DIFFERENT IMPLICATIONS OF A SPATIAL BOUNDARY
Jebel Bishri between the Desert and the Sown in Syria

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ABSTRACT:

The mountain of Jebel Bishri forms a strategically important natural bastion on the Middle Euphrates in Syria. The mountain has been a natural, economical and political border zone for different cultures and empires. The area is environmentally limited with the Syrian desert and the irrigated fields of the river plain. The neighbourhood is the cradle of agriculture: the earliest cultivation at the village of Abu Hureyra on the Euphrates dates to ca. 9000 B.C. Remote sensing methods reveal the character of this natural frontier, which during the past decades has been combating against increasing desertification. Satellite images have been used in mapping and monitoring the area of Jebel Bishri. A 3-D-model of the area has been constructed fusing radar and satellite images. Environment has stimulated different formation processes and spatial patterning of the sites on the mountain compared to those of the riverine zone. The cycle of nomadism and sedentism is reflected on the lifestyle still today. The mountain is exemplified with the flimsy remains of mobile societies detectable only with the satellite images offering high spatial resolution. With the satellite images numerous tells, ruined towns or villages, have been detected in the green river valley that reflects the sedentary way of life and trading activities. Archaeology provides a long-term perspective to subsistence patterns and site development processes that helps to understand and plan enduring development in the area.

1. FOCUSING ON JEBEL BISHRI IN CENTRAL SYRIA

More frequently archaeological research designs have a global perspective to cast light on people in their environment. Archaeology can be brought to study human beings in their environmental context through long-term perspectives in order to approach present environmental problems and make forecasts for the aid of enduring development.

Jebel Bishri is a mountain covering ca. one million hectares and forming a natural border zone in Central Syria. The highest peak of the table mountain reaches 865 m. The eastern piedmont areas start already from the suburbs of the city of Deir ez-Zor on the Euphrates River. The mountain itself consists of desert-steppe; the Syrian desert opens to the south while the northern and eastern side beneath is covered by flooded and irrigated plains of the Euphrates. The mountain consists of limestone and sand stone, but there also exist basalt outcrops and marl terraces on the edges of the alluvial zone. Tectonic activities are distinctly visible in the basalt outcrops, such as the cape of Halabiya. (Wirth, 1971).

The yearly precipitation in the area of Jebel Bishri hardly reaches 150 mm; only once in ten years the amount of rainfall extends to 250 mm. Farming is restricted to irrigated fields in the riverine valley beneath the mountain or in oases and wadis of the desert-steppe. According to the UNESCO global definition, the arid zones receive 80-350 mm rainfall within the range of 50-100 mm interannual fluctuations. Grazing but not continuous dry farming can be maintained in this zone. (Beaumont, 1993). The Euphrates flowing beneath Jebel Bishri has been a source of incipient farming and the oldest civilizations in the world. The river has always served not only as a natural border but also as a means for transportation and flow of information.

The Finnish archaeological survey and mapping project SYGIS is focusing its explorations on the mountain of Jebel Bishri for archaeological reasons in order to survey and map ancient remains in the area (see Lönnqvist – Törmä, 2003). The area has earlier remained virtually unexplored by archaeological means. With the aid of remote-sensing data we have been able to cover large areas and to choose different types of environments for our field surveys on the ground. Global grids, such as UTM, can be used as spatial units in archaeological research strategies as they offer objective areas to retrieve varied information. But natural formations, like mountain edges or rivers, may also serve as transect lines offering specific archaeological data within different natural boundaries on the ground.

The purpose has been to catch information of human occupation and its relationship to the environment. The ancient remains are the target of our study not only for their own sake as material remains marking early human activities in the area, but also in order to understand long-term development through the remains. Environment is a significant context in which changes occur, and the region of Jebel Bishri is a mosaic of different environments.

Jebel Bishri is a natural bastion that has been not only an economic but also a socio-political border between nomadic pastoralists and village agriculturalists for millennia. The development and relationship of nomadic and village cultures through time are of special interest. Nowadays the groups identified as nomads consist of Bedouin tribes grazing their flocks on and around the mountain, and peasants are identified as Fellahin engaged in agriculture and village life in the plain regions.

2. ENVIRONMENTAL DEVELOPMENT OF THE REGION

In the absence of deforestation, grazing or cultivation the modern climatic conditions would allow the vegetation typical of the Terebinth-Almond Woodland steppe in the region of Jebel Bishri. Changes in vegetation of the region took place 11 000 to 10 000 years ago, when the drastic retreat of the woodland took place ca. 11 500 B.P. (See Moore et al., 2000). The continuous zone of forest has not reached the area for past ten thousand years, although occasional trees or small plots of woods have existed. Only earlier in the Palaeolithic Stone Age the area has obviously been greener exemplified by several wadis and terraces which offer plenty of archaeological remains of past human activities.

Nowadays the mountain of Jebel Bishri itself is practically devoid of agriculture and constant combating against increasing desertification is under way by ACSAD (The Arab Centre for the Studies of Arid Zones and Dry Lands). During the past hundred years the ecological balance of this Syrian steppe has suffered major setbacks caused by grazing, gathering of firewood, agriculture and increasing traffic. However, the neighbourhood belongs to the perimeters of the so-called Fertile Crescent and the cradle of agriculture. Ca. 100 kilometers northwest from Jebel Bishri up the stream of the Euphrates lies Abu Hureyra, the oldest agricultural site in the world.. It offers the earliest hither-to-known signs of domestication of cereals (rye) dated to ca. 9000 B.C., i.e., to the Epipalaeolithic Period by radiocarbon datings. Abu Hureyra is an important example of the change from the mobile hunter-gatherer way of life to sedentarization and the development of the village life. (See Moore et al. 2000). The oases of El Kowm and Qdeir on the western piedmont area of Jebel Bishri have offered comparable evidence of the sedentarization and nomadization processes of early humans. (See, e.g., Cauvin, 1982 and Zarins, 1989).

In order to visually approach the environmental contrasts of the region the Finnish project SYGIS has used satellite data in constructing a 3-- model of the border zone representing the mountain and the alluvial zone of the Euphrates (see Figure 1.).

Figure 1. The 3-D-model of Jebel Bishri and the Euphrates valley from the east. Construction by Markus Törmä, raw data copyright: DLR and Eurimage
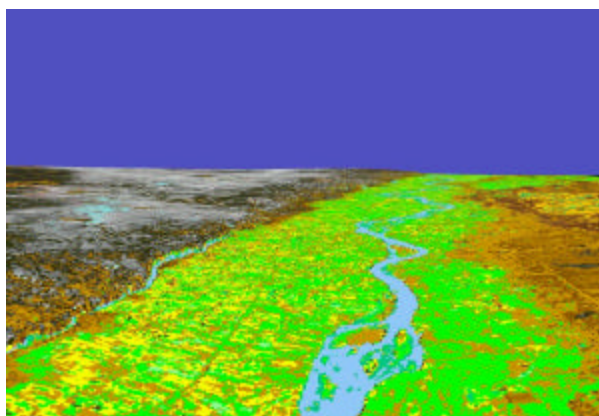
Monitoring changes from past to present in this environmental border zone opens vistas for human responses to the environment in space and time. Human groups have found different strategies to adapt to marginal environments. These responses can be expressed in different economic and social ways, and it is our task to delineate the responses in the archaeological record.

But to avoid environmental determinism we ought to understand that people also alter the environment: e.g., agriculture causes sedimentation and over-grazing desertification. Different sources of satellite data from various years offer excellent possibilities to detect changes in desertification and river channel migration. Monitoring and comparing environmental changes through satellite data in different years elucidates the post-depositional processes and preservation of archaeological remains in the area. Understanding the change also offers us means to follow the development in the area, find new sites buried by environmental changes and to offer choices for planning new strategies of preserving traditional economies and culture in the area.

3. DATA ACQUISITION, PREPROCESSING AND INTERPRETATION METHODS

Remote sensing data utilized so far consists of optical satellite images and digital elevation models.

3.1 Satellite images

In order to determine the land cover of study area and its changes as well as visualization purposes, following remote sensing images have been acquired:

- 4 Landsat Multi-Spectral Scanner (MSS) images, 185/35 and 185/36 taken 27.6.1975 (Landsat 2) and 172/35 and 172/36 12.7.1983 (Landsat 4). Downloaded from Global Land Cover Facility (http://glcf.umiacs.umd.edu/).
- 2 Landsat Thematic Mapper (TM) images, 172/35 and 172/36 taken 1.9.1990 (Landsat 4). Downloaded from Global Land Cover Facility (see the website above).
- Landsat Enhanced Thematic Mapper image, path 172, row halfway 35 and 36, taken 29.1.1999. Acquired from Novosat Ltd. Copyright Eurimage.
- QuickBird pan-sharpened multispectral image, coordinate of the centre: lat. 35. 422, long. 39. 4788 , taken 15.7.2003. Acquired from Novosat Ltd. Copyright Eurimage.
- 3 CORONA images, taken 28.6.1966, 22.1.1967 and 22.1.1967, places S FWD 1034-2, S FWD 1038-2 and S FWD 1038-2. Acquired from USGS.

The spatial and spectral properties of these images are presented in Table 1. in the end of the article.

Landsat is a series of polar orbiting remote sensing satellites. The first Landsat was launched 1972 and the last one, the seventh, 1998. The most important instruments onboard Landsat-satellites have been Multi-Spectral Scanner (MSS), Thematic Mapper (TM) and Enhanced Thematic Mapper (ETM). These instruments are electro-optical scanners which produce digital data (Kramer, 1996). The main differences are number of channels and their wavelengths and spatial resolution (see Table 1 in the end of the article).

QuickBird is a modern digital imager with very high spatial resolution, less than 1 meter on panchromatic channel. There are also four multispectral channels (see Table 1 in the end of the article). Due to the high spatial resolution, the image size is

considerably less than with Landsat. Also the radiometric resolution is higher than before (DigitalGlobe, 2004).

The CORONA satellites, used 1960 – 1972, were the first generation of US reconnaissance satellites and they took stereo photos using two oblique viewing panoramic cameras. One photo is a panchromatic film strip of 7 x 90 cm. The best spatial resolution is 1.83 m for the KH-4B mission at a flight height of 150 km. The SYGIS project has utilized photographs from the KH-4A mission, the size of the photos being 2.25 x 29.8 inch and the resolution 2.7 m (www.earthexplorer.usgs.gov). Geometric correction of the CORONA images is very difficult due to the lack of information about the principal point and fiducial marks, and panoramic distortions (Altmaier - Kany, 2002).

3.2 Digital elevation model

A digital elevation model (DEM) covered part of the study area and its data sources were SRTM-DEM and ASTER-DEM. The DEM was used to remove shadow areas from satellite image interpretation results and to make 3-dimensional visualizations (still images and flight movies) of the ground.

3.2.1 SRTM-DEM: The Shuttle Radar Topography Mission (SRTM) provides a DEM at resolution levels of 30 and 90 m covering the earth between latitudes 60N and 57S measured in February 2000. The DEM is constructed using synthetic aperture radar (SAR) interferometry, meaning that two radar images have been taken from slightly different positions and the surface height is determined using phase differences between images. The DEM was measured using two frequencies (C- and X-bands). X-band data was used in this study. The drawback is that the swath width is 45 km, meaning that there are gaps between neighboring orbits. WGS84 is used as horizontal and vertical datum. This means that ellipsoidal heights are provided. The vertical accuracy should be better than 16 m absolute and 6 m relative, and <the horizontal accuracy better than 20 m (Rabus et al., 2003). The SRTM-DEM was provided by DLR (The German Aero-Space Center) to SYGIS (the Finnish project in question) as a project member of the DLR project.

3.2.2 ASTER-DEM: ASTER (Advanced Spaceborne Thermal Emission and Reflection radiometer) is a multispectral imager which was launched onboard Terra satellite in 1999. ASTER has 14 spectral bands from visible to thermal infrared region and their spatial resolution varies from 15 m to 90 m. There is also one telescope looking backward in the near infrared region (channel 3B, 0.78 – 0.86 µm, spatial resolution 15m) to give stereoscopic capability in the along-track direction. Digital elevation model generation algorithm uses only instrument and satellite ephemeris data. The geodetic map projection is WGS84 and pixel spacing 30m. The horizontal and vertical accuracy should be better than 50m and 15m, respectively (ASTER, 2002). Two ASTER-DEMs were acquired through NASA Earth Observing System Data Gateway (http://edcimswww.cr.usgs.gov/pub/imswelcome/).

3.2.3 Matching of the SRTM- and ASTER-DEMs: SRTM-DEM covered only part of the study area so it was decided to augment the DEM by ASTER-DEM. The coverage of DEMs can be seen in Figure 2., red represents the coverage of SRTM-DEM and green and blue that of ASTER-DEMs. Because the heights of SRTM-DEM are from the surface of ellipsod WGS84 (Rabus et al., 2003) and the heights of ASTER-DEM were relative, there was a need to study the heights of different DEMs more carefully.

Compared to STRM-DEM, the heights of ASTER-DEM 1 (the light green small triangle visible on the top in Figure 2) were 46.9 m lower and root-mean-square-error (RMSE) between DEMs was 48.5 m. The heights of ASTER-DEM 2 (the darker blue small triangle visible below in Figure 2) were 22.8 m lower than SRTM-DEM and RMSE was 27.0 m.

Figure 2. The study area and the coverage of DEMs, the largest red area represents the coverage of SRTM-DEM and the green above and the blue beneath ASTER-DEMs. Data copyright DLR and Eurimage.
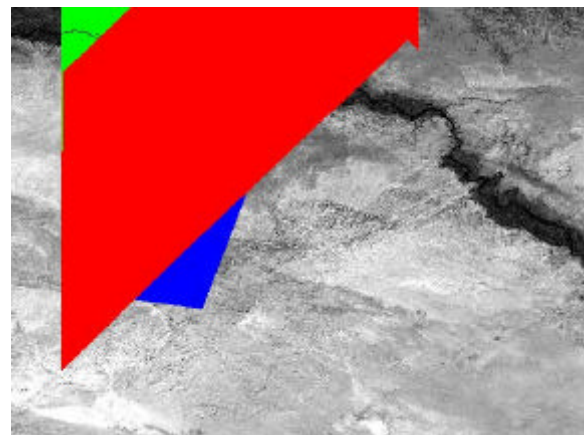
It was decided to adjust the ASTER-DEMs to STRM-DEM. After removing the average difference between DEMs, it was noticed that the slope of the linear regression equation between SRTM and ASTER-DEMs were not equal to 1, meaning that there was scaling factor in the ASTER-DEMs which needed to be removed. Therefore the adjustment of ASTER-DEMs were based on the regression equations between SRTM- and ASTER-DEMs. The correlation between dems were high, the correlation coefficients were 0.9855 for ASTER-DEM 1 and 0.9952 ASTER-DEM 2. After the adjustment, the RMSE between SRTM-DEM and ASTER-DEM 1 was 7.8 m and ASTER-DEM 2 10.6 m.

3.3 Georeferencing

The georeferencing of satellite images and digital elevation models was performed by choosing the panchromatic channel of Landsat ETM image as a master image and georeferencing other images and DEMs to that master image using ground control points. The master image was georeferenced using ground control points measured from UK military aviation maps (TPC G-4C, TPC G-4D, Scale: 1: 500 000, UK 1998).

Other images were georeferenced using an ETM-image. 20 - 30 ground control points were determined from images and first degree polynomial transformation and nearest neighbor interpolation was used in each case. The root mean square errors were less than one pixel. The CORONA images were not georefenced due to the previously mentioned difficult imaging geometry.

The effect of georeferencing was studied by comparing the georefenced images using orbital information and the georeferenced images using ground control points. The corners of the images were measured and errors computed between the mean coordinates. Errors in east and north directions were defined as the ETM-coordinate minus the corresponding coordinate from other image and planimetric error is length of error vector. Table 2 represents the results. The results indicate

that the orbitally georeferenced images are too much in the east and usually in the south. It should be noted that these results are the comparison to the reference, i.e., to the georeferenced ETM-image using ground control points from the map.

Table 2. The comparison of the location of the images georeferenced using orbital information to the reference image georeferenced using ground control points

	Error in east direction	Error in north direction	Planimetric error
MSS 1975	-915.0	-2.0	915.0
MSS 1983	-978.0	205.0	999.3
TM 1990	-1019.0	126.0	1026.8
ETM 1999	-414.0	1070.0	1147.3
SRTM-DEM	-268.0	233.0	355.1
ASTER-DEM 1	-410.0	851.0	944.6
ASTER-DEM 2	-898.0	481.0	1018.7

It is very likely that the positional accuracy of images georeferenced using orbital information is higher than using ground control points due to a small scale map used in the ground control point collection. The master image was georeferenced using 14 ground control points measured from the 1: 500 000 scale maps (TPC G-4C, TPC G-4D, UK 1998) and first degree polynomial transformation. The georeferencing errors are very high due to the small scale map, the average root-mean-square-error being 19.7 pixels.

3.4 Interpretation methods

Image interpretation methods were image clustering of the Landsat-images to determine the general land cover, change detection using the Landsat-images and image enhancement of the QuickBird image to aid visual interpretation.

3.4.1 Clustering Landsat images: A general overview of land cover was acquired using clustering analysis. In clustering analysis, or unsupervised classification, the image pixels have been divided into categories or clusters according to their spectral similarities. The principle is that the spectrally similar pixels belong to the same cluster and different pixels to different clusters. When the clusters have been formed, they are interpreted by comparing them to satellite image, reference images like aerial images or maps, or ground survey data. The Landsat MSS-, TM- and ETM-images were clustered into 30 clusters using k-means algorithm. (Richards, 1993). The clusters were interpreted by comparing them to satellite image and determining the most likely land cover.

3.4.2 Change detection using Landsat images: Change detection was performed between the Landsat images in order to determine the places of land cover changes. Change images were formed by computing the differences of red and near-infrared channels (ETM-channel – other image channel) and clustering these two differences to 30 clusters using k-means algorithm and the clusters were interpreted to categories no-change and change. Also the type of change was interpreted if possible.

Change images were computed using red channels (channel 5 in MSS, 3 in TM and ETM) and near-infrared channels (channel 6 in MSS, 4 in TM and ETM). The purpose of using red channel

was to find changes concerning bare ground and mineral soil, especially sand. The purpose of using near-infrared channel was to find changes related to vegetation cover. The used pixel size was 60 meters when comparing the MSS- and ETM-images and 30 meters when comparing the TM-and ETM-images. Ratio images CH7/CH1 were also computed from TM- and ETM-images and their difference image computed. It was hoped that this channel ratio would be sensitive to sandy soils (see also, Hofmann, K. – Geerken, R., 1998). It should be noted that the seasons of images were different, so some changes are due to the seasonal difference of vegetation. Also, some detected changes can be due to the misregistration between images.

3.4.3 Image enhancement of the QuickBird image: Gradient images were computed from the previously referred QuickBird-image in order to enhance linear features like roads and paths, or other signs about the human activity like houses or ruins. Gradient images were computed using a Sobel gradient (Gonzales and Wintz) with 3x3 filtering window for channels 1, 2 and 3.

4. THE CONSTANTLY CHANGING DESERT BORDER

At Jebel Bishri environment largely dictates the possibilities to carry out certain subsistence strategies, and this has also affected the formation of particular types of archaeological remains in the area which has been desert-steppe throughout the Holocene, i.e., the past ten thousand years.

The specific archaeological remains left by different groups of people are usually determined as tool-kits, assemblages or technocomplexes (see definitions in Clarke, 1978). The desert-steppe environment offers sites that have a good surface distribution and are often visible for thousands of years on the surface. However, the Mediterranean and semi-arid regions are especially vulnerable to erosion. The limestone and sandstone slopes of Jebel Bishri are easily eroded by winds, sand storms and different run-off mechanisms caused by rains. It is known that generally erosion causes decreasing artefact diversity from slopes towards valleys (Evans - O´Connor, 1999), but this is a theoretical approach which does not take into account the possible density of occupation and accumulation of occupational layers at the sites beneath slopes.

The increasing desertification on the mountain is especially detectable in the Landsat satellite data comparing the movements of sands during the last thirty years. There was a drastic increase of the sand cover from the year 1986 to 1993. The peak of the sand movements was reached in 1993 (see Meissner - Ripke, 1995). Some minor increase was still detectable in the central area of Jebel Bishri and to the north from the Landsat-7 ETM image analysis marking the difference between the years 1993 and 1999. Monitoring these changes allows us to understand the environmental changes, which have affected the constrains to different livelihoods in the region.

The influence of a state in the livelihood of the nomads has been detectable in our ethnoarchaeological study of the sedentarizing nomads in the village of Shanhas in the western piedmont area of Jebel Bishri. The CORONA satellite photographs also provide evidence that agricultural initiations were carried out by ploughing the ground also on the mountain in the 1960s. Ploughing and agriculture have, however, been found to cause catastrophic effects to the grazing grounds and the traditional livelihood of the nomads. Well water does not suffice in the

desert-steppe to irrigate the lands, and the watering points are vital for the animals.

The archaeological remains consist of rock-shelters, hut or tent bases, tumulus or cairn burials, animal pens and traps as well as hunter´s blinds. (A particular concentration of these remains have bee studied during the year 2000 field survey at the escarpment of Tar al-Sbai on the southwestern edge of the mountain the UTM- coordinates 0517906, 3507065 – 0520209, 3903263). The Upper Palaeolithic accumulated sites dating to tens of thousands of years back are countless on the mountain and on the southwestern piedmont area. They witness favourable conditions for hunting; and it seems that steppic landscape with small rivers prevailed in the area. Animal pens dating from the Chalcolithic Period (ca. 5000-3300 B.C.) to the recent years provide information that semi-nomadic pastoralism, such as the herding of goats and sheep, has been prevailing form of nomadism on the mountain.

Apart from this non-monumental region of the desert-steppe and steppe sedentary remains are also naturally devoid in the desert exemplified by caravan trails and trade routes. In the desert camel nomadism is the only way to survive long distances between the watering points. The Landsat images reveal straight caravan routes in the desert to the south of Jebel Bishri. The witness that stars and planets must have been used in navigating the routes. The routes in the desert lead to Iraq and Saudi Arabia. The most famous is the Silk Road, which passes the mountain to the south.

In contrast to the non-monument areas monuments, such as castles and tombs, on the mountain edges and piedmont areas are largely result of the military organisation of the eastern border zone of the Roman empire. The Roman fortress of Tabouz (UTM 0586948, 3925414) is one of these sites on the northeastern edge of the mountain facing the Euphrates.

5. TRANSFORMATIONS IN THE RIVER CHANNEL

Fertile flooded and irrigated plains surround the river channel beneath the mountain of Jebel Bishri. At the beginning of the 20th century Alois Musil described the geography of the Middle Euphrates: The valley is ca. forty meters deeper from the surrounding valley. In some places the valley is only two hundred meters wide, in others it can reach even ten kilometers. The table mountain range of Jebel Bishri is following the course of the river from Deir ez-Zor to the basalt cape of Halabiya. There the rocky spurs reach the river. (Musil, 1927). Andrew Moore carried out an archaeological survey on the right bank of the Euphrates identifying several tells from Tell Abu Hureyra to the cape of Halabiya during the 1970s (see Moore, 1985). The Finnish project SYGIS has focused its survey and mapping on the area from Halabiya to Deir ez-Zor along the Jebel Bishri range following the riverine valley.

With a CORONA satellite photograph we have been detected one tell, an ancient town (UTM coordinates 0574179, 3941645), next to the village of Tibne in the river valley beneath Jebel Bishri. However, there obviously exist several undefined sites buried during the course of the river migration. In the riverine zone the sedimentation pace is faster and the burial of sites is speeded by alluvial changes, agriculture and traffic. The processes can consist of land-use, erosion and sedimentation, but changes also take place through the river channel migration. (Brown, 1997). Deposits are not only created by flooding but also by the channel migration which in turn is affected by

climate and tectonic activity. Geometrical channel pattern of the Euphrates beneath Jebel Bishri is a mixture of meandering and braided patterns. Frequency of flooding and alluviation rate which changes the river valley vary. (Brown, 1997).

Comparing the CORONA satellite photographs from the 1960s with the Landsat images from the 1990s the change of the river channel is clearly detectable during the thirty years. Floodplain "islands" or terraces can submerge or disappear into silts when alluviation raises in the floodplain. (Brown, 1997). Sometimes river erosion and channel migration destroy sites completely. For example, ancient city of Emar up the stream of the Euphrates, was apparently destroyed in the course of channel migration (see Geyer, 1990). One of the causes beside the natural effects has also been the human intervention by building the Tabqa dam, which caused the submerging of several ancient sites.

Changes in a stream from aggradation to degradation cause incisions to the flood plain and may create fluvial terraces. (Brown, 1997). Pleistocene marl terraces on the slopes of Jebel Bishri mark the most ancient course of the river channel. Terraces are of particular interest to archaeologists, because they are the driest areas of the floodplain and therefore were inhabited in antiquity (Brown, 1997), like today. In the Middle Euphrates valley such ancient sites as Doura Europos and Mari are situated on the terraces of the Euphrates. Mari is situated on a historical *alveolus* terrace, and during the Amorite period (18th century B.C.) three large canals were irrigating the lands of the kingdom (Lafont, 2000).

6. CONCLUSIONS: BOUNDARY BETWEEN MOBILE AND SEDENTARY SOCIETIES

The desert-steppe of the mountain and the fluvial area of the river valley form a natural border zone contrasted not only by their environment but also in the archaeological remains connected with particular subsistent strategies The preservation of human activities in these zones is also different. The mountain is largely a non-monument area of mobile people while the edges and piedmonts offer monuments and tells, ruined villages and towns, of sedentary people basing their subsistence economy on agriculture.

The natural forces as well as human interference cause changes in the limits of the zones and preservation of the ancient sites. Mobile people, such as hunter-gatherers and nomads, leave relatively flimsy structures, but the remains in the deserts and steppes are not vulnerable to such post-depositional processes as the agricultural regions. The remains of mobile people are concentrated on the desert-steppe areas of the mountain, but distinct change of the environment and increasing desertification can be detected from the beginning of the Holocene. The sedentary remains are found in the alluvial zone.

Not only the agriculture, but also the transportation of raw materials has offered possibilities for the growth of small cities and village along the Euphrates. The ancient Mesopotamian cuneiform texts (Gudea Statue B) reveal that marble or alabaster was an important raw material that was acquired and transported from the district of Jebel Bishri. Also salt (Buccellati, 1990) was brought from the area. Along the valley of the Euphrates we have detected tells, ancient towns, which consist of several occupational layers of sedentary life surrounded by cultivated fields. These ancient towns and

villages must have played an acitve role in transportation along the river.

There seems to have existed an enclosed relationship of nomads and villagers in the Middle Euphrates region at least from the 3nd millennium B.C. This kind of society often has a dimorphic structure in which there is a special relationship between tribal societies and villages as well as towns. (See Rowton, 1973 and 1976). To avoid environmental determinism there exists evidence that governments may politically affect the sedentarization process of nomads. The cycle of nomadism and sedentism is typical of Jebel Bishri, situated between the desert and the sown However, the increasing adoption of the steppe land for agriculture has deteriorated grazing lands by increasing desertification. To preserve the natural livelihoods of nomads and traditional culture in the region is of outmost importance. There is a vital need to diminish the overtaking forces of the desert and to prevent the increase of agriculture over the steppic grasslands.

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Table 1. The spatial and spectral properties of the used satellite images.

Instrument	MSS	TM	ETM	QuickBird	Corona
Channels	4: 0.5 – 0.6 µm 5: 0.6 – 0.7 µm 6: 0.7 – 0.8 µm 7: 0.8 – 1.1 µm	1: 0.45 – 0.52 µm 2: 0.52 – 0.60 µm 3: 0.63 – 0.69 µm 4: 0.76 – 0.90 µm 5: 1.55 – 1.75 µm 6: 10.4 – 12.5 µm 7: 2.08 – 2.35 µm	1: 0.45 – 0.52 µm 2: 0.52 – 0.60 µm 3: 0.63 – 0.69 µm 4: 0.76 – 0.90 µm 5: 1.55 – 1.75 µm 6: 10.4 – 12.5 µm 7: 2.08 – 2.35 µm Pan 0.50 – 0.90 µm	1: 0.45 – 0.52 µm 2: 0.52 – 0.60 µm 3: 0.63 – 0.69 µm 4: 0.76 – 0.90µm Pan: 0.45 – 0.90 µm	Panchromatic Film
Spatial resolution	79m	30m Ch6 120m	30m Pan 15m Ch6 60m	2.44 m Pan 0.61 m at nadir	About 2m in the best case
Image size	185 x 185 km2	185 x 185 km2	185 x 185 km2	16.5 x 16.5 km2	188 x 14 km2
Radiometric quantization	7 bit	8 bit	8 bit	11 bit	Film