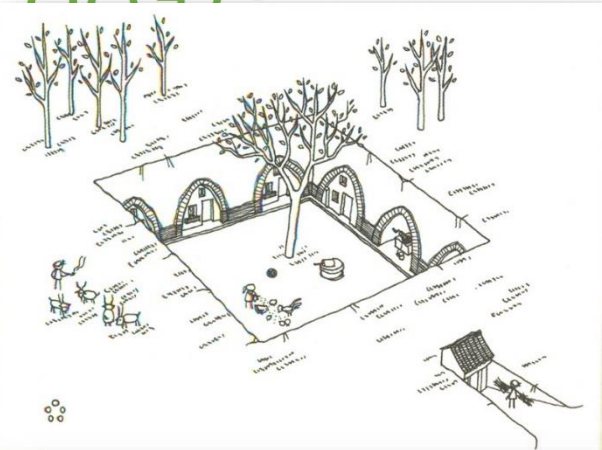
C area

地坑院窑洞 63.3公顷 430人

Underground cave 63.3 hm<sup>2</sup> 430p

一种是将其保留，作为蔬菜大棚、或者养殖基地；一种是将其充填、与周围地块形成台地模式，对于充填平整的复垦技术共包括土方开挖工程、土方回填工程、道路建设等阶段。

The reclamation for such cave has two methods, one is to remain, which is used for greenhouses or breeding base, the other is to be filled it as a vegetable greenhouses or breeding base; one is to be filled with soil making the cave form with Mesa pattern. The technology for second one is including earthwork excavation, earthwork backfilling, drainage works and so on.





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项目区废弃窑洞复垦受国土资源部公益性行业科研专项项目（编号201111015）支持，已在2014年12月完成复垦，本文就项目区的实施情况作出效应评价，客观评判项目实施所产生的生态、经济、社会和景观等方面的影响。

方法：层次分析法 模糊综合评判

**The reclamation in project area of abandoned cave has been supported by the Ministry of Land as nonprofit industry research and special projects, and completed in December on 2014. The paper made the evaluation on the effects of the implementation of the project area, making objective judgment for ecological, economic, social and other aspects of the landscape impact.**

**Methods :**

**AHP Multilevel Fuzzy Comprehensive Evaluation Model**



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Target layer	Criterion layer	Element layer
Reclamation of Abandoned Cave Effect Evaluation (A)	Ecological effect (B <sub>1</sub> )	Improve degree of soil and water loss(C <sub>11</sub> ) Change of soil bulk density(C <sub>12</sub> ) change of protection forestdensity(C <sub>13</sub> )
	Economic effect (B <sub>2</sub> )	the newly-increased cultivated land rate(C <sub>21</sub> ) Change of Farmers' Income(C <sub>22</sub> ) Change of the food yield output on unit area(C <sub>23</sub> ) Change of production scale(C <sub>24</sub> )
	Social effect (B <sub>3</sub> )	Change of public support(C <sub>31</sub> ) Change of density of road network(C <sub>32</sub> ) Increase support population(C <sub>33</sub> )
	Landscape effect (B <sub>4</sub> )	Decrease rate of landscape fragmentation(C <sub>41</sub> ) Decrease rate of patch shape index(C <sub>42</sub> )



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Target layer	Criterion layer	Element layer	Weight (A-C)	Weight (B <sub>i</sub> -C)
Reclamation of Abandoned Cave Effect Evaluation (A)	Ecological effect(B <sub>1</sub> )	Improve degree of soil and water loss(C <sub>11</sub> )	0.1878	0.6327
		Change of soil bulk density(C <sub>12</sub> )	0.0519	0.1749
		change of protection forest density(C <sub>13</sub> )	0.0571	0.1924
	Economic effect(B <sub>2</sub> )	the newly-increased cultivated land rate(C <sub>21</sub> )	0.0847	0.2247
		Change of Farmers' Income(C <sub>22</sub> )	0.1747	0.4636
		Change of the food yield output on unit area(C <sub>23</sub> )	0.0914	0.2424
		Change of production scale(C <sub>24</sub> )	0.0261	0.0693
	Social effect (B <sub>3</sub> )	Change of public support(C <sub>31</sub> )	0.0312	0.1359
		Change of density of road network(C <sub>32</sub> )	0.041	0.1790
		Increase support population (C <sub>33</sub> )	0.1569	0.6851
Landscape effect(B <sub>4</sub> )	Decrease rate of Landscape Fragmentation(C <sub>41</sub> )	0.0729	0.7500	
	Decrease rate of patch Shape Index(C <sub>42</sub> )	0.0243	0.2500	





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Element layer	Before reclamation					After reclamation				
	A	B+	B	B-	C	A	B+	B	B-	C
Improve degree of soil and water loss(C <sub>11</sub> )	0	0	0.29	0.29	0.43	0.43	0.57	0	0	0
Change of soil bulk density(C <sub>12</sub> )	0	0	0.14	0.43	0.43	0	0.86	0.14	0	0
change of protection forest density(C <sub>13</sub> )	0	0	0	0.43	0.57	0.57	0.29	0.14	0	0
the newly-increased cultivated land rate(C <sub>21</sub> )	0	0	0	0.57	0.43	0.57	0.29	0.14	0	0
Change of Farmers' Income(C <sub>22</sub> )	0	0	0.29	0.57	0.14	0	0.57	0.43	0	0
Change of the food yield output on unit area(C <sub>23</sub> )	0	0	0.29	0.43	0.29	0	0.43	0.57	0	0
Change of production scale(C <sub>24</sub> )	0	0	0.29	0.43	0.29	0	0.29	0.71	0	0
Change of public support(C <sub>31</sub> )	0	0	0.43	0.43	0.14	0.29	0.57	0.14	0	0
Change of density of road network(C <sub>32</sub> )	0	0	0.29	0.71	0	0.14	0.71	0.14	0	0
Increase support population (C <sub>33</sub> )	0	0	0.29	0.57	0.14	0	0.71	0.29	0	0
Decrease rate of Landscape Fragmentation(C <sub>41</sub> )	0	0	0.57	0	0.43	0	0.57	0.43	0	0
Decrease rate of patch Shape Index(C <sub>42</sub> )	0	0	0.29	0.43	0.29	0.14	0.43	0.43	0	0



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	Before	After
ecological effects	35.27	86.61
economic effects	39.58	74.20
social effects	43.88	76.29
landscape effects	42.20	72.10
Overall effects	39.54	78.16



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THE SILK ROAD (DUNHUANG) INTERNATIONAL CULTURAL EXPO

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