Detecting Old Buried Channels and Structural at Ancient Samarra City by Using Remote Sensing Satellites Images

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ABSTRACT *Samarra represents a distinguished architectural stage in the Abbasid period and it was the second capital of the Abbasid Caliphate (Baghdad was the first). This ancient city, located on bank of Tigris River was the capital for 58 years (836-892) AD. Mysteriously the city was suddenly abandoned. Recently various threats take a part which is the expanding of modern city and other agriculture areas to the old city because of no clear boundary to it (UNESCO inscribed on the list of the world heritage in danger in 2007). Mainly 80% of the archaeological-city is still unexcavated. Using remote sensing methods that could differentiate between the ancient and modern settlements is our goal, be used in combination with ground survey to detect and mapping the past sites. Many Landsat and quick bird images used with image processing software (especially change detection and edges enhancement) to detect the old buried channels with other buildings. Many signs of invisible features at ground were found with compare to old archaeological maps showed the irrigation channels system and other sites . Real threats face the ancient city by recent human activity that need fast rules and laws to stop that sabotage to one of heritage places at the world.*

Introduction

Archaeology is the study of the physical remains of past human societies. Archaeologists look at both upstanding monuments (for examples, buildings that are clearly visible) and sub-surface remains (material found in the earth that has been gradually covered over as time progressed). The use of remote sensing technology offers the archeologist the opportunity to detect these impacts which are often invisible to the naked eye.. its can be used as a methodological procedure for detecting, inventorying, and prioritizing surface and shallow-depth archeological information in a rapid, accurate, and quantified manner (Smool,2007)

The 1920s and 1930s were a phase of early thoughts and theory building about the relationship between surface signatures and subsurface archaeological Remains (Bevan.2011) to Finding a historic site: different tools of archeology Remote Sensing can be used to trace the buried sites Such as Aerial Photography - Color Infrared Film (CIR):- Multispectral Scanner (Hadjimitsis,2013) . Landsat imagery played a very important role in the search Using a sensor known as the Thematic Mapper, produced images that can use to identify features like surface tracks (Omaninfo, 2005)

The physical theory of remains reflectance

The most important is the spectral signature of an object; its analysis permits to univocally identify different features and materials. If the spatial resolution of the sensor is high, (Trampier,2009) . The sensors in the satellites capture the spectrum of sunlight reflected by the surface of the earth . These spectrum give us information about the surface composition or past activities of mankind like pattern or distribution of houses, drainage pattern, road networks and other characteristics ,The sensors in the satellites capture the spectrum of sunlight reflected by the surface of the earth . These spectrum give us information about the surface composition or past activities of mankind like pattern or distribution of houses, drainage pattern, road networks and other characteristics (Hadjimitsis,2013) .

Remote sensing archaeology is to explore cultural relics from space borne images and ground survey Overlying soil on the relics is distinct from surrounding soils in color, texture, humidity, and compactness, especially, when the farming soil layer has been ploughed, These differences will affect the absorption and reflection of solar radiance and thermal radiation from objects, Remote sensing technology can perceive the spectral characteristics of objects on ground and from a short distance beneath the surface (1-2m) (Kelong, 2009) . Predictive model building: Rough data about buried archaeological site underneath the water or beneath the soil help to build models of the underlying

site or artifacts. This type of model building actually depends on the characteristic of the reflectance wave.

Buried features can be identified by a simple visual interpretation of image, analyzing the different color, tone and texture of the image. Some polygonal features and a paleo river ramification, structures are characterized by brighter grey tones in pca1 and by darker colors in pca2 (Trampier,2009) .

History of Samarra

At 2007, UNESCO named Samarra one of its World Heritage Sites , Samarra is 130 km north of Baghdad (fig1) and it was the second capital of the Abbasid Caliphate (Baghdad was the first). (Raouf- Sarti,2010) In year 836 the Abbasid caliphate's Turkic and Armenian slave soldiers -known as Mamluk- had some problems with citizens of Baghdad, so . The capital of the Caliphate was moved from Baghdad to the new city of Samarra later that year by Caliph Al-Mu'tasim , until 892 when it was returned to Baghdad by Al-Mu'tamid. Al-Mu'tasim's, Al-Wathiq, developed Samara into a commercial city, and it was further developed under Caliph Al-Mutawakkil , (UNESCO, 2013) ..

Samarra represents a distinguished architectural stage in the Abbasid period, new capital with high design level of architecture and many social places (Caliph Palace - main streets 60 -100 m wide - gardens - safari open zoo - many residential sectors - fountains - public bathrooms - mosque - stables - some defense castles - with complex system of fresh and irrigation water) most of these buildings destroyed completely except some of ruins still exist at the region . (Abd.,1984)

This ancient city, located on both the sides of the River Tigre was the capital for 58 years (836-892) with length about 41Km and width 4-8 Km (UNESCO.2007). Mysteriously the city was suddenly abandoned. Also when the course of the Tigris shifted, This quick abandon is the reason for which Samarra represents today one of the best preserved plan of an ancient large city, (Raouf-Sarti,2010)

There are many channels of water in all places because of the high level Samarra area above Tigris river the water of all human uses was carried to people by animals and the wells need very deep digging also very salty water. So the large solution to digging channels (open and underground) from Tigris up stream north of Samarra to main places at the city with many holes to take fresh water .all that channels formed complex features still exist to our day (Hamdy,1982) .

Detecting of old channels and structures

Naizek take water from north (Nahrwan channel) to south

Tigris River they used this old river to Irrigate the gardens and other artificial forest been inside the Heer area (Sosa.1948) , now days no walls still around can be detected on land The results from remote sensing may allow archaeologists to choose select areas of a site to open small excavations, rather than excavating an entire site (Sunderland,2012), The material which used in Samarra buildings are : 1 – Gypsum with coarse materials at buildings 2 – fire mud at walls 3 – coarse gravels 4 - fired brick, mud-brick 5- some cemented materials   (mud – gypsum) Because of these building materials climatic factors continuously affect the archaeological monuments recently, new anomalies in the climate (e.g. climate change) made that the winds are blowing stronger or that isolated stronger rains, previously nonexistent, makes that the archaeological monuments are being severely affected by dust storms covering great part of them and rain destroying the adobe constructions. (Raouf- Sarti,2010) (AL-Rawi,1982) . any detecting at that city become very important because of 80% of the archaeological-city is still unexcavated , all the city structures and channels built by material in general similar with the soil at area around, so the reflectance signature will by congruent , for that the best processing to detect the buried features is edge enhancement by making high level of contrasting .

The Sobel operator performs a 2-D spatial gradient measurement on an image and so emphasizes regions of high spatial frequency that correspond to edges. Typically it is used to find the approximate absolute gradient magnitude at each point in an input grayscale image. the operator calculates the gradient of the image intensity at each point, giving the direction of the largest possible increase from light to dark and the rate of change in that direction . the operator consists of a pair of 3×3 convolution kernels. (Fig2)

1-Five important historical sites chosen at Samarra city to be detect in this research , using old maps to define the possible places because most of that sites destroyed or covered by sediment and recent human activities , we used the records of Earthsat ETM+ date 16 April 2000 with resolution 15 m to get certain match between the maps and the images , then we did image processing by filters to get more information and most clear images about that covered historical sites The 4 circles : that circles have been used at Abbasid period as places of military parade or some times sports events . old aerial photo taken 1938 showed 4 similar circles centered together , by using satellite images and edge enhancement a new image showed ruins of that site circles No. 3 still recognize easily because no new village near it but circles 2 and 4 effect extremely by recent activities building – farming – irrigation channels ,,, etc , with totally absent of circle no.1 for same reason   .(Fig 3)

2- The Heer (open safari Zoo) : Large open area built by Caliph Al-Mu'tasim with high walls and about 30 Km around to prevent escaping of free animals (fawns – Zebras – Camels – Rabbits – Ostriches) but other wild animals in cages (Tigers – Lioness – Cheetahs) , total area of that safari about 20.000 acres , also the Caliph Al-Mu'tasim dig a river called visit except some places we can find 1-1.5 m. ruins of that origin walls , by using image processing for satellite record edges detect and enhancement a trace of walls can be notice clearly with the channel of Naizek river which is buried now . (Fig 4)

 3- Horses race circle : all the historical references said there was a circle of horses racing and some sports shows with a serves building (caliph and other VIP balcony and other public places - horses stables – veterinary doctors -– guards) , we can detect the race circle because of ellipse shape still exist but became agricultural areas now days , by using Sobel filter all the edges of the circle and other establishments appear with a very high sharpen edges (Fig5)

4- AL-Qadisya Barbican : one of outer defense lines castles , cadmic shape walls with some great gates and many inside establishments such as places of living for officers and soldiers – administrations – military stores also the references mentioned some channels of fresh water enter the castle and other go outside as channels of drain , at recent no one of that details can notice in ground , using sobel filter show the buildings and rivers with high level of clearness (fig 6)

5- The Heer palace : at the south wall of the Heer area there was a great palace called Heer palace and a large artificial Lake called al Buhtary with fountain as a rest place to the when he visit the lake with all the channel of Heer , that palace and lake get the fresh water from the Nizek river come from Nahrwan channel passing the Heer and place to Tigris river at the south . Sobel filter showed the boundary of the palace and Nizek river (fig 7) .

There are many other places at Samarra old city (palaces and residences for public and mosques or government offices) but many archaeological groups worked there for many decades so no new details can be find or some un recognize features can show . but at other areas about 80% of the archaeological city is still unexcavated

Results

Remote Sensing techniques and satellite recordings have a great powerful evidence to show many of covered buildings and unrecognized structures at field work , because of most of building materials of Samarra city much similar to the around sediment particles so no strong reflectance variation can notice by naked eyes at ground but at satellite recording with other wave lengths and image processing many details appear in the city.

Many historical sites at Samarra city now days was damaged or totally disappeared because of ignorance and credulity of the farmers live near that sites (new farms - using the old bricks in building their homes - digging random water channels - looting) , so as a World Heritage Sites all this clutter must be stop to save the all Samarra area .

A new satellite imaging and processing must done to detect un recognized features must once again specially at the sites mention above to give great help to any future field work .
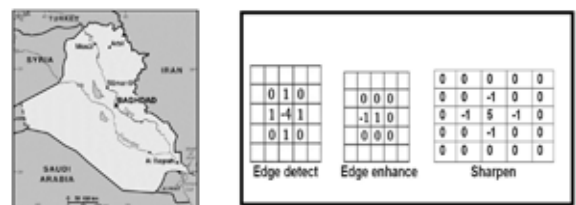

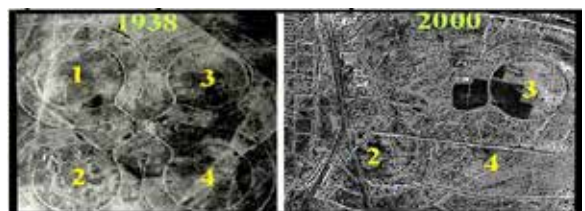**Fig (1) Location map of samara**
Fig (2) Kernels of filters

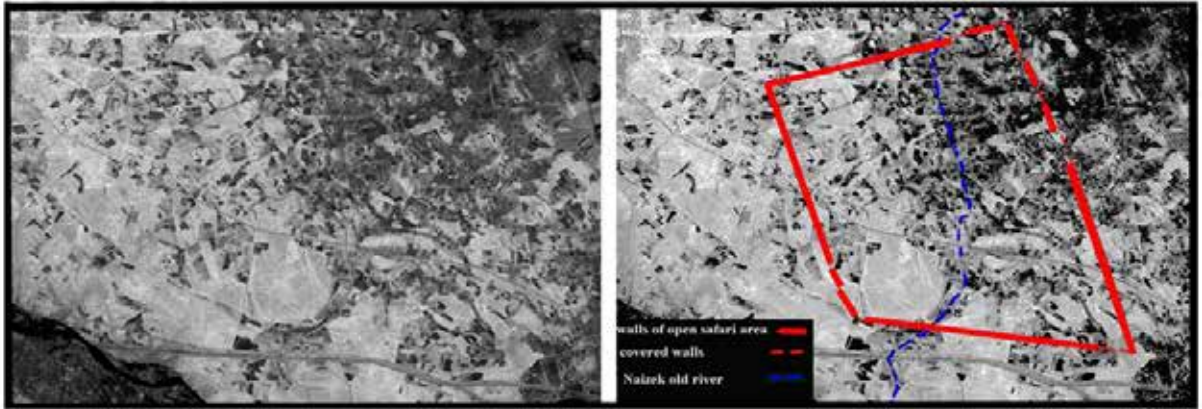**Fig (3) The four circles 1938 - 2000**

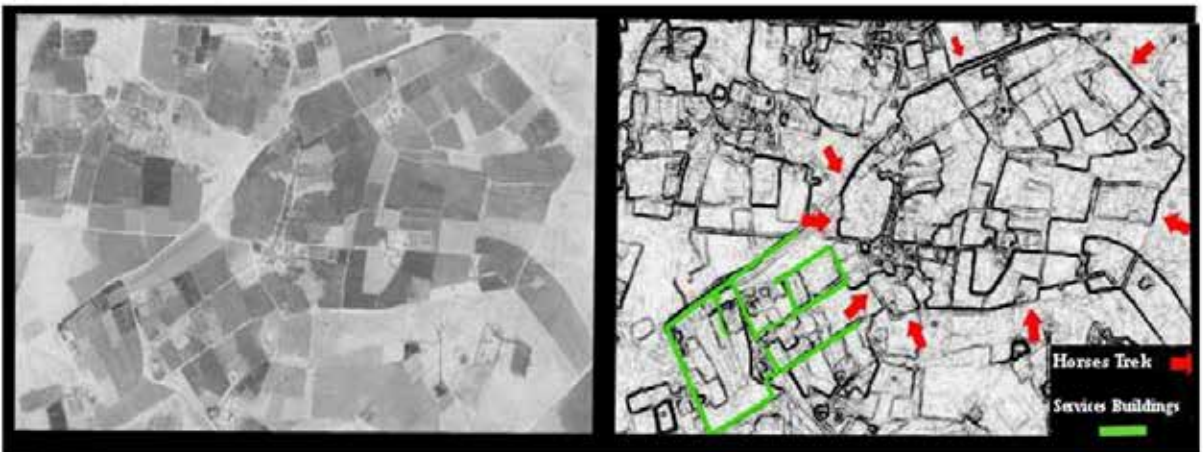Fig (4) The Heer (open safari Zoo)
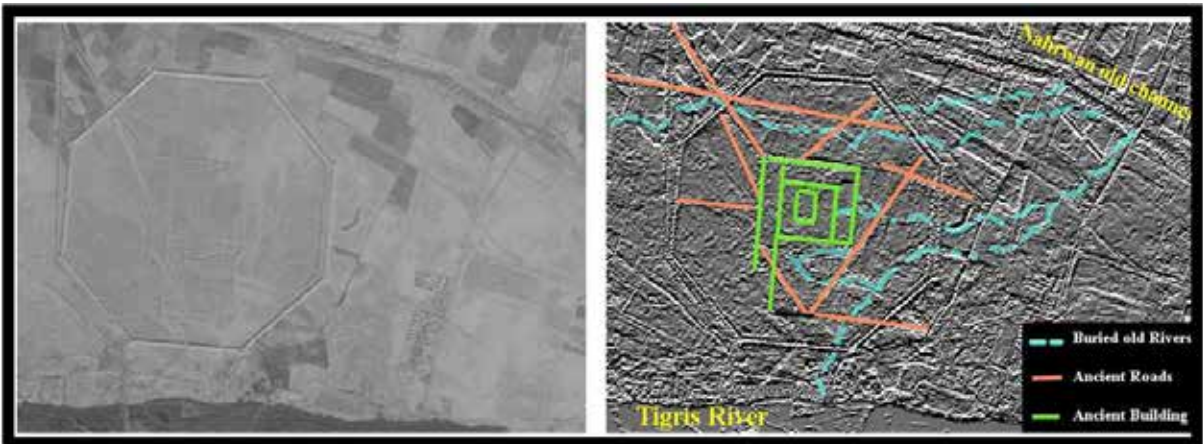

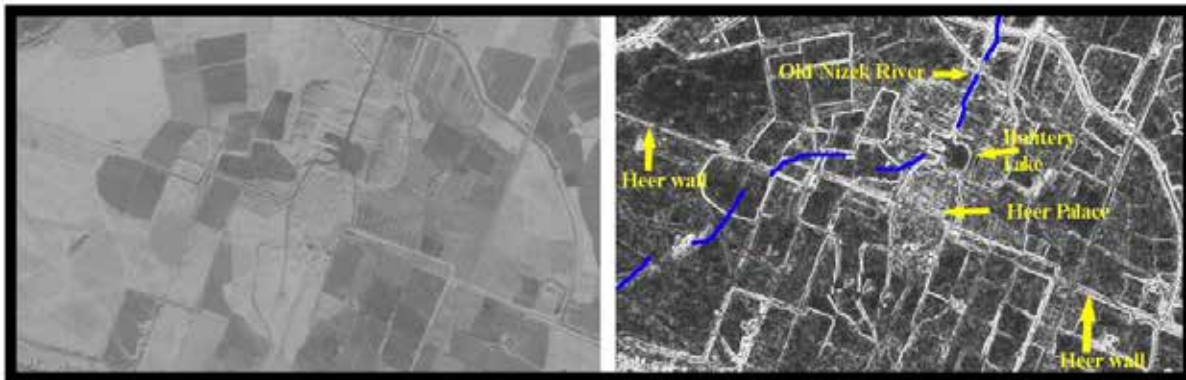Fig (5) Horses race circle

Fig (6) AL-Qadisya Barbican

Fig (7) The Heer palace

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