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Ancient monument-high technology advances application/safety and security

Abstract

Background: It is obligation to use efforts of restoration as well as create an environment on safety and security facilities for ancient monuments. In this paper has been studied of the ancient monument regeneration by use of space technology advances. It is demonstrated advantages of high technology application starting from design and construction stages of engineering during regeneration processes.

This study demonstrates opportunities of remote sensing and geographical information system developments in regeneration of the ancient monument of Sabail fortress.

In the meantime, there is no doubt that historic preservation, heritage preservation or heritage conservation is an endeavor that seeks to preserve, conserve and protect buildings, objects, landscapes, ancient monuments or other artifacts of historical significance. This term refers specifically to the regeneration of the ancient monuments with focus on preservation of the built environment.

In conformity with the foregoing approach development of the safety and security aspects of the ancient monuments are important for transferring heritage to the next generation. From this point of view in this paper some aspects of the ancient monuments security and safety problems have been undertaken and pointed out for discussion.

Keywords: ancient monument, sabail fortress, architectural design, space technology in architectural regeneration

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Nargiz A Muradova,[1] Mahfuza H Zeynalova,[2] Rustam B Rustamov[3]
[1]ENCOTEC LtD, Baku, Azerbaijan
[2]National Museum of History of Azerbaijan, Baku, Azerbaijan
[3]Institute of Physics National Academy of Sciences, Baku, Azerbaijan

Correspondence: Nargiz A Muradova, Architect, ENCOTEC LtD, Moscow Avenue 1025/30, AZ1078 Baku, Azerbaijan, Tel (+994 50) 777 14 04, Email nargiz_babayev@yahoo.com

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Introduction

The digital information and communications technologies (ICT) have produced a wide range of applications for collecting and processing historical data, documenting and monitoring the physical conservation of objects and monuments, visualizing historic structures and environments, and creating interactive information networks that can link professionals and scholars with students, museum-goers, and interested amateurs. The integration of heritage with digital technology has already shown the potential for greatly enhancing many aspects of the research, management, and public involvement in the material remains of the past. It opens an opportunity to use space technology in solving variety of problems relevant to collection required information and development of data base for the security and safety issues of the ancient monuments. There are number of examples of the use advance of space data for achievement of expectation for observation of any possible changes in heritages.

The fact is that interferometric synthetic aperture radar (InSAR) techniques and their derived products are currently increasingly uses in a wide areas of archaeology for the purpose of prospection, condition monitoring as well as ground stability assessment.[1,2] Land deformation, which is one of the vital tectonic processes affecting the land environment, needed to be considered and measured continuously for safety and security of the historical buildings and facilities.

Obviously, the studies demand long-term preservation of historical buildings and ancient remains exposed to urban and geo-hazards can be cost-effectively managed by using regularly-acquired InSAR imagery to update their condition reports based on the results of observation.

Sabail fortress

Within the heritage and historical disciplines, the past is no longer only the domain of specialised scholars, but is also seen as a resource for the economic development of local communities and regions, a medium for cultural identity and cross cultural communication, an edifying destination for cultural tourists, and a focus for educational enrichment. At the same time, However, it is important to understand that ICT is a complex field whose contribution to cultural heritage can only be realised if it is utilised in effective, sustainable ways. It cannot be considered an immediate or magical cure-all. Cultural heritage professionals must understand what ICT can do, and in which situations or contexts it is most effective. With the rapid development of digital applications for historical research and public heritage presentation, the integration of digital technologies into the field of cultural heritage must be undertaken with the full awareness of their potential uses and effects.

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 believe 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. I 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".

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.

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 began from the island of the Sabail lock and proceeds to the west. The structure of the island has a rectangular shape up to 75m 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 5m. The island is presented in the Figure 1.

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. Available written information relevant to Baku history for the indicated periods is not enough, or almost is absent.

Figure 1 The area of the Sabail fortress.

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 challenges 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 5-8m 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 150-200m 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 180x40 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 are 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.

Security and safety

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

The main reasons of destructions of historical and cultural monuments

The main reasons affecting to the cultural and historical heritage depends on the degree of the influence of various kind of natural, technogenic and anthropogenic factors capable to lead to degradation of the facilities for further threating of technical and technological safety.

The following is the natural factors:

- Earthquakes;
- Earth crust movements;
- Abrasion of the rivers, lakes, reservoirs, seas and oceans coastal line;
- Aeration (physical, chemical, biological);
- Wind and water erosion;
- Floods;
- Bio defeat of different types; and
- Landslides, exogenous processes.

Technogenic factors can be indicated:

1. Violations of the geological environment as a result of any construction activities during the new area development (for instance, oil and gas pipeline, hydro or any kind of power station construction etc.);
2. Impact of aggressive natural environment;
3. Pollution of the air basin by industrial emissions, transportation and municipal services;
4. Pollution of surface and underground water;
5. Physical violation of the land cover (plowing, meliorative works, etc.);
6. Chemical pollution of soil and land;
7. Land use degradation (owing to deforestation, construction works etc.);
8. Noise, vibration and other violations of natural physical parameters of the environment, including different types of transport; and
9. Visual violation of landscapes and independent building(s) construction.
10. As the anthropogenic factors promoting destruction of cultural heritage objects can be indicated as below:
11. Absence of the owner, user or other lawful owner;
12. Works on preservation of cultural heritage objects without existence of the coordinated project packages and permissions to work on preservation given by the appropriate state authorities of protection of cultural heritage objects;
13. Non-compliance with standards of fire safety;
14. Excess growth of attendance;
15. Excess constant presence or single visit of objects of cultural heritage;
16. Vandalism;
17. The vandalism shown in plunder or destruction of elements of monuments from non-ferrous metals; and
18. Commercialization of cultural heritage owing to development of the international tourism and increase in demand for various objects and phenomena of culture as a part of a cultural tourist's product.

General measures of suspension of processes of destruction

- This subject can be pointed out as below:
- Effective operation of the buildings and constructions which are cultural heritage objects according to requirements of design/ construction normative documents and security obligations and provisions of the project documentation for preservation of the cultural heritage object;
- Reduction pollution sources and vibration in a security zone of the cultural heritage object of (transportation, restriction of vehicle parkings, the ban of the vehicles movement near monuments, replacement of the industrial enterprises, improvement and renovation of industrial lands);
- Decrease in vulnerability of historical constructions by means of the best use, protection of structures against weather conditions, the elimination of the defects weakening the structure;
- The ban on use of unsuitable and harmful materials in restoration, preservation and repair;
- Physical protection (inforcement of the doors, video surveillanceobservation, control center development, etc.); and
- Continuous fire-prevention actions.

Remote sensing and geographical information system environment

For the 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 gests 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.

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.

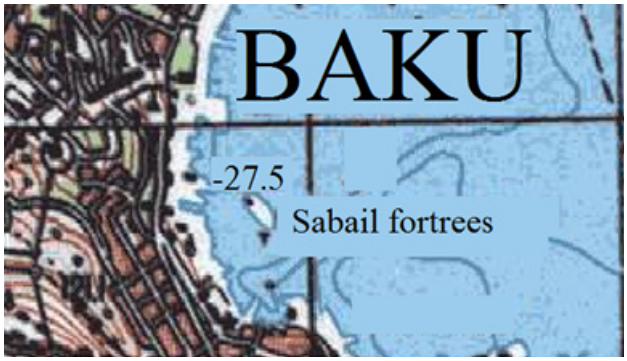

Figure 2 The map of selected area.

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

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.

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

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-Kopetdakksom 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.

Caspian sea underwater flows

Seawater circulation in the Caspian Sea is connected with a drain and winds. The northern water flows has 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]

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.

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 – 100°C in a northern part to above 8–100°C in the southern part, during the summer period from +24 - 25 in a northern part to +26 - 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]

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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.

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 Mangyshlaksky 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] 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.

Figure 4 Sabail fortress regeneration.

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 urbanisation, 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;
- 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.

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

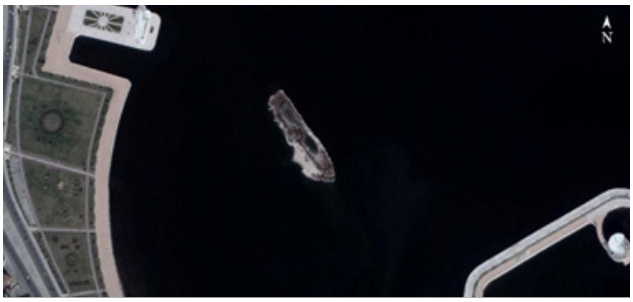

Figure 5 Space image of Sabail fortress area.

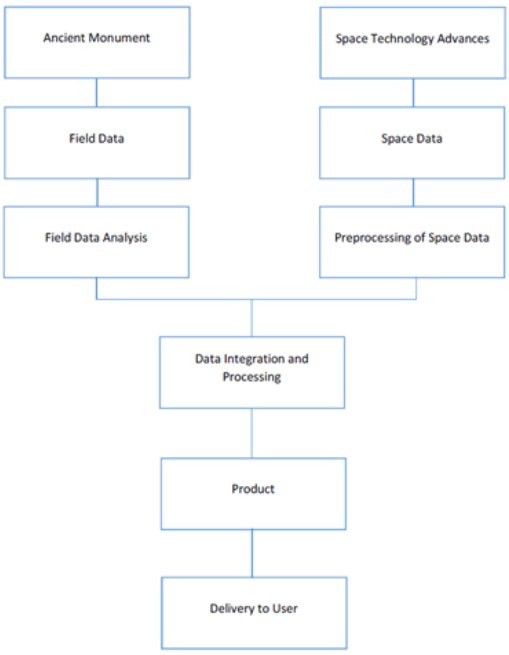

Figure 6 Space technology applications in regeneration of ancient monuments.

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.

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. In the meantime has presented general subjects safety and security options of the ancient historical monuments and cultural heritages.

Acknowledgments

None.

Conflicts of interest

The author declares there are no conflicts of interest.

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