

THE EUPHRATES CHANNEL CHANGES AND ARCHAEOLOGY ALONG JEBEL BISHRI IN SYRIA

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ABSTRACT:

Remote-sensing, archaeological field survey and GIS are combined by the Finnish Project SYGIS in the studies of the Euphrates valley confined by the mountain of Jebel Bishri in Central Syria. Changes in the course of the river channel have caused transformations in the occupational past and landscape. The alluvial terraces offer evidence of the earliest human impact from the Lower Palaeolithic period. Several tells, ancient mounds of towns or villages, have been identified, surveyed and mapped in the region. Our aim is to study short-term variations of the river channel with satellite images in order to trace some scales and tempo of the channel changes that may also have affected the past occupation. Our aim is to find out, how the acquired information can be combined for the purpose of interpreting the archaeological evidence of the past occupation, even the landscape of historical events in the area. Satellite images used in this study consists of declassified CORONA satellite photographs from 1966, Landsat MSS (1983), Landsat TM (1990) and ETM (1999 and 2001) images. SPOT images covering the research area are used for mapping tells and for evidence of the present situation of the river valley. The interpretation of the water areas is based on the cluster analysis and visual interpretation. The topographic variations of the river channel are visualized using colour coding of DEMs and plots of the cross sections of the river channel. An Aster image from USGS has been used to produce DEM in order to study the cross-section of the river valley.

1. INTRODUCTION

Alluvial systems are special in their preservation mechanisms. Data concerning the changes in these systems is important for archaeology. (Brown 1997, 2-3) Floodplains preserve information about climatic conditions and types of cultures of different time periods. The Euphrates (Fig. 1) is clearly the current of time and civilization as the earliest Sumerian civilization was born on its banks over 5000 years ago. Archaeological remote sensing has used alluvial environments for prospecting information about landscape changes and tracing ancient remains left by humans. This approach is closely attached to the view that cultural activity in alluvial systems is largely defined by its potentials and constrains. (Challis and Howard 2006) However, one needs to refrain from environmental determinism, when humans also alter environments.

The relationship of humans with environment is reciprocal, i.e., open to reverse directions. Holocene evidence from fluvial deposits is increasingly used for studying the roles of climate change and the role of humans as agents in geomorphological activity (Tipping 2000). Several studies of Holocene avulsions and their effects on the evolution of civilizations have previously been carried out in Lower Mesopotamia, the area now on the Iraqi side (e.g. Adams 1965, 1982, Morozova 2005).

Apart from the Tabqa dam archaeological salvation project (Moore et al. 2000) and the archaeological survey between Deir ez-Zor and Mari (see, e.g., Lafont 2000), many studies of the ancient landscape and cultural change in Syria have not earlier touched the mountain line of Jebel Bishri that follows the Middle Euphrates in Central Syria. Since 1999/2000 remote-

sensing, archaeology and GIS have been used in the studies carried out by the Finnish project SYGIS (= the Syrian GIS) for the archaeological surveying and mapping of Jebel Bishri (see the project, the remote-sensed data and surveying in Lönnqvist and Törmä 2003, 2004, Lönnqvist et al. 2006).

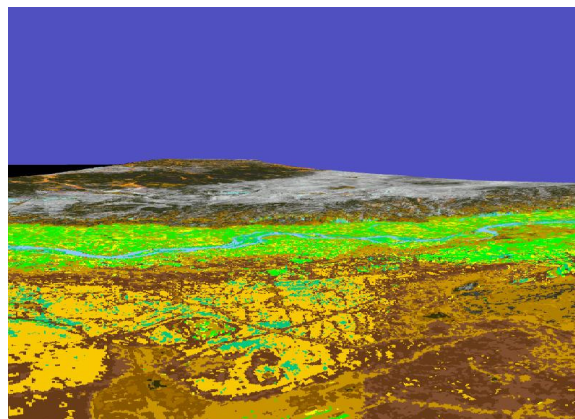


Fig. 1. A landscape model of the Euphrates valley seen from the North from the Jezira towards Jebel Bishri. The model is constructed by fusing SRTM shuttle mission DEM tiles (courtesy DLR) with land cover classification based on Landsat-7 ETM (data courtesy Eurimage). Construction by Markus Törmä 2003. © SYGIS - the Jebel Bishri project

The aim of this paper is to study the Euphrates river channel following the mountain of Jebel Bishri, the morphology of the channel, flow of water and river channel changes affecting cultural sites and periods on the right bank even the effects of

the landscape change to historical events. These studies are based on remote sensed data and recent archaeological field surveys along the Euphrates side of Jebel Bishri in 2003-2006. As C. Vita-Finzi (1978) emphasized already in the 1970s, the natural setting of an archaeological site is crucially important for understanding a site and its preservation. The ancient sites along the Middle Euphrates should be understood in their environmental context also for their preservation and protection.

2. THE EUPHRATES AS A PHYSICAL CONTEXT

The Middle Euphrates *graben* forms a boundary intersected in the continuation of the Arabian platform at Jebel Bishri. The graben offers geomorphological evidence that dates the sedimentations to the Mesozoic and mainly Cenozoic geological periods. The Bishri area was strongly influenced by the Late Cretaceous Euphrates fault system. (Brew et al. 2002). Jebel Bishri consists of gypsum, limestone, sandstone, marble and basalt; the peninsulas of Halabiya and Ayyash are basaltic and form outcrops of Jebel Bishri at the edge of the Euphrates.

By using an Aster image the Finnish project has produced DEM in order to study the cross-section of the river valley (Fig. 2.). The chosen bank location for the section is at the village of Kharita ca. 22 km west from Deir ez-Zor. The diagram demonstrates the width of the river valley with fluvial terraces and the heights of Jebel Bishri on the banks seen from the NW.

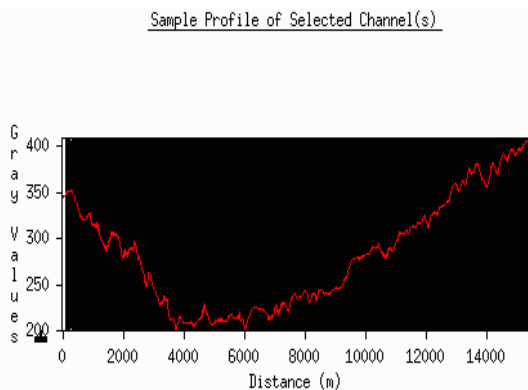


Fig. 2. A diagram profile of the Euphrates graben. Constructed by Markus Törmä and Jaakko Latikka from an Aster image. © SYGIS - the Jebel Bishri project

The Euphrates that starts in Turkey is the most important river in Syria, where it stretches ca. 675 km in length. In average the alluvial plain is 8 km in width (Besançon and Sanlaville 1981), generally ranging from 2 to 12 km (SIAS 1996, 149). The sources of the river are in the Taurus mountains which generally vary 4000-3000 m a.s.l. in height culminating at Mount Ararat that spires 5156 m a.s.l. The annual precipitation in the region ranges from 600-1000 mm (see e.g. Mutin 2003, 1). In Syria the river flows through steppe and desert type environments, where evaporation is high.

The construction of the Tabqa dam in Syria began in 1963 across the Middle Euphrates ca. 50 km west from the city of Raqqa, and it was completed in 1973 forming a large reservoir known as Lake Assad. Before the completion of the Tabqa dam the water flow of the river had been ca. 840 m³/s on average the highest months being April and May, but when the snows were

melting in Anatolia the water flow could have reached ca. 5000 m³/s after which it diminished becoming lowest in autumn (Wirth 1971, 109-110). The dams in Turkey and Syria have increased the water flow in Meskéne in Syria is 998 m³/s on average, and during humid years reaching up to 7000 m³/s (SIAS 1996, 147).

In 1963 the Directorate General of Antiquities and Museums in Syria together with the patronage of UNESCO, launched a salvage program in the Middle Euphrates for archaeological sites including surveys and excavations before the dam building was completed (Moore et al. 2000, 19). Several sites were rescued excavated before they were submerged under the huge water reservoir.

The river valley is affected by degradation, and irrigation using pumping that has caused ca. 17.6 % of the valley to become salinized and over 50% is under salinization process causing thousands of hectares of arable land to become out of use. (ACSAD 2003). Over the later half of the past century the irrigation technology has in many ways spread from the river valleys to the steppe and has changed the landscape of northeastern Syria in many ways (Hole and Zaitchik 2006).

According to environmental theory, irrigation has caused salination through human mismanagement of the environment and has been interpreted as a cause of, e.g., the decline of the Sumerian civilization (See, e.g., Adams 1974, 1988).

3. RIVER TERRACES AND EARLY HUMANS

Floodplains such as the terraces of the Euphrates were typically used by early humans, especially by the Lower Palaeolithic hunter-gatherers (cf. Evans 1978, 90). The past river channel changes are visible in the landscape and affect floodplain sedimentation process. Terrace formations belong to the evolution of floodplain. The stream changes from aggradation to degradation causing incision into the old floodplain forming a fluvial terrace. Generally terraces can be formed by climatic changes, changes in available sediments, changes in hydrological catchment, tectonic activity and base-level transformations. (Brown 1997, 17-)

There are several fluvial terraces in the Euphrates valley. Basically they are divided into three categories: The upper ones are called *plateaus* and may date from the Pleistocene, and then there are usually two lower ones beside the immediate river channel. Some of the terraces in the Middle Euphrates area are connected with the piedmont of Jebel Bishri. J. Besançon and P. Sanlaville (1981) have previously carried out geomorphological studies and associated prehistoric surveys concentrating on Palaeolithic finds on the fluvial terraces between Raqqa and Deir ez-Zor. The mentioned tools found between Sabkha and Ain Abu Jima appeared to be of the Achaean type and date to the Lower Palaeolithic. A British team including R. Westaway, D. Bridgman, K. Challis and M. White (2005, 31-33) has radiometrically dated the actual deposits at Ayyash and Halabiya to define the chronology of the Lower and Middle Palaeolithic artefacts discovered in the area. At least the dates for the banks of the Euphrates at Halabiya were obtained ~ 2800-2100 ka equivalent to QfIII. For the village terrace of Ayyash the dating for QfI was ~ 425-415 ka, which is far older than has been previously suggested using stratigraphical techniques, that is QfI being ~140-70 ka. The older dating provides the *terminus post quem* for the Lower Palaeolithic finds associated with Ayyash and Ain Abu Jima. During the

intensive field survey of the Finnish project Lower and Middle Palaeolithic flint tools have also been found in abundance along the terraces and at the edges of the mountain between Ayyash and Mustaha on the right bank of the Euphrates. These open accumulated sites began to appear on the southern side of the Deir ez-Zor – Aleppo highway at the village of Ayyash.

Ancient structures in the location of pottery concentrations have been traced with Ground Penetrating Radar (GPR) on fluvial terraces, *plateaus*, in anticipation that some of the structures have been submerged and disappeared in the accumulated sediments. (See Fig. 3)

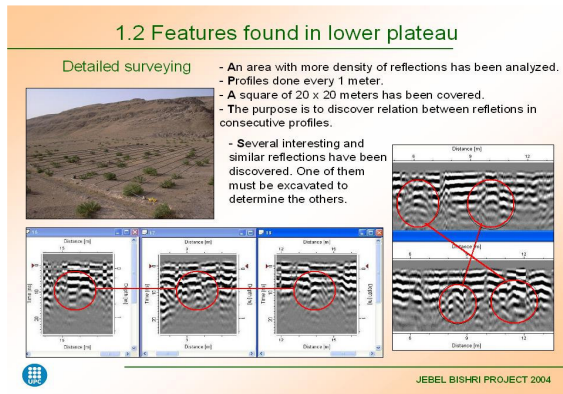


Fig. 3. Archaeological tests with a Ground Penetrating Radar (GPR) on a terrace plateau Site H 1 in the village of Kharita-Mustaha. Josep Pedres-Rodés 2004. © SYGIS - the Jebel Bishri project

4. REMOTE SENSING AND FIELD SURVEYING ON THE PIEDMONT OF JEBEL BISHRI

The Finnish project SYGIS has acquired and used different kinds of remote-sensed data sources for archaeological prospecting, mapping and studying the landscape and its changes on the Middle Euphrates limited with Jebel Bishri. The data sources consist of declassified CORONA satellite photographs, Landsat, SPOT as well as QuickBird satellite images, SRTM DEM and DEM produced from Aster images.

Apart from J. Besançon's and P. Sanlaville's (1981) Palaeolithic studies, earlier archaeological surveys on the right bank following Jebel Bishri have been carried out by A. Moore (personal communication) and K. Kohlmeyer (1984, 1986), whose study from the west reached to Halabiya that has been under French studies for decades.

The intensive and systematic field survey area of the Finnish project starts ca. 12 km west from the city of Deir ez-Zor at the village of Ayyash and concentrates on the terraces between the villages Ayyash, Ain Abu Jima, Kharita, Kharita-Mustaha and Mustaha covering an area ca. 10 km in length and 100 m in width (Fig. 4). Special short checks by a jeep were made on terraces along the way from Mustaha to Tibne and continuing to Raqqa. All the locations of ancient tells, so far seven, that were recognized on the way from Deir ez-Zor to Raqqa were recorded at the foot of the mountain and mapped on panchromatic SPOT images using ERDAS MapSheets software.

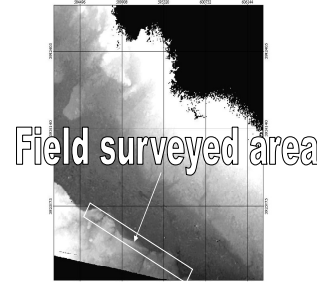


Fig. 4. The field surveyed area at the northeastern edge of the mountain facing the Euphrates graben between villages Ayyash and Mustaha, mapped by ErDAS MapSheets Express software on an Aster image. Mapping Minna Lönnqvist 2007. © SYGIS - the Jebel Bishri project

5. RECENT RIVER CHANNEL CHANGES

The Holocene river channel changes are visible in the landscape of the Euphrates. The reasons for these changes are both environmental and direct impacts of human activity through the irrigation technology. Floodplain "islands" or terraces can submerge or disappear into silts when a flood rises on the floodplain.

Channel change observations and analyses in the Middle Euphrates by satellite imagery are limited, with only a few decades of the availability of the imagery. By using imagery one is, however, able to demonstrate visible changes in the meandering channels. The Finnish project has carried out an analysis of such changes (Fig. 5). Initially, CORONA satellite photographs and Landsat images were geometrically corrected according to common map projection (UTM 37S, WGS84). A Landsat-7 ETM panchromatic image taken 29.1.1999 was used as a base image for geometric correction, since it was orthorectified using DEM and ground reference points measured using GPS. Geometric correction was done using the second-degree polynomial model and 8-10 reference points measured from both images.

Because CORONA satellite photographs are panchromatic, river channels were interpreted visually. Cluster analysis was used with Landsat images. First the Landsat images were clustered to 30 clusters, and thereafter these clusters were interpreted and divided into clusters representing water, land and those representing possible water by comparing the clustering result and satellite image. This latest category includes areas with shallow water, but also some areas with vegetation and wet, irrigated ground.

6. TELLS ALONG THE RIVER AT THE FOOT OF THE MOUNTAIN

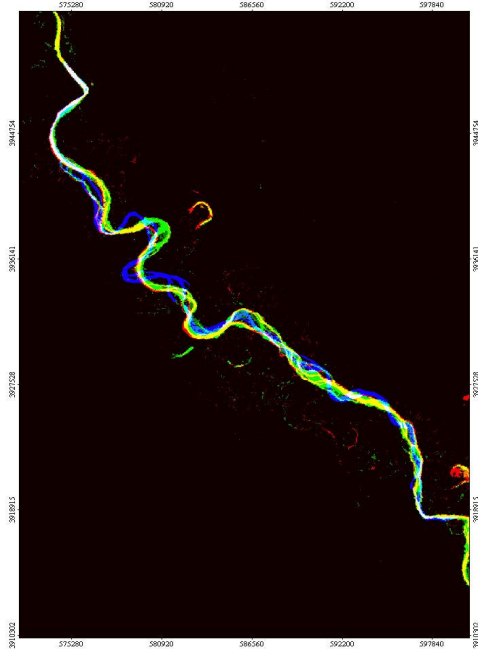


Fig. 5. The analyses of the river channel changes in different decades covering a period of 35 years. CORONA satellite photographs from 1966 (blue colour), Landsat MSS 1983 (green colour) and ETM 2001 (red colour). The common shared channel alignments in 1983 and 2001 expressed in yellow, the ones shared in 1983 and 1966 in light green and finally those shared in 2001 and 1966 in purple. White colour denotes the common alignment during all the years. © SYGIS - the Jebel Bishri project

The most notable change is visible when comparing the river channel (blue) from 1966 in relation to all the later years; in two decades the channel has changed as much as in hundreds of meters. However, some spotted differences are also visible in 2001 (red colour) Because the Tabqa dam construction was completed in 1973 the rate and shape of the short-term changes are not directly comparable to ancient river channel changes through natural flow. The CORONA photographs from the 1966 show a difference to the years 1983-2001 on the Landsat images. The reason appears to be as simple as the fact that the years 1983 - 2001 is the time when the Tabqa dam was already controlling the water flow and was able to harness the unpredictable channel changes and control their rates (cf. SIAS 1996, 147).

Visual indications of up to hundreds of meters of lateral movement can be received during 35 years when the channel has moved in specific locations. The river channel has a braided pattern which has become a more prominent part of its character between 1983 and 2001 leaving vegetated bars in between the channels. Because of the short period of time, namely a few decades, and the existence of the dam constructions, the satellite images cannot be conclusively used in studying the rate and tempo of the channel changes as an aid for long-term cultural interpretations of the landscape change. Earlier before the dam control the channel change is more visible than during the time of the dam.

Most of the seven tells that have been identified and mapped by the Finnish project between Raqqa and Deir ez-Zor have been previously located by K. Kohlmeyer (1984, Beilage 4) and by J. Besançon and P. Sanlaville (1981, 10-11, Carte 1, four tells) but they had not been mapped into a coordinate system like SYGIS has done on SPOT satellite images. In addition, three of the tells (Tell Tibne, Tell Tabus and Tell Kharita) were closely studied by the projects teams and for two of them (Tell Tibne and Tell Tabus) topographic maps were produced by capturing data with an EDM/tacheometry. An elevation model was also produced for Tell Tibne from the EDM/tacheometric data (Fig. 6. identified with the fort of Mambri built by Diocletian and rebuilt by Justinian according to historian Procopius) next to the peninsula of Halabiya.

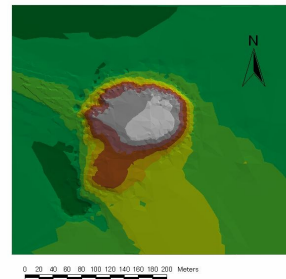


Fig. 6. The elevation model of Tell Tibne next to Halaibya constructed from EDM/tacheometric data captured on the field. Jari Okkonen 2005. © SYGIS - the Jebel Bishri project.

During the 2006 field season the project found an unknown tell at the village of Kharita (Fig. 7). Special attention was given to its position in the landscape and association with the Holocene river channel changes. The tell at Kharita contained Al Ubaid pottery while Tell Tibne has offered Uruk pottery - both tells therefore show contacts to the Mesopotamian cultural phases in the emergence of the Sumerian civilization and writing. CORONA satellite photographs demonstrate the ancient river channels and their locations in association with the tells such as Tell Kharita and Tell Tabus (Fig. 7).

There are historical descriptions of Assyrian military campaigns against Arameans, or crossing the Euphrates as well as stepping ashore at certain sites to attack an Aramean town in the foot of Jebel Bishri. Landscape archaeology can be used in order to study these historical events at the foot of the mountain (cf. Darmark forthcoming). Actually Jebel Bishri is a region, where the Arameans are mentioned for the first time in history. Assyrian king Tiglathpileser I (1116-1090 BC) carried out a military campaign ca. 1112 BC against Ahlâmu-Arameans (Luckenbill 1926, § 239), first crossing the Euphrates in leather boats (cf. Fig. 8) and destroying six of the Aramean towns in the foot of the mountain with fire, destruction and calamity.

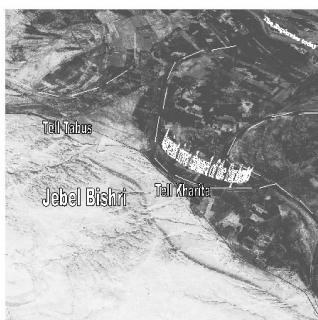


Fig.7. The location of Tell Kharita on a CORONA satellite photograph (taken 28th June, 1966) and the association of the location with ancient Holocene river channels (marked with white stitched lines).

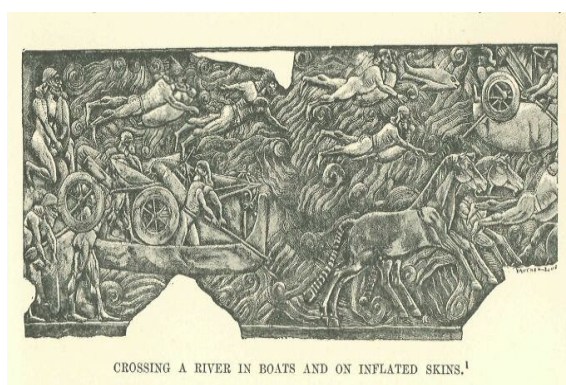


Fig. 8. An Assyrian relief depicting a crossing of a river in leather boats and regular boats. Source: Maspero 1903.

The second major Assyrian campaign associated with Jebel Bishri took place ca. 878 B.C. and was led by Assurnasirpal II (883-859 B.C.), then king of Assyria. The troops approached the region along the Euphrates: *Wherever the navigation of the Euphrates proved to be difficult, the boats were drawn up out of the water and dragged along the banks over rollers until they could again be safely launched; thus, partly afloat and partly on land, they passed through the gorge of Halebiyeh, landed at Kharidi, and inflicted a salutary punishment on the cities which had defied the king's wrath on his last expedition. Khindānu, Kharidi, and Kipina were reduced to ruins, and the Sukhi and the Laqi defeated, the Assyrians pursuing them for two days in the Bisuru mountains (Jebel Bishri) as far as the frontiers of Bit-Adini.* (See *Annals of Assurnasirpal's*, e.g., Maspero 1903)

The locations of *Khindānu*, *Kharidi*, and *Kipina* have been of interest to several scholars for long, but thus far no specific archaeological site identification has earlier been verified. A. Musil (1927), however, suggests that Kipina should be associated with the site of Qreiye situated in the village of Ayyash only a few kilometres northeast from Tell Kharita. Qreiye is known as a Roman fort, but next to it lies a Pre-Roman tell, an ancient town, which a German mission led by Markus Gschwind has studied beside the Roman fort.

It is suggested here that the newly discovered Tell Kharita might be Kharidi (cf. the name Kharita). The reasons for this suggestion are the following: 1) archaeological remains dating to the Iron Age were found at the site, 2) the name of the village "Kharita" is close to the site name "Kharidi", and modern names may carry remnants from the older ones, 3) the Assyrians passed the gorge of Halabiya when floating down the river, Tell Kharita is after Halabiya down the river and being before and west of Ayyash – the suggested site of Kipina. Finally 4) ancient Holocene river channels of the Euphrates can be found just below the tell, although relatively far today, offering a place for easily going ashore.

7. CONCLUSIONS

The Euphrates is a current of time and civilization on the banks of which the earliest Sumerian civilization was born. Since 1999/2000 the Middle Euphrates in association with the mountain of Jebel Bishri has been under a remote-sensing study and archaeological field surveys by the Finnish project SYGIS. Satellite images have been used for archaeological prospecting, landscape studies as well as mapping. The present study has concentrated on channel changes of the Euphrates along Jebel Bishri from satellite image data and the perspective of archaeological field studies on the ground. The satellite images offer a means for demonstrating and for analysing short-term scales and rates of the river channel changes in the Middle Euphrates region. However, the Tabqa dam has been controlling the water flow over 30 years, and drastic lateral channel changes that could earlier have been hundreds of meters in a few decades, have now ceased. In any case, ancient Holocene river channels are still visible in satellite images and can be tentatively connected with archaeological sites on terraces that have been much closer to the river in ancient times. This also illustrates historical events like the Assyrian troops crossing the river and going ashore for conquering Aramean cities at the foot of Jebel Bishri.

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