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THE DISTRIBUTION OF WIND VELOCITIES IN POLAND AT HEIGHTS 10 AND--ETC(U)
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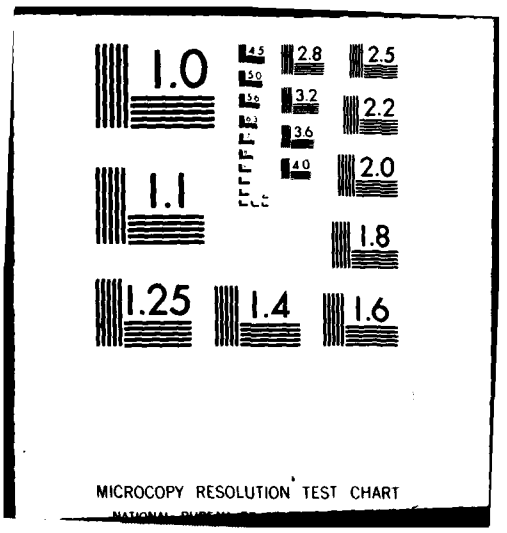
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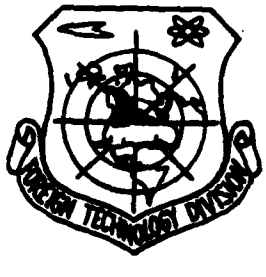
FTD-ID(RS)T-1714-81

FOREIGN TECHNOLOGY DIVISION

THE DISTRIBUTION OF WIND VELOCITIES IN POLAND AT HEIGHTS 10 AND 25 M ABOVE GROUND LEVEL

by

Zenon Wierzbicki



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THE DISTRIBUTION OF WIND VELOCITIES IN POLAND AT HEIGHTS 10 AND 25 M ABOVE GROUND LEVEL

Zenon Wierzbicki

Summary

In this work three zones of wind velocities (strong, average and weak) were distinguished at 10 and 25 m above ground level in Poland. The reduction of wind velocities to these levels was carried out by means of a formula which takes into account the turbulence in the friction layer and roughness of the ground base.

1. The aim and scope of this work

Studies of wind velocities play an important role in solving many technical problems both in urbanistics, architecture, building and in energetics. In urban planning, winds have a decisive effect on improvement of air quality in towns, and on climatic conditions of towns and settlements. The wind accelerates the heat exchange between insides of buildings and the outside environment, and it affects the ventilation of buildings through direct penetration and by its effect on the work of air conditioning systems. Because of pressure exerted on buildings and their elements, the velocity of wind affects primarily the stability of wooden structures.

Lately our literature saw the appearance of a report on average wind velocities for the whole country [5], based on observations of PIHM (National Institute of Hydrology and Meteorology) for the period 1947-1958. The present work is an extension of that publication, and it considers the possibility of application of reduction formulas to two levels - 10 and 25 m above ground level, corresponding to most typical buildings in Poland.

This work is based on material observed at 62 locations in the period 1947-1963. Average values for months, seasons and years were calculated from daily values obtained in three periodic observations performed at 7, 13 and 21 h on Wild type anemometers. The Wild anemometers allow one to measure wind velocities up to 20 m/sec only. As follows from a number of works [1,10], ground winds with velocities above 15 m/sec are not frequent in Poland (for instance, in Warsaw they are only 0.1%). Hence, calculations neglecting winds above 20 m/sec will not have a crucial effect on average values obtained in multi-year observations.

In the Polish network of meteorological stations, the anemometers were placed at different heights from 10 to 24 m, depending on the height of objects in the near vicinity. The intention was to prevent these adjacent objects from affecting anemometer readings.

When developing maps of the distribution of wind velocity zones, we applied a schematic method for separating areas with different velocities by means of iso-lines every 0.5 m/sec.

2. Wind velocities and pressure

The surface of the ground base has a large effect on reducing wind velocity; hence, as the height increases, the velocity of the wind also increases. In the layer near the ground, this velocity increase proceeds rapidly up to a height of about 5 m, and then goes much slower. The dependence between the average wind velocity and height has been given by Hellmann [4] in the form of a logarithmic formula, based on observations in Nauen. The empirical formula of Hellman cannot be applied to conditions other than those under which it was established.

In recent years, a number of authors proposed various forms of the dependence of wind velocity on height in the near-ground layer. Studies carried out by Prandtl [11] showed that the wind profile under conditions of neutral equilibrium

should change according to the logarithmic law. Among other authors concerned with this problem we should mention Best, Swerdrup, Paeschke, Thornthwait, Deacon, Rossby and Sutton. Moreover, nearly simultaneously, the results of their studies in this field were published by Laikhtman [6, 7] and by Forst [2].

In 1944, L.D. Laikhtman offered an analytical formula to calculate the change of wind with height, in the form:

$$\frac{u}{u_1} = \frac{z^{\varepsilon} - z_0^{\varepsilon}}{z_1^{\varepsilon} - z_0^{\varepsilon}}$$

where:

u and u_1 - wind velocities at heights z and z_1,

ε - coefficient depending on stratification of atmosphere,

z_0 - coefficient of roughness depending on the character of ground base.

As is seen from the form of Laikhtman equation, this formula can be applied under different topographic conditions after previous determination of the coefficients ε and z_0.

D.L. Laikhtman [7] states that the condition necessary for steady equilibrium is $0 < \varepsilon < 1$, for neutral equilibrium $\varepsilon = 0$, and for unsteady equilibrium $-\frac{1}{3} < \varepsilon < 0$.

For the coefficient of roughness z_0 we can take [3]:

- for a field with a high rare vegetation $z_0 \approx 5$ cm,
- for a field with grass and crops $z_0 \approx 1$ cm,
- for even, plain surfaces $z_0 \approx 0{,}5$ cm,
- for snow cover $z_0 \approx 0{,}1$ cm.

The frequency of weather at different stratifications for Cracow and Zgorzelec was reported by J. Michalczewski and W. Parczewski [8] and by W. Parczewski [9]. These weathers are in % per year as follows:

Equilibrium	Cracow	Zgorzelec
1. Steady	40.7	38.4
2. Neutral	36.5	32.2
3. Unsteady	22.8	29.4

On the basis of the types of clouds, this author [12] calculated the percentage share of particular types of equilibrium Jelenia Gora. For yearly percents the stratifications are: steady 34.6%, neutral 32.2%, and unsteady 33.2%. It has to be noted that the calculated values are only tentative, since they are based on indirect data; nonetheless, they are, in general, in agreement with the results of other authors [8, 9] .

In recalculations of average winds for particular months from the observed level to the ground level one may take the value of ε in Laikhtman equation as $\varepsilon = 0$, as an intermediate value between the states of steady and unsteady equilibrium.

Putting then the value $\varepsilon = 0$ into Laikhtman formula, and using the rule of de L'Hopital, we obtain the following form:

$$\frac{u}{u_1} = \frac{z' - z_0'}{z_1' - z_0'}\bigg|_{\varepsilon=0} = \frac{\frac{d}{d\varepsilon}(z' - z_0')}{\frac{d}{d\varepsilon}(z_1' - z_0')}\bigg|_{\varepsilon=0} =$$

$$\frac{z' \ln z - z_0' \ln z_0}{z_1' \ln z_1 - z_0' \ln z_0}\bigg|_{\varepsilon=0} = \frac{\ln \frac{z}{z_0}}{\ln \frac{z_1}{z_0}}$$

The obtained equation applies to changes of wind velocity with height in ground-adjacent layers. The lack of appropriate studies in Poland impedes the further development of this topic by reduction of winds from the level of anemometers to other levels.

The flowing wind exerts pressure on objects in the way of its flow, and the pressure is proportional to the square of velocity. The relation between pressure exerted by winds on surfaces perpendicular to the wind direction and between wind velocity is expressed by equation:

$$p = c \cdot \frac{v^2 \cdot \gamma}{2g} = c \cdot \frac{v^2 \cdot \gamma}{19{,}62} \text{ [kG/m}^2\text{]}$$

where: v - wind velocity, m/sec,
γ - specific weight of air , kG/m^3, at a given temperature and a given humidity,
g - gravity acceleration, g = 9.81 m/sec^2,
c - a constant depending on the size and other features concerning the shape of barrier.

Accepting for climatic conditions in Poland the average yearly temperature about 8°C and humidity about f = 80%, specific weight of air will be γ = 1.253 kG/m^3. With the coefficient c = 1 for this average specific weight of external air, the relation of wind pressure on wind velocity will be:

$$p = 1 \cdot \frac{v^2}{15{,}66}, \quad v = \sqrt{15{,}66p}$$

Calculations using these formulas are presented in Table 2.1 and in Figure 2.1.

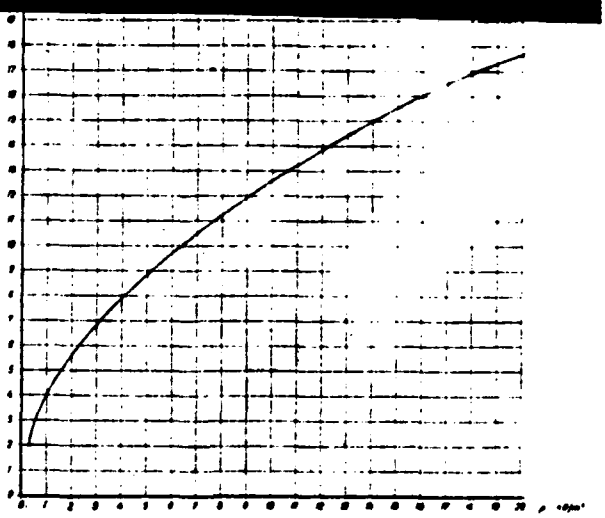
3. Daily and yearly distribution of wind velocities in Poland

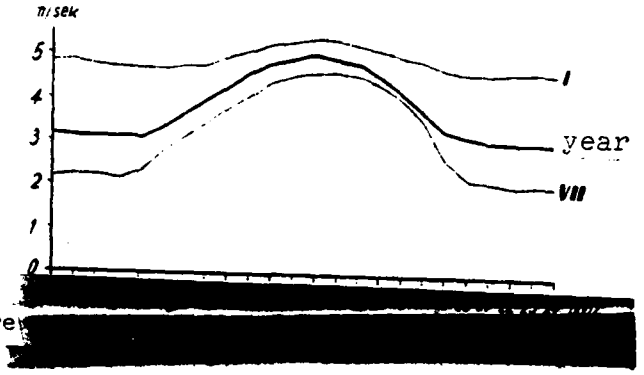
Wind velocities have their yearly and daily cycles; the lowest values occur at night and the highest in the afternoon hours. The amplitude of daily variations of wind velocity undergoes changes in particular seasons of the year (Figure 3.1). The lowest amplitude occurs in winter, and the highest comes in summer

Table

velocity V m/sek	pressure p kG/m²	velocity V m/sek	pressure p kG/m²
1,98	0,25	9,70	
2,80	0,5	11,20	
3,96	1	12,51	

Figure





Figure

despite the fact that in summer winds have the lowest velocities (Table 3.1). The analysis of yearly amplitudes in the whole country shows that the highest amplitudes occur at mountain peaks (Sniezka 6.95, Kasprowy Wierch 3.4) and then at the seashore (Hel 2.1, Rozewie 2.5). The lowest values occur in Malopolska Wyzyna and in Wielkopolska Lowlands. The yearly maxima of wind velocities appear usually in January, although there are cases when these values appear already in December (Hel, Ustka, Ketrzyn.). Also, they may occur in the time of early spring, that is in March (Warsaw, Mlawa, Resko, Gorzow, Kielce, Przemysl and Wlodawa).

The minima of wind velocities occur primarily in months VII, VIII (July, August), but there happen to be cases when these minima appear exceptionally early (VI) or exceptionally late (IX).

4. Reduction of winds from the level of anemometers to the levels 10 and 25 m above the ground

The results of observations obtained from anemometers of the Polish meteorological network have been reduced to the level of 10 and 25 m above the ground, using the formula of Laikhtman

with the assumption that $\varepsilon = 0$; moreover, the coefficient of roughness was taken as $z_0 = 1$ cm. There were 44 anemometers at the height of 10 to 15 m, and only 18 at the height 15-24 m.

The values of differences obtained on reduction of wind velocities from the height of anemometers to the 10 and 25 m levels depend primarily on values of differences of the height levels, and then on values of wind velocity.

After reduction of speed to the 10 m level above ground the corrections for anemometers placed up to 15 m above ground are small (values of 0.0 and 0.1 m/sec) and can be neglected. But for anemometers located more than 15 m above ground level the wind velocities are higher and amount to from 0.2 to 0.5 m/sec - depending on values of wind velocity - for instance at Sniezka with anemometers at 18 m the difference on reduction to 10 m above ground level amounts to 0.9 m/sec. On reduction of wind velocities to the level of 25 m above ground - for anemometers at the height of up to 15 m above ground the differences are from 0.2 to 0.5 m/sec on the average, and for anemometers higher than 15 m above ground, from 0.0 to 0.2 m/sec (Table 4.1). These differences have to be added to obtain velocities adjusted to the height of 25 m above ground.

It follows from the above considerations that for differences between levels less than 5 m the corrections can be neglected.

5. Wind zones in Poland at the levels 10 and 25 m above ground

When drawing isotachs for 10 and 25 m above ground level (Figures from 5.1 to 5.10) it was noted that the results of certain meteorological stations show values which deviate from average wind conditions in the neighborhood of a given station. Presumably, this is due to local conditions governing in the locality represented

Table [redacted]

H, height in m	number of wind vanes	$\Delta U = U_{10} - U_N$	$\Delta U = U_{25} - U_N$
10	2	0,0	+0,4
11	11	0,0	+0,5
12	10	0,0	+0,3
13	7	0,0	+0,3
14	8	-0,1	+0,3
15	6	-0,1	+0,2
16	5	-0,2	+0,2
17	2	-0,2	+0,2
18	3	-0,4	+0,2
19	0	-	-
20	2	-0,4	0,0
21	2	-0,4	0,0
22	2	-0,4	0,0
23	0	-	-
24	2	-0,5	0,0

by a given station.

The comparative analysis of these maps for the heights 10 and 25 m above ground level reveals the following common features in different seasons of the year in Poland, for both these levels.

Winter season (XII, I, II) This period shows the strongest winds in the year, caused by an increased activity of atmospheric circulation. The highest average velocities appear on the seashore (4-6 m/sec), in Northeastern part of the country (4-4.5 m/sec), in the lower part of Vistula river up to Nogat, and also in the basin of middle Vistula up to Pilica (4-4.5 m/sec). Larger average wind velocities are noted sporadically in Lodz higher plateau and in the areas of Katowice and Rzeszow.

Winds with average velocity (3-3.5 m/sec) cover the areas South of Pojezierze Pomorskie and also of Pojezierze Mazurskie along the edge of Wyzyna Malopolska and Lubelska.

Weaker winds (2-3 m/sec) blow in Wyzyna Malopolska and in mountain bowls. Mountain ridges, similarly to the seashore, have much higher wind velocities (4-14 m/sec).

Spring time (III, IV, V) The activity of low baric areas undergoes a considerable weakening. Strong winds appear now in smaller sections of the country, limited to the seashore belt and a small area in the Northeastern part of Poland (4-4.5 m/sec). In spring time the winds with average velocities (3-3.5 m/sec) cover predominant areas, and in the South the area of weak winds (2-3 m/sec) becomes enlarged.

Summer season (VI, VII, VIII) The area of stronger winds is limited to a narrow belt along the coast (3.5-4 m/sec). The largest part of the country is covered by winds with average velocity (3-3.5 m/sec). The area of weak winds (2-3 m/sec) enlarges its influence. At the same time, very weak winds (below 2 m/sec) begin to appear in the Southern part of the country.

Autumn period (IX, X, XI) This period sees an increase of the gradients of pressure. At this time, strong winds increase their range, primarily at the seashore and in Northeastern part of the country (4-5 m/sec). The middle part of the country is covered by average winds (3-3.5 m/sec), whilst weak winds (2-3 m/sec) appear South of Pojezierze Pomorskie and in the Southern high country.

Of basic importance for technical purposes is the yearly map of isotachs, as a resultant of wind velocities which appear in particular periods of the year. Moreover, the values used here are taken after the intended recalculations.

On the basis of maps of the average yearly distribution of wind velocities we can distinguish the following three main zones of wind activity:

- zone of strong wind activity, with wind velocities above 4.0 m/sec exerting the wind pressure on the average above 1.0 kG/m^2, covering the coastal belt and the Northeastern part of the country,
- zone of medium activity, with wind velocities from 3 m/sec to 4 m/sec, exerting the pressure from 0.575 kG/m^2 to 1.0 kG/m^2, covering the major part of the country and first of all Pojezierze Mazurskie, and Eastern and Western Pojezierze Pomorskie with exception of its middle part and the area of extended lowlands,
- zone of weak activity, with wind velocities below 3.0 m/sec, that is below the pressure 0.575 kG/m^2, covering the areas South of Odra river (without mountain ridges) and Wyzyna Malopolska and Lubelska. In this 3rd zone one can distinguish also a sub-zone of very weak activity, below 2.0 m/sec hence below 0.25 kG/m^2, which covers mountain bowls particularly in Carpathian Mountains.

6. Concluding remarks

- In the reduction of wind velocities to the level of 10 m there were 44 stations with anemometers up to 15 m above ground which did not require any adjusting corrections. For the remaining 18 stations with anemometers at heights up to 24 m, the reduction of average yearly wind velocities indicated differences from 0.2 to 0.5 m/sec.

- In the reduction of wind velocities to the level of 25 m above ground there were 54 stations with anemometers up to the height of 20 m for which differences of wind velocities amounted to from 0.2 to 0.5 m/sec. For the remaining 8 stations the reduction

could be neglected.

- The maps of wind activity zones for both levels 10 and 25 m do not show any significant differences. In this connection, reductions to the mentioned levels may be considered as applicable only to individual cases requiring particularly high accuracy.

In the technical studies, I was helped by meteorology technician Comrade Izdislawa Rogowska.

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Table 3.1 [redacted] 1969–1988

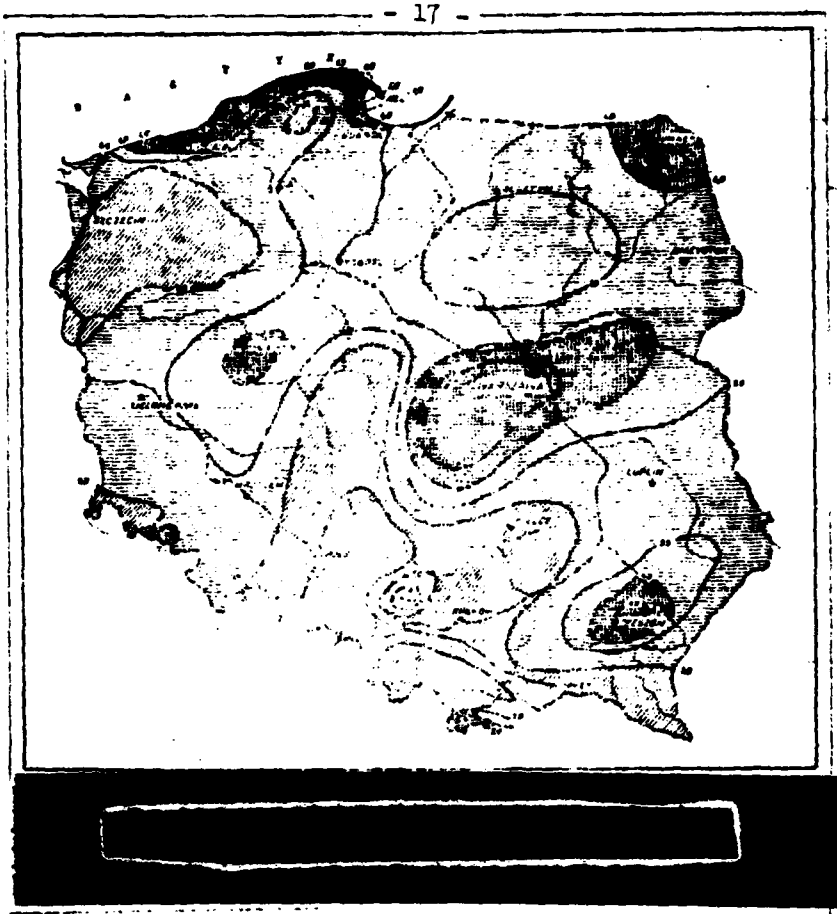
Lp.	Location	Height m												Annual
1	*Biała Podlaska*	10	3,6	3,8	3,9	3,2	2,8	2,7	2,4	2,7	2,8	3,2	3,9	3,6	3,2
		25	3,9	4,1	4,2	3,5	3,1	3,0	2,7	3,0	3,1	3,4	4,2	3,9	3,5
2	Białowieża	10	4,1	3,8	4,2	3,3	3,1	2,8	2,8	3,1	3,0	3,4	4,0	3,8	3,4
		25	4,3	4,1	4,6	3,7	3,4	3,1	3,1	3,4	3,3	3,8	4,4	4,1	3,8
3	Białystok	10	4,0	3,7	3,7	3,4	2,9	2,8	2,6	2,8	2,8	3,1	3,8	3,7	3,3
		25	4,5	4,2	4,2	3,8	3,3	3,2	3,0	3,2	3,2	3,5	3,2	4,1	3,8
4	Bydgoszcz	10	3,5	3,5	3,7	3,4	3,2	3,1	2,9	2,9	2,7	2,9	3,1	3,3	3,2
		25	4,0	4,0	4,2	3,8	3,6	3,5	3,3	3,3	3,1	3,3	3,5	3,7	3,6
5	Chojnice	10	4,1	3,9	3,8	3,4	3,1	3,0	2,7	2,8	3,0	3,2	3,4	3,7	3,3
		25	4,6	4,3	4,2	3,8	3,4	3,3	3,0	3,1	3,3	3,5	3,8	4,1	3,7
6	Cieszyn	10	2,0	1,8	1,6	1,7	1,5	1,4	1,3	1,3	1,4	1,5	1,7	1,8	1,6
		25	2,2	2,0	1,8	2,0	1,7	1,6	1,5	1,5	1,6	1,7	1,9	2,0	1,8
7	Częstochowa	10	2,5	2,5	2,4	2,2	2,3	2,2	1,9	1,9	1,9	1,9	2,1	2,2	2,2
		25	2,8	2,8	2,7	2,5	2,6	2,5	2,2	2,2	2,2	2,2	2,4	2,5	2,5
8	Elbląg	10	3,8	3,7	4,2	4,0	3,7	3,4	3,0	3,0	3,1	3,4	3,7	3,8	3,6
		25	4,3	4,2	4,7	4,5	4,1	3,8	3,4	3,4	3,5	3,7	4,0	4,1	4,0
9	Gdańsk	10	4,2	4,1	4,1	3,7	3,5	3,2	3,2	3,1	3,2	3,5	3,5	3,8	3,6
		25	4,6	4,5	4,5	4,1	3,8	3,5	3,5	3,4	3,5	3,8	3,8	4,1	3,9
10	Gdynia	10	5,1	5,1	5,2	4,2	3,7	3,7	3,6	3,9	3,9	4,6	5,1	4,8	4,4
		25	5,7	5,7	5,8	4,7	4,2	4,2	4,1	4,4	4,4	5,1	5,6	5,5	5,0
11	Gorzów Wlkp.	10	3,3	3,3	3,6	3,2	3,0	2,8	2,5	2,6	2,7	2,7	2,9	2,9	3,0
		25	3,6	3,6	3,9	3,5	3,3	3,1	2,7	2,7	2,9	2,9	3,2	3,2	3,2
12	Hel	10	4,8	4,5	4,2	3,3	3,1	3,2	3,1	3,3	3,6	4,4	4,6	4,9	3,9
		25	5,4	5,0	4,7	3,7	3,5	3,5	3,4	3,6	4,0	4,8	5,1	5,5	4,4
13	Jelenia Góra	10	3,1	3,0	2,9	2,4	2,2	2,1	2,0	1,7	2,1	2,3	2,7	2,6	2,4
		25	3,5	3,4	3,3	2,7	2,5	2,4	2,3	2,0	2,4	2,6	3,0	2,9	2,8
14	Kalisz	10	3,1	2,9	3,0	2,6	2,4	2,3	2,4	2,3	2,4	2,2	2,5	2,8	2,6
		25	3,5	3,3	3,4	3,0	2,7	2,6	2,7	2,6	2,7	2,5	2,8	3,1	2,9
15	Kasprowy Wierch	10	7,8	7,2	6,8	5,8	4,8	4,7	4,5	5,0	5,2	6,1	7,4	7,8	6,1
		25	8,8	8,2	7,8	6,5	5,5	5,4	5,2	5,7	5,9	6,8	8,3	8,7	6,9
16	Katowice	10	3,7	3,5	3,5	3,2	3,0	2,7	2,7	2,7	2,9	2,9	3,3	3,4	3,1
		25	4,2	4,0	4,1	3,6	3,4	3,1	3,1	3,0	3,3	3,3	3,7	3,8	3,5
17	Kętrzyn	10	3,7	3,6	3,6	3,3	2,9	2,7	2,4	2,6	2,8	3,1	3,5	4,0	3,2
		25	4,3	4,1	4,1	3,7	3,3	3,0	2,7	2,9	3,1	3,4	3,9	4,5	3,6
18	Kielce	10	2,8	2,8	3,3	2,6	2,6	2,4	2,4	2,3	2,4	2,4	2,5	2,6	2,6
		25	3,2	3,2	3,7	3,0	3,0	2,8	2,7	2,6	2,8	2,7	2,9	3,0	3,0
19	Kłodzko	10	3,5	3,0	2,8	2,6	2,1	1,9	1,9	1,8	2,0	2,5	3,0	3,1	2,5
		25	4,0	3,5	3,3	3,0	2,5	2,3	2,5	2,1	2,4	2,9	3,5	3,6	2,9
20	Koło	10	2,9	2,9	2,9	2,5	2,3	2,1	2,0	2,0	1,8	2,0	2,4	2,6	2,4
		25	3,5	3,3	3,5	2,8	2,6	2,4	2,2	2,3	2,1	2,2	2,7	3,0	2,8

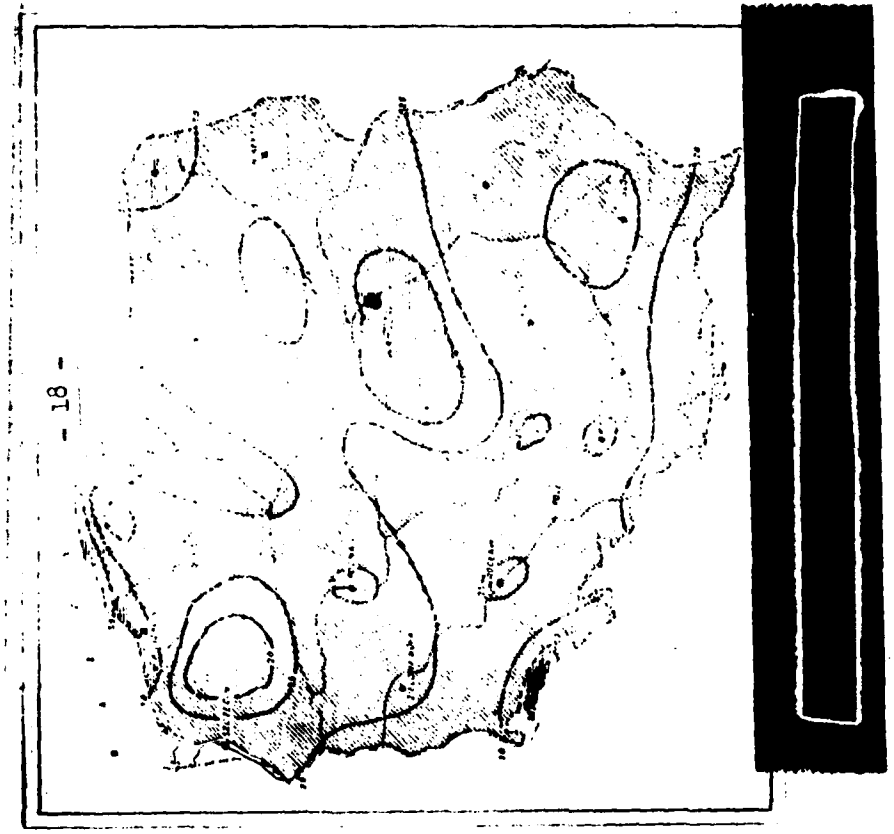
Table 3.1 (cont.

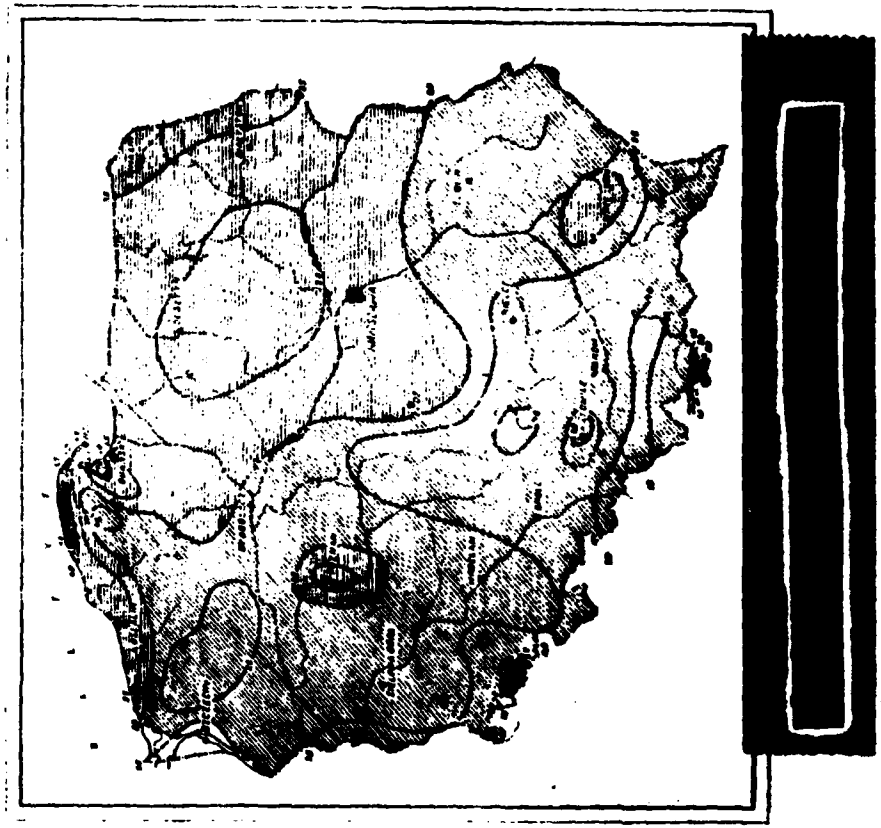
Lp.	Location	Height m	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Annua
21	Kołobrzeg	10	4,7	4,5	4,4	3,8	3,5	3,3	3,3	3,3	3,5	3,6	4,0	4,4	3,9
		25	5,2	5,0	4,9	4,2	3,9	3,7	3,7	3,7	4,0	4,1	4,5	4,9	4,3
22	Koszalin	10	5,1	4,5	4,2	4,3	3,9	3,4	3,3	3,4	3,7	3,8	3,9	4,6	4,0
		25	5,7	5,1	4,8	4,9	4,5	3,8	3,7	3,8	4,1	4,4	4,5	5,2	4,5
23	Kraków	10	2,8	2,9	3,2	2,6	2,7	2,3	2,2	2,1	2,3	2,2	2,6	2,7	2,6
		25	3,1	3,2	3,6	2,8	2,9	2,5	2,4	2,3	2,5	2,4	2,8	2,9	2,8
24	Legnica	10	3,8	3,0	3,2	2,7	2,7	2,5	2,5	2,2	2,3	2,4	2,7	2,6	2,7
		25	4,2	3,3	3,5	3,0	3,0	2,8	2,8	2,4	2,5	2,7	3,0	2,9	3,0
25	Lębork	10	3,1	3,1	2,9	2,9	2,6	2,6	2,4	2,4	2,3	2,4	2,7	2,8	2,7
		25	3,4	3,4	3,3	3,3	2,9	2,9	2,7	2,7	2,6	2,7	3,0	3,1	3,0
26	Lublin	10	3,4	3,2	3,3	2,8	2,6	2,5	2,1	2,2	2,3	2,5	3,1	3,2	2,8
		25	4,0	3,8	3,9	3,4	3,2	3,0	2,6	2,5	2,8	3,0	3,6	3,8	3,3
27	Łeba	10	4,6	4,7	4,7	4,1	3,7	3,7	3,7	3,9	4,1	4,6	4,7	4,8	4,3
		25	5,0	5,2	5,1	4,5	4,1	4,1	4,1	4,3	4,5	5,0	5,1	5,3	4,7
28	Łódź	10	5,0	4,9	5,0	4,3	3,9	3,5	3,4	3,4	3,7	3,7	4,5	4,7	4,2
		25	5,7	5,5	5,6	4,9	4,5	4,0	3,9	3,8	4,1	4,1	5,1	5,3	4,7
29	Międzyzdroje	10	3,6	3,2	3,3	3,0	2,8	2,8	2,8	2,5	2,8	2,9	3,0	3,3	3,0
		25	3,9	3,5	3,6	3,3	3,1	3,1	3,1	2,8	3,1	3,2	3,3	3,6	3,3
30	Mława	10	3,0	3,1	3,3	3,0	3,0	2,7	2,5	2,4	2,4	2,4	2,8	2,8	2,8
		25	3,4	3,5	3,7	3,4	3,4	3,1	2,8	2,7	2,7	2,7	3,1	3,1	3,1
31	Olsztyn	10	3,6	3,5	3,5	3,2	3,0	2,8	2,6	2,6	2,6	2,9	3,3	3,3	3,1
		25	3,9	3,8	3,8	3,5	3,3	3,1	2,9	2,9	2,9	3,2	3,6	3,6	3,4
32	Opole	10	2,5	2,5	2,5	2,4	2,3	2,2	1,9	2,1	2,0	2,0	2,3	2,4	2,3
		25	2,8	2,8	2,8	2,6	2,5	2,2	2,1	2,3	2,2	2,2	2,5	2,6	2,5
33	Ostrołęka	10	3,4	3,3	3,3	3,0	2,7	2,3	2,3	2,3	2,3	2,5	3,0	3,1	2,8
		25	3,7	3,6	3,6	3,3	3,0	2,5	2,5	2,5	2,5	2,7	3,3	3,4	3,(
34	Płock	10	3,9	3,7	3,8	3,1	3,2	2,9	2,7	2,9	3,0	3,1	3,5	3,6	3,3
		25	4,3	4,1	4,2	3,5	3,6	3,3	3,1	3,3	3,3	3,5	3,9	4,0	3,7
35	Poznań	10	4,5	4,1	4,3	3,9	3,7	3,4	3,4	3,3	3,3	3,4	3,7	3,9	3,
		25	5,0	4,6	4,8	4,4	4,1	3,8	3,8	3,7	3,7	3,8	4,1	4,4	4,
36	Przemyśl	10	3,1	3,2	3,6	2,8	2,6	2,5	2,4	2,4	2,4	2,4	2,8	2,9	2,
		25	3,5	3,6	4,0	3,2	3,0	2,9	2,7	2,7	2,7	2,7	3,1	3,3	3,
37	Puck	10	4,3	4,3	4,3	3,6	3,4	3,0	2,9	3,0	3,1	3,5	3,8	3,8	3.
		25	4,8	4,8	4,8	4,1	3,8	3,4	3,3	3,4	3,5	3,9	4,3	4,3	4.
38	Rabka Zdrój	10	1,9	1,8	1,8	1,7	1,7	1,4	1,3	1,3	1,3	1,4	1,7	1,8	1
		25	2,2	2,0	2,0	1,9	1,9	1,6	1,5	1,5	1,5	1,6	1,9	2,1	1
39	Racibórz	10	2,4	2,3	2,3	2,3	2,3	2,1	2,0	1,8	1,7	1,8	2,1	2,3	2
		25	2,6	2,5	2,5	2,5	2,5	2,3	2,2	2,0	1,9	2,0	2,3	2,5	2
40	Radom	10	3,4	3,4	3,5	2,7	2,6	2,4	2,4	2,4	2,4	2,5	3,0	2,9	2
		25	3,8	3,8	3,9	3,1	3,0	2,8	2,7	2,8	2,8	2,9	3,4	3,3	3
41	Rzeszów	10	2,9	2,8	2,7	2,3	2,0	1,8	1,8	1,8	1,9	2,1	2,3	2,5	2
		25	3,2	2,9	3,0	2,6	2,3	2,0	2,0	2,0	2,1	2,4	2,6	2,8	2

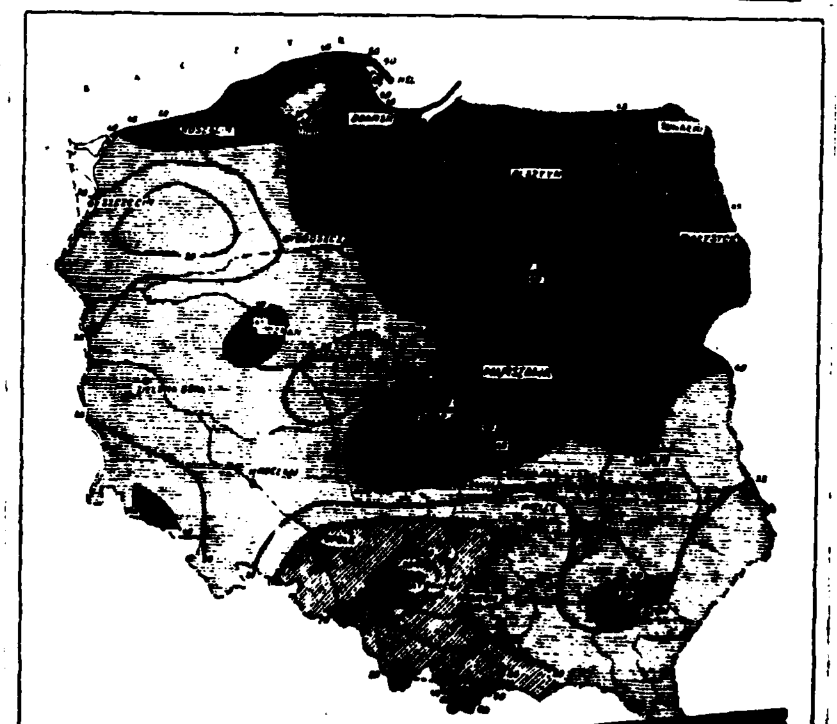
Table 3.1 (cont.)

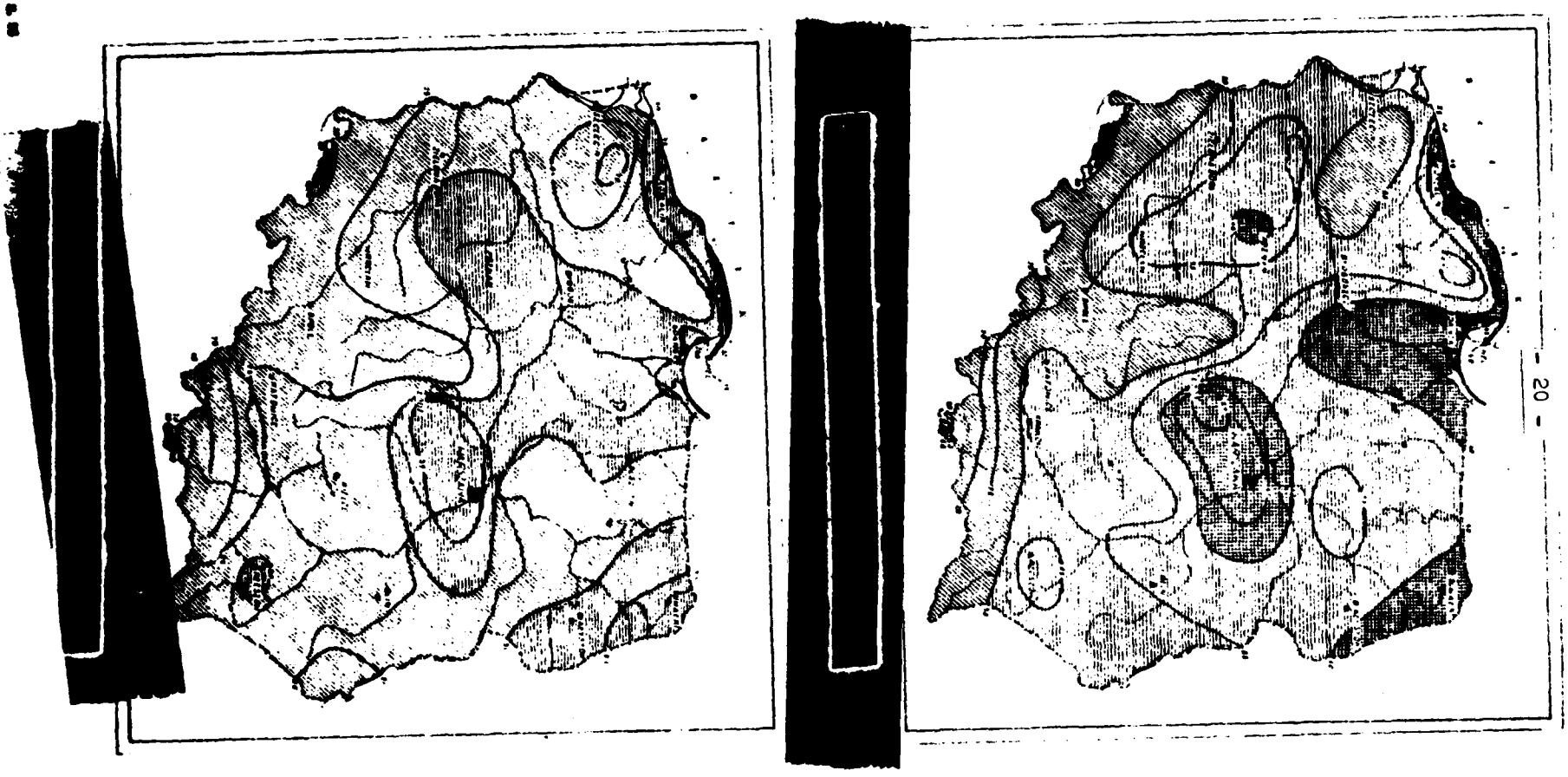
Lp.	Location	Height m	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Annual
42	Rozewie	10	5,7	5,1	5,3	4,0	3,6	3,7	3,5	3,7	4,3	5,0	5,4	5,7	4,6
		25	6,5	5,8	6,0	4,6	4,1	4,2	4,0	4,2	4,8	5,6	6,1	6,5	5,2
43	Rzeszów	10	4,6	4,6	4,4	3,4	2,9	2,8	2,7	2,8	2,9	3,1	4,2	4,5	3,6
		25	5,1	5,1	4,9	3,7	3,2	3,1	3,0	3,1	3,2	3,5	4,7	5,0	4,0
44	Sandomierz	10	3,5	3,4	3,4	3,0	2,8	2,7	2,3	2,5	2,5	2,6	3,1	3,0	2,9
		25	3,9	3,8	3,8	3,4	3,2	2,9	2,5	2,7	2,7	2,8	3,5	3,4	3,2
45	Siedlce	10	4,4	4,2	4,4	3,4	3,1	2,8	2,8	2,8	3,0	3,3	3,8	4,0	3,5
		25	5,0	4,7	4,7	3,8	3,5	3,1	3,1	3,1	3,3	3,6	4,2	4,4	3,9
46	Słubice	10	3,1	3,1	3,1	2,8	2,6	2,5	2,4	2,3	2,3	2,3	2,6	2,9	2,7
		25	3,5	3,5	3,5	3,2	3,0	2,8	2,7	2,6	2,6	2,6	2,9	3,3	3,0
47	Suwałki	10	4,4	4,2	4,1	4,0	3,6	3,3	3,4	3,4	3,4	3,7	4,2	4,2	3,8
		25	5,0	4,8	4,7	4,6	4,2	3,7	3,9	3,8	3,8	4,3	4,8	4,8	4,4
48	Szczecin	10	4,0	3,9	3,9	3,5	3,1	2,9	2,9	2,9	3,0	3,4	3,6	3,7	3,4
		25	4,4	4,3	4,3	3,8	3,4	3,2	3,2	3,2	3,3	3,7	3,9	4,1	3,7
49	Szczecinek	10	3,3	3,2	3,3	3,0	2,9	2,7	2,5	2,4	2,6	2,8	3,0	3,2	2,9
		25	3,6	3,5	3,6	3,3	3,2	3,0	2,7	2,6	2,8	3,1	3,3	3,5	3,2
50	Szczytno	10	3,4	3,4	3,6	3,2	3,0	2,9	2,6	2,6	2,7	2,9	3,1	3,4	3,1
		25	3,8	3,8	4,0	3,5	3,3	3,2	2,9	2,9	3,0	3,2	3,5	3,8	3,4
51	Śnieżka	10	14,6	13,2	12,5	10,3	8,7	8,2	8,7	9,1	10,1	10,3	11,0	13,1	10,8
		25	16,5	15,2	14,0	11,7	9,8	9,3	9,7	10,3	11,3	11,7	12,3	15,0	12,2
52	Tarnów	10	3,0	3,3	3,3	2,7	2,5	2,2	2,0	2,0	2,1	2,3	2,9	2,9	2,6
		25	3,3	3,6	3,6	3,0	2,8	2,5	2,3	2,3	2,4	2,6	3,2	3,2	2,9
53	Toruń	10	3,8	3,9	3,9	3,8	3,6	3,2	2,9	2,9	2,8	2,9	3,3	3,4	3,4
		25	4,2	4,3	4,3	4,2	4,0	3,5	3,2	3,2	3,1	3,2	3,6	3,7	3,7
54	Ustka	10	4,8	4,5	4,2	4,0	3,4	3,6	3,6	3,6	3,8	3,9	4,0	4,6	4,0
		25	5,3	5,0	4,7	4,4	3,8	4,0	4,0	4,0	4,2	4,3	4,5	5,1	4,4
55	Wałcz	10	2,8	2,7	2,9	2,5	2,4	2,2	2,1	2,1	2,2	2,2	2,5	2,5	2,4
		25	3,0	2,9	3,1	2,7	2,6	2,4	2,3	2,3	2,4	2,4	2,7	2,7	2,6
56	Warszawa – Okęcie	10	4,8	4,6	4,9	4,2	3,8	3,5	3,3	3,2	3,5	3,6	4,4	4,5	4,0
		25	5,3	5,1	5,4	4,6	4,2	3,9	3,6	3,5	3,9	4,0	4,9	5,0	4,4
57	Włodawa	10	3,4	3,3	3,5	2,7	2,5	2,5	2,2	2,4	2,6	2,8	3,5	3,2	2,9
		25	3,8	3,7	3,9	3,1	2,8	2,8	2,4	2,6	2,9	3,1	3,9	3,6	3,2
58	Wrocław	10	3,6	3,4	3,5	3,1	2,6	2,6	2,5	2,4	2,6	2,6	3,1	3,2	2,9
		25	4,0	3,8	3,9	3,5	3,0	2,9	2,8	2,7	2,9	2,9	3,4	3,5	3,3
59	Zakopane	10	1,7	1,6	1,7	1,7	1,5	1,4	1,3	1,4	1,4	1,2	1,6	1,5	1,5
		25	1,9	1,8	1,9	1,9	1,7	1,6	1,5	1,6	1,6	1,4	1,8	1,7	1,7
60	Zamość	10	3,5	3,3	3,3	2,7	2,5	2,3	2,1	2,2	2,5	2,7	3,2	3,3	2,8
		25	2,9	3,6	3,6	3,0	2,8	2,6	2,4	2,5	2,8	3,0	3,5	3,6	3,1
61	Zgorzelec	10	3,4	2,8	2,6	2,4	2,3	2,2	2,0	2,2	2,2	2,4	2,5	3,0	2,5
		25	3,7	3,1	2,9	2,7	2,6	2,5	2,3	2,5	2,5	2,7	2,8	3,3	2,8
62	Zielona Góra	10	3,6	3,2	3,3	3,0	2,7	2,5	2,6	2,6	2,8	2,8	3,0	3,3	3,0
		25	4,0	3,6	3,6	3,3	3,0	2,8	2,9	2,9	3,1	3,1	3,3	3,6	3,3











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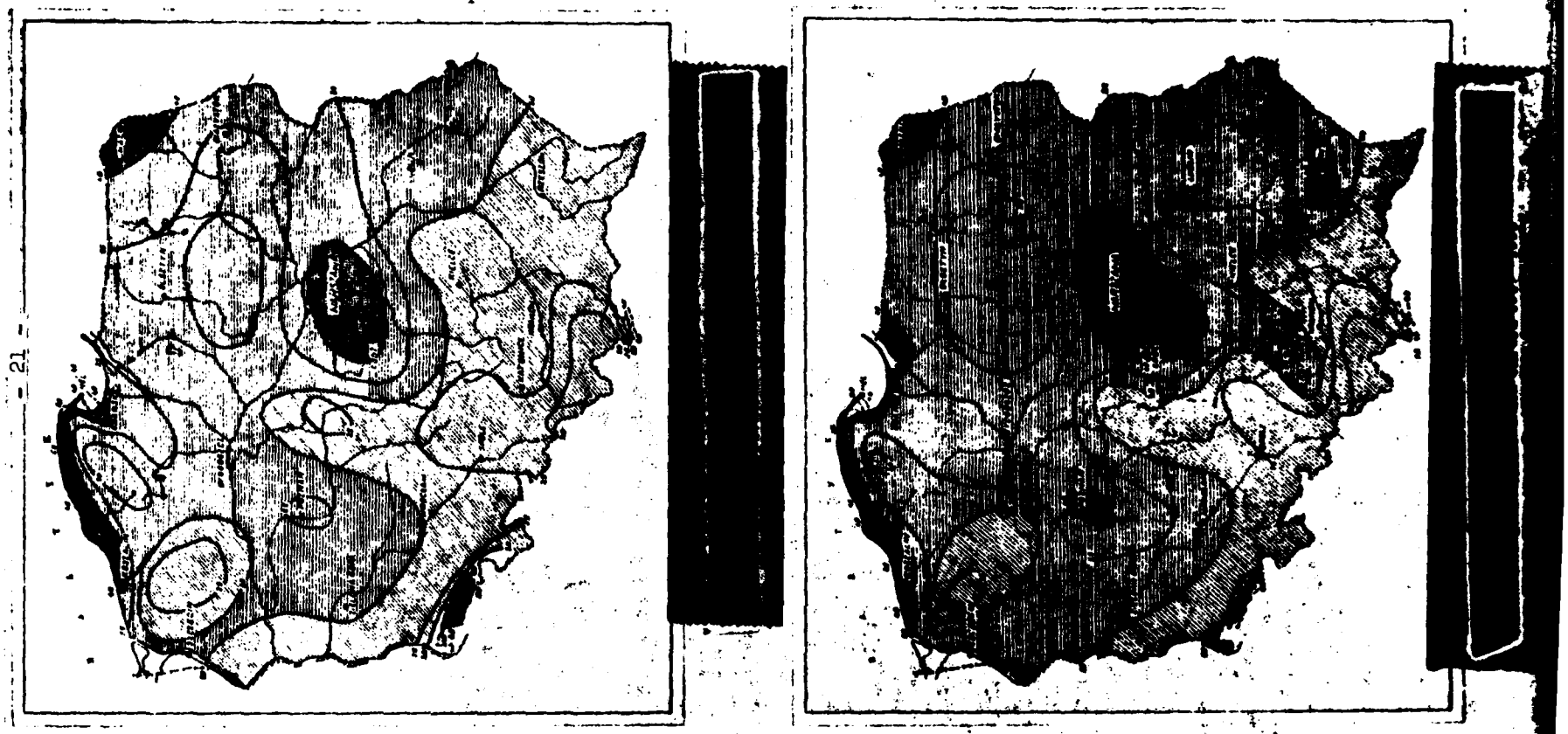

SUMMARY

This work should be of use to architecture in determining the mean velocities (m/sec) and wind pressure (kG m^{-2}), corresponding with these velocities in climatic conditions of Poland, at the heights 10 and 25 m above ground level for the most typical heights of buildings.

Table I and diagram (fig. 1) show thex relations of wind speed to wind pressure.

Table II contains mean wind velocities from 62 meteorological stations on the Poland's area at the heights of wind vanes and values reduced to the heights 10 and 25 m above ground level.

The maps of isotachs (fig. 5—14) contain mean distribution of wind velocities at the heights 10 and 25 m above ground level.

TABLES

FIGURES