

Gully Erosion Rate Assessment at the Choqazanbil Temple Using GIS Methods

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Abstract: The Choqazanbil temple located at 60 km of south west of shush city in the south west of Iran. This temple with 3500 years archaism is one of the oldest historical titles in Iran. The temple position is close to the Sardarabad anticline with Neogene to Quaternary deposits. Many news about damaging of ancient buildings are reported most recently. This report shows that stream erosion can excavate the land of temple up to 2 m. The aim of this study is to determine the rate of erosion around the Choqazanbil temple using GIS methods. We select one of streams in the western templeside. Aerial Photos and satellite imagery from 1951 to 2014 was collected for use in GIS calculations. The results of this study shown that gully erosion rates take increased over time. The average rate is 18.2 m/y. In next years, this value of gully erosion can make irrecoverable damages to the Choqazanbil temple.

Keywords: Choqazanbil Temple, Gully Erosion, Shush City, Quaternary Deposits

Introduction

Iran with more the 12000 years of civilization, is one of the most ancient countries in the world (Abrahamian, 2008; Foltz, 2015). However, preservation and restoration of the remaining workson the history of this country have always been far from the authorities'eyes. Perhaps remnants of a civilization with a history of several thousand years, with costs and archaeologists carefully and with years of hard work brought the earthout, but over the decades, the atmospheric effects and disappears completely destroyed. Choqazanbil civilization (Foltz, 2015) is one of these cases that considered in this study. The most important dangers around Choqazanbil temple is Gully erosion. Gully erosion, the most impressive and striking erosion type, has been recognized as one of the major global environmental problems (Poesen *et al.*, 2003). Gully erosion is the removal of soil along drainage lines by surface water runoff (MPORG, 2009). Once started, gullies will continue to move by head ward erosion or by slumping of the side walls (Abdulfatai *et al.*, 2014). In recent years, gully erosion is going to destroy the body of temple and other ancient mansions.

Study Area

The temple, is located at 60 km of south of Shush city and the western coast of Dez river. This temple was

a most fortified city in its time and protected using 3 circular walls with more than 20 m height Fig. 1. The wall length in order from outside to inside is 1200, 450 and 130 m (Mahmoudi *et al.*, 2015; NAT, 2011). Temple area drains with several streams that its twigs are located near this ancient place. Gully erosion caused by atmospheric agents (Albert *et al.*, 2006), excavated the stream bed and made deepening and expansion drainages in the temple area Fig. 2.

Materials and Methods

Erosion is surface processes that sculpture the earth's landscape and constitutes one of the global environmental problems. Soil erosion is perhaps the most serious mechanism of land degradation in the tropics (El-Swaify *et al.*, 1982). However, gully is visually the most impressive of all types of erosion (El-Swaify, 1990). Gully erosion is a well-defined water worn channel (Monkhouse and Small, 1978). In this part of study, we want to calculate the gully erosion rate. Gully erosion started in the past. So we should have data for a wide range of time. Therefore, we select the GIS method to do the study. Aerial photographs from 1951 to 2014 are available Fig. 3. As a first step, this photograph should be geo referenced using Arc GIS. We used Quick Bird Satellite imagery to create reference points. Then, the trace of gullies should digitized. After digitizing each part of gullies, the gully length is accessible. This process should be performed on all Photographs.

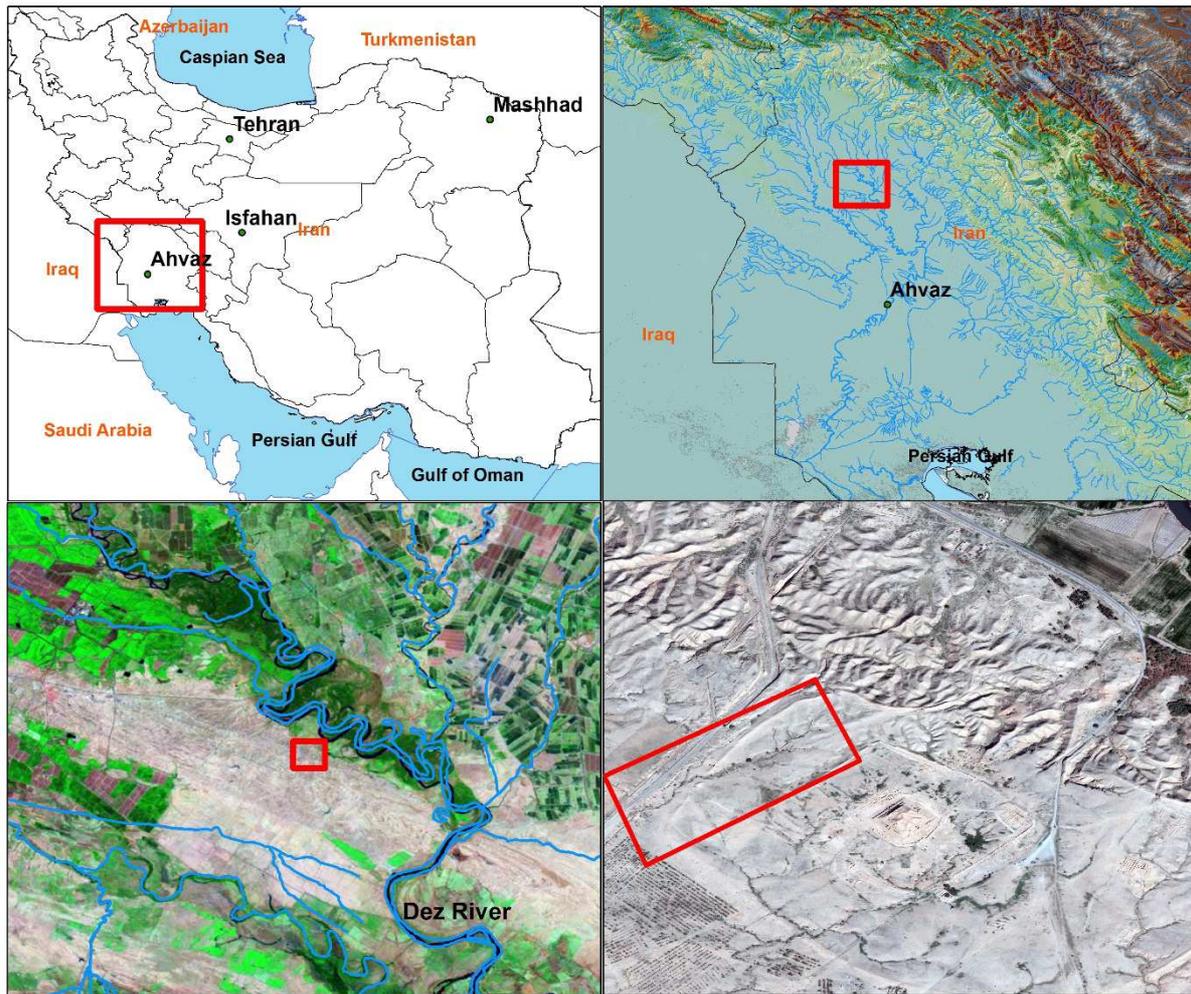


Fig. 1: Study area showed on a GIS map



Fig. 2: Sample of Gully erosion in the Choqazanbil temple area of selected stream

Determining Gully Erosion Rate

As it mentioned, we used Aerial photographs that are taken in 1951, 1966, 1993, 2006, 2011 and 2014. These images covered 63 years of erosion time. After digitizing the photographs, trend of gullies developments was

founded Fig. 4. The results of GIS measurements are in Table 1. Figure 5 was made for better understanding of Table 1 data's. Base on this data's, the gully erosion rate take increase by time. The minimum value is 5.5 m/y that is for 1951 and the maximum value (29) calculated for 2014. The average gully erosion rate is 18.2 m/y.

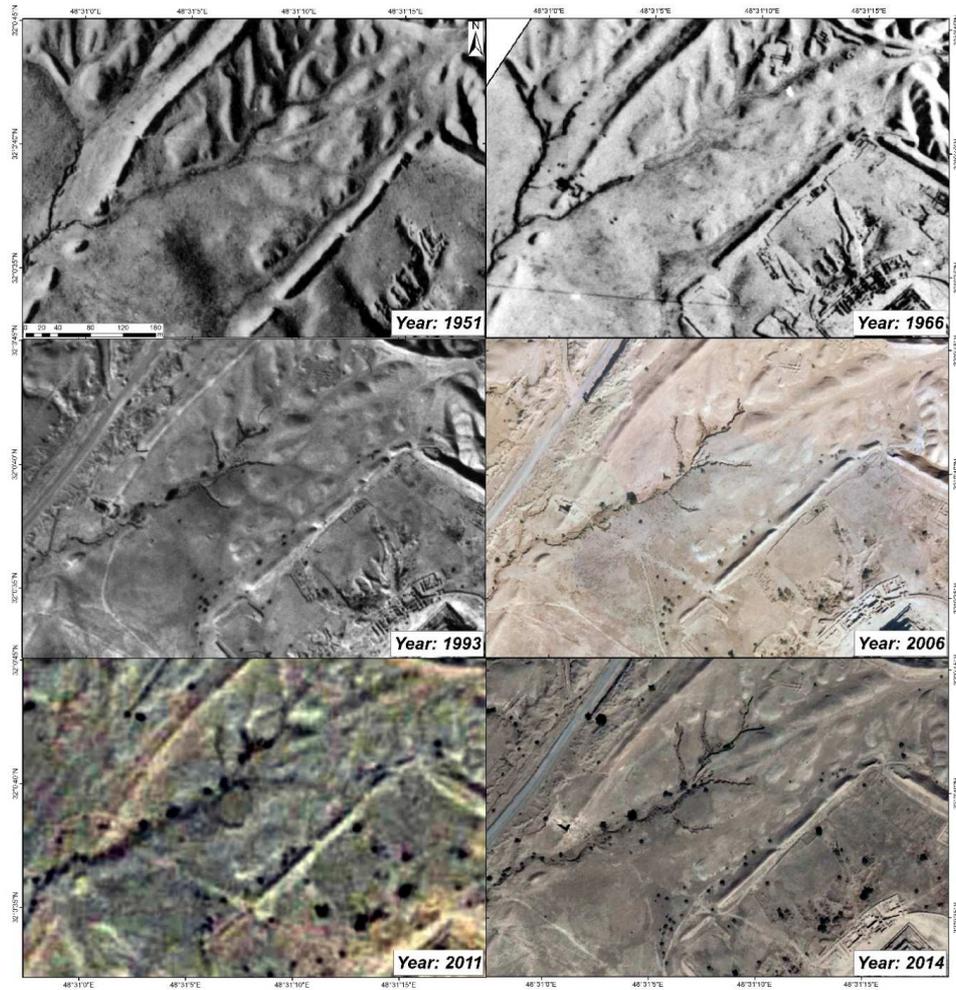


Fig. 3: Gully erosion shown in Aerial Photograph from 1951 to 2014



Fig. 4: The gully erosion trend shown by green tone colors from 1951 to 2014

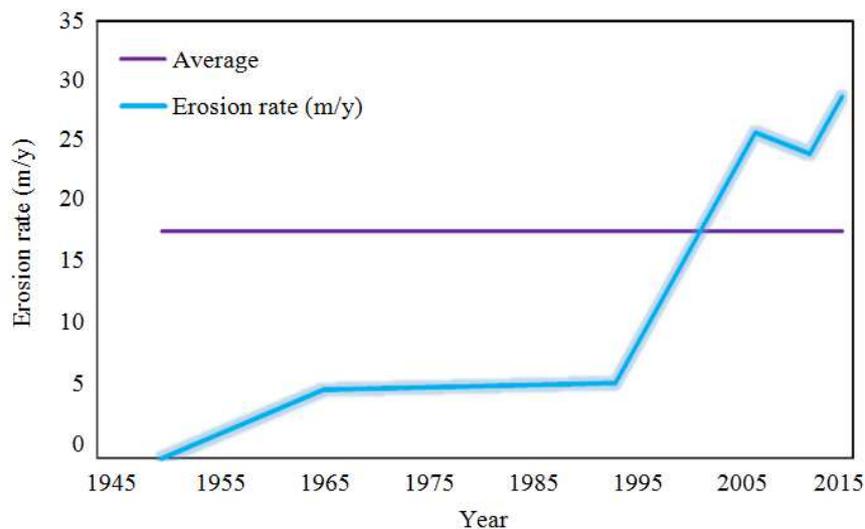


Fig. 5: Chart of erosion rate change

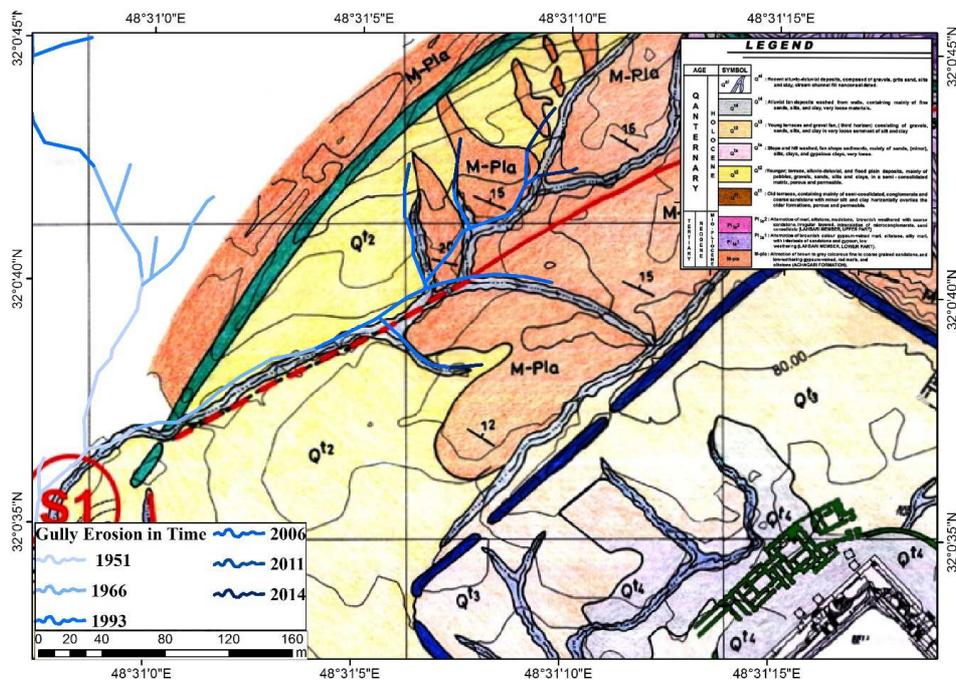


Fig. 6: Geological map of Choqazanbil temple (Jarahi, 2013)

Table 1: The value of erosion rate in choqazanbil temple

Erosion rate (m/y)	Average		Imaging date
	Period (year)	Erosion (m)	
0	0	33	1951
5.5	15	83	1966
6.1	27	165	1993
26	13	339	2006
24.4	5	122	2011
29	3	87	2014
18.2	63	829	Sum

Effective Parameters on Erosion Rate

The erosion rate from 1965 to 1993, is about 5.5 (for 28 years). But from 1993 to 2006 (for 13 years), this value has increased five times. Changing at the gully erosion rate caused by two main parameters; climate changing and geological units change. In the short period (about 3000 years), the climate can't change. To check the geological parameter, we used the geology map Fig. 6 of Choqazanbil temple (Jarahi, 2013; Perry and Setudehnia, 1967). As it is shown in Fig. 6, before 1993 the activation of gully erosion take location in Q¹² deposits with more than 200 m thickens. The constituent materials of this unit include moderate compacted gravel, sand and silt with low permeability. After 1993, the gully continues its erosion in M-Pla units. Deposits of this unit are alternately of marl and gypsum-bearing sandstone, with a poor degree of compaction. Therefore, change in geological unit can be the main effective parameters in association with increasing gully erosion rate.

Discussion and Conclusion

The hazard of gully erosion is threatening the Choqazanbil temple. This kind of erosion can excavate the earth up to 2 m. We used Aerial photography from 1951 to 2014 to calculate the rate of erosion. Based on results, the average rate is about 18.2 m/y. From 1993 to 2006, the rate value increased five times. According to geological studies, changing of units is the effective factor to change the gully erosion rate. It is expected in future years, this kind of erosion makes irretrievable damages to the Choqazanbil temple.

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Ethics

This article is original and contains unpublished materials. The corresponding author confirms that all of the other authors have read and approved the manuscript and there are no ethical issues involved.

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