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STRONG WIND OCCURENCES IN EGYPT DURING 1994

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Összefoglalás - A szerzők az 1994. évi, naponként kétszeri mérésadatok alapján megvizsgálják három egyiptomi állomáson a legalább 14 csomó erősségű szelek előfordulását. Megállapítják ezek évszakos és napszakos fellépését, a szélirányok gyakoriságát erős szelek esetén. Külön elemzik a délies szeleket kísérő légköri paramétereket, így a hőmérsékletet, relatív nedvességet, felhőzetet és a tengerszinti légnyomást.

Summary - The authors investigate the occurrences of strong winds of at least 14 knots wind speed, using twice-a-day records at three Egyptian stations from 1994. The frequencies of strong winds are established both in seasonal and diurnal variations as well as wind directions. Special attention was paid to weather phenomena during wind blowing from south quadrant, analysing the synchronous values of temperature, relative humidity, cloud and sea level pressure.

Key words: climate of Egypt, strong wind, khamsin, wind direction, sand storm

INTRODUCTION

Strong wind is defined in this paper as wind speed of at least 14 knots (about 7 m/s). It is likely that such wind speeds are often accompanied by gusts of 15 m/s velocity or more. In Sahara and its vicinity strong winds indicate either sand storms or atmospheric fronts. Sand storm or in Arabic: "*khamsin*", is one of the most unpleasant and harmful phenomena in North African desert. It is well known in Egypt and Sudan, in the latter country it is called: "*ghibli*".

The purpose of this paper is to give a survey on occurrences of strong winds observed in three Egyptean stations and to select some case studies to be scrutinized. The meteorological stations involved into this paper are as follows:

1. Mersa Matruh	(62 306)	31°21'N	27°13'E
2. Alexandria	(62 318)	31°12'N	29°57'E
3. Cairo	(62 366)	30°08'N	31°34'E

In parentheses: the synoptic code numbers of the stations.

DATA BASE

Regular daily weather records were used in this investigation, namely from three Egyptian stations mentioned above. Measurements were made twice a day, at 00 and 12 GMT, respectively. The weather records include relative humidity, sea level pressure, air temperature, wind direction and velocity in knots and clouds in octas. These data have been available for the complete year of 1994.

It was found that strong winds (at least 14 knots) occurred most frequently in some months, namely from January to May as well as in November and December. From June to October strong winds are infrequent or entirely missing. Thus days with strong wind were selected from relevant months only. Five to sixteen records per month have been chosen including cases when strong wind happened twice a day, both at 00 and 12 GMT.

The main features of climatic background in North Africa are given in books, like Climates of Africa, edited by *J.F. Griffiths* (World Survey of Climatology, Volume 10, 1972) - Tropical Meteorology, Compendium of Meteorology, prepared by *T. N. Krishnamurti* (1979) - Climate of the Earth (in Hungarian) by *G. Péczely* (1984) - Climatological Normals for the Period 1931-1960 by WMO (1982).

SOME CHARACTERISTICS OF THE CLIMATE IN EGYPT

There are essentially four sub-regions that one should consider when describing the weather systems over tropical Africa:

1. West Africa,
2. The deserts,
3. Somalia and East Africa, and
4. Central Africa.

The area of Egypt is mostly covered with desert except the northernmost part, close to the Mediterranean Sea. The annual amount of rain varies between 20 and 190 mm in the region affected by the sea, where the rainy season begins in October and finishes by March or April. To the south of 30°N latitude practically no significant rainfall occurs in Egypt.

The annual mean temperature ranges between 19 and 26°C, the seasonal variation of monthly mean temperature is as much as 13-18°C, with maximum in July or August and minimum in January. The absolute maximum of temperature measured in Egypt has been nearly +50°C, while as absolute minimum -4°C was recorded.

In winter the Mediterranean depressions affect Lower Egypt directly, causing surface winds to become variable, both in speed and direction. Since the tracks of depressions are north of the coastline the prevailing directions are south and southwesterly in front of the depressions and west or northwesterly in the rear. The subtropical high pressure cell covers the

western desert of Egypt during this season. The prevailing winds are, therefore, northerlies. Winter and early spring are the seasons of strong and gale winds in Lower Egypt usually blowing from the western quadrant. Stronger winds become more frequent in the spring months over Lower Egypt because of the passage of the centre of "*khamsin*" depressions at the south of the Mediterranean coast line.

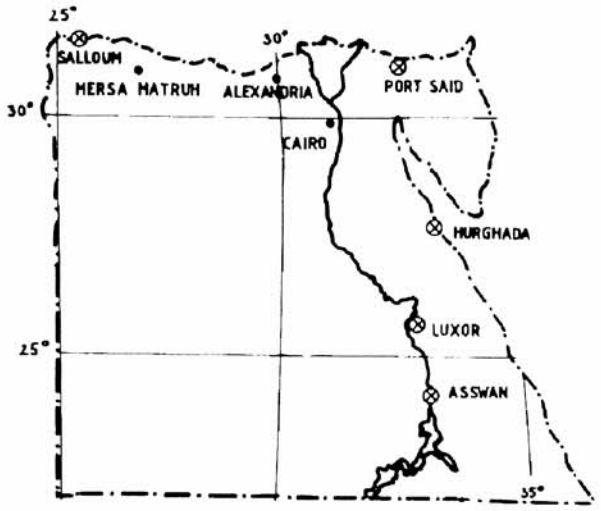

Fig. 1 Meteorological stations in Egypt in this investigation

In summer steady northerly winds prevail over all of Egypt. Gales do not occur during this season, except on the Red Sea. In this area the strong northwesterly winds are the products of the local topography and centres of low pressure that appear over the northern Red Sea.

The mean annual values of wind speed are the highest on the western side of the Mediterranean coast. The value decreases from about 20 km/h in the extreme west, Salloum (31°32'N, 25°11'E) to about 8 km/h in the extreme east, Port Said (31°17'N, 32°14'E).

In the Mediterranean coastal areas the mean monthly values of relative humidity increase eastwards, but they decrease rapidly southwards. For example the mean annual value is 69 % at Alexandria and 29 % at Aswan.

ANALYSIS AND RESULTS

Out of the twice-a-day weather records (00 and 12 GMT) there were selected cases with comparatively strong wind, at least 14 knots, regardless the wind directions. Data were available from Mersa Matruh, Alexandria and Cairo (*Fig. 1*). In months from January to May and November, December 44 to 81 records were chosen depending on the stations (*Table 1*).

	Mersa Matruh		Alexandria		Cairo	
	n	%	n	%	n	%
NW-NE	30	37	18	27	3	7
SW-NW	34	*42*	26	*40*	13	30
SE-SW	13	16	16	25	20	*45*
NE-SE	4	5	5	8	8	18
total	81	100	65	100	44	100

Legend: **n** - number of occurrence, **%** - relative frequency

Table 1 Frequency of wind directions

In *Table 1* the number or relative frequency of strong winds are presented regarding the four quadrants of wind directions. It is remarkable that at the westernmost Mersa Matruh the westerlies are predominant with 42 %, while easterlies are rare but eastwards, at Alexandria and farther at Cairo the south quadrant becomes gradually prevailing, meanwhile the frequency of northwinds decreases from 37 % at Mersa Matruh to 7 % at Cairo. (The maximum frequencies are marked by italics in *Table 1*.) It means that from the western part of Lower Egypt to its eastern area the wind turns from west, northwest to south, southeast.

The individual cases of strong winds occur most frequently in Mersa Matruh and rather rarely in Cairo (*Fig. 2-8*). It seems evident that wind directions of south quadrant are linked with transport of air masses with low relative humidity arriving from the Sahara. So it is expected that strong southerlies are accompanied with dry and hot air. Data given in *Table 2* prove partly our expectation.

a: Mersa Matruh **b: Alexandria** **c: Cairo**

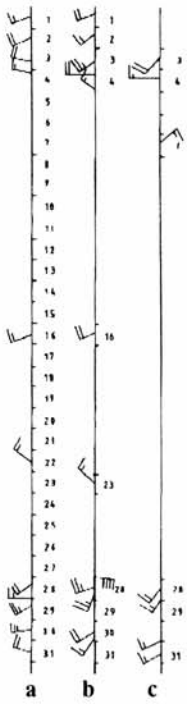

Fig. 2
Chronological occurrences of strong wind in January, 1994

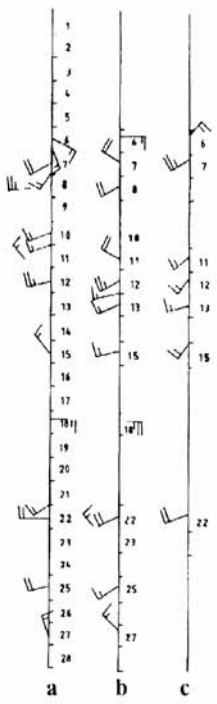

Fig. 3
The same as in *Fig. 2* but in February, 1994

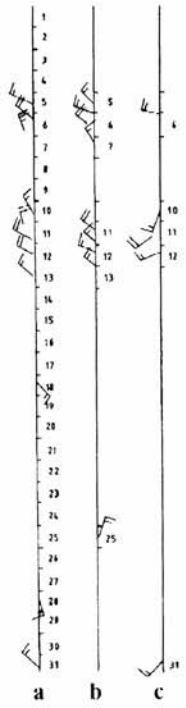

Fig. 4
The same as in *Fig. 2* but in March, 1994

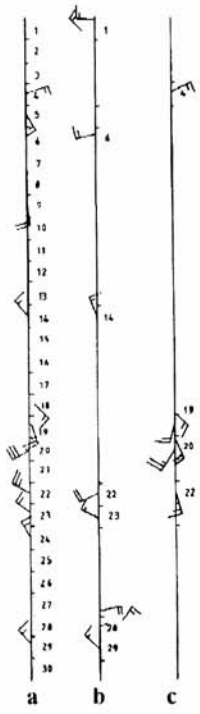

Fig. 5
The same as in *Fig. 2* but in April, 1994

a: Mersa Matruh **b: Alexandria** **c: Cairo**

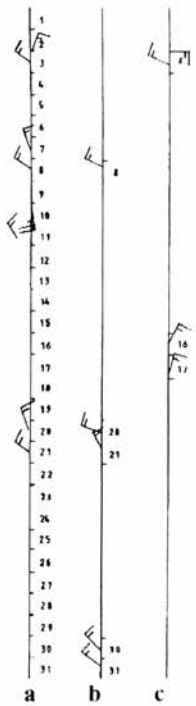

Fig. 6
The same as in *Fig. 2* but in May, 1994

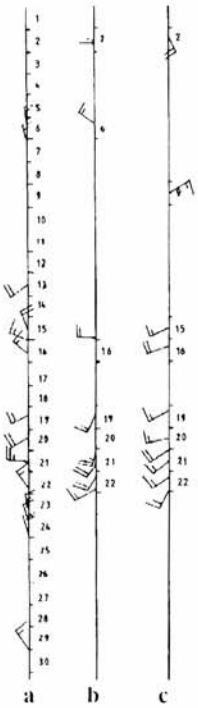

Fig. 7
The same as in *Fig. 2* but in November, 1994

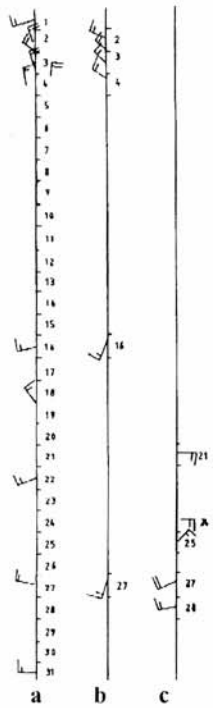

Fig. 8
The same as in *Fig. 2* but in December, 1994

Date	relative humidity, %	temperature °C	sea level pressure, mb	clouds octas
February:	**Mersa Matruh**			
6.	53	17.8	1019.6	0
7.	30!	15.0	1015.0	0
8.	33!	17.4	1016.4	0
March:	**Mersa Matruh**			
18.	77	15.0	1014.4	8
28.	22!	27.9	1014.1	7
	Cairo			
10.	38!	19.7	1009.8	4
11.	78	12.6	1007.8	7
12.	57	16.4	1014.3	6
31.	32!	19.7	1014.8	5
April:	**Mersa Matruh**			
5.	21!	30.1!	1007.6	2
9.	24!	27.4!	1015.4	0
18.	13!	36.3!	1007.7	4
19.	11!	39.2!	1000.3	4
20.	10!	39.7!	1003.3	0
	Cairo			
19.	13!	30.6!	1006.8	0
19.	5!!!	39.6!!!	1005.9	7
20.	6!!!	40.2!!!	1005.6	6
22.	11!	31.7!	1009.4	7
May:	**Mersa Matruh**			
10.	28!	31.7!	1008.4	6
November:	**Alexandria**			
19.	53	22.7	1011.2	0
21.	61	17.6	1008.8	4
22.	61	18.6	1011.0	7
December:	**Alexandria**			
16.	50.	19.8	1017.0	4
27.	62	18.6	1008.0	3

Table 2 Cases with strong southerly wind in 1994

The unusually low values of relative humidity and high temperature, respectively, are indicated with simple or triple exclamation marks. Such weather phenomenon occurred almost exclusively in spring months. It can be also established that extreme high temperature values were recorded in cases with rather low sea level pressure and vica versa.

The temporal distribution of strong wind occurrences is unequal between days and nights. Strong winds appear more frequently at noon than at midnight, as it can be established from data as follows (*Table 3*):

	Mersa Matruh		Alexandria		Cairo	
at 12	63	(78%)	44	(68%)	37	(84%)
at 00	18	(22%)	21	(32%)	7	(16%)
total	81	(100%)	65	(100%)	44	(100%)

Table 3 Strong wind occurrences

It can also be seen in *Table 2* that there is not strong correlation between amounts of clouds and the synchronous relative humidities. It is hoped that with more availability of weather records made in North Africa we shall be able to carry out more detailed analysis of that kind of peculiar weather phenomenon as sand storms, especially "khamsin" and "ghibli".

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