

## MONITORING SURFACE ALTERATIONS IN THE YAMIN PLATEAU BY SPACEBORNE IMAGING AND AERIAL PHOTOGRAPHY DURING 1945 TO 2009.

Guy Hetz<sup>1</sup>, Dan G. Blumberg<sup>1</sup>, Dodik Avraham<sup>2</sup>, Hai Cohen<sup>1</sup>  
[hetz@bgu.ac.il](mailto:hetz@bgu.ac.il)

1- Department of Geography & Environmental Development, Ben-Gurion University of the Negev.  
2- NRCN (Nuclear Research Center-Negev), Environmental Research Unit- Head.

Commission VI, WG VI/4

KEY WORDS: Yamin Plateau, Landform changes, Zibar, Clay minerals.

### ABSTRACT

This research studies the Yamin Plateau which is 100 km<sup>2</sup> and is a part of the Yamin-Rotem Syncline. The research objective was to document and characterize landform changes in the Yamin Plateau from 1945 when the area was closed (trampling and grazing were limited), until 2009. The study used space and air-borne images, corroborated by field measures that lead us to the following conclusions: 1. Soil stabilization processes took place earlier than the area closure. Despite decreasing precipitation measured during the past 50 years in Yamin Plateau, the vegetation cover nowadays constitutes 67% compared to 55% in 1945. This is caused by the area closure and the subsequent formation of biological soil crusts. 2. In the past there were active Zibar morphologies in the region. The most frequent grain-size is 0.35 mm which supports this. 3. Although the current geologic map of the Yamin Plateau is characterized by a sandy soil texture, nowadays the study area surface contains more than 40% of clay minerals, which were probably trapped by soil crusts during dust storms.

### 1. BACKGROUND

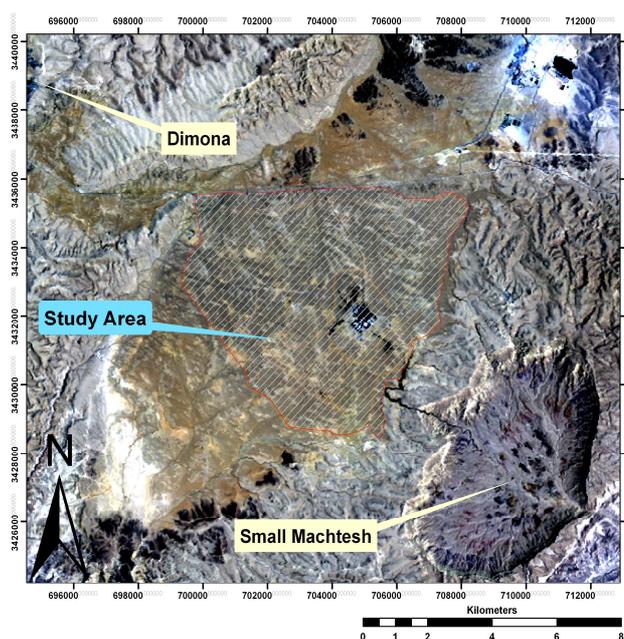
Landscapes of arid environments are modified through fluvial and aeolian processes and at times, tectonic and anthropogenic processes. Focusing on the two processes related to climate and human impact, the fluvial processes have a low frequency but strong intensity whereas aeolian processes tend to be continuous and gradual.

The Yamin Plateau area closure in the 1950's has accelerated the development of biological soil crusts (BSC) and dust sedimentation and has changed the soil texture. Avraham et al., 2009 suggested that the evolution of the BSC nowadays, is mainly because the area was fenced in the 1950's which prevented trampling and grazing. Several studies (Verrecchia et al., 1995; Kidron et al 1997; Kidron et al., 2001; Kidron 2007) investigated the essential part of BSC in the formation of runoff on sandy soils, showing that BSC increase runoff in sandy soils. In addition, Avraham et al., 2009 claimed that BSC yielded a decrease in aeolian process and an increase of runoff at flood time.

The BSC evaluation in the Yamin Plateau has contributed significantly to the landscape development. In order to understand landscape changes, vast quantitative field data were required. Traditional field methods for data collection are point specific, time consuming (Wright et al., 2000) and misleading when generalizing for large areas. Therefore, the integration of spaceborne images and air photography with high spatial and spectral resolution taken from different dates, is an effective way for upscaling from the sample level to the regional scale.

#### 1.1 STUDY AREA

This research takes place in the Yamin Plateau which is 100 km<sup>2</sup> and is a part of the Yamin-Rotem Syncline (**Figure 1**).



**Figure 1.** Landsat TM image of the study area (bands 3, 2, 1 composited in red, green and blue, respectively).

In this syncline there are features of the Syrian Archer system (Krenkel, 1924; Salomon, 1987). The exposed geology section of the Yamin Plateau consists mostly of the Miocene Hazeva Group (Calvo and Bartov, 2001) where sedimentary processes started 20 million years ago and continued for 12-14 million years. The Hazeva Group is composed of alluvial sediments and contains conglomerates, limestones, marlstones, sandstones and mostly a

thick sand section. Two significant items of the Miocene Hazeva Group appear in the Yamin Plateau: one is the Zefa item and other, younger one, is Rotem. The compositions of these two items are similar and sometimes defined as "the main sand body" in the Hazeva Group. The maximum thickness of the sand section measured in the Yamin Plateau is 180 m (Bruner et al., 1999). The mean temperature in July is 27.5°C and in January is 11.5°C. The mean annual precipitation is 75 mm (Avraham et al., 2009) with 20 days of rain. The common wind direction is NW (19 %) and W-NW (18 %), which means that one thirds of the time the wind blows in narrow segment of 50°.

**1.2 RESEARCH OBJECTIVES**

The Yamin Plateau hosts the national nuclear waste depository (Avraham et al., 2009). Such a site must be stable for many years which requires an understanding of the geomorphologic processes that occur in this area. One of the risks is erosion within the site. The research objective is to document and characterize landform changes between 1945-2008 of the Yamin Plateau as an indicator for the site stability.

**2. METHODOLOGY**

To understand the landform development of the Yamin Plateau three research fields were combined: geomorphology, soil science and geography information technologies. For this purpose vast quantitative data were collected by spaceborne images and air photography. For better surface characterization a large number of soil surface examinations were made including: spectral measurements, grain-size distribution and hydraulic conductivity of the soil. All the parameters, from different years, were extracted in the laboratory and were combined with field measures in the study area. The final propose was to compare the result between past and present and change detection in landscape (Figure 2).

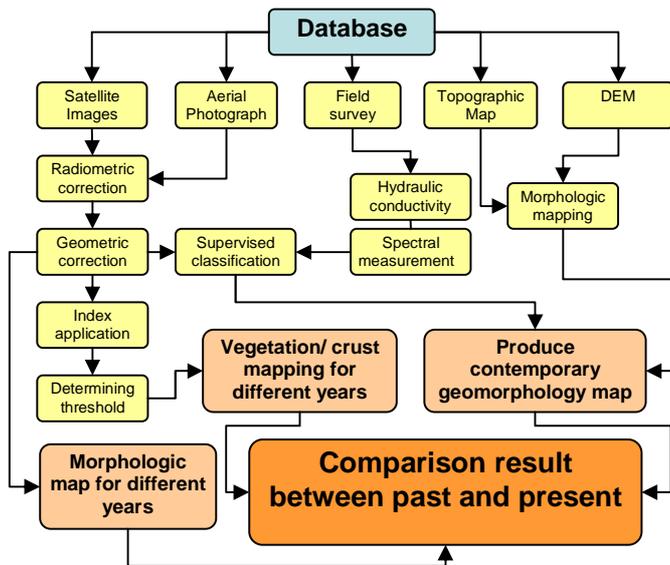


Figure 2. The flowchart of the research methods steps.

**3. RESULTS**

The research results show that soil stabilization processes took place earlier than the area closure. Although trends show a decrease in precipitation measured during the last 50 years in the Yamin Plateau (Figure 3a), the vegetation cover has increased from 55% to 70% during this time (Figures 3b, 4).

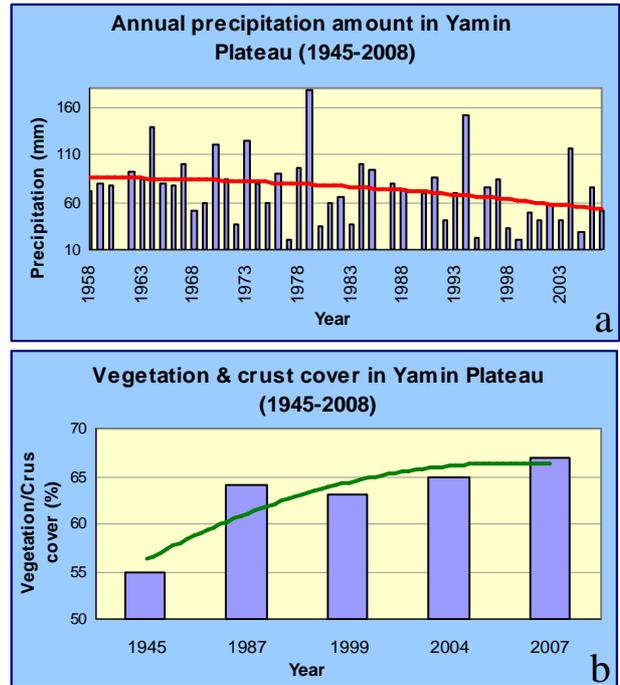


Figure 3. Two opposite trends: (a) the red line demonstrates the decreasing precipitation between 1945- 2007 and (b) the green line demonstrates the increasing vegetation/ crust cover between these years.

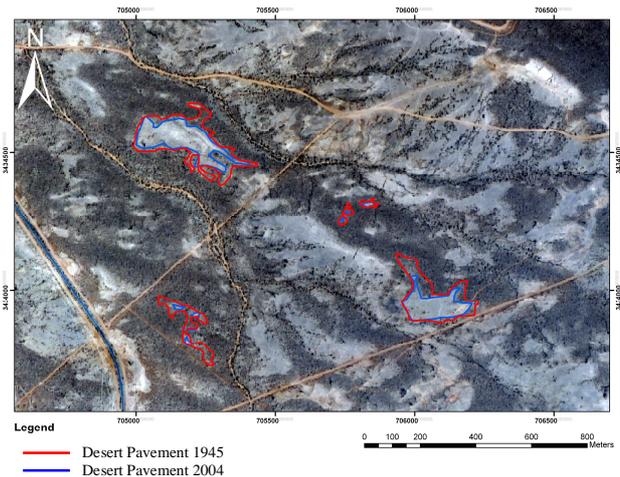
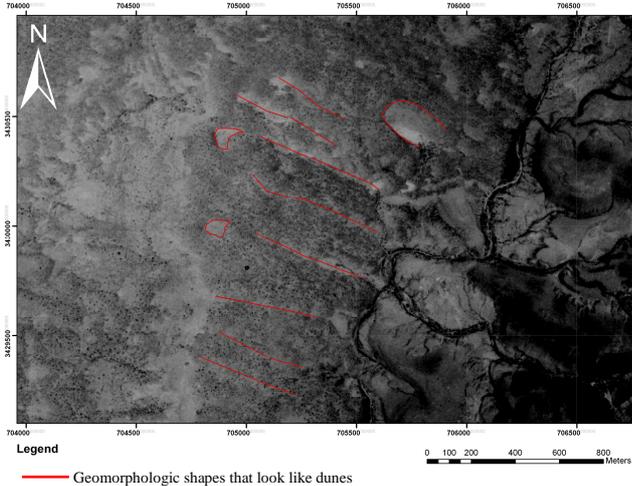


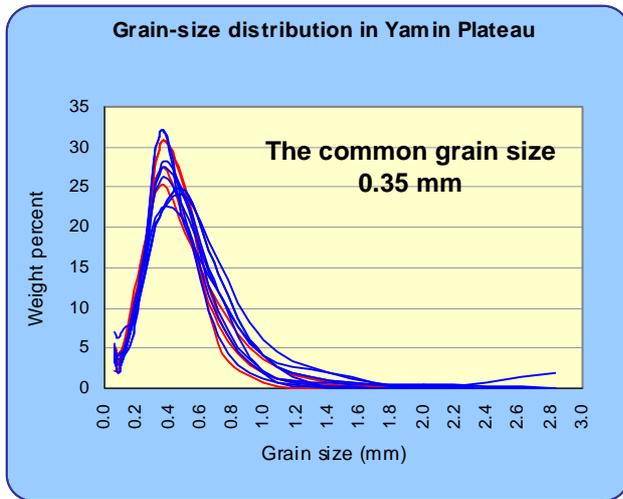
Figure 4. Decrease of desert pavement area in Yamin Plateau. The red polygons demonstrate the desert pavement in 1945 and the blue ones demonstrate the desert pavement in 2004.

In addition, the last 50 years analysis have shown that aeolian processes took place at the South-East part of the Yamin Plateau

in the past (Figures 5, 6). Field studies and image processing of aerial photographs show that in the past there were active Zibar morphologies in the region. The most frequent grain-size of 350 μm supports this.



**Figure 5.** Aerial photograph of South-East part of the Yamin Plateau from 1945. Linear forms are relicts from Aeolian processes that took place in the past. Nowadays this area is covered by vegetation and it is difficult to realize the Aeolian features from aerial photographs.



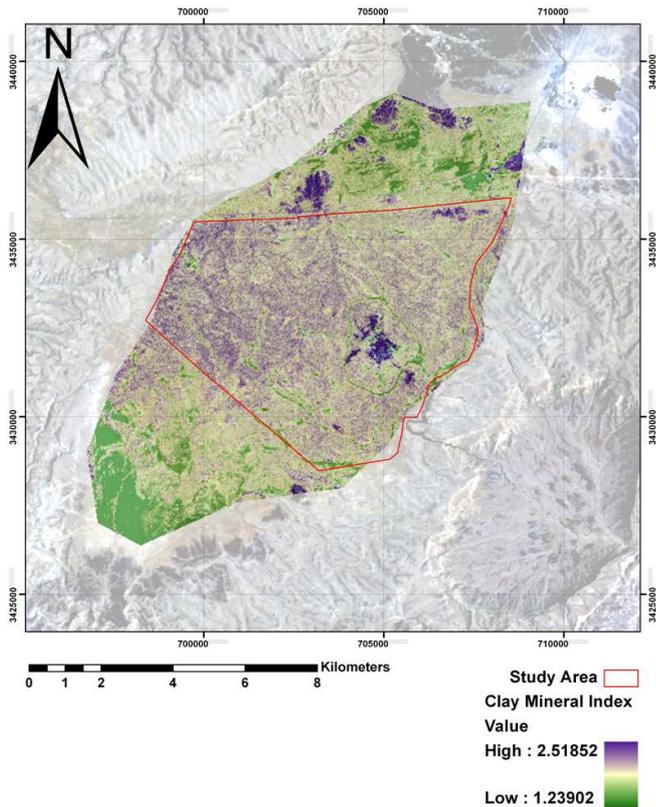
**Figure 6.** Grain- size distribution in Yamin Plateau. The red samples were taken from the South-East part of the Yamin Plateau, the blue ones were taken from all over the research area. The results show a common grain size of 0.35 mm. This grain size distribution indicates a coarse sand existence in Yamin Plateau.

Geological Survey of Israel has analyzed surface samples that were taken from the area, and found that the minerals on the surface are: Quartz, Montmorillonite, Kaolinite and Chlorite. These four minerals constituted endmembers for spectral measurements that were taken in the field using an ASD Field Spec Spectro-Radiometer. In order to recognize the quantitative relationship between the spectral signatures of the endmembers and the field measurements (Table 1), we used a SAM (Spectral Angle Mapper) method, and Unmixing. These findings indicate

that although the soil texture is sandy, the Yamin Plateau is abundant with clay minerals. This process occurs because clay particles are captured by the biological soil crusts, which prevent dust floating. The combination of the BSC and clay particles on the surface reduces aeolian processes. In addition to field spectral measurements, Landsat images show that the closed area contains more clay particles compared to the non- closed area outside the fence (Figure 7).

**Table 1.** Based on table 1, clay minerals are revealed in all landforms in the Yamin Plateau and constitute more than 40% from the mineralogy on the surface. We assume that the high clay concentration is probably trapped by biological soil crusts during dust storms. Montmorillonite is the most common clay mineral on surface, afterward are Kaolinite and Chlorite. Quartz constitutes around 55% from the minerals composite on surface, except for desert pavement which contains 40% only.

Clay minerals	Chlorite	Kaolinite	Montmorillonite	Quartz	Mineral
58%	14%	4%	40%	41%	Desert pavement
43%	8%	1%	34%	57%	Sand
48%	4%	12%	32%	53%	Average BSC
50%	2%	15%	33%	50%	BSC sample 4
49%	3%	8%	38%	51%	BSC sample 3
43%	5%	9%	29%	57%	BSC sample 1
45%	5%	14%	26%	55%	BSC sample 1



**Figure 7.** Clay concentration in the closed area is higher compared to that outside the fence. This situation is caused by the fact that Clay particles capturing by BSC prevents a dust floating.

#### 4. SUMMARY & CONCLUSIONS

- A trend showing a 35 % decrease in precipitation during the last 50 years at the Yamin Plateau is documented. A concurrent 13 % increase in vegetation cover was observed.
- Field studies and image processing of aerial photographs and recent Quickbird images alongsite grain-size distribution show that in the past there were active Zibar morphologies in the region. The most frequent grain-size of 350  $\mu\text{m}$  supports this.
- Although the current geologic map of the Yamin Plateau is characterized by sand soil texture, nowadays the study area surface contains around 50 % clay minerals which were probably trapped by biological soil crusts during dust storms.

#### 5. REFERENCES

- Avraham D., Nahlieli A., Avni Y., Cohen H., Weiner D., Porat N., 2009. Late quaternary deposition and erosion processes along the margins of the Yamin Plain, Northeast Negev, Israel. *Israel journal of Earth sciences*, 57, 199-211.
- Bruner, I., Weiner, D., Goldman, M., Calvo, R., Bartov, Y. 1999. Geophysical investigation through subsurface imaging in the Mishor Yamin area. *Geophy. Inst. Isr. Rep.* 641/170/96, Geol. Surv. Isr. Rep. GSI/10/99, 36 p. (in Hebrew).
- Calvo, R., Bartov, Y. 2001. Hazeva Group, southern Israel: New observations, and their implications for its stratigraphy, paleogeography, and tectono-sedimentary regime. *Israel journal of Earth sciences*, 50, 71-99.
- Kidron G.J., Yair A., 1997. Rainfall-runoff relationship over encrusted dune surfaces, Nizzana, western Negev, Israel. *Earth surface processes and landforms*, 22, 1169-1184.
- Kidron G.J., Yair A., 2001. Runoff-induced sediment yield over dune slopes in the Negev Desert. 1: Quantity and Variability. *Earth surface processes and landforms*, 26, 461-474.
- Kidron G.J., 2007. Millimeter-scale microrelief affecting runoff yield over microbial crust in the Negev Desert. *Catena*, 70, 266-273.
- Krenkel, E. 1924. Der Syrische Bogen. *Centralbl. Mineral.* 9, 274-281.
- Verrecchia E., Yair A., Kidron G.J., Verrecchia K., 1995. Physical properties of the psammophile cryptogamic crust and their consequences to the water regime of sandy soils, north-western Negev Desert, Israel. *Journal of arid environments*, 29, 427-437.
- Eldridge D.J., Zaady E., Shachak M., 2000. Infiltration through three contrasting biological soil crusts in patterned landscapes in the Negev, Israel. *Catena*, 40, 323-336.
- Wright A., Marcus A., Aspinall R., 2000. Evaluation of multispectral, fine scale digital imagery as a tool for mapping stream morphology. *Geomorphology*, 33, 107-120.