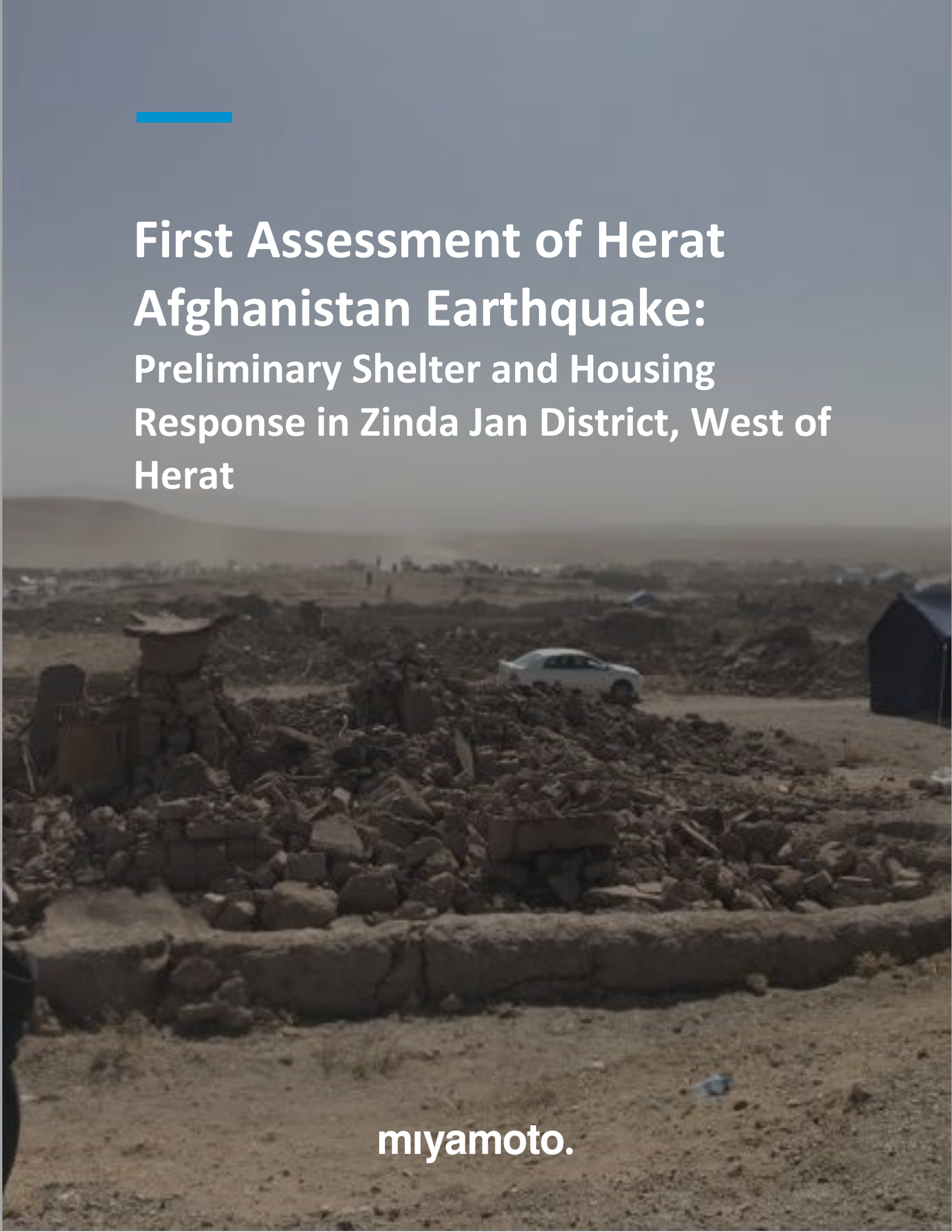
First Assessment of Herat Afghanistan Earthquake:

Preliminary Shelter and Housing Response in Zinda Jan District, West of Herat



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First Assessment of Heart Afghanistan Earthquake: Preliminary Shelter and Housing Response in Zinda Jan District, West of Herat

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Miyamoto International, Inc.

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CONTENTS

Earthquake Impact Metrics 1
Key Findings 2
Habitation 2
Quality of materials and work 2
Preliminary Recommendations 5
Village Site Visits 5
Cheshma Ghori 6
Sar Boland 7
Nayeb Rafi 8
Wardak Ha or Karnail 9
Sia Aab 10
Maliki Ha 11

FIGURES

Figure 1 Earthquake location. 1
Figure 2 No rock foundation and rock stem wall. 2
Figure 4 Domed roof construction process and thickness of failed domes. 4
Figure 5 Location of villages assessed. 6
Figure 6 Cheshma Ghori village. 7
Figure 7 Sar Boland village. 8
Figure 8 Nayeb Rafi village. 9
Figure 9 Wardak ha or Karnail village. 10
Figure 10 Sia Aab village. 11
Figure 11 Maliki Ha village. 12

On Oct 8th, 2023, Miyamoto's first assessment team was deployed to conduct a rapid assessment of the affected area. The earthquake affected 11 villages in the Zinda Jan district of Herat province. It is estimated that more than 100,000 people were exposed to high ground intensity. The epicenter was about 40 kilometers north-west of Herat city and brought significant causalities in these villages.

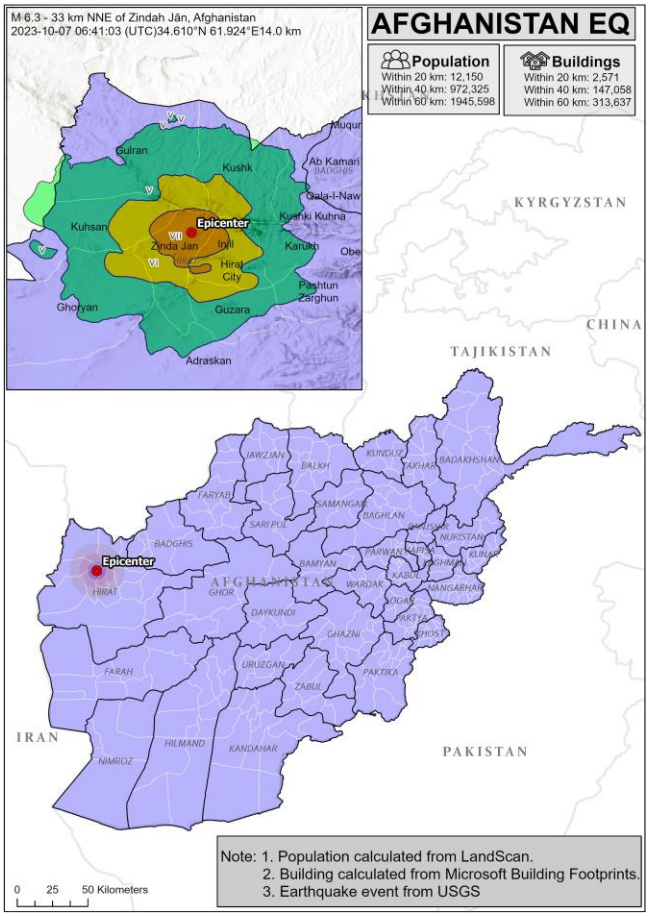

Figure 1 Earthquake location.

EARTHQUAKE IMPACT METRICS

The following statistics are per the Afghanistan National Disaster Management Authority (ANDMA). Figures of second earthquake are not included.

Fatalities	**2,445**
Injuries	**2,440**
Damaged houses (completely destroyed)	**1,983**

KEY FINDINGS

Habitation

- The demographics in this region are characterized by an average family size of six individuals with four families residing in each compound.
- Families are living inside of compound walls. Walls provide very important social structure such as privacy for women and girls.
- Many of the structures are built with raw earth.
- Almost all of the affected people in Zinda Jan and Enjil districts are herders and do not have skills of building quality and safe houses.
- Affect region is prone to heavy and cold sand storms which has compare to other r

Quality of materials and work

Foundation and stem walls

- It was observed during the assessment that both compound and house/room walls built with raw earth have no stone foundation and stone stem walls (see Figure 2). It was also heard during an interview with villagers that they cannot afford stones for foundation and stem/plinth walls. Some stone sources were located at an average distance of 7-10 km. The foundations and stem walls made of stone at the bottom of the raw earth walls are essential to prevent moisture from rising into the walls by capillarity. Excess moisture in raw earth walls reduces their mechanical capacity and increases vulnerability to earthquake damage.

Figure 2 No rock foundation and rock stem wall.

Walls

- It was observed that approximately 90% of the walls in these structures have been constructed with raw earth employed according to the *Pakhsa* (cob) construction process

and the remaining 10% with *Khama-khashta* (adobe) bricks. Notably, in a significant number of cases, mud plaster has been applied to these walls. In addition to this, the soil sources were observed in the villages. A suitable clay and mineral charge composition was confirmed for *Pakhsa* and *Khama-khashta* after field testing (Cigar and Wash).

- The following structural deficiencies were observed:
  - The local skills for construction of mud vernacular structures are limited; this was observed in the low quality of works with several failures. For instance, it seemed that the soil was not soaked for enough time in order to be sufficiently saturated with water. In addition, regarding the thickness of the walls, in some cases the lower part was smaller than the upper part. This can reduce stability during earthquakes (see Figure 3). However, it will be important to also highlight good practices, in order to develop key messages and training.
  - Heterogeneous brick dimensions were used. This bad practice causes difficulty during bricklaying, which results in irregular and unstable walls.
  - In some walls, cement blocks were adjacent to *Khama-khashta*. Raw earth is a material that constantly regulates its humidity content in relation to the environment, which guarantees its structural qualities and environmental comfort. Cement has a high degree of impermeability; putting cement in direct contact with raw earth causes problems of excess humidity (see Figure 3).

Figure 3 Wall thickness at the lower part of the wall is thinner than its upper section, and cement blocks are used together with adobe.

Roofs

- Approximately 95% of the houses in the affected area feature domed roofs constructed from traditional materials, such as adobe.
- The use of *Khama-Khashta* with soil mortar for dome roofing is common in this area.
- The use of large-sized mud bricks (30 x 30 x 20 cm) with soil mortar poses a challenge in terms of cohesion between them.
- The thickness of such roofs reached 40 cm in some cases. This may be designed for waterproofing and thermal comfort; however, this thick material is heavy and creates high seismic mass which induces higher seismic damage to walls.
- The villagers stated that the domed roof construction process starts from all four sides of the rooms simultaneously without any shoring under them, thus the failure of such roofs is very common even during the construction process (see Figure 4).
- In Sarbuland village, the villagers reported that 36 people were killed by failure of dome roofs, while few injuries were reported by failure of flat roofs.
- 5% of roofs are flat roofs constructed from steel I-beams with bricks serving as infill between the beams and stucco as cohesion materials. These structures did not sustain major damage in the earthquake and no fatalities occurred.

Figure 3 Domed roof construction process.

PRELIMINARY RECOMMENDATIONS

With the impending arrival of the harsh winter, it becomes increasingly imperative to ensure the provision of safe shelters for the affected population, not only before the winter sets in but also as a lasting solution beyond the winter months. In this regard, the following actionable recommendations are provided for both immediate and transitional responses:

1. **Immediate response:** It is of utmost importance to swiftly establish temporary warm "bunkers" to offer refuge for the affected residents. These bunkers were often found in southeast region during the war. They are built by digging 2 meters into the ground and build 1-meter-high clay walls. The roof is composed of flat clay roof supported by steel beams, and these temporary shelters will serve as a vital lifeline, providing a safe and warmer environment for people to weather the freezing winter. Such bunkers were built after the 2022 earthquake in the southeast region before winter. It's crucial to note that the winter is expected to make its presence felt by mid-November, underlining the urgency of this short-term intervention. The villagers reported that this area is prone to heavy winds that tents cannot withstand. This southeast vernacular technology can be rapidly adapted into local populations. This was extensively discussed with affected populations, and they agreed on the approach.

2. **Mid-term solution:** Based on field observation and interviews with villagers, the houses are not repairable due to the low quality of construction. Thus, we recommend:
    - Enhance the technical capacity of the local community.
    - *Paskha*/ cob or *Khama-Khashta*/adobe for walls and flat roofs made of steel I-beams with clay roof are safe earthquake construction strategies that can be adapted with further analysis. Steel I-beams can be reused from the temporary "bunker".
    - Since domed roofs are common, it is important to grow awareness on good building practices to cope with earthquake effects.
    - Soil capping for *Paskha* and *Khama-Khashta* walls is recommended to reduce the risk of wall erosion.
    - The villagers asked for compound walls around their shelters in order to ensure women's privacy.

VILLAGE SITE VISITS

The team visited six villages that were significantly affected by the earthquake. The information from site observations and interviews is stated below.

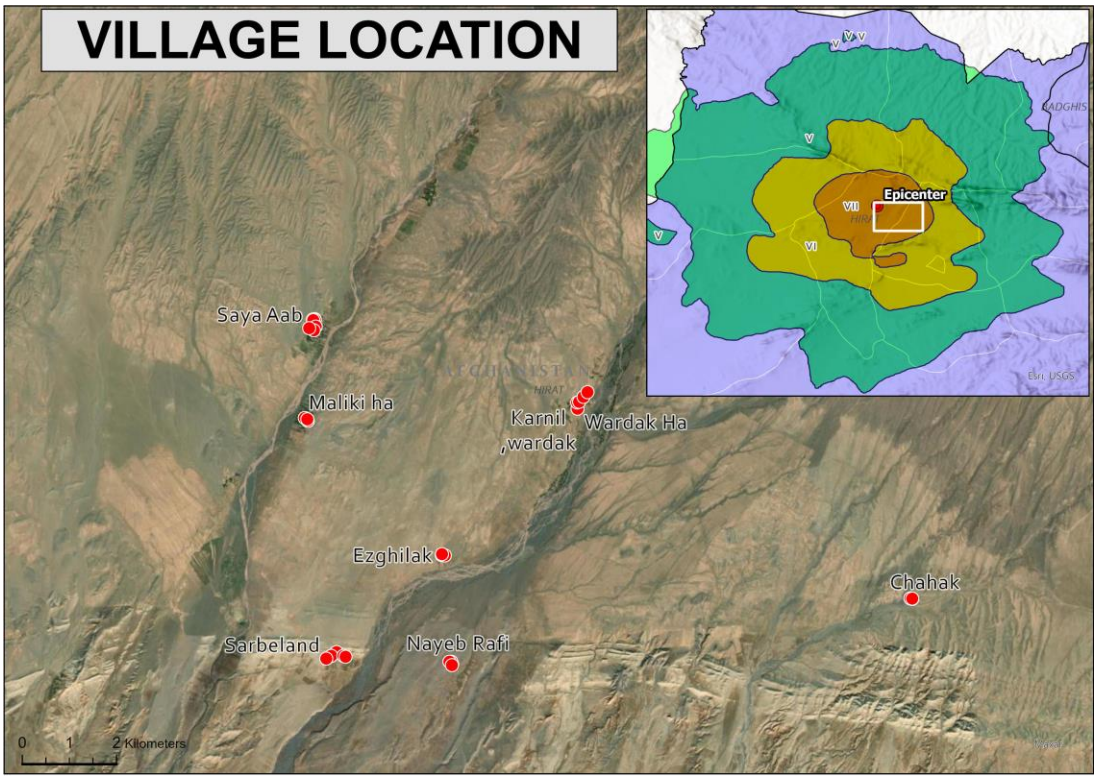

Figure 4 Location of villages assessed.

Cheshma Ghori

Most of the houses in this village are traditionally made of raw earth with dome slabs constructed from *Khama-khashta*. The houses are partially damaged with less than 10 injuries and no loss of lives reported. However, second shocks increased the level of damage.

According to an interview with a local villager, the total population of this village is 220 people.

Figure 5 Cheshma Ghori village.

Sar Boland

The houses in this village are also traditionally made of raw earth with dome roofs. It was observed during the assessments that 60% of the houses were fully damaged while the remaining experienced partial damage. The village was visited after the second earthquake occurred on the 11th of October; the damage percentage increased to 90% of houses. The remaining 10% were not totally collapsed, but they had severe damage.

The population of this village is 807 individuals.

The casualties reported by some sources are 50% of the total population, while some interviewees said that 37 people lost their lives.

Figure 6 Sar Boland village.

Nayeb Rafi

The typology of this village is similar to the two mentioned above. This village suffered extensive devastation. About 50% of its inhabitants lost their lives. The village is now in a state of complete collapse and disrepair.

The population of this village is between 1,000 to 2,000 individuals.

Figure 7 Nayeb Rafi village.

Wardak Ha or Karnail

The houses in this village have the same typology as the villages stated above. In some areas, houses utilize steel I-beams with brick between them for roofs. This village witnessed the loss of approximately 24 lives. Similar to Nayeb Rafi, Wardak Ha has also experienced complete structural collapse and damage.

This village is home to a population ranging from 1,000 to 1,500.

Figure 8 Wardak ha or Karnail village.

Sia Aab

This village saw around 40% (2,000 individuals) lose their lives. The village is now entirely in ruins due to the disaster's impact.

This village is larger compared to other villages visited, with a population of 5,000.

Figure 9 Sia Aab village.

Maliki Ha

Maliki Ha suffered the loss of around 150 lives. A tragic incident occurred in Maliki, where 15 children lost their lives as a wall collapsed while they were studying under its shade. The village was found totally collapsed when visited for second time after the earthquake occurred on the 11th of October.

This village has roughly 4,200 residents.

Figure 10 Maliki Ha village.

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