SUNSHINE DURATION IN IOANNINA - GREECE

by

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Abstract: *The study of sunshine duration in the city of Ioannina is based on data from the meteorological station of the city's airport between the years* 1964-1973. *Conclusions are drawn as to the effect of the local ground relief on sunshine duration during the year and also on its diurnal variation.*

INTRODUCTION

In a study on the climate of Ioannina by the last of the authors of the present work *Maldoyannis*[4] sunshine duration was examined from data of various meteorological stations that functioned at times in the area of Ioannina till the year 1969.

The area of Ioannina is a small sunken valley, surrounded on all sides by mountains, stretching 28×3 km, at the bottom of which lies the lake Pamvotis or lake of Ioannina (surface area 22 km², elevation 469 m):

The southern end of the valley is edged by the descending slopes of the mountain mass of Mt Tomaros (1.974 m), Zoumerka (2.469 m) and the hills of Kastritsis (elev. 542 m), Koutseli (elev. 540 m), Bizani (elev. 510 m), Manouliassis (elev. 752 m) Sadovitsis (elev. 632 m), and Domvros (elev. 708 m), Lacmos (2293 m) Kourenti (1172 m)

The northern end of the valley is enclosed by Mitsikeli (elev. 1.810 m) and Mt Soutisti (elev. 1316 m) and the hills of Gardhiki (elev. 853 m) and Dovras (elev. 817 m).

The study of sunshine duration in the area of Ioannina is of particular interest, because this part of Greece, besides its singular ground relief which also affects its sunshine duration (not only by obstructing sunshine but also by producing convective clouds), happens to stand to the west of the main mountoin mass that divides Greece, that is in a rainy

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area rich in all forms of precipitation (annual mean 1.262 mm, *Maldo-yannis*[4]).

SUNSHINE DURATION IN IOANNINA AIRPORT

A. T h e a n n u a l m e a n and extreme values of sunshine duration in Ioannina, resulting from ten years observations (1964-1973), at the met. station of the city's airport are given in *Table I*.

MAP I. Contours of Ioannina Area.

TABLE I

Annual sunshine duration in Ioannina (1964 - 1973)

Maximum	2.509,40[h] (1967)
Mean	2.343,83[h] ± 105,30[h] (coef. of variation 4,5%)
Minimum	2.182,00[h] (1973)

An examination of deviations from the mean annual value, shows that the S.D. is 105,30 hours, and their distribution has as follows:

$+3\sigma$	$+2\sigma$	$+\sigma$	$-\sigma$	-2σ	$+3\sigma$	Σ (years)
0	2	3	3	2	0	10

This means that annual sunshine duration is smoothly distributed, 60% of its values standing between ±σ.

B. The monthly mean sunshine duration for the 120 months of the period examined, as well as monthly minima and maxima are given in *Table II*.

This Table shows that the longest sunshine duration corresponds to the month of July, a month that also has the largest value of theoretical sunshine duration (see Table V) and the largest maximum and minimum. On the other hand, the smallest mean monthly minimum has been recorded in December, that is the month with the shortest theoretical sunshine duration, and also the shortest absolute monthly maximum as well as the shortest absolute monthly minimum of sunshine duration ever recorded.

TABLE II

Mean and extreme monthly values of sunshine duration (in hours) for 120 months in Ioannina.

	Max.	Year	Mean	±σ	Min.	Year	Coef. of Variation
J	185.4	1964	108.06	38.91	43.7	1972	36.00%
F	157.4	1967	103.78	25.72	64.5	1969	24.78
M	211.1	1967	151.26	33.23	111.8	1969	21.96
A	257.7	1968	184.50	32.70	142.6	1972	17.72
M	290.7	1969	254.23	18.09	225.8	1964	7.11
J	324.1	1972	280.69	25.41	246.9	1964	9.05
J	378.6	1968	325.30	32.35	268.3	1972	9.94
A	331.2	1964	304.41	19.99	263.3	1972	6.56
S	263.6	1968	233.82	20.22	198.6	1971	8.64
O	258.0	1965	189.14	38.87	129.3	1972	20.55
N	174.3	1967	125.66	22.75	99.5	1971	18.10
Ď	116.4	1971	82.98	26.81	36.6	1969	32.30
Year			2343.83				

It should be mentioned that the absolute monthly maxima or minima are totaly independent of each other. Thus, for instance, we notice:

a. In the year 1971, November with a minimum sunshine duration of 99,5 hours (the shortest of the ten year period examined) was followed by December with 116,4 hours, the longest duration for this month in the same period.

b. In 1972, June with 324,1 hours of sunshine duration was followed by July with 268,3 hours and then August with 263,3 hours. Yet the

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last two months are considered the sunniest months in the area of Greece, being the only with a monthly mean value > 300 hours even at the met. station of Ioannina airport.

Moreover, studying the monthly mean values of sunshine duration recorded during the ten-year period examined (1964-1973), we observe that it is possible for consecutive months with increasing or decreasing

GRAPH I.
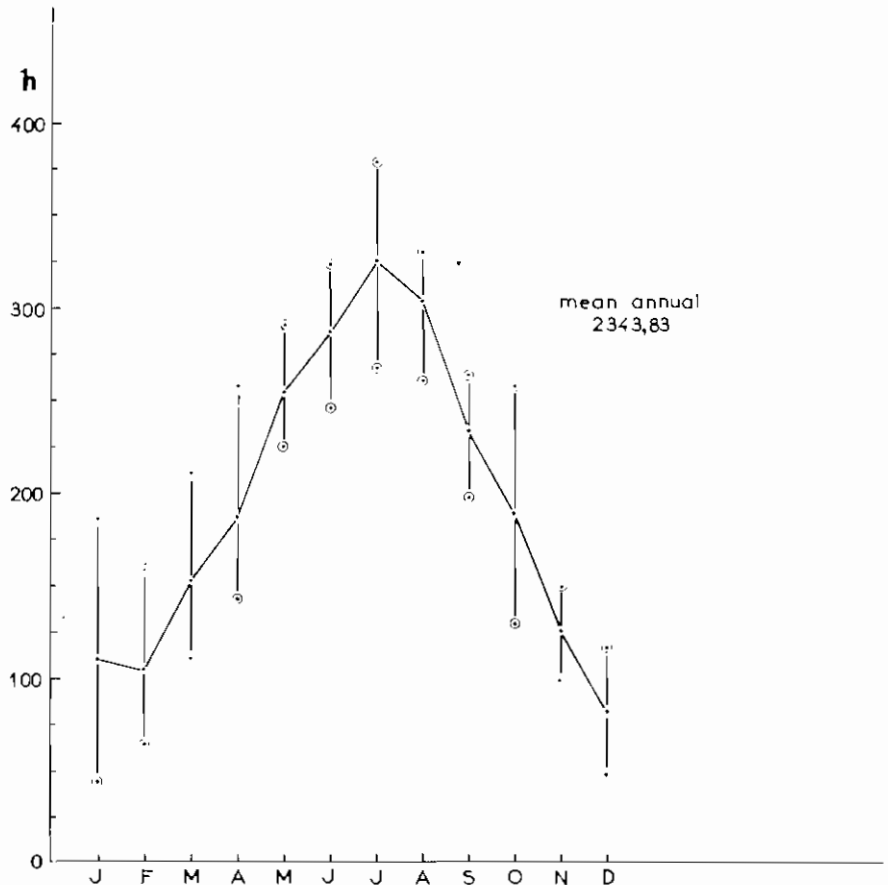
mean values, to deviate from the rule (G r a p h I). Thus, for instance, we have:

a) January surpassing the next two months, February and March in three years (1964, 1965, 1969).

b) Another three winter cases (in the years 1970-1971, 1971-1972,

1972-1973), when December recorded longer sunshine duration than the next two months (January and February).

c. Once, the sunshine duration of November was shorter than that of December (1971), and that of October shorter than November (1972).

It should also be mentioned that February only seems to have the shortest sunshine duration, this however not being the fact, since this month has only 28, 29 days while the one before and after have both 31 days each. (See Table VI-Daily mean sunshine duration values).

Out of the 120 months examined, 58 had a positive standard deviation and the remaining 62 had negative. The S.D. distribution is given in the following *Table III*.

TABLE III

$+2\sigma$ to $+3\sigma$	4 months			0.033	
$+\sigma$ to $+2\sigma$	20 »			0.167	
$+\sigma$ to mean	34 » ⎫			0.283 ⎫	
		} 79		} 0.658	
mean to $-\sigma$	45 » ⎭			0.375 ⎭	
$-\sigma$ to -2σ	17 »			0.142	
-2σ to -3σ	—				

Examining the distribution of monthly mean values recorded during the ten year period examined, *(Table IV)*, we observe that monthly mean values < 100 hours may occur from November till February, while monthly values above 300 hours may be recorded during the summer quarter, from June to August.

As to the number of months, the above two groups are almost equal with 17 months and 20 months respectively, while the remaining 83 months (69%) have durations varying between 100-300 hours.

It should be mentioned that here also the sunshine duration of October is equal to that of April, while November exceeds March. All the above are indications of a late winter which is characteristic of all Northern Greece.

The mean fraction for the year is 0.529, while the absolute maximum fraction has been recorded in July and the absolute minimum in December.

It should be noted that during the cold semester from November to April the mean per month fraction is < 0.50, and only during the main two months of the warm season in Northern Greece does this

TABLE IV

Distribution of monthly sunshine duration frequencies.

Duration in hours	J	F	M	A	M	J	J	A	S	O	N	D	Σ₁	Σ₂
381-400							2						2	
361-380							1						1	
341-360						1	2	2					5	
321-340					1	2	1	4					9	17
301-320				1	3	3	1	3	2	2			6	
281-300				3	4	3	2	1	1	1			10	
261-280				1	3	3	1	1	5	1	1		10	
241-260				1	2				1	1	2	3	9	40
221-240			1	1					1	2	4	2	5	
201-220	1	1	1	1					1		1	3	6	
181-200	1	1	2	3					1	2	1		6	40
161-180		1	2	1						3	2		12	
141-160	1	2	2							1	2	3	9	
121-140	2	2	2								4	2	10	43
101-120	1	1									1	3	10	
81-100	4	4										2	11	
61- 80	1	1										3	6	20
41- 60	1	2										1	2	
21- 40	1											1	1	
Total	10	10	10	10	10	10	10	10	10	10	10	10	120	120

fraction rise above 0.70. Actually this small per year and per month fraction is partly due to the ground relief obstructing sunshine, which is quite usual in all mountainous areas of Greece.

As a matter of fact a look at the Horizontiogram I (p. 20) shows that sunrise in the met. station of Ioannina is delayed by 70 minutes, while sunset comes earlier by 44 minutes both because of surrounding mountains. Thus, we have a loss of 426 hours per year, all due to the local ground relief.

TABLE V

Theoretical, observed sunshine duration, and per month fraction in Ioannina.

	Theoretical*	Observed	Sunshine fraction		
		Mean	Max.	Mean	Min.
J	297	108	0.62	0.36	0.15
F	297 , 308	104	0.52	0.34	0.21
M	369	151	0.57	0.41	0.30
A	396	185	0.65	0.47	0.36
M	445	254	0.65	0.57	0.51
J	448	281	0.72	0.63	0.54
J	454	325	0.83	0.72	0.59
A	423	304	0.78	0.72	0.62
S	372	234	0.71	0.63	0.53
O	343	189	0.75	0.55	0.38
N	296	126	0.59	0.43	0.34
D	288	83	0.34	0.29	0.13
Year	4428	2344		0.529	

*Theoretical suushine values for Ioannina have been calcutated by (Maldoyannis 4).

However, besides the above permanent factor, we have yet another variable factor, that affects sunshine duration, and this is «cloudiness». Actually this factor may diminish sunshine duration considerably, as in the case of December 1969 with 0.13 of its theoretical duration, and January 1972 with 0.15.

C. Daily mean values of sunshine duration:

Besides the comparatively high variability of sunsbine duration in monthly values, the exact knowledge of the variation of its values from

TABLE VI

Distribution of daily sunshine duration values.

Duration in hours	J	F	M	A	M	J	J	A	S	O	N	D	Σ	
13.50-14.49	—	—	—	—	—	—	—	—	—	—	—	—	0	0
12.50-13.49	—	—	—	—	24	63	89	2	—	—	—	—	178	0.0487
11.50-12.49	—	—	—	17	65	54	83	98	—	—	—	—	317	0.0868
10.50-11.49	—	—	17	32	28	28	28	74	53	11	—	—	261	0.0714
9.50-10.49	—	5	22	38	29	25	29	33	73	1	19	—	265	0.0725
8.50- 9.49	9	25	34	28	30	28	19	29	39	98	48	19	356	0.0975
7.50- 8.49	41	26	23	16	21	17	19	27	28	40	27	20	328	0.0898
6.50- 7.49	35	22	15	19	24	18	8	39	29	32	24	24	261	0.0714
5.50- 6.49	26	18	36	17	11	21	15	11	19	22	19	25	238	0.0652
4.50- 5.49	23	18	24	19	9	14	8	9	5	16	35	20	202	0.0553
3.50- 4.49	15	15	12	19	13	8	4	28	17	13	22	22	169	0.0463
2.50- 3.49	13	22	18	27	17	13	8	17	9	21	26	22	202	0.0553
1.50- 2.49	19	18	26	16	11	4	2	16	11	9	17	28	162	0.0443
0.50- 1.49	25	42	29	22	10	4	2	1	6	20	32	40	233	0.0638
0.01- 0.49	26	22	20	4	6	—	—	1	7	6	19	25	139	0.0381
0	78	50	34	26	12	3	—	—	4	21	36	78	342	0.0936
	310	283	310	300	310	300	310	310	300	310	300	310	3653	1.0020

day to day, as well as its diurnal variation are also of interest, especially for technological applications.

Table VI contains all the daily values of sunshine duration for the period examined herein, that is for 3.653 days in all. From this Table VI we draw the following conclusions.

a) Days with sunshine duration $\geq$ 12.50 hours may be recorded from May to August (178 cases / 4.87%), while days with sunshine duration $\geq$ 8.50 hours (which by Greek standards can be considered as a «good» day from the viewpoint of sunshine duration) were recorded (1.377 cases / 37.70%) more or less in every month of the year, to the exeption of December. From May to September the percentage of such days is > 50%, while April has 38.3% and October 35.4%.

TABLE VII

Percentage of days with various sunshine duration during the year.

	Daily duration (in hours).				
	$\geq$ 12.50	$\geq$ 8.50	$\leq$ 1.49	$\leq$ 0.49	= 0
J	0	2.9	41.6	33.5	25.2
F	0	10.6	40.3	25.4	17.7
M	0	20.3	33.2	17.4	11.0
A	0	38.3	17.3	10.0	8.7
M	7.7	56.8	9.0	5.8	3.9
J	21.0	66.0	2.3	1.0	1.0
J	28.7	80.0	0.6	0	0
A	0.6	75.5	0.6	0.3	0
S	0	55.0	5.7	3.7	1.3
O	0	35.4	15.2	8.7	6.8
N	0	6.3	29.0	18.3	12.0
D	0	0	47.1	34.2	25.2

It must also be noted that during the ten-year period examined, July and August, that is the main two summer months, have never had sunless days at the airport of Ioannina. Yet, such days have been recorded in every one of the remaining ten months, the highest percentage of sunless days belonging to the months of December and January. Here also April exceeds October in sunless days (duration = 0).

If besides the sunless days we also take into account the «practically sunless» (duration < 0.49 hour) and the «almost sunless» (sunshine duration < 1.49 but > 0.49 hour) still the moths of the year remain in the same orded of «favorable» or «unfavorable» classification.

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The percentage of «almost sunless» days is > 40% during the main winter quarter from December to February, while during the five summer months from May to September it becomes less than 10%, falling below 1% during the main two summer months of July and August.

D. Duration of groups of consecutive sunless days:

The problem of whether sunless days happen at random, alternating with sunny ones, or if they occur as groups of consecutive sunless days, is of paramount importance, from the meteorological and climatological point of view as well as that of technological applications (utilization of solar energy (sunpower)).

Mean and extreme per month occurances of sunless days in Ioannina. Period 1964 - 1973.

	Maximum	Mean	Minimum
J	13(1972)	7.7	3(1964)
F	9(1965)	5.0	· 3(1966, 1968, 1971)
M	7(1973)	3.4	0(1967)
A	4(1965, 1970, 1972)	2.6	1(1968, 1969, 1971)
M	3(1964, 1965,1971)	1.2	0(frequently)
J	2(1965)	0.3	0(frequently)
J	—	—	—
A	—	—	—
S	2(1971)	0.4	0(frequently)
O	5(1968)	2.1	0(1971)
N	7(1966)	3.6	0(1970)
D	15(1965)	7.8	4(1971, 1972)
Year		34.2	

We give herewith Table VIII, in which are included data of sunless days (duration = 0), as a climatological feature. From this Table we observe that: a) The two summer months of July and August lack any sunless days, while the maximum occurs during the main two winter months of December and January. b) The tendency of late winters is observed in sunless days too, since April exceeds October e.t.c.

In *Table IX* we have included cases of groups of consecutive sunless days (duration = 0), during each month of the year. According to this Table, we have;

a) 39.2% of sunless days occured during the period examined in groups of two or more consecutive days.

b) The most numerous group is that consisting of two-consecutive days cases (45 cases out of a total of 58). Such two-days groups may occur from September till May.

c) Groups consisting of more consecutive days (3 days) hold 23.4% (13 cases out of 58).

TABLE IX

Distribution of groups of consecutive sunless days in Ioannina. (duration = 0).

	2	3	4	5	6	7	Total of groups Σ_1	Total of days Σ_2	Σ_1/Σ_2 %
J	13	5	1	—	1	—	51	78	60.2
F	10	1	—	—	—	—	23	50	46.0
M	2	—	—	—	—	—	4	34	11.8
A	1	—	—	—	—	—	2	26	7.7
M	2	—	—	—	—	—	4	12	33.3
J	—	—	—	—	—	—	—	3	—
J	—	—	—	—	—	—	—	—	—
A	—	—	—	—	—	—	—	—	—
S	1	—	—	—	—	—	2	4	50.0
O	2	—	—	—	—	—	4	21	19.0
N	2	1	—	—	—	—	7	36	19.4
D	12	3	1	—	—	—	37	78	47.4
Total of cases	45	10	2	—	1	—		342	
Total of days	90	30	8	—	6	—	134		

d) As to the distribution of these groups among the various months of the year, we observe that January has more groups of sunless days (60.2%) than every other month. But while this should rather be expected, what in our opinion is worth noting is the fact that sunless days of May and September too, occur as groups of consecutive days. This is characteristic of weather conditions at the beginning and the end of the warm season, when fine weather is succeded by a group of consecutive sunless days, whose cloudiness is followed by rains.

Of a certain importance for technological applications, is also the examination of consecutive «practically sunless» days, that is days whose sunshine duration varies between 00-0.49 hours. Such cases, 95 in all,

The percentage of «almost sunless» days is $> 40\%$ during the main winter quarter from December to February, while during the five summer months from May to September it becomes less than 10%, falling below 1% during the main two summer months of July and August.

D. D u r a t i o n   o f   g r o u p s   o f   c o n s e c u t i v e   s u n-l e s s   d a y s:

The problem of whether sunless days happen at random, alternating with sunny ones, or if they occur as groups of consecutive sunless days, is of paramount importance, from the meteorological and climatological point of view as well as that of technological applications (utilization of solar energy (sunpower)).

TABLE VIII

Mean and extreme per month occurances of sunless days in Ioannina. Period 1964 - 1973.

	Maximum	Mean	Minimum
J	13(1972)	7.7	3(1964)
F	9(1965)	5.0	· 3(1966, 1968, 1971)
M	7(1973)	3.4	0(1967)
A	4(1965, 1970, 1972)	2.6	1(1968, 1969, 1971)
M	3(1964, 1965,1971)	1.2	0(frequently)
J	2(1965)	0.3	0(frequently)
J	—	—	—
A	—	—	—
S	2(1971)	0.4	0(frequently)
O	5(1968)	2.1	0(1971)
N	7(1966)	3.6	0(1970)
D	15(1965)	7.8	4(1971, 1972)
Year		34.2	

We give herewith Table VIII, in which are included data of sunless days (duration $= 0$), as a climatological feature. From this Table we observe that: a) The two summer months of July and August lack any sunless days, while the maximum occurs during the main two winter months of December and January. b) The tendency of late winters is observed in sunless days too, since April exceeds October e.t.c.

In *Table IX* we have included cases of groups of consecutive sunless days (duration $= 0$), during each month of the year. According to this Table, we have;

a) 39.2% of sunless days occured during the period examined in groups of two or more consecutive days.

b) The most numerous group is that consisting of two-consecutive days cases (45 cases out of a total of 58). Such two-days groups may occur from September till May.

c) Groups consisting of more consecutive days (3 days) hold 23.4% (13 cases out of 58).

TABLE IX

Distribution of groups of consecutive sunless days in Ioannina. (duration $=0$).

	2	3	4	5	6	7	Total of groups Σ_1	Total of days Σ_2	Σ_1/Σ_2 %
J	13	5	1	—	1	—	51	78	60.2
F	10	1	—	—	—	—	23	50	46.0
M	2	—	—	—	—	—	4	34	11.8
A	1	—	—	—	—	—	2	26	7.7
M	2	—	—	—	—	—	4	12	33.3
J	—	—	—	—	—	—	—	3	—
J	—	—	—	—	—	—	—	—	—
A	—	—	—	—	—	—	—	—	—
S	1	—	—	—	—	—	2	4	50.0
O	2	—	—	—	—	—	4	21	19.0
N	2	1	—	—	—	—	7	36	19.4
D	12	3	1	—	—	—	37	78	47.4
Total of cases	45	10	2	—	1	—		342	
Total of days	90	30	8	—	6	—	134		

d) As to the distribution of these groups among the various months of the year, we observe that January has more groups of sunless days (60.2%) than every other month. But while this should rather be expected, what in our opinion is worth noting is the fact that sunless days of May and September too, occur as groups of consecutive days. This is characteristic of weather conditions at the beginning and the end of the warm season, when fine weather is succeeded by a group of consecutive sunless days, whose cloudiness is followed by rains.

Of a certain importance for technological applications, is also the examination of consecutive «practically sunless» days, that is days whose sunshine duration varies between 00-0.49 hours. Such cases, 95 in all,

have been included in *Table X*, a study of which leads to the following conclusions:

TABLE X

Distribution of groups of «practically» sunless consecutive days in Ioannina.
(duration ≤ 0,49 hour).

	2	3	4	5	6	7	8	Total of groups Σ_1	Total of days Σ_2	Σ_1/Σ_2 %
J	12	8	4	—	—	1	—	71	104	68.26
F	12	1	1	—	—	—	—	31	72	43.05
M	11	1	—	—	—	—	—	25	54	46.29
A	1	—	—	—	—	—	—	2	30	6.66
M	2	—	—	—	—	—	—	4	18	22.22
J	—	—	—	—	—	—	—	—	3	—
J	—	—	—	—	—	—	—	—	—	—
A	—	—	—	—	—	—	—	—	1	—
S	1	—	—	—	—	—	—	2	11	18.18
O	2	—	—	—	—	—	—	4	27	14.81
N	12	5	—	—	—	—	—	39	55	70.90
D	11	6	3	—	—	1	—	59	106	55.66
Total of cases	64	21	8	—	—	2				
Total of days	128	63	32	—	—	14	—	237	481	

a) Here again the group consisting of cases with two consecutive days is the most numerous holding 64 out of 95 cases or 67.4%.

Also this group holds 54.0% of all the sunless or practically sunless days that occured in sequence during this 10 year period (1964-1973).

b) 49.3% out of a total of 481 sunless days recorded during the period examined, occured in groups.

c) Comparing the two-days cases of *Tables IX* and X, we observe that those recorded in the months of April, May, September, and October are cases of totally sunless days (duration = 0), meaning that «bad weather» in these months is induced by sunless, that is, overcast, days.

d) November, if we take into account cases with sunshine duration ≤ 0.49 hour, has the highest percentage of grouped days, followed by the truly winter-month of January, which again has the largest number of grouped days.

E. D a i l y   a n d   D i u r n a l   v a r i a t i o n   o f   s u n s h i n e
d u r a t i o n - H o u r l y   v a l u e s:

The period of daylight changes continuously, and accordingly also changes the theoretical duration of sunshine, from day to day, from month to moth, during the evolvement of the year.

From the adjoined *Table XI*, we observe that the length of actual day, as it ensues from the sunshine duration recorded, changes: thus it has its minimum (10 hours) during the period from November to January while actual day increases to 14 hours during the May - August four-months.

The maximum of hourly mean values occurs during the properly cold season (November - January) after mid-day, while as the length of daylight increases and we advance towards the warm season, this maximum regresses before noon. During the main two summer months, July and August, the maximum is recorded between 09:00 — 10:00, and then it moves again towards noon.

This regression of maximum hourly sunshine duration towards the forenoon, results in annual mean values showing their highest duration values as forenoon ones.

CONCLUSIONS

Most of these conclusions have already been mentioned in previous sections of this work; there are however a few more general conclusions, which, we believe should be stressed also here.

I. The annual mean sunshine duration of Ioannina (Airport weather station), amounting to 2.343,83 hours, is rather high for an area which is one of the most unfavorably situated in Greece, from the climatological point of view as well as that of local ground relief.

This «disadvantage» is the effect of the following two factors:

a) The city of Ioannina has an average of 131,2 rain days per year, with an annual amount of precipitation of 1.262,1 mm, a rainfall that is considered high even for the rainy belt of Western Greece, while the duration of precipitation is 706,4 hours per year, one of the highest in Greece *Maldoyannis*[4].

b) The local ground relief, as can be also seen from the Horizonti-ogram (G r a p h   I) obstructs sunshine considerably, at sunrise as well as at sunset.

As a matter of fact, another factor has been added during these

TABLE XI

Mean hourly values of sunshine duration, per hour and per month in Ioannina. (in hours). Period 1964 - 1973.

|	5-6	6-7	7-8	8-9	9-10	10-11	11-12	12-13	13-14	14-15	15-16	16-17	17-18	18-19	19-20	Observed
J			0.05	0.27	0.38	0.47	0.48	0.50	0.49	0.45	0.33	0.05				3.47
F		0.00	0.12	0.33	0.43	0.48	0.50	0.48	0.46	0.41	0.34	0.17				3.72
M		0.04	0.32	0.49	0.55	0.58	0.59	0.55	0.50	0.48	0.43	0.29	0.04			4.86
A		0.20	0.48	0.59	0.65	0.66	0.63	0.60	0.51	0.53	0.51	0.47	0.24	0.00		6.07
M	0.03	0.52	0.69	0.77	0.78	0.77	0.75	0.69	0.66	0.65	0.63	0.59	0.51	0.14		8.18
J	0.14	0.69	0.80	0.81	0.83	0.85	0.83	0.79	0.70	0.68	0.67	0.63	0.61	0.28		9.31
J	0.14	0.79	0.87	0.92	0.93	0.92	0.91	0.87	0.84	0.78	0.75	0.76	0.72	0.28		10.48
A	0.00	0.65	0.86	0.90	0.92	0.90	0.89	0.88	0.84	0.81	0.79	0.76	0.56	0.04		9.80
S		0.17	0.63	0.43	0.82	0.85	0.83	0.79	0.78	0.74	0.70	0.59	0.11			7.44
O		0.01	0.33	0.59	0.70	0.73	0.74	0.73	0.72	0.70	0.64	0.20	0.00			6.09
N			0.07	0.29	0.44	0.54	0.58	0.59	0.59	0.55	0.47	0.06				4.18
D			0.01	0.16	0.30	0.36	0.42	0.43	0.42	0.39	0.17	0.00				2.66
Year	0.027	0.258	0.439	0.576	0.646	0.677	0.681	0.664	0.628	0.601	0.536	0.383	0.234	0.064		6.355

last years obstructing the sunshine at sunset, especially in winter time, and this is the growing vegetation on this side of the station (Fig. II).

II. Lake Pamvotis, (22 km², see Map.) lying at the bottom of this enclosed valley, almost touches with the airport and its weather station. The location is ideal for the formation of low Stratus ($\equiv$) clouds in the area of the airport and the lake, resulting in 31,2 days of fog per year[4]. This fact again reduces sunshine duration, especially in the autumn and winter season.

GRAPH II

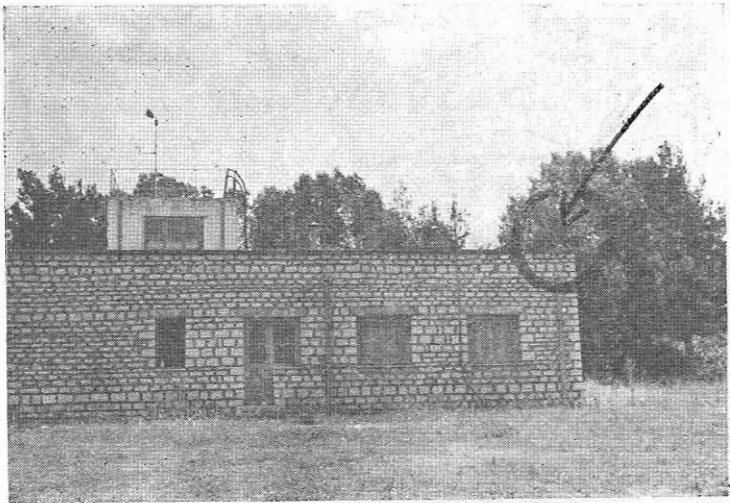DAILY VARIATION OF SUNSHINE IN IOANNINA

July

mean annual

December
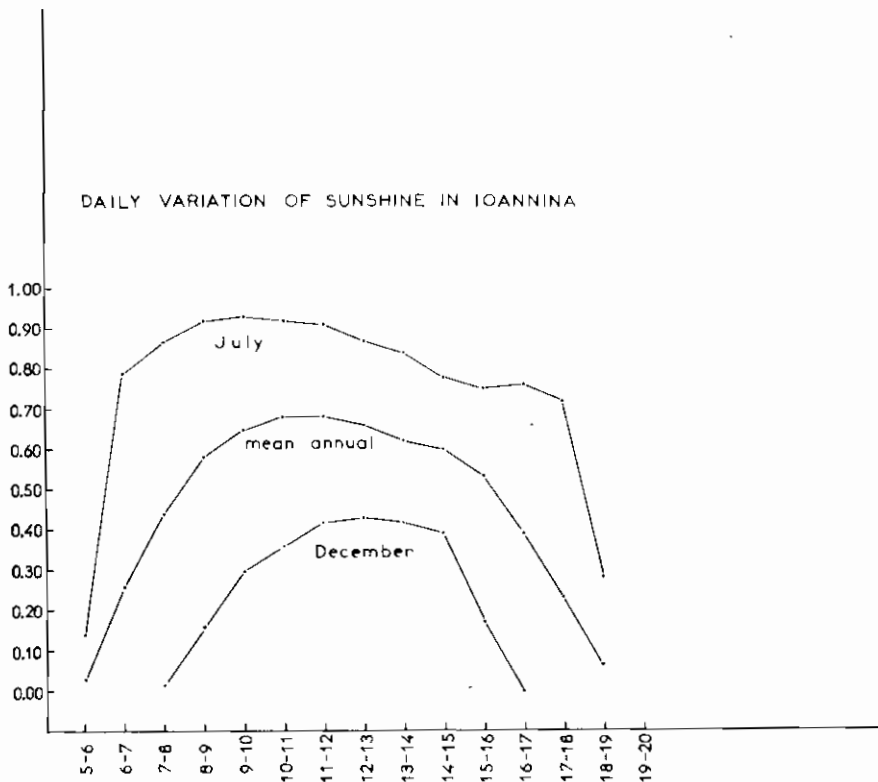
III. The local ground relief facilitates convection during the day, this being the main factor for the development of cumuliform clouds which increases cloudiness around midday during the warm season.

2
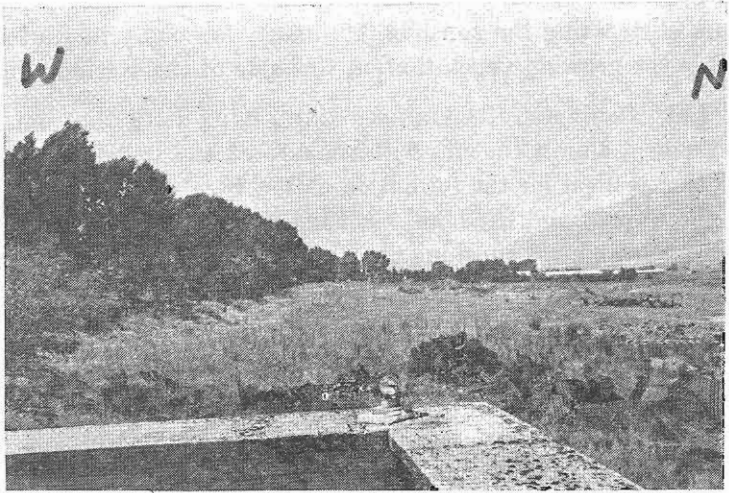
Fig. I. The building of the Meteorological Station;
with in the circle the sunshine recorder.

Fig. II. The sunshine recorder and tree on the west side of the station.

This increase of cloudiness results, especially during the warm season, in the occurence of maxima of hourly mean sunshine duration values not at noon, but much earlier (see *Table XI*).

TABLE XII

Mean cloud cover at Ioannina airport (measured in tenths).
(Maldoyannis[4])

	Winter semester (Oct. - March)	Summer semester (April - Sept.)
08:00	6.7	3.1
14:00	6.5	4.8
20:00	5.4	4.2

A similar observation was made by *Livadas - Semerdzidis* [3] in their study of sunshine duration on the mountain mass of Mt Olympus, as well as by *Metaxas*[5] on the variations of cloudiness over the plain of Attica, comparing a coastal station (Hellenikon Airport) with an in-land station (Tatoi School of Aviation).

Acknowledgements.
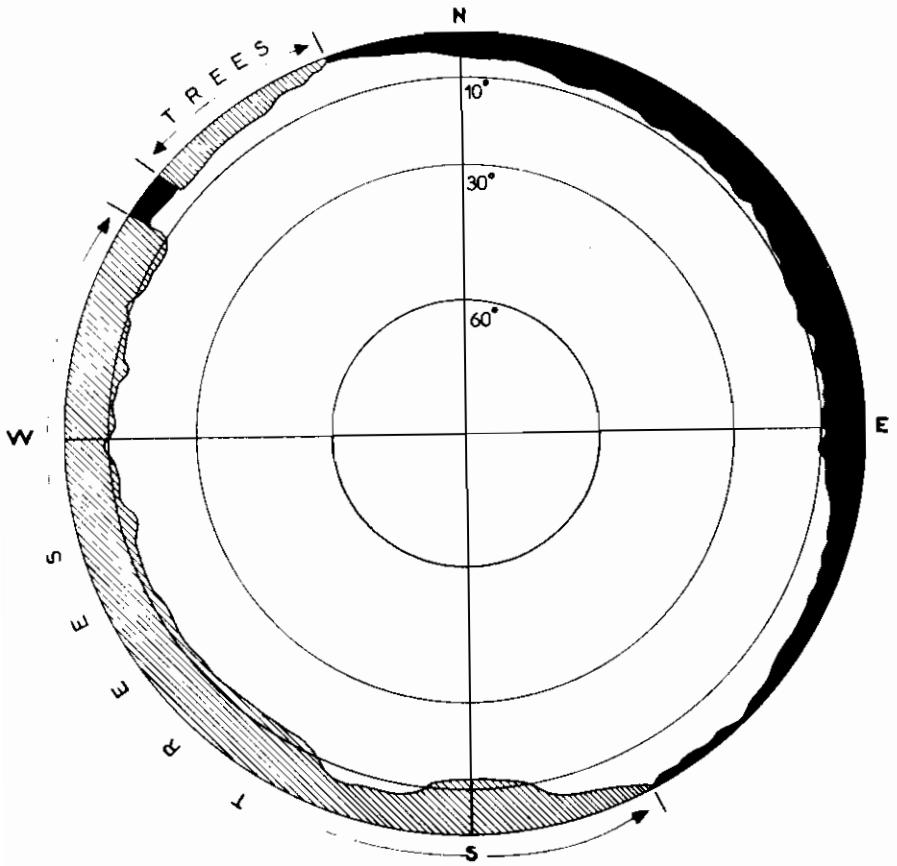
Horizontiogram

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ΠΕΡΙΛΗΨΙΣ

ΔΙΑΡΚΕΙΑ ΗΛΙΟΦΑΝΕΙΑΣ ΕΙΣ ΙΩΑΝΝΙΝΑ

ὑπὸ

Γ. Κ. ΛΙΒΑΔΑ, Π. Ι. ΠΕΝΝΑ καὶ Θ. Ι. ΜΑΛΔΟΓΙΑΝΝΗ

Μελετᾶται ἡ διάρκεια τῆς ἡλιοφανείας εἰς τὸν Μ. Σταθμὸν τοῦ ἀεροδρομίου τῶν Ἰωαννίνων μὲ βάση τὰ στοιχεῖα τῆς χρονικῆς περιόδου 1964-1973. Ἐξάγονται συμπεράσματα ὡς πρὸς τὴν **μέση** ἐτησία διάρκεια τῆς ἡλιοφανείας (2.343,83±105,30 ὧραι), ὡς ἐπίσης ἡ κατανομὴ τῆς ἡλιοφανείας εἰς ἕκαστον μῆνα τοῦ ἔτους.

Ἐπίσης μελετῶνται ἡ μέση ἡμερησία πορεία τῆς ἡλιοφανείας, ὡς καὶ αἱ παρατηρηθεῖσαι τιμαὶ τῆς καθ᾽ ἑκάστην ἡμέραν σημειωθείσης διαρκείας αὐτῆς.

Τελικῶς μελετᾶται, τόσον ἡ ἐπίδρασις τοῦ ἀναγλύφου ὅσον καὶ ἡ ἐπίδρασις τῆς νεφώσεως εἰς τὴν διάρκειαν τῆς ἡλιοφανείας, τὰ δὲ προκύπτοντα συμπεράσματα ἐκ τῆς ἐπιδράσεως τῆς ἡμερησίας κυμάνσεως τῆς νεφώσεως **ἐπὶ** τῆς ἡλιοφανείας, ἀποδεικνύουν ὅτι καὶ εἰς τὰ Ἰωάννινα ἡ νέφωσις ἀκολουθεῖ τὴν ἡμερησίαν κύμανσιν τῶν ἠπειρωτικῶν ὀρεινῶν Μετεωρολογικῶν Σταθμῶν.