Impact of Seasonal Climate Changes in Beni Hassan Archaeological Site, El Minya, Egypt

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الملخص:

يعد الموقع الأثري في بني حسن ذات قابلية للتغيرات المناخية الموسمية، بالإضافة إلى تعرضه لبعض الأخطار الناجمة عن التفاعلات ما بين المناخ والبيئة. ويشير البحث إلى أن كلاً من كمية ونوعية البيانات عن الحالة الراهنة مهمة للغاية لوضع استراتيجية للحفاظ على المواضع الأثرية في بني حسن. هذا وترتكز أهداف البحث على محورين الأول: إظهار أهمية وجود منظور طويل الأجل على ديناميكية التفاعل بين المناخ والبيئة، والثاني: إظهار أهمية التأثيرات المناخية من خلال دراسة حالة لتحديد العمليات وعناصر التغير البيئي في المناطق الأثرية. وتطلب تقييم التأثيرات الناجمة عن التغير المناخي المحتمل على موقع بني حسن الأثري منهجية التحليل الجغرافي لإحصاءات المناخ المتطرفة والقصيرة المدى من حيث الفترة الزمنية؛ حيث تم دراسة تأثيرات التغيرات المناخية الموسمية من خلال تحليل الاتجاهات في السجلات المناخية طويلة الأجل، كما استندت دراسة التغييرات المتوقعة لدرجات الحرارة والأمطار إلى سيناريوهات مستقبلية تعتمد على محاكاة انبعاثات غازات الدفيئة في النماذج المناخية، بالإضافة إلى الاستقراء الإحصائي استنادًا إلى الملاحظات التاريخية والمسح الميداني. وتوصلت نتائج الدراسة إلى أن المقابر الأثرية في بني حسن تعرضت لتعديل هيكلي ملحوظ. هذا التعديل ناجم عن التغيرات المناخية الموسمية وتقلباتها، بالإضافة إلى التأثيرات البشرية السلبية. وأوصت الدراسة بالحماية الخارجية للمقابر من خلال إزالة تراكم الرمال، وحمايتها من مياه الأمطار، ومعالجة الفجوات والشقوق، وترميم المقابر بطرق علمية سليمة وفقًا لتصميمها الأصلي.

الكلمات المفتاحية: التغيرات المناخية الموسمية، المواقع الأثرية، بني حسن، المنيا.

ABSTRACT

Archaeological site in Beni Hassan vulnerability to Seasonal climate change and other hazards constitutes a critical set of interactions between climate and environment. The research indicates that both the amount and quality of data on preservation status of archaeological surveys in the Beni Hassan. The objectives of this search are twofold: firstly; to demonstrate the importance of a long-term perspective on climate-environmental dynamics. Secondly; to show the relevance of climatologically data in impact to illustrate with a case study how one may identify the component processes of environmental change in archaeological areas. Evaluating regional impacts from possible climate change on Beni Hassan Archaeological Site requires a methodology to estimate extreme and short-duration climate statistics for the time period and the geographical analysis of interest. For historical conditions, Seasonal Climate Changes effects can be investigated by analyzing trends in long-term historical records of climate. For future conditions, projected changes in temperature and rainfall statistics are based on future scenarios in greenhouse gas emissions simulated in climate models or statistical extrapolation based on historical observations and field survey. The results show that Tombs Archaeological in Beni Hassan has been subjected to marked physiographic modification. This modification has been induced by Seasonal Climate Changes and variability. In addition, negative human impacts. The study recommends external protection of tombs, to reduce sand accumulation and rainwater harvesting, to address gaps, and to use colors for restoration in accordance with the design of tombs.

Key Words: Seasonal Climate Changes, Archaeological Sites, Beni Hassan, El Minya.

Introduction

El Minya is called the 'Bride of Upper Egypt' due to its location which is roughly at the border of Upper and Lower Egypt. When the renowned Arab traveler “Ibn Batota” visited El Minya in 762H, he described it saying, “It is a large town, built on the Nile. It has schools, sights, and mosques, and it really supersedes the other upper Egyptian towns”. El Minya Governorate has many of important archaeological sites. In this study one archaeological site has been selected Figure (1), which includes; Beni Hassan (Pharaonic). The potential impacts of climate on Archaeological sites are significant, ranging from direct effects such as temperature and wind, to indirect effects such as changes Due to weathering and erosion. Naturally that climate is only one aspect of the Geo-Environmental Hazardous at the site Archaeological in Beni Hassan.

Beni Hassan of the most important archaeological sites in the governorate of Minya, it Ancient Egyptian tombs site, located in the region known as Middle Egypt, on the River Nile, At Latitude 27°55'47"N and longitude 30°52'29"E. Is characterized as a Semi-tropical region, between the Semi-dry and tropical zone. It part of the Region sixteenth of regions Upper Egypt, known as the Mht, and is located 23 km south of Minya on land east of the Nile at a distance of 1200 meters from the river, which houses the tombs of the rulers of the region sixteenth. During the First Intermediate Period from 323 to 325, and the Central State from 348 to 350 (Vandier Manuel ц).

The geographic location of Beni Hassan, at the southern limit of influence of the Semi-polar front in sensitive Mediterranean zone, provides potential for elucidating short and long term climatic changes at Beni Hassan Archaeological Site. The sensitivity of the area is shown in the temporal and spatial variability of natural indicators, such as flash flood, droughts and desertification, which are closely related to seasonal climatic changes.

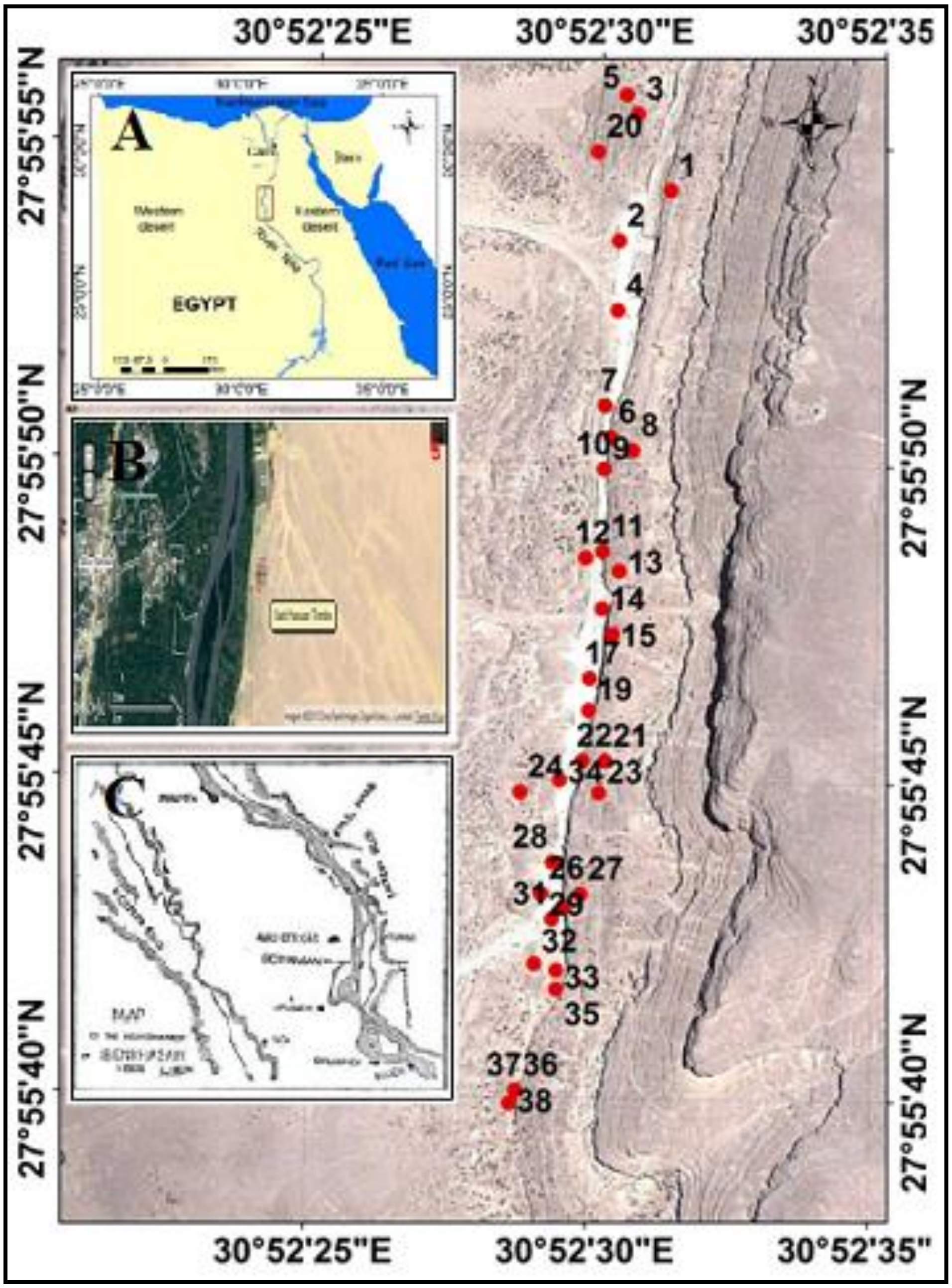

Figure 1. Location of the Study area

(A) Location of El Minya Governorate, (B, C) Neighborhood of Beni Hassan.

Background (Archeological properties)

Beni Hassan site located on a hillside near the eastern bank of the Nile, about 250 kilometers south of Cairo. The site is a vast and important provincial necropolis containing about Thirty-nine tombs, divided into two ranges of markedly different types that span the late sixth dynasty and the twelfth dynast (C.2200-1785 BCE). Sometimes included in the designation “Beni Hassan” is Speos Artemidos, a valley at three kilometers south of the necropolis and the site of a beautifully decorated rock-cut temple built in honor of the lion goddess Pakhet by the eighteenth dynasty woman pharaoh Hatshepsut. Thirty-nine tombs. These tombs have some drawings which represent various sports These tombs were built for feudal lords, and they come full with decorations in frescos (Baines and Malek 2000).

The tombs are normally organized with two square rooms in from the cliff wall, before ending in a small niche. The tombs vary in size, but lies on a row parallel to the eastern Nile bank. The upper necropolis at Beni Hassan consists of about forty large rectangular or square chambers cut straight back into the hill. Here were buried the monarchs and other important civil leaders of the Nome (from the Greek word nomos, for "province"). The date of the upper tombs has been debated widely. Three of the burial (No.2, 3, and 14) are reasonably well dated to the twelfth dynasty by their inscriptions, and many scholars regard the remaining tombs in the upper tier as contemporary. Textual, archaeological, and artistic evidence, however, has led to a redacting of some of the tombs (No.15, 17, 27, 29, and 33) to the late eleventh dynasty or perhaps even earlier to the poorly understood era known as the First Intermediate Period. The lower tomb contains about 890 pit tombs or L – shape shafts sunk into the slope of the hill; these burials date from the late sixth dynasty to the first half of the twelfth dynasty.

The best preserved painting in upper cemetery appears in the tombs of the official Amenemhat (tomb No.2), Khnumhotep II (No.3), Baqet III (No.15) and Kheti (No.17). The repertory of vignettes is enormous; perhaps the most popular topics belong to the genre known as "scenes of daily life" because they depict a wide variety of everyday activities, such as brewing, baking, butchering, cooking, wine making, bunting, fishing, fowling, harvesting, irrigating, laundering, stone working, weaving, dancing, singing, and game playing. The tomb of Baqet III has two splendid registers of carefully detailed birds and bats. Many of those scenes may represent the material wealth and the ambience that the tomb owner hoped to enjoy in the other life. Some pictorial elements in the tombs of Baqet III and Kheti are harder to classify: mythical animals of the desert and several unique hieroglyphs of sexual and cryptographic nature.

The inscriptions in tombs 2, 3, and 14 contain vague references to civil strife. In tomb No. 3 (Khnumhotep II) is a long biographical inscription that details the division of the Nome by the kings Amenemhet I and II and Khnumhotep’s promotion by the second king to the office of mayor. In the same tomb, a brightly colored and boldly executed painting shows a procession of Near Easterners, whose chief was labeled “ruler of foreign lands,” a designation later applied to the groups who migrated to Egypt during the latter half of the twelfth dynasty and throughout the Second Intermediate Period. In a much later Greek historical record, those people are the Hyksos, which is simply a Greek rendering of the ancient Egyptian term. Egyptian and Greek accounts vilify the Hyksos as aggressors, and the Egyptians indeed engaged in sporadic battles with the Near Easterners during the Second Intermediate Period. Those conflicts represent; a later development in Egyptian-Near Eastern relations, however, because in

Khnumhotep’s tomb at Beni Hasan, the “ruler of foreign lands” and his family are shown as: peaceful pastoralists and traders.

From 1902 through 1904, the lower necropolis was excavated by John Garstang for the University of Liverpool. Despite Newberry's and Garstang's efforts, Beni Hasan has not been completely explored, and the archaeological material has never been thoroughly analyzed. In particular, the burial shafts in the tombs of the upper range have not been completely excavated. Numerous wall paintings and inscriptions from those same burials remain unpublished. The correspondence between the many coffins from the site and the tombs in which they were deposited cannot be determined in several instances. Newberry made little, if any, effort to analyze the pottery found in the upper, tombs. Furthermore, because Garstang did not record carefully the distribution of the material that he took from the lower cemetery, the current locations of many items cannot be determined. Consequently, the full significance of the lower necropolis may never be realized.

Previous Studies

There many studies carried out in the study area (Verité, 1981; Smith, 1986; Zielinski,1989), the most Noticeable studies, which dealt with the conservation of the archaeological sites in conjunction with climate, geology and groundwater hydrology include the following facts:

- The causes and effects of rainfall on tombs of Beni Hassan and they related the damage to the swelling of shale due to flood water.
- The effects of air temperature on the archaeological stones, that causes static pressure leading to weakness and collapse of stone surfaces.

- The role of humidity and groundwater in deteriorating the porous stones where humidity and groundwater are powerful physic-chemical factors can cause deterioration of building stones.
- The dangerous effects of humidity are related to its role in facilitating the reactions and its contribution in weathering of stones.

Reviews research into in this regard (climate impact on the Archaeological). Abdel-Aziz (1982) studied the climatic characteristics of a heat during the twentieth century. Abdel-Qader (1992) studied the contrast of spatial and temporal temperature in Egypt. Arnold (2003) studied dust differentiate recent artefacts from those of antiquity. Martın (2005) studied the relationship among climate, weather and tourism from the perspective of the geography of tourism and climatology, analyzed the nature of the influence that climate has on tourism and recreation. stressing the need to maintain different facets of this industry. Archaeological materials are exposed to local environmental and depositional processes in a cave or soil. Analysis of potential geophysical fields and 3D magnetic field modelling where given by Benito (2008) and Eppelbaum (2009) dealt with Systems transported by westerly airflow over the Mediterranean Sea and its relation to the floods and heavy rainfall. Eissa & ELashmawy (2009) characterized of severe dust Storms in Egypt. Lioubimtseva (2009) Examine the concepts of vulnerability, adaptation, and mitigation in the context of climate change in Central Asia.

Objectives

The study aims at achieving following research axes:

1. Studying Climate Characteristics include temperature values, rainfall; especially rainy days, relative humidity and Sand or dust storms.

2. Studying Seasonal Climate Changes in the past and future include Palaeo climatic and severe synoptic situations.
3. Analysis of climatic conditions impact include Petrography of area study, by X-ray and Thin section from Samault Formation.
4. Analysis of field survey/emulation results include comparing the drawings in the tombs with the drawings and photographs documented.
5. provide estimates that are most needed for Seasonal Climate impact at specific site in El Minya, and the potential damage on Tombs Beni Hassan Archeological.

Methodology

Study depends on analytical methodology based on Database building were directed towards understanding the following topics:

- Studying carefully the climate and geomorphology for detecting the expected Impact of Seasonal Climate Changes that may be affecting the archeological content.
- Achieving detailed archeological survey for the archeological objects that is subjected to Seasonal Climate Changes.

The research utilizes some parameterization of climatic data from Minya meteorological station collected from the 1961s to the early 2011s (Table 1), related to erosion, weathering processes, especially salt weathering. and severe synoptic situations. In addition, Petrography of area study, X-ray and Thin section from Samault Formation (Beni Hassan site- Figures 2).

Table 1. Monthly averages of climatic elements in Beni Hassan

Climatic elements	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Greater mix. Temp. (˚c)	**31.7**	**35.4**	**40.9**	**44.3**	**48**	**47.5**	**45.5**	**44.6**	**41.6**	**41.7**	**39.3**	**33.2**
Average mix. Temp. (˚c)	**20.6**	**22.5**	**25.8**	**30.6**	**34.8**	**36.6**	**36.7**	**46.4**	**33.4**	**31.3**	**26.7**	**21.9**
Average daily Temp. (˚c)	**12.3**	**13.9**	**16.9**	**21.3**	**25.6**	**27.9**	**28.4**	**33.4**	**26**	**23.4**	**19.1**	**14.3**
Average min. Temp. (˚c)	**3.9**	**5.2**	**7.9**	**12**	**16.4**	**19.1**	**20.1**	**20.4**	**18.5**	**15.5**	**11.5**	**6.6**
Smaller min. Temp. (˚c)	**1**	**0.5**	**3.2**	**6.2**	**11.6**	**16.5**	**17.9**	**18**	**14.8**	**11.2**	**3**	**3.3**
Relative humidity (%)	**57**	**53**	**47**	**40**	**35**	**39**	**44**	**50**	**54**	**54**	**60**	**61**
Average sum. Rain (mm)	**0.3**	**1.1**	**0.2**	**0.4**	**0.5**	**TR**	**0**	**TR**	**TR**	**0.5**	**0.1**	**0.6**
Greater sum. Rain (mm)	**6.8**	**11.2**	**3.2**	**10.5**	**8.4**	**TR**	**0**	**0.1**	**1.2**	**6.7**	**2.7**	**2.2**
Greater Rain per day(mm)	**6.8**	**9.2**	**3.2**	**10.5**	**8.4**	**TR**	**0**	**0.1**	**1.2**	**6.5**	**2.7**	**4.4**

Source: Authority for Meteorology, Cairo, Egypt.

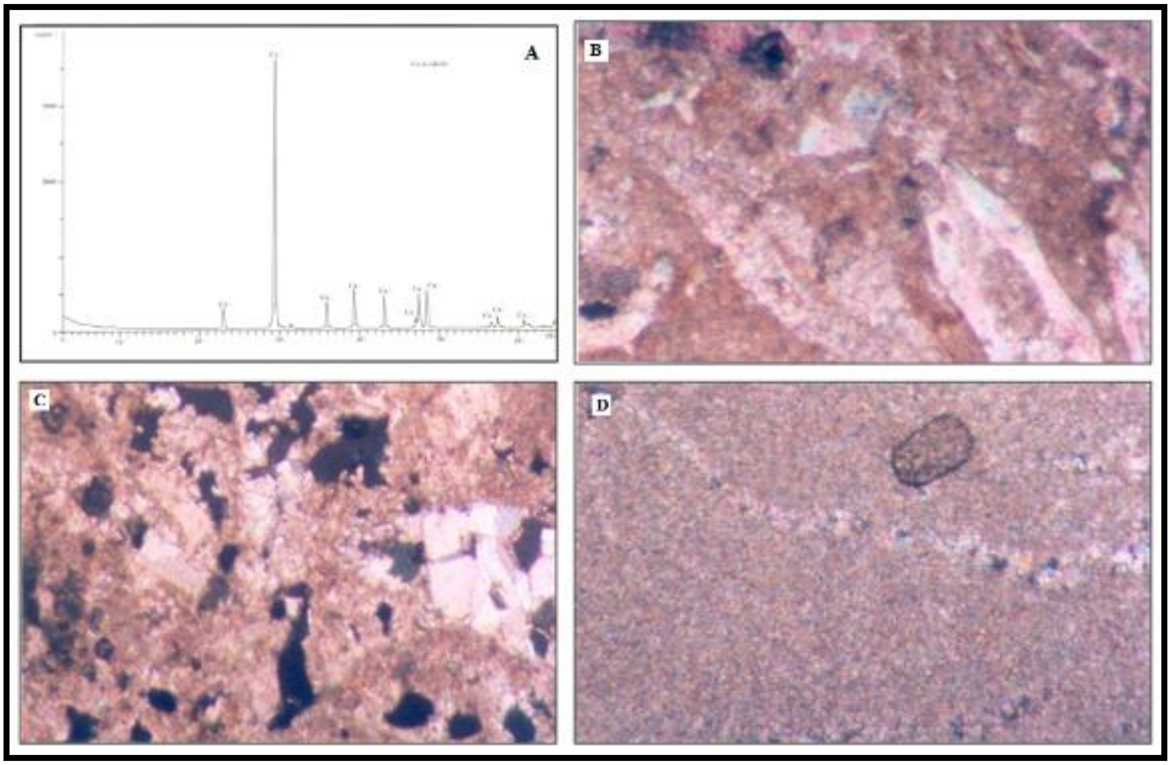

Figure 2. Petrography and mineralogy of area study, (A). X-ray diffract graph showing the mineralogical composition of Samault Formation limestone. (B, C and D) Thin section from Samault Formation.

Field work has been done during January and October 2012, for surveying the Archaeological site in Beni Hassan. The land use around this site have been documented (Figures 3 to 5). Locations of the studied tombs were defined by using GPS.

Figure 3. Tombs in Beni Hassan Archeological site.

Figure 4. upper cemetery appears in the tombs of the official Amenemhat

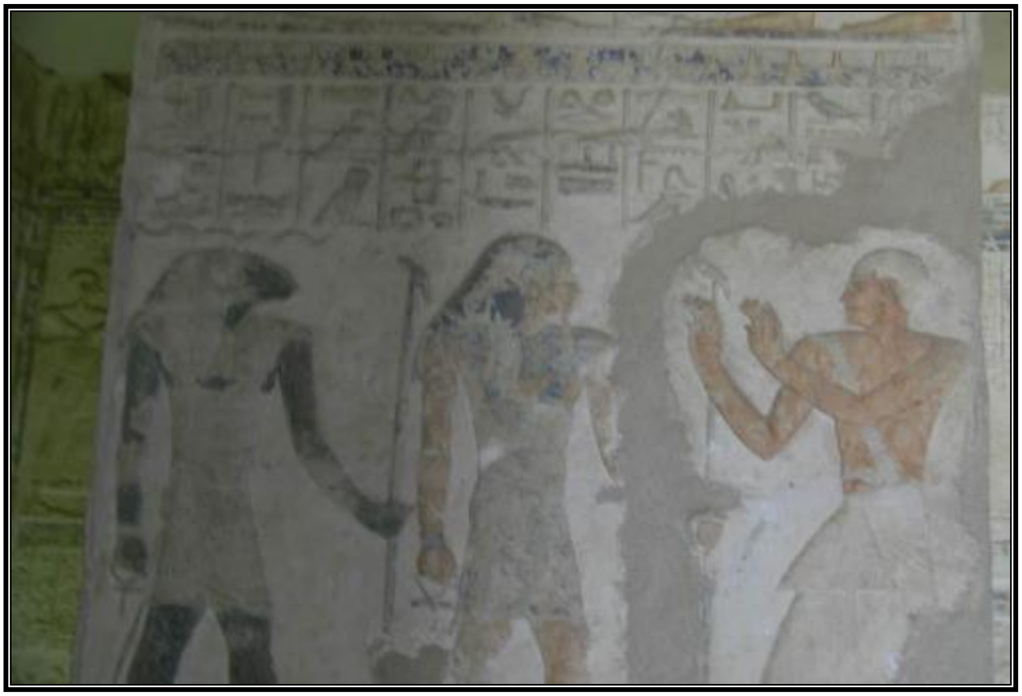

Figure 5. Restoration of diagonal fissure on a tomb wall in Beni Hassan. Notice the fissure cut through a colorfully painted scene.

Discussions & Analysis

1. Climate Characteristics

Minya meteorological station is the nearest station to Beni Hassan site. Through a general examination of the available climatological records (Ministry of Civil Aviation – Meteorological Authority (1961s – 2011s), the climatic features of the study area and adjoin region could be summarized as follows:

1. Maximum annual temperature value is 30.6°C.
2. Greater Maximum temperature value is 48.0°C.
3. Average daily temperature value is 25.6°C.
4. Minimum annual temperature value is 17.3°C.
5. Smaller Minimum temperature value is 0.5°C.
6. Average relative humidity is 55.8%.

7. Total annual rainfall is 3.7mm, and rainy days consider rarely.
8. The maximum amount of precipitation recorded in one day was 11.2 mm (18-2- 1975).
9. A main thunderstorm is an accident, unpredictable and of short duration (few hours), causing flash flood.

The climatic conditions of Beni Hassan are those characterizing the deserts of Egypt, i.e., aridity with long hot rainless summer and mild winter with scarce amounts of rainfall. The other seasons are also characterized by unstable climate, storms and sometimes heavy rainfall. Precipitation is a rare and unpredictable event, and is accompanied by average annual potential evaporate-transpiration (ETP) greater than of 30 times the average precipitation. Figure 5. Shows climate variability in Beni Hassan, where average temperature 18˚C, while July is the warmest months of the year, with an average temperature of 32˚C; which means high temperature during the hot summer months. The averages two extremes of small and majority of the temperature during the month of January between 9˚C and 19˚C. The temperature range is growing daily and seasonal sharply in archaeological sites in the deserts of Beni Hassan, where the average temperature to 40˚C during daylight hours, while declining to about 7˚C after sunset.

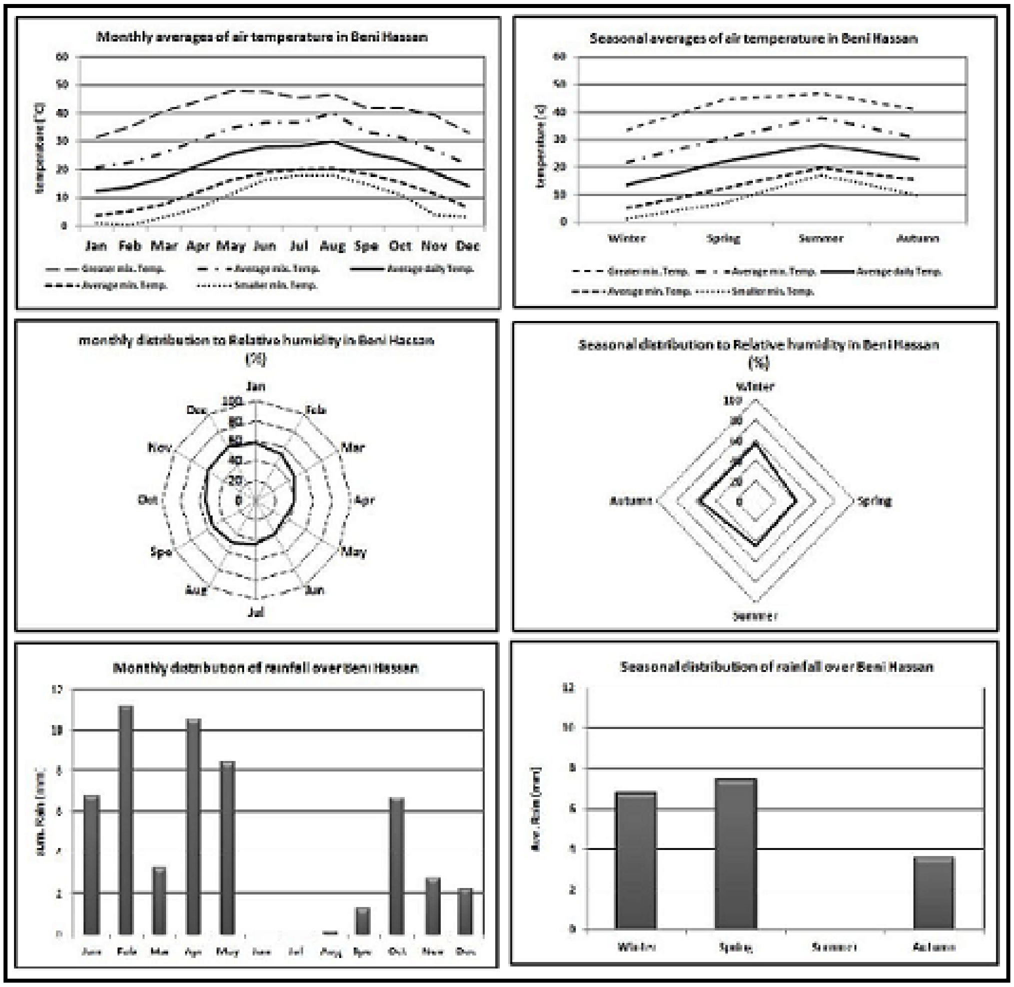

Figure 5. Monthly and seasonal averages of air temperature, Relative humidity and rainfall in Beni Hassan

Low humidity in general in Beni Hassan, especially in parts of the desert, but they rise along the Nile River throughout the year and especially during the summer months, while the humidity up when a Beni Hassan to wind North coming from the Mediterranean Sea, and decreases sharply when it exposed the Local winds blowing hot dry dusty air decreases at the forefront of the Mediterranean during the period between March and June. It winds give rise to soft sand, in addition to low humidity. Beni Hassan archaeological site is exposed to limited amounts of rainfall during the winter months as a result of exposure to the air blowing some declines coming from the northwest, the quantity of rain falling on this site less than one inch (2.5cm) per year, and almost non-existent to the south of the city of Minya.

The sand storm phenomenon occurs over El Minya during the equinoxes (autumn and spring). The frequency of occurrence of sand storms during spring is higher than that autumn. The sand storms usually happen due to the passage of a thermal surface depression (Khamasin type) associated with a strong subtropical jet stream at the upper troposphere. It can persist for several days and is characterized by its fast movement from west to east and the associated strong surface winds that can carry the sand aloft. It is a sub-synoptic scale phenomenon and is hard to be detected from ordinary weather maps. However, the current satellite images are a useful tool in this respect since they are capable of monitoring the development, and tracking the path, of such thermal depressions. Sand or dust storms occur occasionally in late winter or during the transitional seasons. These dense storms carry thousands of tons of sand and are accompanied by warm winds. Sand or dust storms duration are about 3 to 5 days each winter or transitional the most season in region. These storms affect many activities in Minya, including archaeological tombs in Beni Hassan, where the sand can cover wide areas in a relatively short time (Eissa & ELashmawy, 2009).

A flash flood usually occurs due to cold air outbreaks over a preheated mountainous land. The torrential rains resulting from such weather conditions accumulate in catchment areas at the top of mountainous. At a critical situation, the water is released from a vulnerable part of the catchment area rushing towards from a vulnerable part of the catchment area rushing towards the valley, acquiring a great momentum during its long path along the mountains, carrying free stones and solid objects and causing a huge damage to the surrounding areas in the valley,By the time, it have been swept over the cliff into the valley floor . Accordingly, most of archaeological tombs in Beni Hassan area has been partly damaged by these kinds of floods.

studied the severe synoptic situations-El Minya - occurred in autumn 1994 (Amount 24. Begin 102. End 118. Intensity 0.075472 mm/ min). These situations caused severe flash floods over eastern El Minya especially valleys which crossing the Red sea hills. Results of the study show that flash floods over central Red sea caused mainly by the northern oscillations of the Sudan monsoon low.

2. Seasonal Climate Changes in the past and future

Surrounding the perception of a climate of Beni Hassan in the past since the history of the effects of many difficulties and these difficulties increase the deeper we went on foot and we moved away from the nineteenth century, And return this difficulty that the basic elements that formed the climate periods old is not known in any manner of accuracy, and despite the difficult reconstruction of the climate of earlier periods, but we can assume that the climate of the periods of old was linked to patterns of the current climate, which has to be and that has evolved from this patterns, and we can there for assume that the climate of Minya desert and Beni Hassan in fluencies by the location of both of my domain assembly between the orbital and the front-polar, who know that they moved out towards the north or south during the previous periods in recent history confirms that the pattern of climate semi-arid had budged with the continuous movement of the scope of assembly orbital across latitude to the south among the most rain periods in the twentieth century (The period in 1921 and the year 1950) and the least rain (The period between 1956 and 1985).

Palaeo climatic and archaeological data indicate that the climate of arid Beni Hassan has experienced many past fluctuations that might be comparable with future climate change. Based on the early-to-mid-Holocene reconstructions, the arid zones of Minya may become moister as a result of global warming, due to an expected southward shift and probable intensification of the westerly cyclones (Lioubimtseva et al., 2009). If we take the years of the twentieth century, we find that this line has budged between two hundred to three hundred kilometers of rain over the years (year 1929) and driest (year 1984). Meteorological data series available since the end of the 19th century show a steady increase of annual and winter temperatures in this region. Both aggregated temperature data downloaded from the Climate Research Unit dataset and earlier study of individual weather stations across the region (Lioubimtseva et al., 2005) indicate a steady significant warming trend in this region.

It seems that the most favorable scenario responsible for the east desert disturbances that lead to flash floods in El Minya comprises two major factors:

- ❖ The existence of a low atmospheric pressure at the surface, the northward extension of the Sudan monsoon trough or the existence of an eastern Mediterranean depression north of El Minya.
- ❖ The simultaneous presence of the polar and subtropical jet streams in the vicinity. The proximity of these two large westerly currents leads to conditions suitable for the onset of a strong hydrodynamic instability associated with severe thunderstorms and torrential rains.

Autumn is considered the season of highest frequency of occurrence of flash floods in El Minya district due to invasion of cold air masses into the preheated mountainous area after a very long hot summer.

The remotely-sensed rainfall data as well as the statistical analyses techniques are particularly valuable for the desert catchments as the rainfalls is being observed at very few locations, and it is also characterized by high spatial and temporal variability. Thus the accurate estimation of essential flow parameters such as, the runoff coefficient is mainly controlled by the accuracy of rainfall data as well as other catchment geomorphological parameters. Several remote sensing-products such as the Tropical Rainfall Monitoring Mission (TRMM) and the Global Precipitation Climatology Project (GPCP) are increasingly available to measure the precipitation at semi-global coverage with a grid spatial resolution of 0.250 X 0.250 (Huffman et al., 2007; Hossain et al., 2011). Although, the remote sensing-based rainfall estimates may represent the sole source of precipitation input to any hydrological model for the dryland catchments, particularly when rainfall stations are insufficient or totally absent. Herein, a designed storm of 50-years return period was estimated in order to analyze the flood probability, and to estimate the resulting hazard (i.e. flood depth and extent)

Normally, a series of annual maximum daily values has to be constructed and ranked in descending order of magnitude. The recurrence interval corresponding to the rank was computed using the Weibull plotting formula as:

$$P = M/n+1 \text{ and } Tr = n+1/M$$

where n is the number of years on record, and m represents the event rank in order of magnitude. P and Tr indicate the probability and return period or frequency, respectively. The statistical analyses showed a strong correlation between the maximum observed rainfall during a single day and the estimated storm of 50- year return period (Subyani et al., 2009). In general, the flash flood hazard is not bounded to a certain designed storm; rather it depends on the importance attached to the susceptible sites and the feasibility of constructing the required structures to mitigate flash floods. Accordingly, the constructed drainage and defense measures of flash floods in the area should be capable to absorb a 50- year return storm to minimize the impact of resulting flash floods. Therefore, the estimated total rainfalls of a 50-year return period were estimated to 80 mm, and these values were used to calculate the runoff hydrographs of the catchments.

3. Analysis of climatic conditions impact

Beni Hassan site are situated along the eastern bank of the River Nile and occupies the alluvial plains. The land features in the study area are mainly of sedimentary origin and including three main geomorphic units. These three units are young alluvial plains, old alluvial plains are present along both sides of the Nile valley and are exposed as terraces found at various heights above the young alluvial plains. These terraces were formed as a result of the gradation and degradation of Nile valley relative to changes of the ultimate base level of Mediterranean Sea (Ball, 1939). and structural limestone plateau. It built up of Eocene deposits consist of limestone marl and sandstone. it characterized by an irregular surface and elevation range from 110 m to about 415 m above sea level. Its limited by a cliff on the western side runs parallel to the Nile. This cliff is broken by many dry wadies drain into the Nile during flash flood. Most of the tombs in the studied sites were built above The eastern plateau.

From field inspection and lab analysis, it is clear that lithology plays an important role on the extent of damage. Bani Hasan tombs were drilled inside the limestone hill, which consists of two distinct Formations, upper limestone beds of Samault Formation and lower beds of El Minya Formation. From field survey and laboratory analysis, Samault Formation is weak in its bearing capacity. Bani Hasan tombs were drilled inside limestone of Samault Formation which is characterized by total porosity reached to 21 % while the total porosity for limestone of El Minya Formation, it is reached to 12 % (Table 4).

Petrographic studies which carried out on the collected samples from limestone layers reveal the highly porous and fossiliferous, even poorly preserved nature of this calcareous beds. The calcareous bed belongs to grain stone texture type, and is considered as bio sparite. Most of the contents of the fossils (especially gastropods) are completely removed due to dissolution processes, leaving fossil moldic pores (Tucker and Paul,1990). The limestone bed is dominated by inter granular and intra granular pores, which could be observed clearly on the thin sections, scanning electron microscope images and even on hand specimens. Inter granular pores are mostly connected while the intra granular pores are considered as moldic porosity. The high percentage of porosity indicated that the limestone beds are partly cemented. As mentioned above that these tombs were constructed in limestone rock of high porosity and fractured range which has a great effect on the destroying action of these tombs.

Table 4. Average petro physical parameters of the studied limestone sample in Beni Hasan site.

Sample No.	**Average petro physical parameters**		
	Effective Porosity (%)	Bulk density	Water Saturation (%)
1	19.40	1.82	12.80
2	20.91	1.96	11.02
3	26.20	1.78	14.50
4	14.20	2.14	8.24
5	14.60	2.13	8.34

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From the tectonic point of view, the upper limestone bed of Samault Formation suffered from map cracking associated with falling rocks. The northern part of El Minya limestone plateau is a sub vertical cliff, on which the Beni Hasan tombs were drilled. The cliff is affected by falling rocks with big volumes which reached to more than few cubic meters Figure (6).

Figure 6. Falling of limestone concretions from upper beds of Samault Formation

which lie directly above Beni Hasan tombs.

The chemical analysis of this limestone reveal that the major constituent is CaCo3 (98 %), Sio2 (less than 2 %) and NaCl (0.078 %). NaCl in moisture is easily transported to the surface by capillary rise and tends to form NaCl crystals. Salt recrystallization, slaking and wind are picked up as causes for tombs. Two of them are associated with movement of moisture content in porous limestone. There is a local cycle of moisture budget between rock surface without major fissure and the air. Its quantity is 2.1-3.3 g/m2*h, and almost constant in winter. Namely, moisture content moves upward and downward in a day. At the major fissures in the monuments, the movement of moisture content is always one directional, namely from the inside of rock to the air only, and its quantity is 4.4 g/m2*h. Radiation cooling accelerates deterioration of limestone on the tombs surface. The magnitude of deterioration is easily distinctive through the reaction to outer walls exposure of these tombs. The field survey found the following:

Tomb No. 1: This tomb consists from three rectangular shafts opened in the top of the hill Figure (7). No painting or writing recorded in this tomb. It is subjected to wind erosion.

Tomb No. 2: The best preserved painting in upper cemetery appears in this tomb. In the front of this tomb there is a plain (8 m width in 9,1 m length) may assist in rain water accumulation. Wall entrance of this tomb includes painting in bad conditions as a result of weathering actions. Drawing in the lower part of the wall tomb to 180 cm height is subjected to detrition process due to increase of humidity or human action.

Tomb No. 3: In the front of this tomb there is a place may be assist in collecting rain water. Drawing in the front of tomb is greatly affected by weathering action. Many natural pores were noted in the celling some of them are resorted. Most of the painting and drawing in the lower part is destroyed either by human or weathering action since tomb is opened to the visitors.

Tomb No. 4: Weathering and human action appear in the northern side of the front wall in this tomb. Drawing and painting in this wall also affected by weathering.

Tomb No. 5: Two columns are present in the front of the tomb. These columns are completely affected by wind erosion and human hazards Figure (7). Also many natural pores filled by bird nests.

Figure 6. General view to wind erosion of tomb No.1.

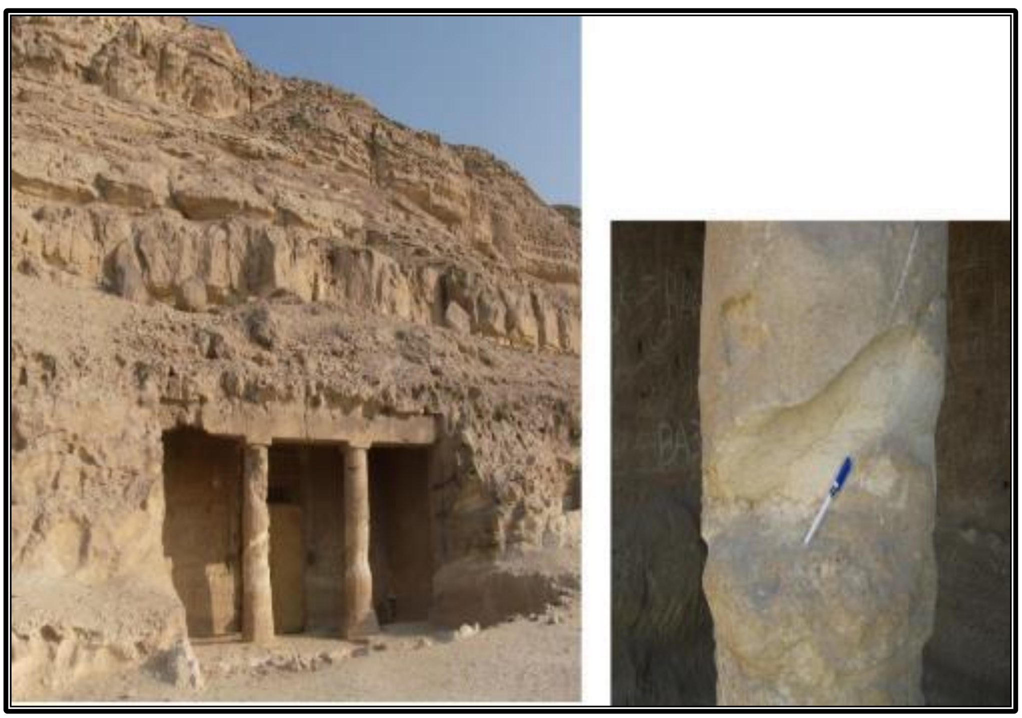

Figure 7. General view, where the wind erosions are shown in the columns of tomb No. 5.

Tomb No. 9: Big hole was founded in the northern western side of the tomb; it seems to be formed by human action. This hole facilitates moving of dusts, insects and winds inside the tomb.

Tomb No. 13: Salts and fungi appear by dense way in the celling and extended to the walls Small hole (30 cm) in the iron door was traced may be facilitate moving of sand and rain water towards the tomb. Small drainage in a form of small wadi was traced between tomb No. 13 and tomb No. 14 with general dip reached to 32.5 degree.

Tomb No. 15: Wind erosion was detected at the column in the front of the tomb. Rectangular plain was found in the front of the tomb may be assist in collecting rain water and sands towards the tomb.

Tomb No. 16: Wind erosion was detected in the front wall where the erosion action appears in a form hole (6.6 m length and 0.31 widths). Many joints and cracks recoded in the western wall as well as traces for the rain water were noticed along these cracks.

Tomb No. 19: Some mud cracks marks were traced in dust at tomb floor which reflects to some degree entering of rain water.

Tomb No. 21: The main floor of the tomb is in lower level than the floor of the main entrance by 50 cm and this will be assist in entering of rain water.

Tomb No. 26: Effect of wind erosion was shown in the front wall by dimensions reached to 3.1 m length and 1.4 m width. Natural pores were also measured in the front wall and ceiling where the diameter reached to 0.4 m. Traces from rain water, salts and fungi was also detected in the walls and ceiling.

Tomb No. 29: There is a natural crack in the ceiling reached to 2 m length and 8 cm width may be responsible for seepage of rain water towards the tomb.

4. Analysis of field survey/emulation results

Beni Hassan tombs were classified into two groups. The northern group includes tombs from number 1 to 13, while the southern tombs started from number 14 to 39. All tombs have iron doors except tombs No 1, 7, 11 and 35 since these tombs considered incomplete. Beni Hassan tombs designed by drilling inside the hill where the rock blocks were catted and through away. It seems that the tombs locations were selected depends on hardness of the rock bank. Only twelve tombs are containing painting. Impact of Seasonal Climate Changes were surveyed at six sites and described in the following:

Tomb NO.2 of Amenemhet’s, has a false door towards west, which is the direction through which the dead were believed to enter the underworld (Garstang, 1907), on the walls are depictions of happenings from Amenemhet's life, but most scenes show what was expected for his afterlife. From field survey and Figure (8) note the following: (A) General view of the west wall peppered the entrance door, it clearly shows the effect of infiltration rainwater from the top of the Tomb. (B) The western wall, the south side, eight rows represent prepare the wine industry, goats grazing and hunting birds and fish, (Bb) The same scene influenced clearly by Climatic factors such as, relative humidity and air temperature variation, (C) The Western Wall, the north side, seven rows representing industries including Woodworking, metals and pottery, (Cc) The same scene influenced by relative humidity and air temperature variation.

Tomb NO.14 of Khnumhotep I, (A) General view of the south wall and shows the effect of humidity on the north side. (B) The north wall, west side, the tomb owner and his wife oversee the work of daily life, (Bb) The same view, shows the effect of humidity and rain on the north side. (C) The northern half of the east wall contains the titles of the tomb owner and three rows representing a group of soldiers training, (Cc) The same view, and shows the effect of humidity, rain and human activity (Figure 9).

Tomb NO.15 of Baqet III, The Tomb of Baqet is the oldest of the interesting tombs and this one offer its main attraction in paintings of wrestlers on the inner wall, but the sport has in many pictures been forgotten for other possibilities close bodily contact involves (Newberry, 1893), gazelles prove their vitality on the north wall. From field survey and Figure (10) note the following: (A) General view of the west wall, in the middle of the entrance and shows the impact of restorations. (B) Views of the north wall, the tomb owner and behind him his wife were oversee the activities of daily life, including hunting in the desert, (Bb) Sensitivity dyeing material relevant a metal origin for damage as a result of air humidity. (C) The east wall, eight rows, five for wrestling, and three for fighting, (Cc) Sensitivity dyeing material relevant a metal Origin of air humidity on the south side. (D) South wall, in the middle of the tomb owner was standing inside the cabin watching the activities of daily living, (Dd) General view of the south wall, it appears natural and human damage.

Tomb NO.17 of Khety, the wall paintings are most interesting in the respect that they show everyday scenes from the Middle Kingdom. (Trudy et al.,1996 and Robins, 1997). It is noticeable from Figure (11) that: (A) Views of the north wall, the middle part of the tomb owner and a group of musicians. The west side, in the desert and hunting stages of linen yarn and sculptors, (Aa) The north wall, the south side affected by humidity and electric lighting. (B) The Western Wall, the north side, three rows representing hunting in the bush, (Bb) The Western Wall, the north side, human influence more than natural. (C)

The east wall, several rows representing different movements wrestling, (Cc) The western wall, the rock was nominated for rainwater, especially in the north side. (D) The south wall, the owner of the tomb and stood behind him Umbrella pregnant and followers, (Dd) The south wall, which shows restorations as a result of natural and human damage.

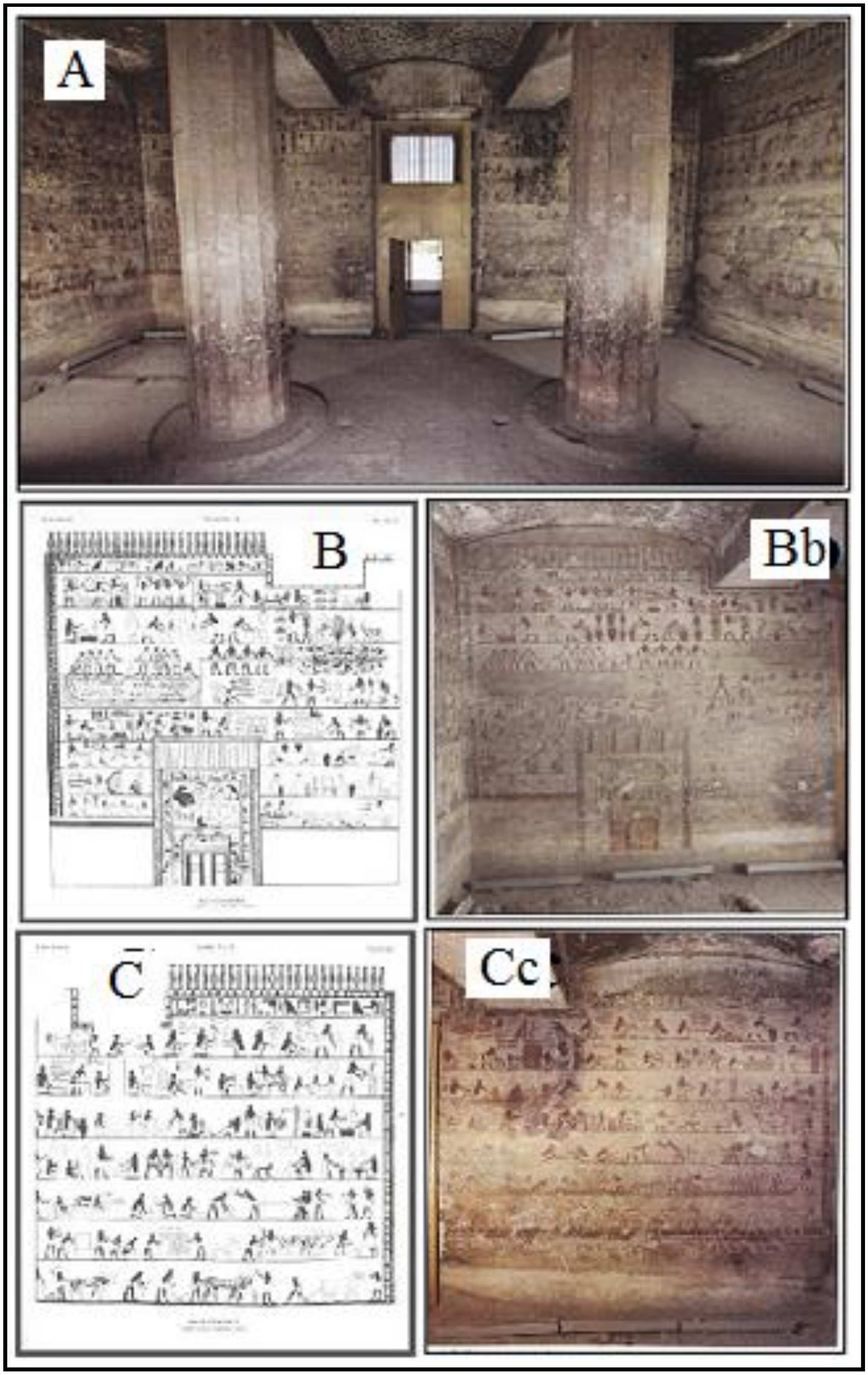

Figure 8. Tomb NO.2 of Amenemhet's.

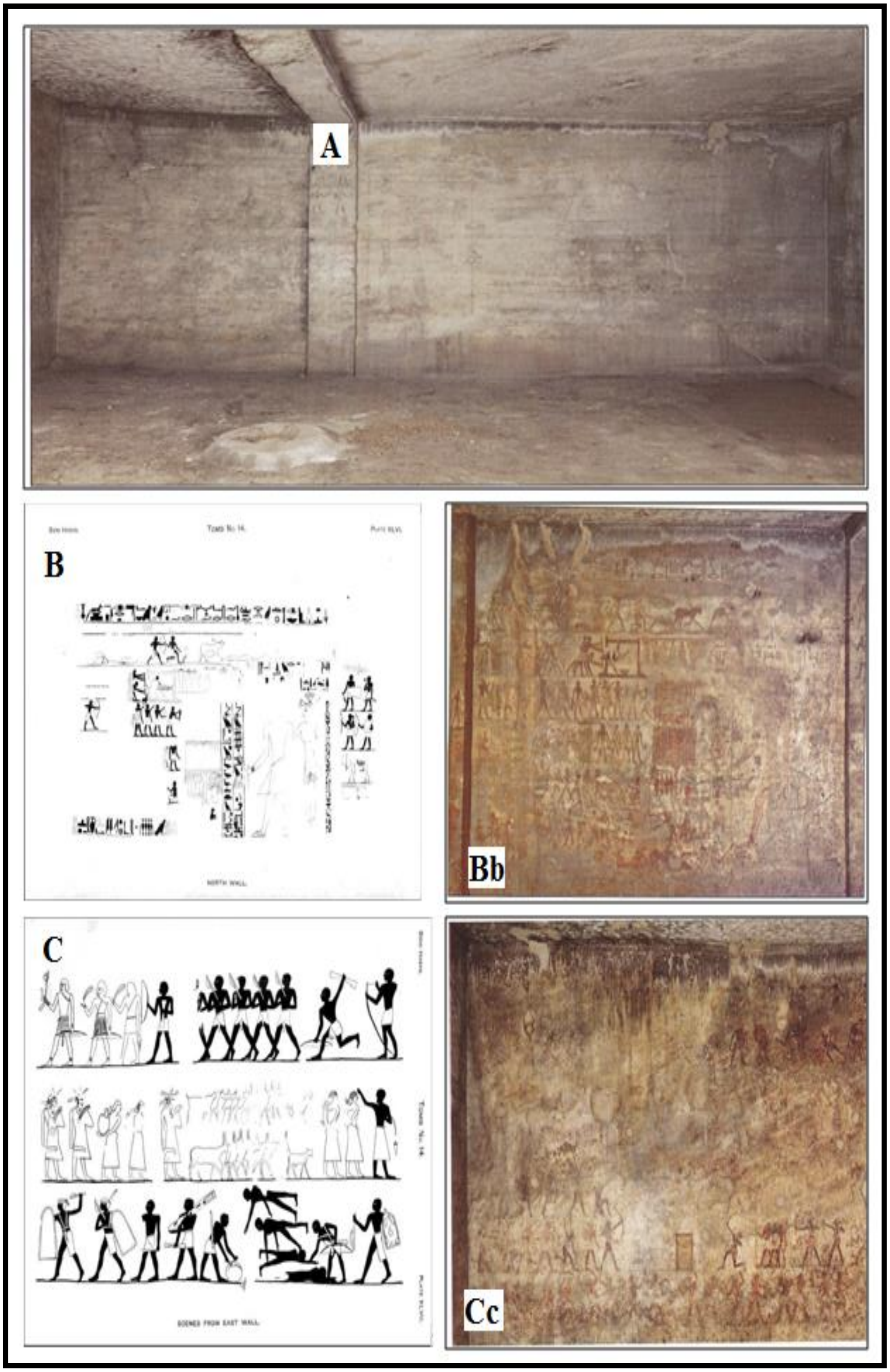

Figure 9. Tomb NO.14 of Khnumhotep I

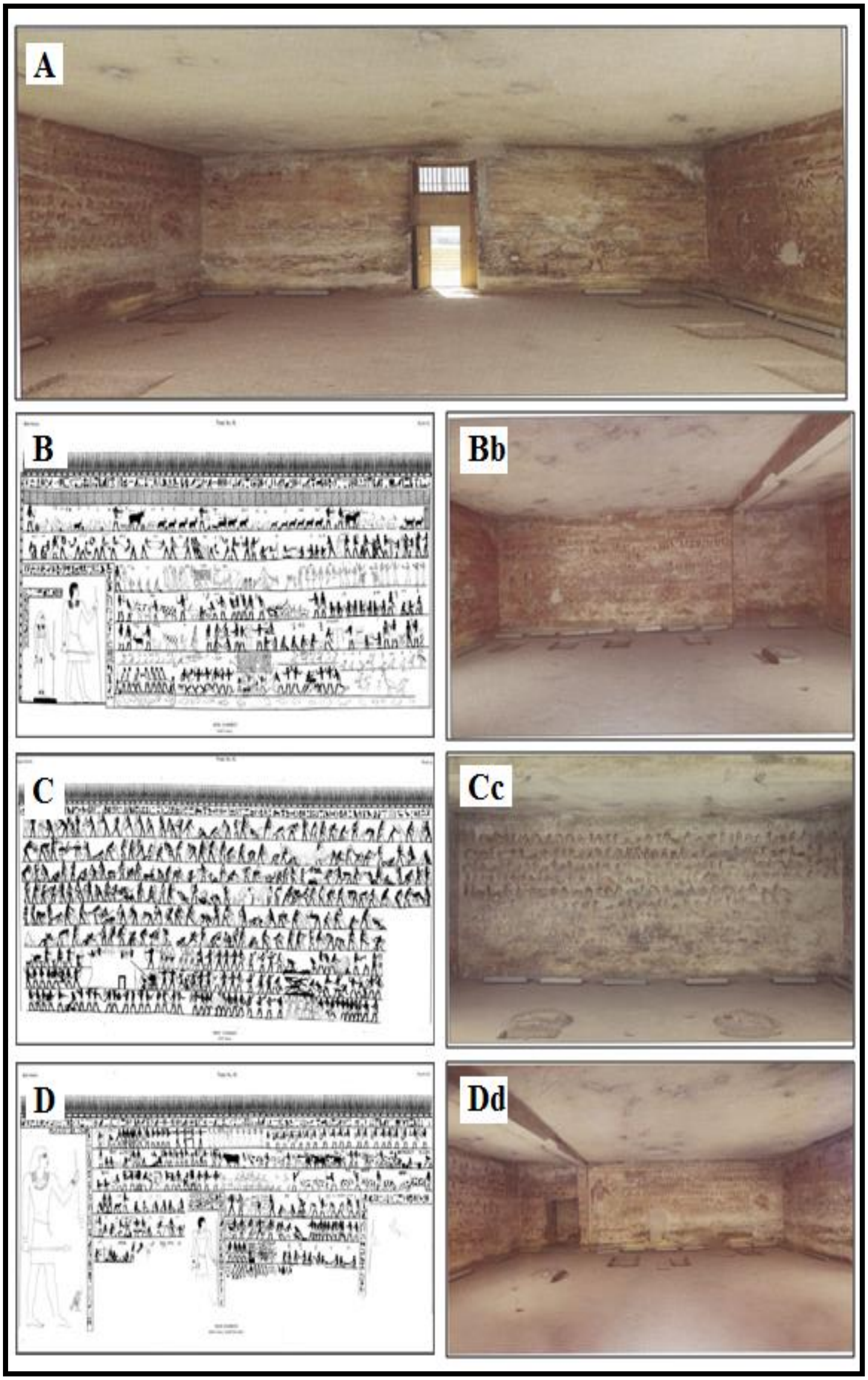
A
B
Bb
C
Cc
D
Dd

Figure 10. Tomb NO.15 of Baqet III

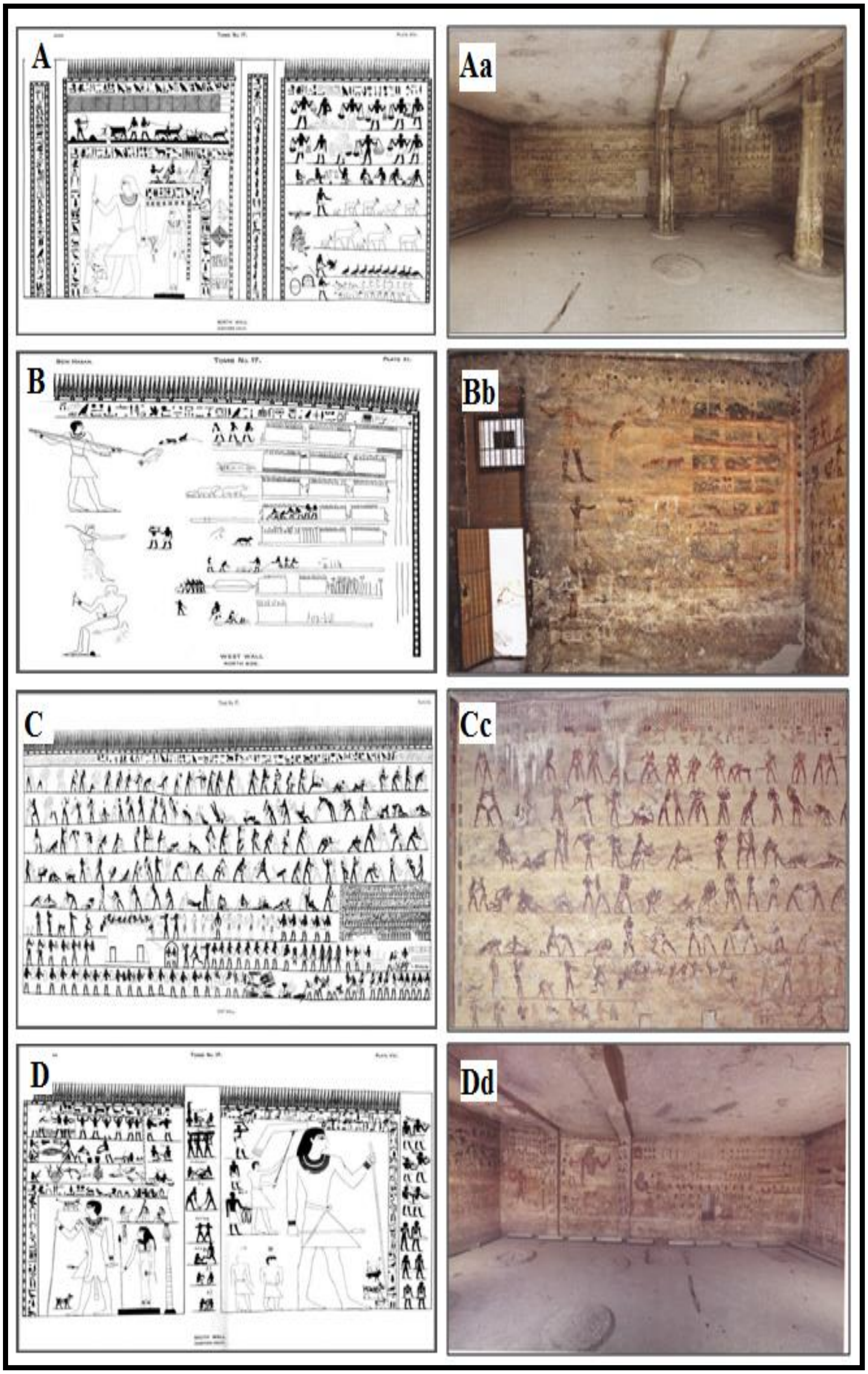

Figure 11. Tomb NO.17 of Khety

Tomb NO.29 of Baqet I, (A) View of the west wall and seems quite crusher. (B) North wall, Baqet I during hunting in the forests, and during bird hunting, and a window lead to the tomb No. 28, (Bb) The north wall, shows the effect of humidity, and distortion of the south side of the Christian era. (C) East wall, door an imaginary on the south side, view Baqet I standing up and rows of offering bearers, (Cc) The east wall, shows the effect of humidity in the north side, and distortion of the south side of the Christian era. (D) South wall, Baqet I sitting and rows of offering bearers, and a window lead to the tomb No. 30 (Dd) General view of the south wall, it appears distortion of the Christian era (Figure 12).

Tomb NO.33 of Baqet II, (A,B,C) The east wall, the left of the row top, the right Baqet II standing up in front of a group of offering bearers, and the distortion appears on the southern and eastern sides. (D) the left false door sculptured on the west wall, the right, distortion appears on the southern and northern sides. (N) the left Baqet II standing up in front of a group of boats, the right General view of the south wall, it appears distortion of the Christian era. (S) The south wall, crusher, except part of the north side (Figure 13).

Conclusions & Recommendations

Tombs Archaeological in Beni Hassan has been prone to marked physiographic modification, cause in This Seasonal Climate Changes impacts. The deterioration of the limestone in Beni Hassan is primarily due to water-soluble salts such as gypsum and halite, Salt crystallization in porous materials constitutes one of the most frequent causes of decay and degradation of Tombs. These salts can be observed directly as efflorescence and appear and disappear periodically according the presence or absence of moisture sources. Some tombs are open, exposed for all types of weather factors (temperature - humidity - wind, etc.). Natural phenomenon striking tomb ground level is significantly low to reach 0.5 meters from the terrace of Foreign Affairs and this in turn leads to the accumulation of sand and dust or collect flood water inside the cemetery

The study concluded that Beni Hassan Archeological is affected by surface water of flash flood and erosion by wind along the western facades of the tombs which facilitate the deterioration processes, which resulted in deterioration of the Tombs stones. Therefore, recommend Ministry of Antiquities, Egyptian Antiquities Authority and the concerned authorities external protection for most of the tombs, to reduce the accumulation of sand and gathered rainwater, and address gaps, and the use of colors in the restorations matching as designed in the tombs.

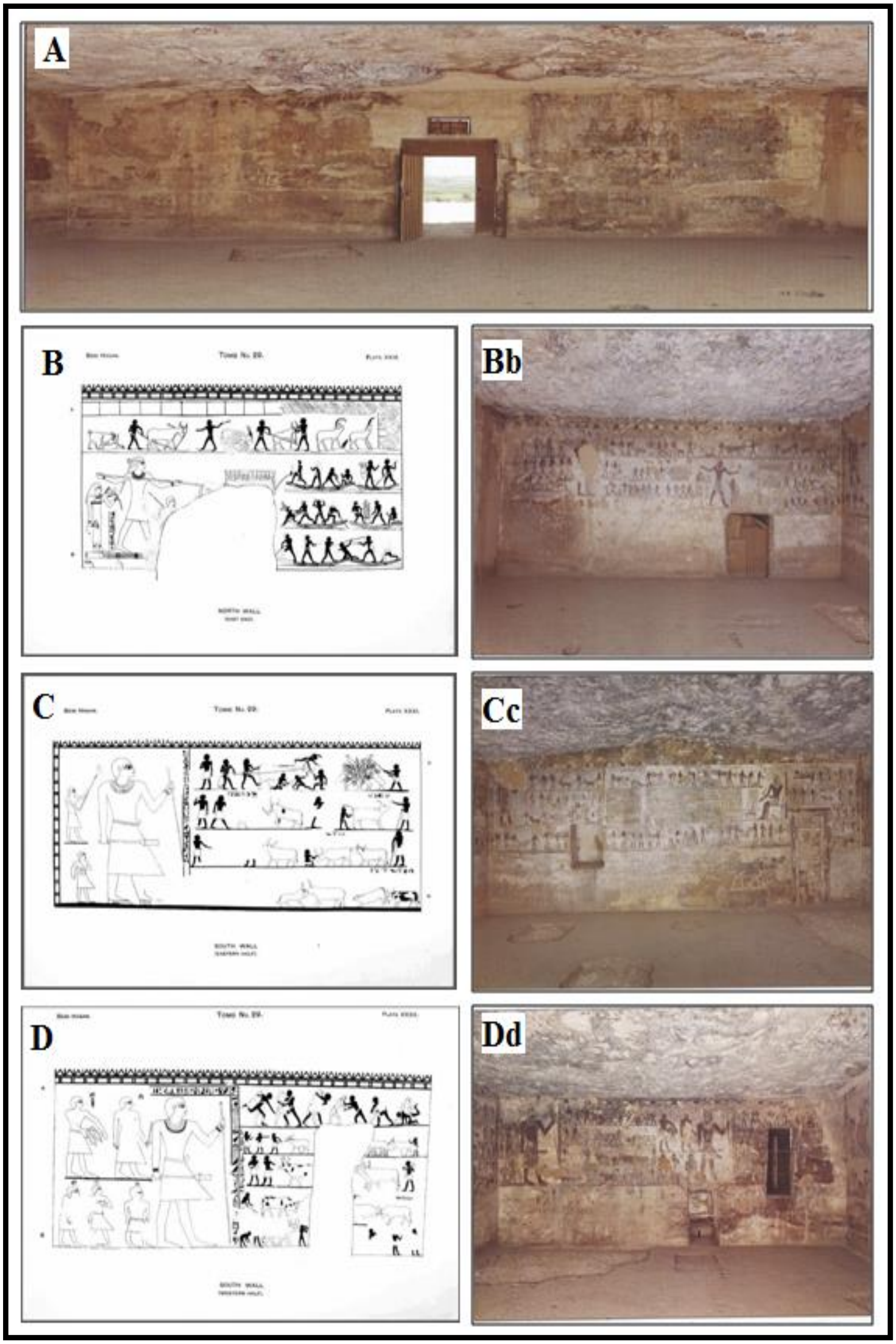

Figure 12. Tomb NO.29 of Baqet I

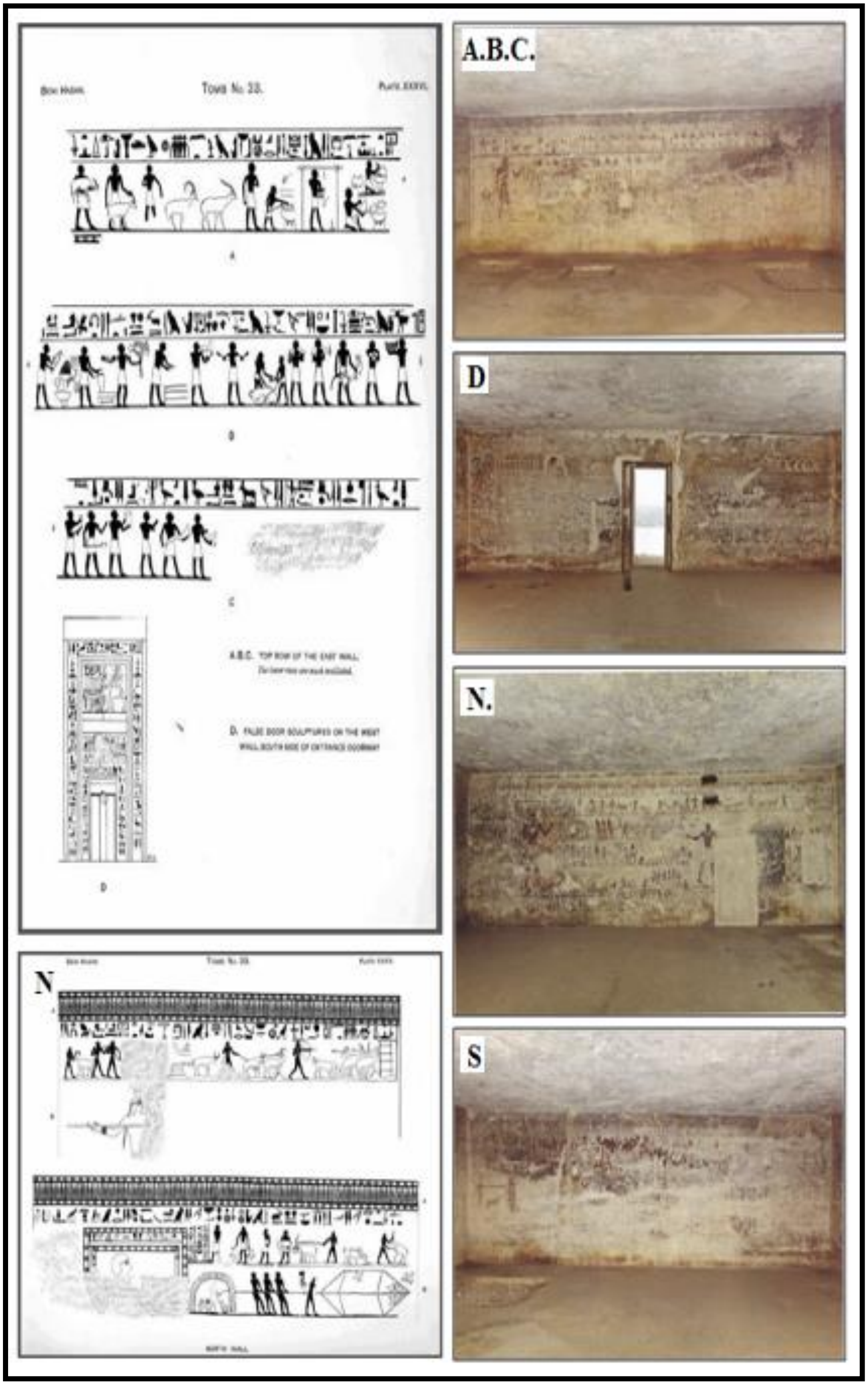

Figure 13. Tomb NO.33 of Baqet II

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