A Non-destructive Excavation in Parse-Pasargad Archaeological Region

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Abstract
There has been growing concern regarding the proposed Sivand Dam. Its placement in the Parse-Pasargad region, between both the ruins of Persepolis and Pasargad, has worried many archeologists that the dam will flood these UNESCO World Heritage sites. Currently the construction of the dam is postponed until the international teams of archeologists announce that their excavations in the area are finished. The aim of this study is to increase the knowledge about this valuable archeological region, focusing on the two plains of Farvardin and Marghab, the seat of Achaemenian governors, where the Persepolis and Pasargad established (2) a wall and watchtowers surrounding Persepolis, (3) and a natural lake in the Pasargad site.

Keywords: achaemenid period, Parse-Pasargad archeological region, Persepolis, Pasargad, remote sensing, guard wall, natural lake, Iran.
Introduction
The Parse-Pasargad region has been home to many unique archeological features dating back to the third and fourth millennium. The well known discovered areas in this region include Persepolis, Naghsh-e-Rostam, the city of Parse, Pasargad, and the city of Istkhr. In addition to these sites, there are small groups of ruins in this area such as that of the village of Hossein abad. Due to possession of such valuable treasures of historical, cultural, and archeological attractions preserved within its natural setting, the area has been a subject of deep interest and working grounds for many scholars. At the same time, development of the villages close to these sites, construction roads and the proposed railroad, Sivand dam, buildings etc., together with archeological excavations, increasing number of tourists, tourist facilities, and lack of multi-discipline investigations, have led not only to severe environmental damages and landscape destruction but also threatened the life of tribes who for centuries migrated from the southern part of this region to the north, and the natural life of the area. To increase the knowledge about this region without any further damages, it is necessary to use new geophysical and spectral techniques to define the ancient landscape and architectural features of the region.

The objectives of this study are derived from the more recent and different debates about the area. The first is focused on the determination of the ruins around each of the valuable heritage sites of Persepolis and Pasargad, something which was only considered when the area threatened by the construction of the Sivand Dam, and still there is no any documentary account about the whole archeological sites in this region. The second is to find out whether physical boundaries (towers and wall bordering) surrounded the site of Persepolis. This has been questioned by Pope (1947), Koch (1996), and Aminzadeh and Samani (2006). The third objective is related to the location of the ancient lake of Pasargad which has not been adequately addressed (Pope, 1947; Stronach, 1963), and the only map that has shown the lake belongs to Pope. This study is an attempt to find out these three critical issues in the area by the application of photogeology, and remote sensing analysis.

Natural Features of Parse – Pasargad Region
The area of Parse–Pasargad has developed as an important part of the Great Achaemenian civilization. A mountainous area of the Zagros Range connects the two great plains of Marghab and Farvardin. The landform of this region results from Zagros folding range. The intermountain plains (such as Marghab and Farvardin) have resulted from the soft and fragile formations that have a high amount of humus and are extremely fertilized. The landform is a unique one with cliffs, steep slopes next to vast mountainsides, natural caves, and crack stones and rocks. These plains are situated in the limestone rocks. The Parse–Pasargad region is located in the watershed of Kor and Sivand Rivers. Rainfall occurs intermittently from early autumn through mid-spring. The precipitation regime of the region corresponds to that of the Mediterranean, the main part taking place in autumn and winter. Generally, the climatic nature of the region can be divided into two main categories:
- the plain climate with cold moderate weather, short to moderate growth season and moderate precipitation (Marghab and Farvardin plains)
- the mountainous climate with cold weather, short growth season and heavy precipitation (the south and southwestern parts of Marghab plain to the northern part of Farvardin plain).

One of the main hydro-geologic features of the Zagros region, especially the heights of Mehr Mountain in the Farvardin plain, and the high altitudes of the southern part of Marghab plain is the formation of springs and fresh water. These springs and caves have been an important factor in attracting human inhabitants to the area (Samani, 2002). The ancient river of Sivand entering Parse–Pasargad the
northeastern parts of Marghab, crossed the Marghab plain, passed the Bolaghy gorge and meandering the valleys north of Farvardin, flowed across this plain. The river is known as Polvar-Pasargad River before entering the mouth of Bolaghy gorge, and Sivand thereafter to the Farvardin plain. The satellite images taken from this region demonstrate the reviving Polvar-Sivand River. Along its meandering route, the river nurtures diverse floral and faunal ecosystems of the Zagros region. Various natural or artificial divisions irrigate the fields and gardens of the region. The underground water level is high in this region. This is another factor contributing to development of vast meadows with rich vegetation and human settlements with good conditions for agriculture from the ancient to the present time.

Methodology

This study required a multi-disciplinary approach covering and combining the three main study areas of information. The important discovery of previously historic literary material on the area, the information needed for providing natural layers such as hydrology, geology, geomorphology, pedology, and plantology, and the main focus of the method which is the application of air photos and remotely sensed data. The GIS software together with a suitable database enabled the management, integration and display of various types of data.

The advances in new sensor technology, computers, and image processing software resulted in the technology becoming widely accepted for different branches of earth surface investigation as well as archeology and landscape analysis. Remote sensing data and image analysis are used as major tools in investigating natural formations and man-made structures (Ben-Dor et al., 1999; Ustin et al., 1999; Elbaz, 1997; Flower, 1994; Ebert, 1984 and Kruckman, 1987). Wilkinson (2003) mentions to the basic imaging system useful for the landscape archeology, while studying the application of this technique in the Near and Middle East. In order to achieve the aim of this research, various integrated thematic datasets were used. This research postulates a combined processing of ETM+ remotely sensed data produces thematic images, significantly enhances the understanding of archeological resources, localities, and their historical-evolution by geo-environmental variations. The principal component analysis has been applied to define collapsed clayey matrix, allocthonous carbonate rock fragments and cultivated characteristics. As differences in soil texture are revealed by fractional temperature variations, it is possible to identify loose soil that once was a prehistoric agricultural field or now covers buried ruins. In many cases, the buried structures can be detected in infrared photographs and images, which better define landscape patterns and vitality of the vegetation. The archeological residues mainly consist of limestone fragments that were cemented by argilaceous silty-sandy material matrix. These components show localized physical and chemical differences compared to the surrounding soil cover. These phenomena, which appear to be partially caused by differences in particles and composition of dumped (collapsed/distributed) materials between these residues, and off-site soil, are used to local archeological features sites within the study area. In order to identify the exact locations of differing features, a global positing system (GPS) of Garmin+3 type was used. Providing new maps based on different information layers led to the possibility of reconstructing the environmental setting and delineating natural and man-made features of the studied area.

Case Studies

-Persepolis

Environmental setting: The landform of the area is a combination of high to medium mountains and plains. The mountains are of moderate height and exhibit uniform trending structures with bedded cliff-forming features resembling natural walls. They belong to the High Zagros with similar folded rock units. Rahmat
Mountain to the north consists of southward dipping limestone beds with karstic characteristics, including water seepages and springs, which supplied fresh water for human occupants and agriculture. The most important plain of the area the Farvardin is surrounded by Tashk Lake to the east and cliff forming ridges to the north (Krinsely, 1970). The fertile soil and relatively abundant water resources have resulted in an extensive and well developed agriculture system. The fertile soil, abundant surface water, and widespread meadows are major factors in attracting a variety of societal forms; urban, rural and tribal. The natural landscape, environmental conditions, and geomorphologic features were the major criteria for settling the Perspolis and the city of Parse by the Achaemenian Empire in this plain.

Architectural Features: Persepolis was built by Darius the Great, embellished by his son Xerxes and Grandson Artaxerxes and virtually destroyed by Alexander the Great. This complex was a ritual space, a sacred national shrine, and a potent setting for the spring festival, the Nou-rouz (Koch, 1996; Ghirshman, 1976; Godard, 1962 and Herzfeld, 1941). It comprised of a group of impressive palaces built in the city of the Achaemenian Empire (560-330 BC), the Parse. Persepolis is marked by a large 125,000 square meter terrace, partly artificial and partly cut out of mountain, with its east side leaning on Kuh-e Rahmet. The other three sides are formed by a retaining wall, which varies in height with the slope of the ground.

Historical Reference: Archeological studies of Persepolis began in the early 19th century with different groups supervised by Schmidt (1957), Pope (1947), Koch (1996), Herzfeld (1941) and Ghirshman (1976). There are considerable literatures on the architectural features of the Persepolis, but the question of the existence of towers and wall bordering of the site has not yet been adequately addressed. Based on discovered documents and clay boards, Koch suggests that the Sofa (Royal Palace), was in fact the treasury and archive storage place of the Achaemenians and therefore a wall would have been a prerequisite to guard it. This feature has been recorded in Babylonian boards documenting repairs made to the wall and watchtowers in 522-488 BC (Koch, 1996). Referring to principles of Achaemenian architecture as evidence, other archeologists such as Godard (1962) disagree, and believe that walls and towers could not have been constructed at Persepolis.

To date, no excavation has been made to prove or disprove the existence of watchtowers and wall around Persepolis. Although the remnants of a wall have been found on the northwest ridge and north of Persepolis, the available records and maps of the site are inadequate to define the full heritage site. The current proposed boundary definitions of the site by Sami (1972), masked the original extension of the Parse, and thus formed a misleading data base on which developments around Persepolis (e.g. tents, motels, parking, and farming) were planned and built very close to the site.

Pasargad

Environmental setting: Pasargad is situated in the Marghab plain with a landscape that is a combination of green cultivated fields, vast pasture lands, and sporadic villages, stretching along the Pasargad-Shiraz road, with some remnants of ancient buildings. This plain has an altitude of 1840m above sea level, rising to 1870m. In the northern and eastern sections it turns into low hills and plains, and is bounded to the south and southwest by the elevated areas of Bolaghy gorge. The Polvar river has a north-to-south flow direction within the Marghab plain, and gently meanders into Bolaghy gorge towards the south. Seivand is a part of the Polvar, and flows from Bolaghy gorge to the Farvardin plain and the ancient city of Estakhr. The presence of natural features and mountainous terrains in the west and southwest, and the hills in the north and east of the Marghab plain, have made it an enclosed space surrounded by natural partitions. Undoubtedly, this and the availability of favorable land, water resources, and suitable defensive features, were important reasons for the selection as the setting for the capital of the first Persian Empire, the Achaemenian kings.
**Architectural features:** Pasargad is situated some 130 km North-East of Shiraz, and 87 km northeast of Persepolis. It was the first capital of the Persian Empire. The construction of the capital city by Cyrus the Great, begun in 546 BC was left unfinished, for Cyrus died in battle in 530 BC. Pasargad remained the Persian capital until Darius began assembling another in Persepolis. The archaeological site covers 1.6 square kilometres, and includes a structure commonly believed to be the mausoleum of Cyrus, the fortress of Tall-e Takht sitting on top of a nearby hill, and the remains of two royal palaces and gardens. The most important monument in Pasargada is undoubtedly the tomb of Cyrus.

**Historical Reference:** Research and excavations of the Pasargada complex date back to the early 19th century. Stronach (1963) pointed to the works by Flandin, Coste, Stolze, Dieulafoy, Curzon, and Sykes and Jackson who had given attention to the Tomb of Cyrus the Great. Other scholars, namely Schmidt (1940), Herzfeld (1941) and later Sami (1959) have excavated the entire archeological area inside and outside the Tomb.

The current literature is mostly focused on archeology of the site. Thus the environmental and natural characteristics, site peculiarities of its historical landscape, and real boundaries have not well investigated. Nevertheless, there are a few studies that mention the presence of a local lake close to Pasargad, and excavations of the site show several waterways in and around this complex (Pope, 1947; Stronach, 1963 and Sami, 1972). Yet the only map that has shown the presence of a vast catchments dam belongs to Pope, who illustrates this, in the northern part of the complex extending to the outer fortifications of Pasargada. The review of the literature shows that the location of the large lakelet, as interpreted by Pope (1947), has holocene fan deposits consisting of conglomerate facies rocks. His interpretation is doubtful, as the location he mentioned has not indicated favorable hydrologic and hydrogeologic characteristics and associated lake sediments. No other scholars or archeologists made note of the presence of such a dam in the area.

**Results**

Based on photogeology and remote sensing image analysis, this region possesses special geomorphology with large farmlands, scattered villages and natural features. Extensive development of different geomorphologic features such as high escarpments and steep slopes close to lowlands, karstic caves, and structural deformations and dissected bedded units present a unique natural landscape. The interpretation of air photos and satellite images indicate scattered excavation, extensive construction, and land-use modifications in this area especially around the two important archeological poles of this region the Persepolis and Pasargad (Figure 1).

**Buried Archaeological Features in Parse-Pasargad Region**

Different material such as sand, cultivated soil, plants, ruins, and various rock types each have distinctive reflects of infrared spectrums on electromagnetic radiation emitted at different rates. Conventional RGB composite images of 147; 531; and 742 have been used for regional landscape, geomorphological and geological analysis to evaluate environmental setting of Parse–Pasargad region where most of the archeological sites are located. On the basis of this analysis, traces of previous human activities (agriculture or housing) are recognized. The Farvardin plain were the Parse city and Persepolis palaces are located indicates an intensive cultivation zone controlled by fertile soil cover and natural-artificial irrigation system. The high biomass content and cultivation activities have masked the historical residues due to intense EMR in different ETM+ bands. To deal with this problem ETM+ panchromatic band 8 has been processed to enhance limestone bedrock; mixed rock fragment and mud matrix in archeological residues in higher spatial resolution. Figures 2 and 6 shows the detected ancient ruins in the Farvardin and
Figure 1- Faro-Pasargad region. Processed image indicating geographical setting, geological environment, geomorphological features, drainage pattern and vegetation covers of Farvardin and Marghab plains. The numbers indicate the locations of Perspolis (1) and Pasargad (2).
Legend:
1: Persepolis
2: Rahmat Mountain

Figure 2: Farvardin plain and its surrounding areas. This image is a density-sliced version of Landsat ETM+, band 8. The magenta-green-yellow colors are assigned to archeological residues of collapsed constructions. The band-like magenta zone on the top is found to be debris flow, and scree, mixture of reworked limestone fragment, and clay-silty-sandy materials.
Marghab plains and their surrounding areas. The high density and scattered distribution of the buried features on this area show that the region, as a whole, is an archeological site.

**The Guard-wall and Watchtower in Persepolis**

Studies using black/white photographs and processed ETM images over the Persepolis suggested that there was a change in soil tone related to slight topographic rises, and collapsed construction materials over buried structures. This difference produces some weak linear patterns with little spots of chaotic texture. These spots could be related to the remnants of guard towers along the palace wall, where a portion of it is visible on the mountain slope, on the northern margin of the site. Original air photos and relevant processed image represent the remnants of linear feature expressing ancient guard-wall and highlighted spots resembling to the location of watchtowers surrounding the Persepolis. The image analysis findings in this study indicate features that help trace these elements around the site. These features have the following characteristics:

- Linear anomalous tone with circular spots indicating material (rock, mortar, clay, gravel) with different composition and texture to the natural context.
- Existence of a slightly higher relief, indicating a ruined structure and dumped materials.
- Existence of bare spot forms, dissection features different from the background landscape indicating differences in material composition, plant ground cover and abundance of rock fragments. There are 34 circular patches with different sizes (small and large), where 17 features are located on the east and northeast hilly parts, and the other 17 are scattered over the plain. It seems that the size and pattern of watchtowers had been designed and constructed according to their defense usage (Figures 3 & 4).

**The Pasargad Laklet**

The geomorphologic characters, deposited fine clayey sediments on flat plains of the area, and depth of groundwater level, vegetation cover, rate of vegetation growth, moisture content of the soil and its type all are having different reflectance and recorded electromagnetic emanations. These differences recorded in aerial photographs and satellite images are the most powerful tools for delineating and separation of geologic environments. The alluvial coverage of the area indicates a high energy and flooding streams which have deposited alluvial type fan deposits containing detrital large grain clastic sediments with low context moisture and poor vegetation coverage. Marghab plain is a floodplain characterized by dendritic pattern drainage stream that recharges the surface waters into Bolaghgy gorge which is the main run out system for Polvar River and Marghab plain (Figure 5). The major rock units belong to folded Zagros sedimentary sequence; mainly consist of limestone, dolomite, marly-clayey limestones, and shales. The major rock units according to their ages (form bottom to top) are Surmeh, Fahlyan, Gadvan, Daryan and Kazhdomi formations (James & Wind, 1965 and EP-NIOC, 1979). The geomorphologic features are being controlled by their lithological nature, which is composed of massive–thick bedded component carbonate units, and soft, incompetent shale, and marl sequences. The massive karstic limestone’s units are the major escarpment forming cliffs, having several caves, caverns, and holes with different dimensions. There were many karstic spring, in the past, but by tectono-eustatic uplifting, and decreasing of water precipitations they have disappeared. Geologically Pasargad is located on the open syncline where Kazhdomi formation is exposed. This rock unit composed of clayey limestones and shales which are impermeable beds forming a substratum unit for descending water. This character facilitates shallow depth water accumulation in overlying gravelly-sandy sediments to from shallow depth aquifers. The tributaries of Seivand and Polvar
Figure 3- Perspolis. Processed air photo applying Laplacian 5x5 convolution and classification for enhancement of earth surface covers (mixture of limestone fragment, calcareous and argillaceous matrix). Red and dark bluish green color assigned to collapse residual material. Location numbers (A, B, C, D, E ...) referred to remnants of ancient guard wall and watchtowers.
Legend:
Remnants of guard wall and watchtowers
Purposed of guard wall and watchtowers

Figure 4- The map depicting the place of guard wall and watchtowers surrounding the Persepolis.
Legend:
1: Marghab Plain  2: Pasargad  3: Polvar river  4: Bolaghy gorge

Figure 5- Processed satellite image of the Marghab plain shows the Locations of Pasargad and Bolaghy gorge.
rivers have trellis pattern. The Polvar river in Bolaghy
gorge follows a trellis pattern which is caused by weak
zones in bedrock that differ in their resistance to
erosion. The trellis pattern usually, indicates that the
region is underlain by alternate bands of resistant
features of same valleys are short narrow segments
walled by steep rock slopes or cliffs. These are called
“water gap” (Samani, 2002). The river in effect, flows
through a narrow notch is a ridge that lies across the
course of the river. This narrow notch, before
degradation had acted as a barrier or natural dam to
form a water reservoir (local lake) on the upstream
part (Marghab plain) where the Pasargada is located
(Figure 6). The boundaries of the lakelet have been
defined by geologic evidence, agronomic criteria, and
processed aerial images, reveal differences in the
texture of green vegetative cover in comparison to the
general texture of the surrounding plain. Considering
the existence of the lakelet in the western and southern
areas, and the position and orientation of the Tomb of
Cyrus the Great, it can be concluded that the original
entrance road was different from the present location.

Conclusion
With an interdisciplinary approach, this paper tries to
introduce a process of environmental analysis for the
archeological sites. The readers whether archeologists,
geologists, or environmentalists will find a common
ground which constituted the shaping of the historical
landscapes. Collecting different sources of
environmental data such as geology, geomorphology,
hydrology together with using remote sensing data and
black and white air photos, with limited spectral and
spatial resolutions, helps to understand the natural and
built landscapes of archeological sites. The advanced
high resolution (both spectral, and spatial), remote
sensing data (ASTER, IKONUS, IRS, etc.) and hyper
spectral surveying assimilates other types of
archeological data to process analyzing, and helps to
better understand the features, their patterns, textures,
size, association, and so on. The results of this study
using different age air-photos and ETM+ images are
indicative of the following features:
- The Parse-Pasargad area had been a unique
environment consisting of plain and mountain
landforms to form intrinsic farmlands and structure
for settlement of Achaemenian kingdom.
- The present Persepolis site is a small sector of a
vast area where the capital city (the Parse) and
satellite villages had been located.
- There are some remnant and residues of a guard-
wall and watchtowers surrounding impressive
palaces of Achaemenian Empire, the Persepolis.
- There was a local lakelet at the entrance of Bolaghy
gorge and the Polvar River, which played a major
role in irrigating the gardens of Pasargad. Shallow
groundwater tables and high humidity soils have
resulted in development of pastures surrounding the
lakelet, used for grazing horses and domestic
animals.
- The location and orientation of the Tomb has been
influenced by the lakelet landscape and access
roads.

In order to precisely define the location of the
irrigation system, housing patterns and the social life
as reflected in the setting of the various elements of
the Parse- Pasargad landscape further surface and
subsurface studies are recommended. These studies
may be carried out by analysis of land cover,
surveying the remnants of ruined materials, and
integration of information from different sources. For
detailed analysis and defining of the ancient lakelet in
Pasargad region, as well as the hidden features and
collapsed buildings, shallow geophysical surveying
methods are recommended.

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Legend:
1: Marghab plain  8: Cyrus Tomb  15: King rock road  22: Audience Hall
2: Bolaghy gorge  9: Outer fortification  16: Do Talloon  23: Entrance Hall
3: Pasargad  10: Charbagh Garden  17: Stone tower (Zendan)  24: Caravanserai
4: Seivand river  11: Bridge  18: Achaemenian crockery  25: Small Pavilion
5: villages  12: Takht-e Gohak  19: Sassanian inscription  26: Ancient graves
6: Old lake  13: Platform (Tale Takht)  20: Yazhi Cave (Ghar-e Yazdi)  27: Sacred area
7: Sassanian fire place  14: Tale khari  21: Private Palace  28: ruined place (Islamic period)

Figure 6- Pasargad, general plan of the palaces, tomb, archeological remnants and old lake on the Marghab plain based on the ETM+ process image of the site.
References


