

## SATELLITE DATA IN REGENERATION OF ANCIENT MONUMENT

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**Abstract-** For the time being the use of advances of technology is vital in solving of a wide problem. It becomes necessary due to the needs to the data with high accuracy and fruitful content. The demand of current circumstances makes necessary to apply reliable methods for data collection being able minimize any possible risks and uncertainties. There is no doubt that high technology application particularly remote sensing method with further geographic information system development makes attractive in appropriate data collection and processing as one of the best instrument for decision making stage of authorities. This paper has dedicated to the study of the ancient monument regeneration by use of space technology advances. It is conceptual approach of high technology application for design of ancient monuments. This study is important from the point of view of enhancement of cultural heritage as subject of transformation of cultural values, both tangible and intangible. The aim is to define how effectively to build up all lines of regeneration processes being able to achieve expectation in restoration of monuments. It depends of successful gathering required information starting from the site area up to the construction or regeneration phases. It is vital to select the method of data collection integrated in to local area natural behavior, creating circumstances for the correct decision-making in all stages of executions. This study demonstrates opportunities of remote sensing and geographical information system developments in regeneration of the ancient monument of Sabail fortress, Baku, Azerbaijan.

**Keywords:** Ancient Monument, Sabail Fortress, Architectural Design, Space Technology, Architectural Regeneration.

### I. INTRODUCTION

#### A. Sabail Fortress (Baku, Azerbaijan)

One of architectural monuments of the Middle Ages in the territory of Absheron, Azerbaijan which remains

within centuries have been hidden under water in the Baku bay is the called "Sabail lock". The name of the fortress in different historical source was designated as "Bailov Stones", "Shakhri Saba", "Nowshahr", "The Bailov lock", "The Underwater City". The reason is the lack of written sources with an exact indication of the name. Therefore, researches leaned generally from available national legends. Researchers B. Dorn [1] consider that the fortress has been constructed at Alexander of Macedon since his name is mentioned in legends.

The other researchers are believing that Sabail fortress related to the period of the Middle Ages at 12-13 centuries. In particular, the famous researcher of history of medieval Baku Sara Ashurbeyli specifies date of completion of construction - 1234/5 years [2].

The fact is that starting from X century the role of Baku considerably was increased. It has become sensible after transferring of the capital of Shirvanshah to Baku as a result of a Shamakhi earthquake taken place in 1192.

Baku as a new capital of Shirvanshah started to be significant city and increased a new large constructions and population. However, Baku has been poorly protected by natural strengthening and the system of protection consisted of a fortification of the city, strengthening on Bailov and strengthening Sabail fortress and also the line of alarm towers along the coast and on adjacent islands [3].

The Sabail fortress settled down out of Baku. Therefore, the first of all fortress was needed, rather reliable fencing which would be able to stay off attacks of small gangs and to maintain short time sieges. Besides, the Sabail fortress was located at an entrance to the Baku bay and had to protect access to the Baku fortress. However, it did not have sufficient fortification strengthening to sustain a long siege and the real storm. At the same, time there was no source internally of fresh water, which made necessary to maintain from the outside. Therefore, it was impossible to call it as Sabail fortress [4].

The fact that the Sabail fortress was seaport of Baku confirms also the stone plate found in his walls with an inscription of Bender-Baku that is in translation from Farsi

means "Port of Baku". The ships of merchants, diplomats and other guests of Shirvan were coming up to Baku, staying in the mooring to the walls of the Sabail fortress and became attached to their "ears".

### **B. Caspian Sea Behavior**

Scientists have revealed regularity that the coastal level of the Caspian Sea rises each 200-250 years and then the same of period of years falls to level is about 5-6 m lower.

For the last 2 thousand years low sea levels were observed in I-II, VI-VII, 11th and 16th centuries [5]. The next minimum of level is expected in this century. At the high level of the Caspian Sea his waters flooded the lower part of the city (at the beginning of the 14th century reached Juma mosque). At that time, the ships could stick nearly to the Baku city streets. It was enough to build only new moorings on city streets.

### **C. Description of the Studied Area**

For the time being using space science and technology advances is available to make out from remote distance of images of the monitored area of features as house or any facilities with high resolution of satellite data. The fact is that it has been discovered first time contours of the construction on the Caspian Sea from satellite in Baku bay. It has begun from the island of the Sabail lock and proceeds to the west. The structure of the island has a rectangular shape up to 75 m wide and with a visible length up to 300 m. It is limited from the North and South two rows of walls with a general width up to 5 m. The island is presented in the Figure 1.



Figure 1. The area of the Sabail fortress

As it is indicated the change of the costal line of Caspian Sea has demanded to relocate the seaport regularly. It has been assumed that three possible locations of the port - very high, low and medium sea levels. There is no doubt that it was also exist the intermediate sea level. Quite possible discovered construction was such intermediate port, which can be only assumed. So far, it can be only assumed and, most likely, guess. Today it is impossible to determine the century of the discovered construction since the level of the last 2 thousand years Caspian Sea level has changed four times. An available written information relevant to Baku history for the indicated periods is not enough, or almost is absent.

Today the island has become a visible due to the decrees of the sea level and looks out from the seawater.

There is an opportunity to start a new stage of study processes of both the Sabail fortress and all any possible underwater constructions of Baku. Up to date technology advances opens a wide challenge for deeply exploration of the selected area. It is obvious that conducting investigations in Baku bay close the area of Bayil up to the depth of 5-8 m can be discovered huge of historical knowledge with a vital value as well as a new approach of significance of facilities constructed during historical period of Baku. It could be excellent source and bases for starting new scientific research studies in the area as a fundamental contribution of historical processes.

In a southwest part of Baku bay was located the stone island extended from the South to the North, separated from the Bail cape by the passage 150-200 m wide. On the surface of the island defensive facility was constructed. It was reflected by a many authors of 17-18 centuries. However, it has described as an underwater construction since at that time facility was drowned into the see. In the XX century the history of the island has been shrouded in the legends related to the construction and drowning the island. In the 30th of the 20th century with the reason of decreasing of the level of the Caspian Sea, the island "has emerged". Due to the new circumstance in 1938 has been made an exact layout of the defensive monument and 35 stone plates are found with bas-reliefs. In the 1939, 1940 and further in 1962 the archeological excavations were carried out which have allowed to understand through this ancient monument the history of Azerbaijan.

Defensive ancient monument had a strongly extended layout with a length of 180 x 40 m, consisted of external walls, as well as internal constructions/facilities and a tower of the Donjon. From the outside of the monument the wall with towers has been covered by tape from stone plates with reflection of pictures and inscriptions. It has been found about 636 plates and identified that the inscription began from the east end of the southern gate. It was continued along all perimeter and came to the end at the western end of the southern gate.

When we are talking about Sabail fortress, it should be noted that scientists disagree in definition, arguing on the time period of its construction and definition. Many of them believe that it has been constructed in the period of the Middle Ages (in particular, at 12-13 centuries). A part of researchers is considered defensive fortress, some of them – customs fortress, other scientists evidenced as fire worshippers temple which has temple adapted into the Islamic traditions. It has been assumed the flood of the island in 1306 as a result of a strong earthquake.

Thus, most likely, in 12-14 centuries the ship, which was swimming up to Baku from the North was approaching to Bail fortress for a control by custom. After the permission by the appropriate staff of custom the ship could approach to the Baku city berth.

## **II. ARCHITECTURAL REGENERATION ASPECTS**

For preservation of a historical monument is necessary to study patterns of the design and existing sources of the literature written and stored by those times travelers of the fortress. It can be find out and discovered from the sources

approximate sizes and dimensions of fortress as pointed out 180×40 m. The fortress was surrounded by fortifications with 1.5-2 m thickness and had 15 towers, where 3 of them were big, and 12 were semicircular.

For use of the monument today with any purposes, it can be suggested to renew a complete type of a monument and create all conditions circumstances for familiarization of the Azerbaijani culture as well as pleasant pastime of local people, country guests and tourists.

An internal part of a monument i.e. an interior should be developed and designed in Eastern style. In the internal area of a monument is expected to build mini-hotel for those who would like and desire to enter into the Azerbaijani culture, place for relax and restaurant with local cuisine.

### **III. REMOTE SENSING AND GEOGRAPHICAL INFORMATION SYSTEM ENVIRONMENT**

Reconstruction such type of infrastructure demands to provide all necessary maintenances such as power supply, water supply, the sewerage and any other related for operation and functioning of facility of communication systems. Figure 2 shows location of the selected area on the map of the Sabail fortress.



Figure 2. The map of selected area

Figure 3 illustrates current condition of the Sabail fortress. Obviously, it is necessary to consider all tectonic and natural circumstances of the area if it is expected to regenerate of the fortress. The main factors can be reflected as below:

1. Costal line rising behavior
2. Seismic behavior of the area
3. Underwater flows
4. Urban communication network study
5. Fauna and flora of the area
6. Alternative power energy supply opportunities
7. Climatic of the area (typical seasonal temperature of the air and water, wind speed etc.)
8. Drink water supply (outsourcing supply or marine water processing)
9. Seabed topographical data
10. Any others



Figure 3. The counters of the Sabail fortress in Caspian Sea

#### **A. Caspian Sea Costal Line Rising Behavior**

As it has indicated above the raise of the Caspian Sea surface is the significantly affecting all the surrounded area. It is vital to estimate/control of damages of the sea surface processes of rising of Caspian Sea costal line based on permanent monitoring. There is no doubt that remotely sensed data achieved from satellite could be used for accurate information as an excellent source for state authority decision makers.

#### **B. Seismic Behavior of the Area**

The Caspian Sea, as well as neighboring onshore area belong to the strong seismic active zone in the Iran-Caucasus-Kopetdaksom region. The seascape of Caspian Sea is also seismically very active. Unfortunately, this natural disaster is not yet seascape sufficiently studied form the seismic point of view.

#### **C. Caspian Sea Underwater Flows**

Seawater circulation in the Caspian Sea is connected with a drain and winds. The northern water flows have the main impact since the most part of the drain takes place in the Northern part of Caspian Sea. The intensive Northern water flow takes out waters from the Northern Caspian Sea along the Western coast to Absheron peninsula where the flow is divided into two branches. One of them moves further along the West costal line, and another one flows to the Eastern part of Caspian Sea [6, 7].

#### **D. Fauna and Flora of the Area**

The fauna of Caspian Sea is presented by 1809 types and from which 415 are related to the vertebrata [4]. In Caspian Sea 101 type of fishes are fixed. A majority of world reserves of sturgeon. In the meantime, fishes such as pikeperch can be discovered in Caspian Sea. Caspian Sea - the habitat of such fishes as a carp, mullet, a sprat, bream, salmon, and perch. The marine mammal also lives in the Caspian Sea [8-10].

There are presented 728 types of flora of Caspian Sea and its coast. A prevail vegetation of Caspian See is the seaweed mainly blue-green, red, brown, choral and others as well as from floral are an eelgrass and rupee.

#### **E. Climatic of the Area**

Climate of the Caspian Sea continental in a northern part, moderate in a middle part and subtropical in the southern part. During the winter period average monthly air temperature changes from below 8-100C in a northern part to above 8-100C in the southern part, during the summer period from +24-25 in a northern part to +2 -27 in the southern part. The maximum temperature of +44 degrees is recorded on east coast Caspian Sea.

The average annual amount of precipitation makes 200 millimeters and from 90-100 millimeters in droughty east part up to 1700 millimeters at the southwest subtropical coast. An evaporation of water from the surface of the Caspian Sea is about 1000 millimeters a year, the most intensive evaporation near Absheron peninsula and in east part of the Southern Caspian Sea - up to 1400 millimeters a year [11].

Average annual speed of wind is 3-7 meters per second, in a wind rose norths prevail. In autumn and winter months winds amplify, the speed of winds quite often reaches 35 - 40 meters per second. The windiest territories of Absheron peninsula are vicinities of Makhachkala and Derbent cities and the highest wave 11 meters is recorded in the same place.

**IV. SEABED TOPOGRAPHICAL DATA**

A seabed relief of a northern part of the Caspian Sea is the shallow wavy plain with banks and accumulative islands, the average depth of the Northern Caspian Sea is about 4-8 meters with the maximum depth 25 meters. The Mangyshlaksy threshold separates the Northern Caspian Sea from the Average Caspian. The Central Caspian Sea rather deep-water, where the depth of the sea in the Derbent hollow reaches 788 meters. The Apsheron threshold divides the Central and Southern Caspian Sea. The Southern Caspian Sea is considered deep-water where sea depth in the Southern Caspian hollow reaches 1025 meters from the surface of the Caspian Sea [12, 13].

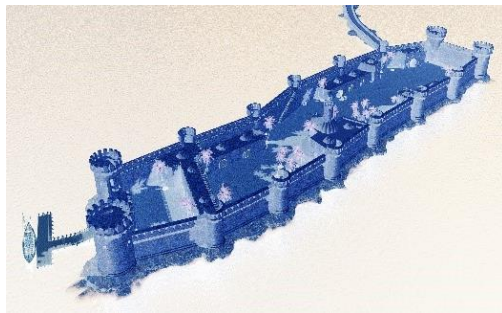


Figure 4. Sabail fortress regeneration

It is vital to consider all circumstance of above factors during regeneration of the Sabail Fortress. It is suggested example of regeneration of the ancient monument in the selected area (Figure 4). The next item of the paper is dedicated of method for successful restoration of the Sabail Fortress.

**V. SPACE TECHNOLOGY APPLICATION**

It becomes a vital to use high resolution satellite images ensure reliable and timely monitoring over ancient monuments located in areas affected by natural disaster, ecological damages, ongoing conflicts and etc. In the meantime, many of ancient monuments face increasing risk from urbanization, economic development and implications of unanticipated changes.

The fact is that satellite archive imagery provides a unique opportunity to compare and assess the damages these sites may have suffered over time being able to protect in time. It is of national importance

The systematic database development can be regenerated and protected by creating of the Management Plans based on using space technology advances. This Management Plan development can consist of appropriate measures in:

- conserving;
- preserving; and
- monitoring activities.

The state authorities who is responsible for the upkeep of ancient monuments can operationally use such developed systems. Figure 5 shows the space image of Sabail fortress area.



Figure 5. Space image of Sabail fortress area

It is necessary to point out how the process of space technology application can be used for regeneration of Sabail fortress (Figure 6).

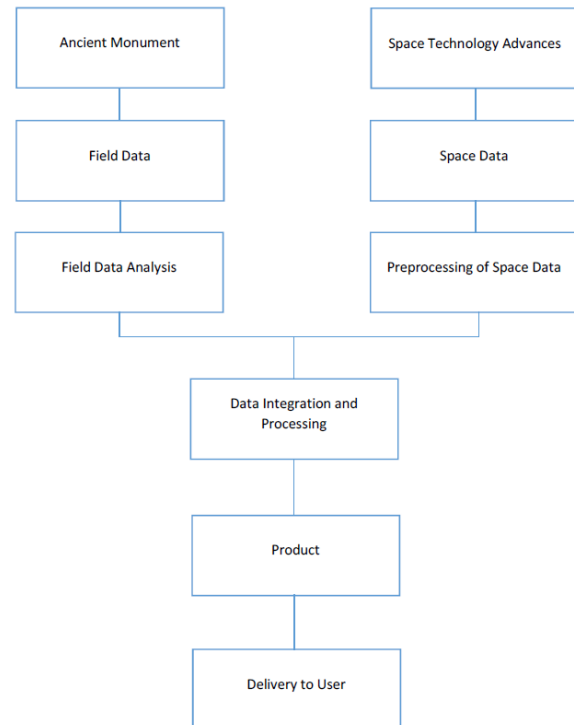


Figure 6. Space technology application in regeneration of ancient monuments

The first stage of regeneration required to be started from the identification and collection available of both filed data of the investigated area and satellite image(s). It has to be provided initially analyses of collected data with further integration and processing. The final stages are being to be producing final product for the users as the source for appropriate personals/engineers decision-making and execution.

**VI. CONCLUSION**

This paper is dedicated to the use of space technology for ancient monuments regeneration. It has been demonstrated conceptual approach of satellite data processing for successful integration of architectural infrastructure into the engineering facilities.

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**BIOGRAPHIES**



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**Rustam B. Rustamov** was born in Ali Bayramli, Azerbaijan, on May 25, 1955. He is an independent expert on Space Science and Technology. In the past, he was in charging of the Azerbaijan National Aerospace Agency activities as an Acting Director General. He has mainly

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