Geomorphological hazards of rockfall between Aswan and Luxor

Mohamed Arfan ALAMRAWY(*) & Ahmed Abou Agiza(**)

Abstract:

Natural hazards depend on various factors. The rock fall is the most threatening risk to the population in Aswan, it appears in a populated area, for this reason, it presents a risk suddenly despite the time it takes to appear. The condition of appearance in Aswan due to density of rocks, orientation discontinuities, and the structure of the rock mass and the presence of cavities are predisposing factors to instability

Key Words: Aswan. Risk. Landslides. Climate. Rockfall. El-Mahamied

INTREDACTION:

The Rockslide in a sparsely populated area presents virtually no risk, but a rockslide or a small rockfall in a city or on a busy road can have considerable human and economic consequences. The preparation phase is characterized by the progressive alteration and damage of the material accompanied by limited openings of fractures that are difficult to detect.

1. Description of the slope

1-1. The shape

The shape of the slope has important morphological consequences, in particular on the functioning of the collapse

1-2. The situation

The eastern slope can be subject to two types of ground movements: firstly, movements due to cracking of the granite due to the large thermal amplitude and seismic vibrations. These processes can play a role in construction. The second type is characterized by falls of sandstone blocks on clay formations.

-The slope is located north of Aswan (figure 1), with a total length of 80 km, it is fed by a steeply inclined rock face (40° to more than 60° depending on the sector) more than 70 m high (Photo 4) intersecting sedimentary formations of Cretaceous age, mainly consisting of sandstone (55%), clayey shale (40%) and limestone (5%) (Said, 1969).

The length of the rockfall slope is 80 km, but the sectors that present a risk of rockfall are 65 km and have a convex profile with a large radius of curvature taking up 80% to 85% of the total length of the slope, which has an inclination lower than the angle of repose o* of the dry debris. Due to their low sphericity index, the debris cannot roll over long distances; they accumulate mainly at the head of the scree, in the corridors of the wall, constituting masses of unstable debris (slope: 40° to 42°).

(*)King Faisal University, College of Arts, Department of Geography alomari@kfu.edu.sa
(**) King Faisal University, College of Arts, Department of Geography aabouagiza@kfu.edu.sa

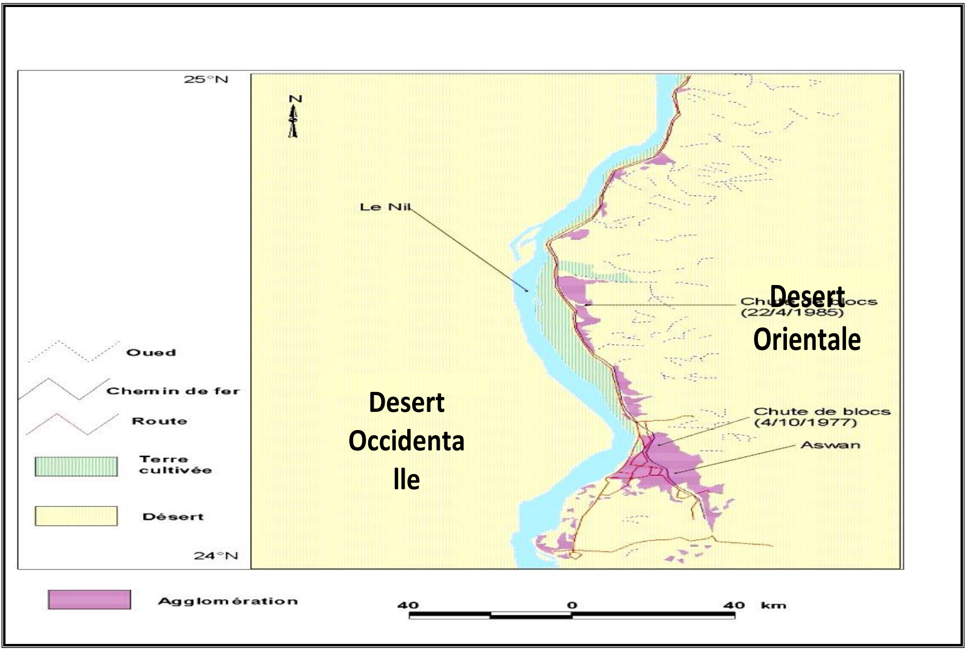

Figure 1. Land use map and location of fall en rocks north of Aswan
(Topographic maps1/50,000)

1-3. The litho-structural framework

More than 40% of the eastern slope is formed of resistant rocks (Said, 1990). Three lithological groups are represented (figure.2):

- Resistant rocks, mainly represented by the sandstones that reinforce the main ridges. These sandstone rocks are jointed and have a high porosity. They provide a material of angular blocks that lines the slope of the embankment. This material plays an important role in the morphogenesis of the slopes of the embankment by the weight exerted on the rock formations, generally soft and plastic.

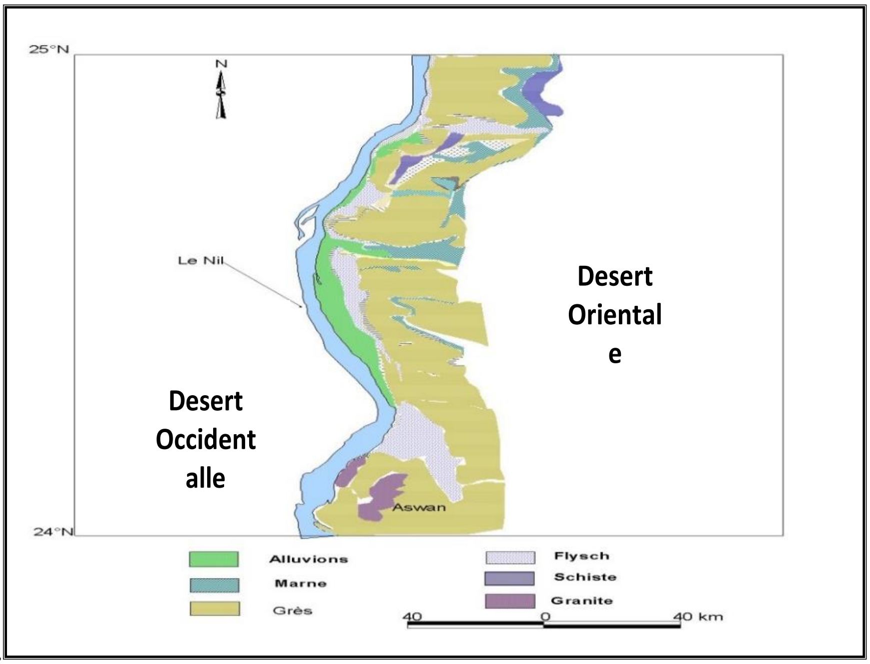

Figure 2. Lithologies and surface formations in the eastern slope north of Aswan
(Geological maps 1/1000 000, 1987)

- The moderately resistant rocks (marl and white flint marls) occupy a large proportion. These two types of rocks have the same behavior with respect to weathering. Soft rocks include Triassic gypsum marls and very soft Cretaceous marls.

1-4. Hypsometry and distribution of altitudes.

The study of the distribution of altitudes in the eastern slope is carried out from a 1/50,000 topographic map by measuring and cumulating the areas located above (or below) a given altitude (figure 3, figure 4 and table 1). We obtain a histogram of altitude frequencies and a hypsometric curve (curve of cumulative frequencies). Between the two extreme altitude values of 203 m (El Sheihk hill) at the end of the slope, and 94 m (the level of the alluvial plain), the distribution of altitudes, expressed by the map of the altimetric slices and the hypsometric curve, reflects the nature of the differentiation between the slope and the alluvial plain downstream of the slope of the slope.

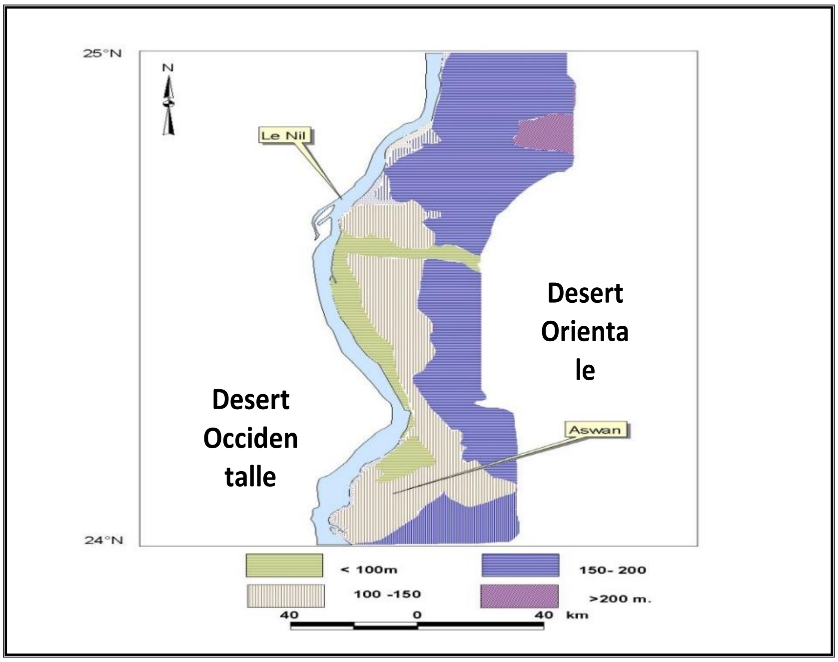

Figure 3. Hypsometric curves and altimetric slices of the slope north of Aswan (Topographic maps1/50,000)

The lowest altitudes, below 100m, represent 15% of the relief in the slope. The percentage of the altitude ranges of 100-150m, 150-200m and beyond this value, varies respectively from 30% to 60%. The highest altitude ranges are above 200m and constitute 5% of all the hills.

The distribution of altitudes shows that those, in general, below 150m are dominant. They represent more than 35% of the total surface area. The 150-200m range alone represents nearly 65% of the total surface area. The intensity of the rock falls is facilitated by the presence of this type of relief in the Eastern Slope, the dip greatly facilitates the movement of rocks on the slope.

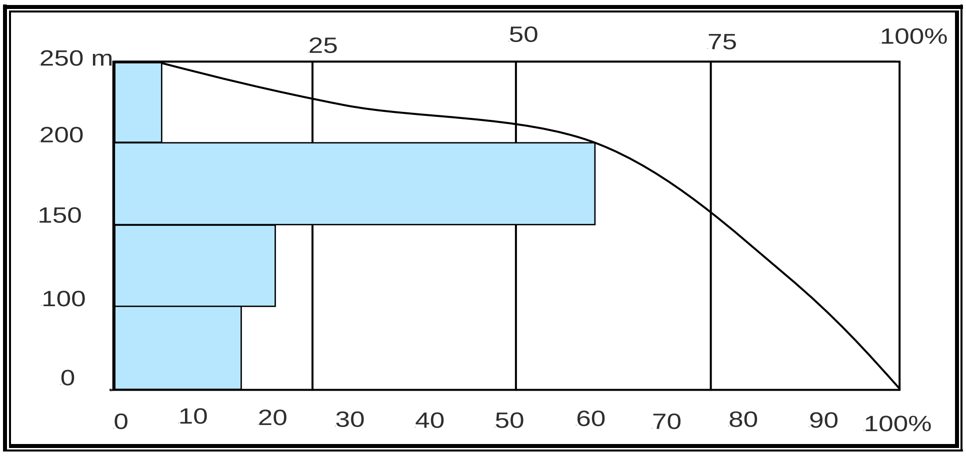

Figure 4. Hypsometric curve and histogram of the frequency of slope altitudes. north of Aswan

altitudes	Partial surfaces		Cumulative surfaces	
	km²	%	km²	%
> 200 m	40	5	40	5
150 – 200 m	480	60	520	65
100 – 150 m	160	20	680	85
< 100 m	120	15	800	100

Table 1. Distribution of altitudes in the eastern slope north of Aswan

1-5 .Slope systems.

Slopes are one of the fundamental factors of land movements and erosion. The altimetric indices that characterize the relief in the Eastern Slope are mainly: the Roche slope index (Ip), the global slope index (Ig) and the specific elevation index (D. S.).

The slope of the slopes of the embankments being basic topographic and hydrological data, its action is exerted during the transmission of precipitated water (fossils) by the different collectors of the hydrographic network. The average values of the slopes and the specific differences in level in the embankment are generally high (table 2) and Figures (5 and 6). In the classification of Gartet A. (1994), the slopes of the embankment enter into the class R6 and R7, that is to say that the relief is strong or very strong, according to the chosen criteria.

These indices have the merit of synthesizing the average slope of all the slopes of the embankment, but they do not allow an approach to the diversity and spatial distribution of the slope.

Slope classes	%	% cumulative
0- 5°	8	8
5- 15°	12	20
15 -25°	19	39
25 -35°	36	75
35- 45°	11	86
45- 65°	9	95
> 65°	5	100

Table 2. Distribution of slope percentages in the slopes of the northern eastern slope of Aswan.

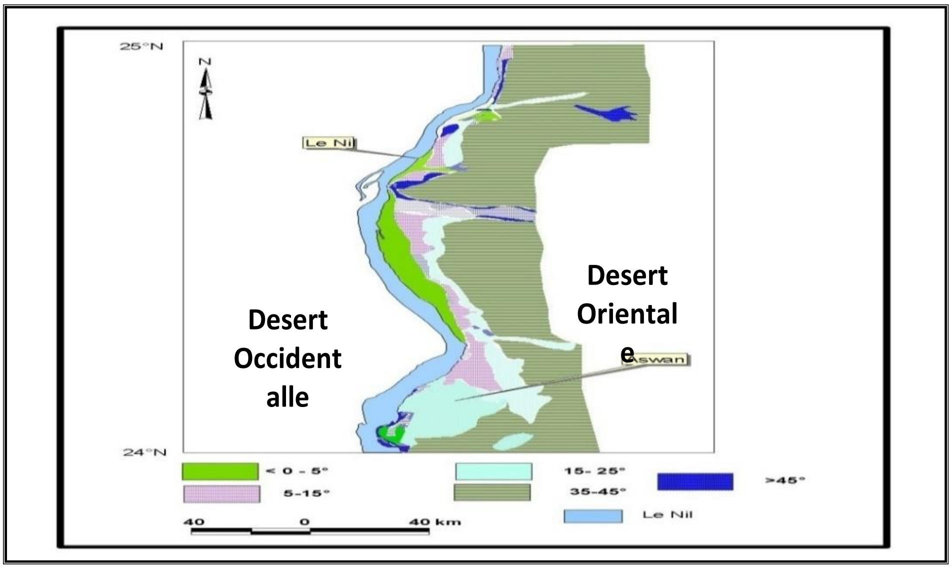

Figure 5. Slope characteristics in the Eastern Slope at Aswan
(Topographic maps1/50,000)

The slope values are highly diversified. It is noted that the relief of the slope is very dissected. Indeed, the distribution of slope percentages (figures 5 and -6) shows a concentration of more than 40% of average slopes, between 15° and 25°. The steepest slopes, on the other hand, have a reduced distribution. They occupy the slopes of the embankment to the east, while the gentle slopes (0 – 15°) constitute 28% of the total surface of the embankment.

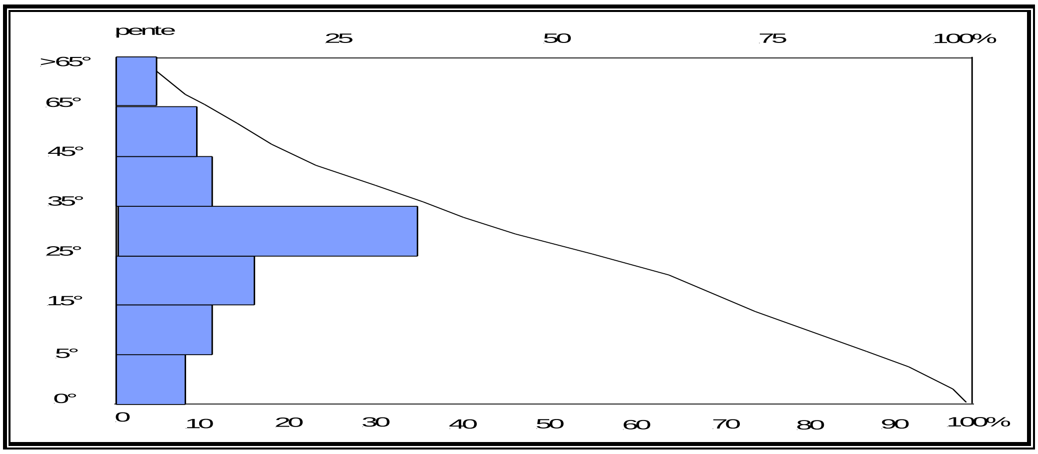

Figure 6. Courbe clinométrique et histogramme des fréquences des pentes nord d'Assouan

We studied the morphometry of the slope of Abou er Rishe and El Mahamied north of Aswan and summarized in the table below.

		Abou er Rishe	.El-Mahamied
P / km	Perimeter of the slopeSurface	80	66
S / km²	Length	895	612
L / km	Longest length	25	18
L / km		31	22
Kc	GRAVELIUS compactness index (1)	1.2	1.1
Ia	HORTONEl ongationIndex (2)	2.3	2.0
Ih	Indice homogeneity TEST (3)	0.60	0.45
If	Form index (4)Indice de circularité	0.32	0.82
Icr	MILER (5)	0.51	0.41
Alt. max. (m)	Maximum altitude / m	235	242
Alt. min. (. m)	Minimum altitude / m	94	95
Alt. Moy. (m)	Average altitude / m	164	187
Alt. med. (m)	Median altitude / m	83	85
Pente moy. (%)	Average slope / %	150-200	150-200
Orient.moy.(°North)	Modal orientation in °North	33 N-N E	36 N-N E
Ip	ROCK Slope Index (6)	0.11	0.13
Ig (m/km)	Overall slope index (7)	18.5	17.1
DS (m)	Specific elevation (8)	150	153
Le (km)	Length of the equivalent rectangle	32	28
Ie (km)	Width of the equivalent rectangle	2.1	2.0
Sc (km)	Surface of the same perimeter as the	895	6.2
Pc (km)	Perimeter of a circle of the same surface area	23.6	21.1

Table 3. - Main characteristics and morphometric indices of the slopes studied north of Aswan.

2. Thermoclasty processes

This process of mechanical weathering consists of the mechanical distraction of rock materials under the effect of numerous and significant daily temperature variations of several tens of degrees per day. The minerals that make up rocks absorb temperatures more or less quickly: they are more or less conductive. Black or formed of metal, they expand in the heat and contract in the cold. White or light rocks and minerals are less sensitive to thermal contrast. The water content of rocks and soils plays an important role.

The repetitive alternation of these processes causes wear of the rock, which crumbles on the surface, to a thickness of a few centimetres at most. The penetration of the thermal flow into the rock depends on the intensity and duration of the temperature (high or low). It also depends on the conductivity of the rock materials and their water content.

The environments affected by thermoclasty are those where there are strong daily temperature variations. But they are also dry environments since atmospheric humidity prevents excessively strong thermal amplitudes. On land, these are mainly continental regions (the maximum annual thermal amplitudes sometimes exceed 50 to 60 °C, especially in dry deserts). In addition, the sunshine that reaches 3863 hours per year and the increase in temperature in Aswan and the rapid gradients in temperature from the surface to the interior of the rocks cause thermoclasty. The action of thermoclasty and its speed vary from one rock to another, limestone disintegrates more quickly than sandstone.

Aswan Governorate is characterized by a very hot climate, especially in summer, but in winter it is temperate. In this region, two main seasons alternate, a hot summer and another nearby temperate one. Due to its position in the South of Egypt, and its latitude 22° North, Aswan Governorate is subject to the influences of lack of precipitation. The concept of thermoclasty is that rock and minerals are broken by large daily and/or seasonal temperature changes, and rapid temperature gradients from the surface to the interior of the rock (photo 1).

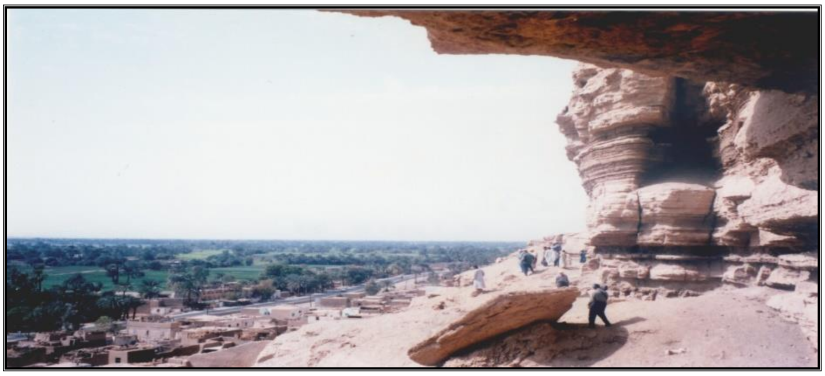

Photo 1. Rockfall at habitat level caused mainly by weathering (north of Aswan)

According to Goudie (1997), exposure of the rock surface to sunlight allows the superficial part to expand. When the lateral expansion is stopped by the surrounding material, a horizontal compressive force develops in the heated part. On the other hand, during the night the rock surface cools, shrinks laterally and develops a horizontal tension in the cooled part.

The moisture is associated with high daily temperature change, water trapped in rock capillaries can (due to its high coefficient of expansion) produce internal pressures high enough to fragment the rock under a temperature range of 10-42°C. This process depends on the rock structure, temperature range and moisture availability (Cooke, 1993).

Temperature data can help us better understand the daily and seasonal temperature differences in Aswan Governorate. Generally, we have explained the climatic constraints and climate of Aswan in the first chapter. We summarize the daily and seasonal differences and the thermal amplitude. In Aswan Governorate, according to Figure (3-12), the daily average temperature reaches its maximum during the summer season in June (42.6°C) and it reaches its minimum during the winter season in January (8.5°C). The thermal amplitude is the same throughout the year and it varies between 18.4°C in June and 10.2°C in November.

Generally, the thermal amplitude is higher in Aswan Governorate mainly during the months of May and June. The effect of thermoclasty that participated in the geomorphological process of the region during the ancient periods of the Holocene continues its effect until now.

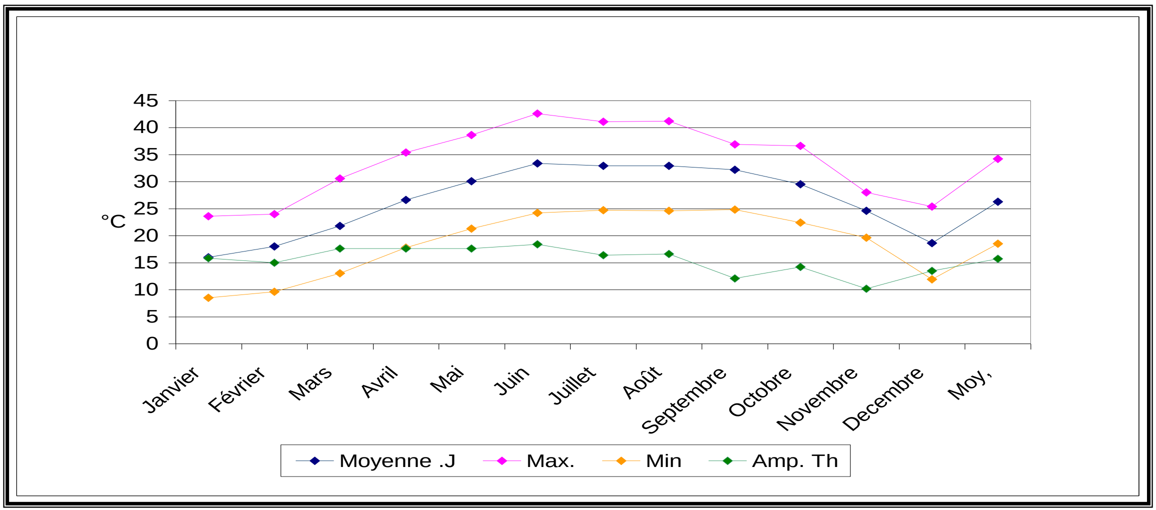

Figure 7. Paramètres de température dans le gouvernorat d'Assouan (Egyptian Meteorological Authority)

The chemical or mechanical fragmentation of parent rocks under the effect of a motorizing agent, played a major role after the cessation of Holocene rains and during the drying period. In this period, the development of cracks was mainly caused by desiccation processes. Photo (2) shows thermoclasty, resulting from weathering during the arid phases of the Holocene, since the rocks are dry and they have fossil water and consequently they favor the phenomenon of thermoclasty, at the same time photo (3) clearly shows thermoclasty in sandstone rocks.

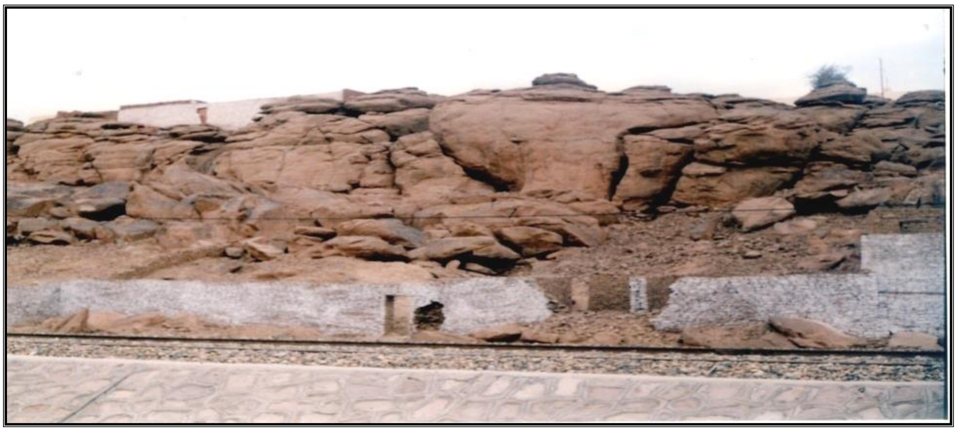

Photo 2. Thermoclasty in the eastern slope of the Eastern Slope (sandstone) north of Aswan.

Currently, disintegration plays two roles:

The first begins in the clay after rain. The second is explained by the differentiated structure of the slopes of the embankment between clayey layers and layers of sandstone and shale. Certainly, the influence of temperature on the different layers of the embankment produces different effects on each layer. These effects are the consequence of the differences between expansion and contraction according to the structure of each layer. In this case, the result of disintegration is represented by cracks scattered in each layer according to the degree of its influence by the processes of expansion and contraction.

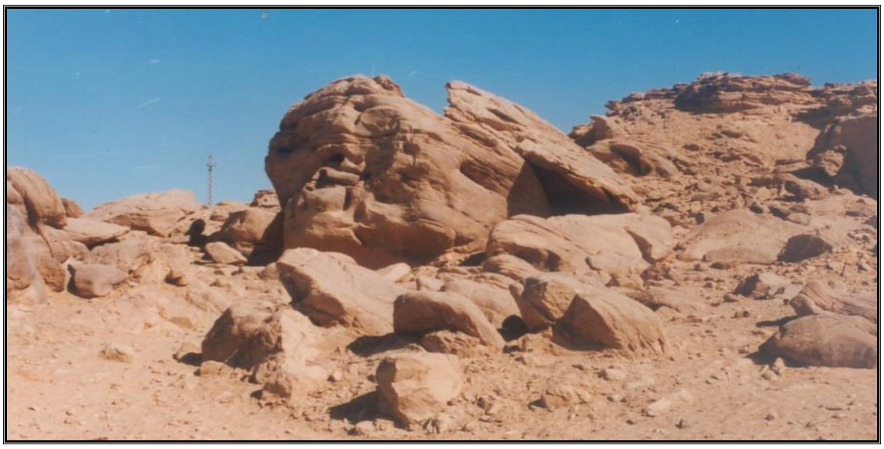

Photo 3. The effect of weathering on sandstone rocks

2-1 Morphogenic processes linked to rain

Although the desert is a zone of moisture deficit, moisture is well presented in various forms and thus can play a role in rock weathering. First, desert precipitation occurs occasionally. Second, dew is the significant source of moisture to promote chemical dissolution (Goudie, 1997).

The climatic data that were presented in the first chapter, show a low annual rate: 0.5mm on average. Precipitation is concentrated in the spring season, particularly in April. Rain can fall in the form of showers in very short moments. In the table below (Table 4), we have summarized the occurrence of occasional precipitation in the governorate of Aswan.

The cracks in the slope were subjected to the erosive role of rain at the end of the last Holocene wet period. The quantities of rain that fell during this period were sufficient to cause runoff on the surface of the slope which created the wadis that cut the slope (photo 5)

Station	**Aswan**		
Month/Quantity	**total**	**Max. J.**	**date**
January	+	0, 1	1971
February	+	0, 1	1976
March	+	0, 7	1974
April	0, 5	7, 2	1986
May	+	0, 1	1963
June	0. 0	0, 0	-
July	0. 0	0, 0	-
August	0. 0	0, 0	-
September	+	0, 1	1977
October	+	0, 3	1973
November	+	1, 4	1966
December	+	1, 0	1962
Total	0, 5		

Table 4. Occurrence of occasional precipitation in Aswan Governorate
(+ = insignificance)
(from Egyptian Meteorological Authority 2001)

On the ground, the erosive role of rain is represented by gutters on the slope of the embankment. This form has different features from one sector to another, due to the difference in lithology. This form is observed more frequently in the areas of Abou er Rishe and El-Mahamied.

Rain also participates in the disintegration process when water penetrates into the body of the sandstone block through cracks, especially with a high thermal amplitude. On the other hand, when rainwater reaches the clay layer by crossing the silty layer, it makes it viscous and slippery. This easily leads to the sliding of the upper masses (blocks), especially if the layer above is already affected by cracks.

Experimental work by Goudie (1997) suggested the ideal conditions to promote salt attack are high nighttime humidity with concomitant low temperature and low daytime humidity when temperatures are around 32°C.

Generally, haloclasty prepares the rock for the following erosive attack by wind and water and produces silty debris. Table (5) shows the increase of salt in the sectors of El Mahamied. The effects of haloclasty are very evident in the lower parts of the muddy layers between the sandstone blocks, since the fossil waters allow the salt content in the rocks to rise.

Salt levels are obtained by the following protocol:
- 10 g of raw sample (> 100 µ)
- 40 ml of sodium chloride solution (100 g/ 1)

The sample is mixed with sodium chloride and stirred for 1 hour. Afterwards, the mixture is filtered and 10 g of barium chloride are added. Once finished, it is allowed to dry and weighed.

Sample	1	2	3	4	5	6	7	8
Abou er. Rishe	18,7 %	18, 2 %	15, 8 %	18, 7 %	17, 3 %	15, 6 %	12, 9 %	13, 7 %
EL-Mahameid	32, 6 %	24,2, %	17, 9 %	16, 8 %	18, 1%	18, 3 %	17, 5 %	18, 2 %

Table 5. Salt occurrence in the clayey layers of the eastern slope (different sectors).

3. The collapsed masses

The sandstone beds in the studied areas are exposed to the processes of collapse of the cracked sections due to the existence of cracks, to the processes of scouring and to the processes of disintegration. The collapse of the few small and medium blocks occurs when the cracks meet a thin horizontal clayey and sandstone layer (Photo 4-5 and 6).

Photo 4. Vertical and horizontal cracks on the slope of the embankment (Village El Khatarah)

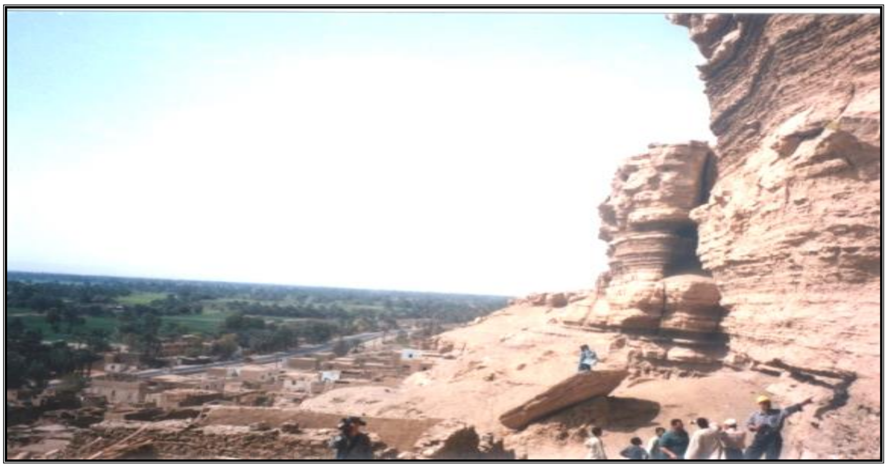

Photo 5. Crack cutting the slope of the embankment (El-Mahamied)

Photo 6-. Les masses chutées dans le secteur d'Abou er Rishe

One type is represented by the collapse of large masses due to the existence of a vertical crack that cuts the slope from the top to the base. This type is more present in all the sectors studied.

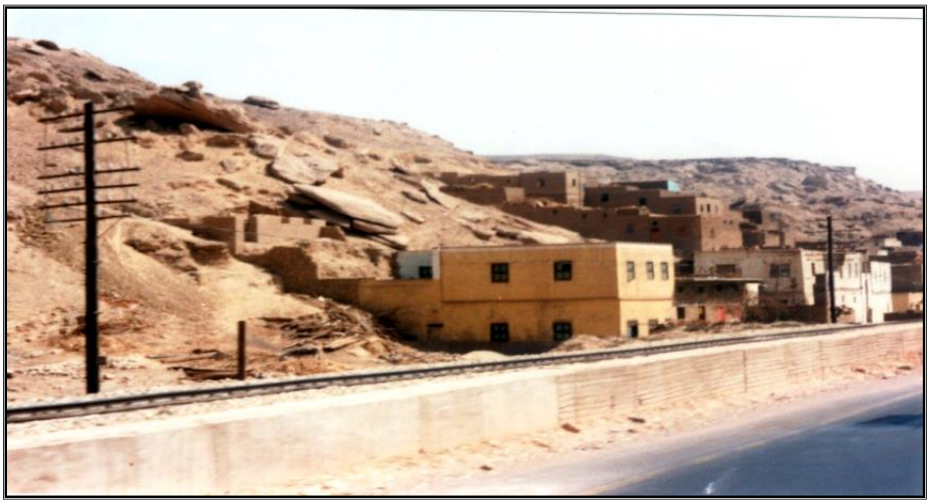

Photo 7-. The masses fall en in the El Mohamed sector

The collapse of the slope front can occur due to the existence of tectonics and weathering. This helps to create other transverse cracks, by the strong increase in tension on the rock formations. This type is also common in all sectors, especially in the sector of Abou er Rishe Bahri.

Table 6 (A-B-C) shows the result of the measurements made on the length, width and height of the fallen masses. The volume varies from one sector to another, it is between 0.3m3 and 4m3 in the sector of Abou er Rishe Qibli, from 0.8m3 to 3m3 in the sector of Abou er Rishe Bahri, from 0.2m3 to 2.6m3 in the sector of Al Aqaba El Qbira, from 0.2m3 to 2.7m3 in the sector of El-Mahamied and from 0.5m3 to 3.3m3 in the sector of El Aqaba El Saghirh

length . /m	Larg. /m	height /m	Volume /m^3
0, 92	0, 75	0, 65	0, 4
1, 23	1, 05	0, 48	0, 6
1, 18	0, 93	0, 92	1, 0
1, 09	0, 28	0, 55	0, 2
1, 00	0, 91	0, 73	0, 7
0, 95	0, 55	0, 64	0, 3
1, 73	1, 03	0, 56	0, 9
1, 54	1, 00	0, 62	0, 9
2, 10	1, 22	1, 03	2, 6
1, 82	1, 15	0, 95	1, 9

length /m	Larg. /m	height /m	Volume/m^3
1, 20	0, 68	0, 90	0, 7
1, 15	0, 92	0, 84	0, 5
1, 02	0, 84	0, 65	0, 6
1, 16	0, 45	0, 74	0, 4
2, 00	1, 12	0, 53	1, 3
2, 10	1, 05	0, 95	2, 0
1, 35	0, 86	0, 64	0, 7
1, 45	0, 90	0, 55	0, 7
0, 95	0, 54	0, 44	0, 2
0, 88	0, 66	0, 21	0, 3

(A) (B)

length . /m	Larg. /m	height . /m	Volume/m^3
1, 23	1, 02	0, 65	0, 8
1, 55	0, 80	0, 93	1, 2
1, 24	0, 98	1, 04	1, 3
1, 66	1, 02	0, 63	1, 0
2, 10	1, 06	0, 85	1, 9
2, 30	1, 23	1, 06	3, 0
2, 14	0, 99	0, 79	1, 6
2, 08	1, 01	1, 12	2, 3
2, 30	1, 25	0, 88	2, 5
2, 15	1, 38	0, 72	2, 1

length . /m	Larg. /m	height . /m	Volume/ m^3
1, 80	0, 90	0, 80	1, 3
1, 10	1, 50	0, 84	1, 4
1, 45	1, 60	0, 77	1, 8
1, 92	1, 20	0, 90	2, 0
1, 05	0, 68	0, 48	0, 3
1, 30	0, 62	0, 37	0, 3
2, 10	1, 00	0, 92	1, 9
2, 80	1, 55	1, 05	4, 5
1, 70	1, 10	0, 85	1, 6
2, 40	1, 85	0, 83	3, 7

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(C) **(D)**

Table 6 (A-B-C-D. Dimensions and volume of the fallen masses in some sectors studied (According to field studies, January and February 2020)

The volume of the masses fallen from the sector of Abou er Rishe Bahri and Abou er Rishe Qibli is greater than in all the other sectors, due to the existence of large transverse cracks and the activity of the scouring process.

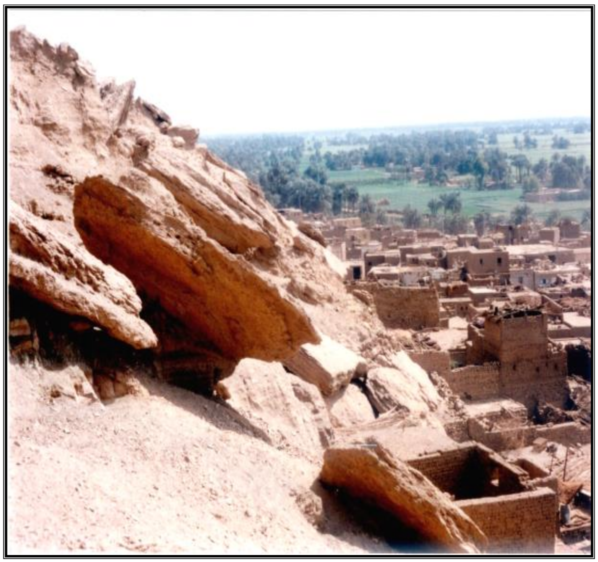
4. Model for the evolution of collapses

4-1. The slope of El-Mahamied

Figure (8) and photo (8) show the reliefs that dominate the gorges of El-Mahamied (x=32° 55 E, y=24°N 15), the collapse of overhangs and the occasional collapses of sandstone blocks, fissured and jointed, represent a form of the current morphodynamics that first passes through the modalities of the karst evolution affecting the mass to the disintegration processes.

4-2. On the slope of El-Mahamied

Hydrodynamic processes affect the sandstones (intercalation of sandstone and marl beds), tearing away part of the mass and calling on the void. The blocks that collapse and crumble, pile up in the narrow alluvial plain (about 50 m).



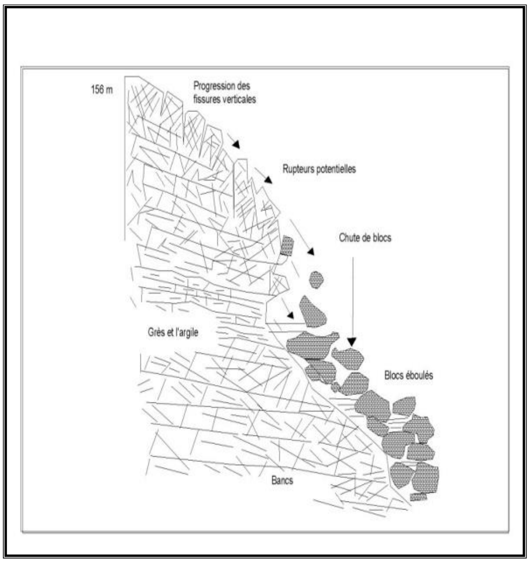


Photo (8) and figure. (8) show Rockfalls in coherent rocks on the slope of El-Mahamied slow evolution in coherent rocks on the slope of El-Mahamied (November 1994)

5- Land use.

Figure (9) show the land use in the area of Abu ErRish north of Aswan at 6 km. The settlements were built on the slope of the Eastern Talus and at the foot of the plateau. This situation is aggravated by the risk of rock slides on the population.

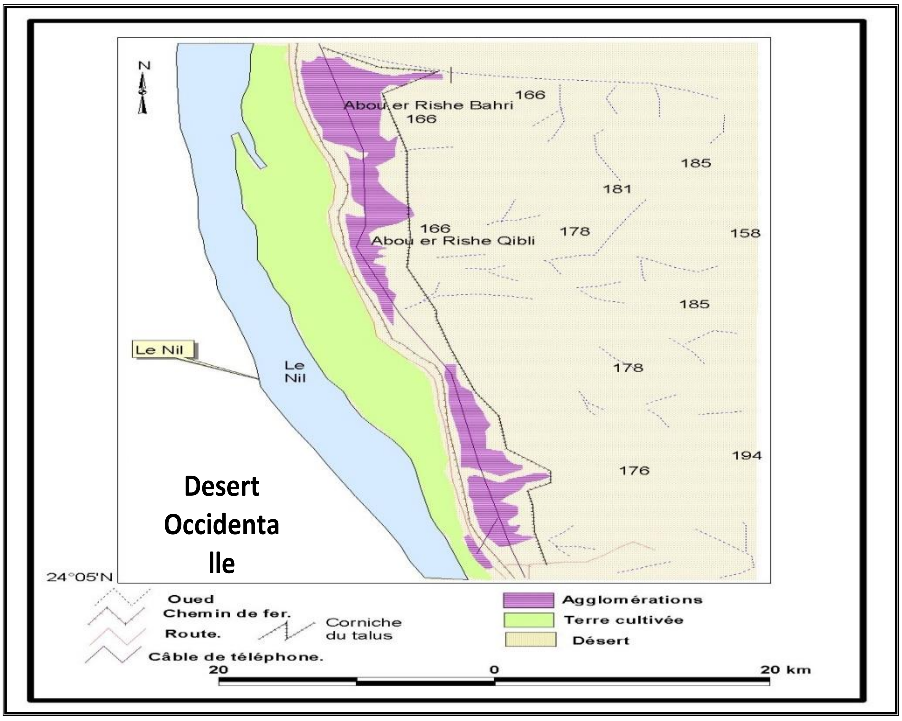


Figure 9. Land use map in the Abu er Rishe area (6 km north of Aswan)
(Topographic maps1/50,000)

6. The exposure map to risks related to ground and subsoil movements of the Eastern Slope of Aswan.

This is a summary map inspired by the French Zermos map (figure 10) which is based on the analysis of existing ground movements and factors that can have effects on the stability of the land (slope, geological framework, climate, etc.) and which defines a certain number of zones of instability.

This map therefore provides information on the probable location of areas exposed to risks of ground movements and the degrees of these risks following the synthesis of instability factors. It was established at a scale of 1/25000 and includes a simple zoning of the land, represented by red colours (high risk), brown (medium risk) and green (zero or low risk).

6-1. The meanings of the colours on the map.

Red: indicates real instability, in the process of developing or a specific threat likely to lead to serious consequences that are difficult to control;
Brown: indicates a potential threat that can be avoided by special measures.
Green: indicates that no instability seems likely to occur in the area in question and that it can be developed without any particular constraints, at the cost of a few checks or precautions, generally of little importance.

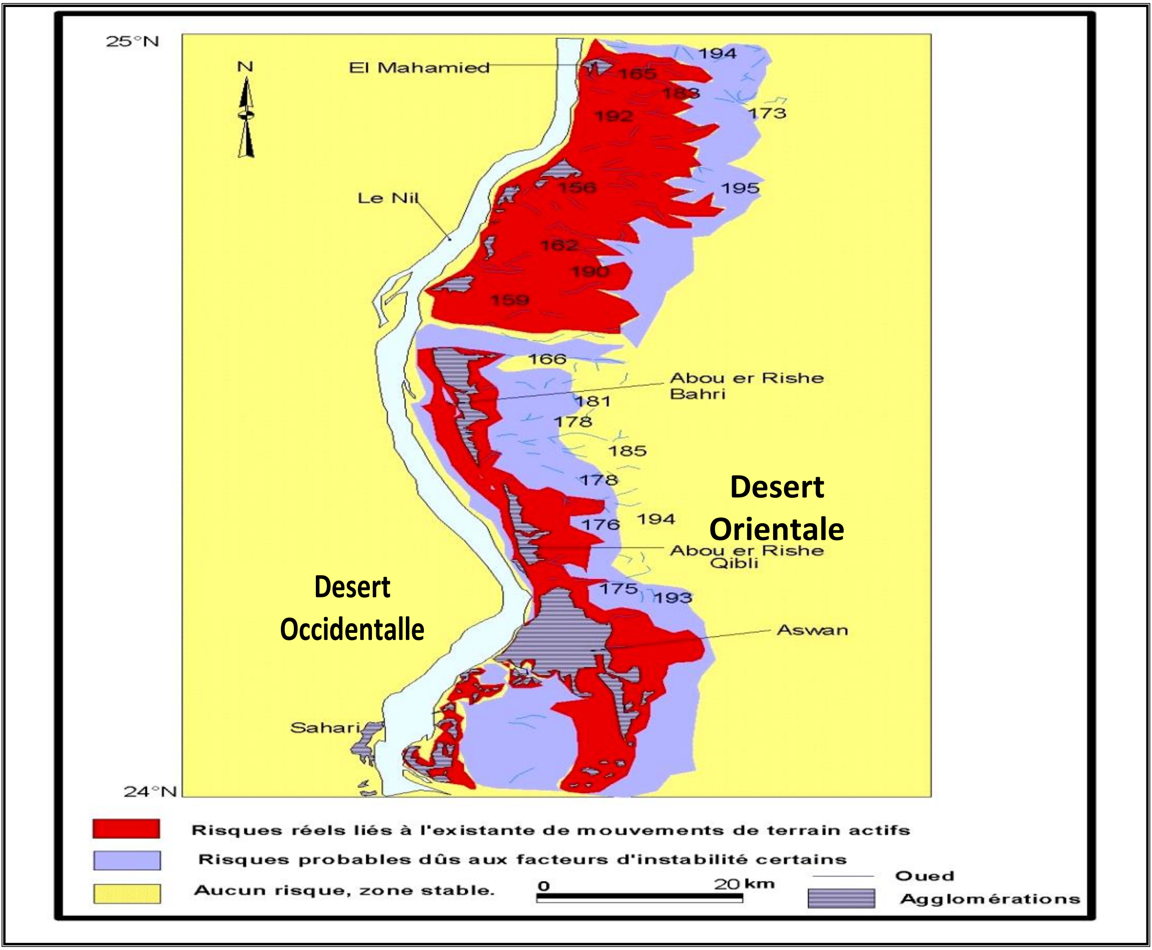


Figure 10. Aswan East Slope Ground and Subsoil Movement Risk Exposure Map

6-2. Field observation

It appears that the degrees of risk are distributed according to the geomorphology and the slope. In the realization of this map, the following arguments were based on the field study in the study region and more precisely between the city of Aswan in the South and El-Mahamied in the North over a distance of 120 km. During this study, it was noticed that some of the stones and blocks fallen under the effect of several weathering processes are more important in the region of El-Mahamied than in the region of Abu er Rishe.

In the region of Abou er Rishe, more than 200 blocks of stones and rocks with diameters ranging from 0.50 m3 to 1.50 m3 were found, and regions more vulnerable to the risks of land movements were detected. In the region of El-Mahamied, more than 300 fallen blocks with diameters ranging from 0.50 m3 to 2.50 m3 were found. In addition, more than 40 blocks were found that are at risk of collapse due to some of the processes studied (Photo 9).

Photo 9. Blocks threatening to collapse (El-Mahamied)

And as an anecdote, we cite the accident that took place in El-Mahamied in 1996, following a fall of blocks on a house and which caused 3 victims (according to Aswan Governorate). In this region, there are about 520 families threatened by the risk of falling blocks and stones and there is no way of protection against this danger.

As an anecdote, we cite the accident that took place in El-Mahamied in 1996, following a fall of blocks on a house and which caused 3 victims (according to Aswan Governorate). In this region, there are about 520 families threatened by the risk of falls des blocs et des pierres et on n'en trouve aucun mode de protection contre ce danger là.

The region of El Mohamed is more exposed to the danger of rockfall than that of the region of Abou er Rishe.

The red zone

In this zone, we find all the manifestations of instability of rock falls and landslides appearing in the superficial formations. This zone extends around the edge of the slope, that is to say from south to north, at the foot of the cornice of the sandstone banks. It is a real danger for the inhabitants.

The blue zone

The instabilities in this zone are represented mainly by rock falls caused by certain instability factors such as the slope. In this zone the slope is moderate. The instability factors are less favorable than the ground instability

La zone jaune

It does not indicate any instability related to movements. The area is stable at the moment.

7. Prevention

For land movements, the temporal prediction was impossible for me to process due to the lack of equipment which amounts to a lack of subsidy, but at the same time I used the survey (Appendix No. 1). A history would have been useful because, when the block fall has taken place, it can continue to collapse since the collapsed part is no longer coherent and no longer united with the substratum.

No preventive measures appear to have been taken. Indeed, the head of the city of Aswan (governing in Aswan) can impose, by virtue of his police powers, works that are the responsibility of the owners on private land. Nothing is specified in the case of public land. Logically, it should be forbidden to build in areas of land movements (falling rocks) on the slopes of the eastern embankment in Aswan, but the land pressure is such that it would seem that in the El-Mahamied sector for example the Nagas (small villages) are built on a risk zone.

Officials in Aswan Governorate are required to make posters in risk areas and distribute leaflets to threatened citizens. Despite all this, during the questionnaires, we noticed that the entire population is not sufficiently informed about the risks they face and they have little awareness.

8. Conclusion

The physical study (structural, climatic etc.) shows that the main processes of slope dynamics are linked to the elements of the natural environment, to the characteristics as they have been analyzed, present on all aspects of the slopes of the embankment. The morphological parameters of the embankment (system of slopes, variation of altitudes, uneven distribution of slope orientations), associated with climatic phenomena, are combined with the effect of anthropization seriously threatening the natural balance in this region.

The causal explanation of land movements can be found. The phenomenon of rockfall has developed under the effect of several morphogenic processes and according to the efficiency of each morphological agent. Although the structure is a main element, field observations have confirmed that the other agents have participated with considerable degrees in the different stages of the development of rockfalls.

Disintegration acts on the slopes of the embankment as on the other surfaces, resulting in the development of some cracks, which widen and increase with time. This process results in the collapse of sandstone blocks in the studied areas. Sometimes the body of fallen blocks shows the important role of occasional rain.

The inhabitants of Abu er Rishe and El-Mahamied consider that the risk related to falling blocks is the most threatening of all natural risks in the Aswan region (Annex 1).

Appendix 1
Example of a questionnaire.
Questionnaire on rockfall risks in Aswan
1-Ranked these risks in the order in which you think they are most likely to occur in your municipality:
(1 = most likely, 4 = least likely)
1-Earthquake: 65% say that earthquakes are the first danger in natural risks.
2-Rockfall: 25% say that rockfall will be the first
3-Flood: 10% saw flooding as the most disastrous
4-Sand movement: the rest, which corresponds to 5%, said that sand movement is the most dangerous seismic risk.
2- Have you ever been the victim of a rockfall? If yes, can you specify the place and date?
(Address, village…)
Yes: 12%
No: 88%
3- Do you know that an information and prevention site is available on the Internet?
-yes: 1%
-no: 99%
4- Do you think you are sufficiently informed about the risks you face?
-yes: 2%
-no: 98%
5-Information sheet:
Highest level of education:
-No level:…………… 25%
-Baccalaureate level………………40%
-License level…………20%
-Master's level or more…15%
AGE:
- less than 20 years old………...15%
-21-30 years old………………..20%
-31-40 years old……………… 25%
-41-50 years old……………… 20%
-51-60 years old……………… 15%
-more than 60 years old……………5%
Geographical Location:
City of Aswan, Abou er Rishe, and El-Mahamied,

REFERENCES BIBLIOGRAPHIQUES

1-**Alamrawy.M** (2006): les risqué géomorphologiques dans le gouvernorat d'Assouan. Thèse Doctorat. Université de Provence**.**
2- **BIROT P.** (1968): *The cycle of erosion in different climates*, London .Bats ford. 314 p.
3- COQUE R. (1993): *Géomorphologie*. Armand Colin, Paris, 430 p
4-**DAUPHINE A.** (2001): *Risques et Catastrophes, Observer- Spatialiser- Comprendre- Gérer,* Armand Colin, Paris 288 p.
5-GARTET A. (1994): *Morphogénèse et hydrologie dans le bassin versant de l'Oued Lebène (Rif Méridional et Prérif Central et Oriental, Maroc*), Thèse de doctorat, Université de Provence (Aix-Marseille I), Institut de géographie, 342 p.

6-GOUDIE A.S (1997): *Weathering Processes*.In ed. David S.G.Thomas, Arid Zone Geomorphology: process, form and change in Dryland, John Wiley & Sons, Chichester, 2nd Edition, pp 25-40.
7-HETU B, VAN STEIJN H & VANDELAC P. (1994) : Les coulées de pierres glacées : un nouveau type de coulées de pierraille sur les talus d'éboulis. *Géographie physique et Quaternaire*, *vol.*48, n° 1, pp 3-22.
8-PARK C. (1997): *The Environment, Principles and Applications*, Routledge, London,424 p.
9-SAID R. (1981): *The Geological evolution of the river Nile*, Springer velage, New York.
10-SAID R. (1990): Quaternary, chapter 25 in the *The geology of Egypt*. Editor: SAID.R. Rotterdam, Netherlands, Balkema, pp 487-507.
11-SAID R. (1990): Quaternary, chapter 25 in the *The geology of Egypt*. Editor: SAID.R. Rotterdam, Netherlands, Balkema, pp 487-507.
12-SAID R. (1993): *The River Nile: Geology, Hydrology and Utilization*, Pergamon Press, Oxford, 320p.