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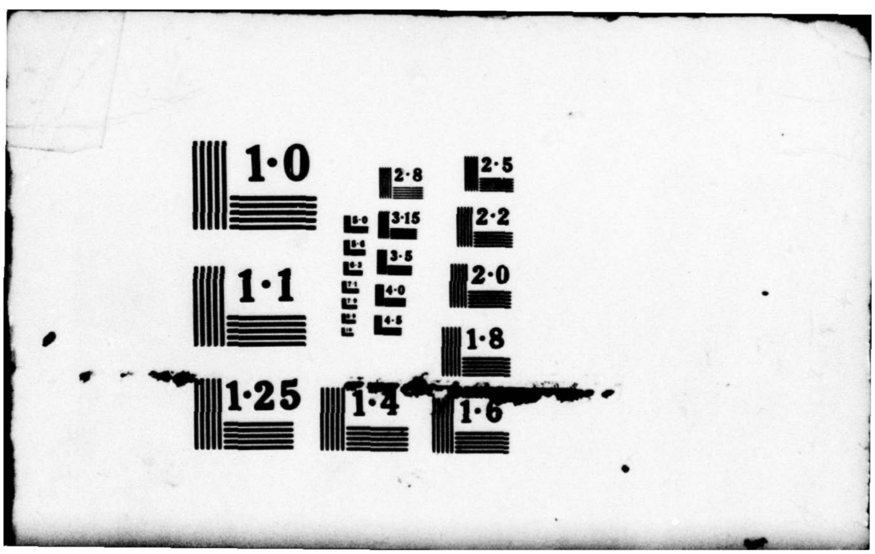
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FOREIGN TECHNOLOGY DIVISION

THE IMGW OBSERVER'S GAZETTE
(SELECTED ARTICLES)

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Table of Contents

THE INFLUENCE OF RAINFALL AND ACCOMPANYING WINDS ON BUILDING MATERIALS

by

Zenon Wierzbicki
IMGW - Department of Opinion and Evidence

The recent introduction into construction of large dimension walls of prefabricated panels made from light, porous materials of great permeability has resulted in lowering the resistance of external partitions to the penetration of rain water (7, 8). In this regard there have been observed an excessive dampening (moistening) of building walls, and even the penetration of rain water through the walls into the interior of the rooms (5). There thus exists the necessity of establishing a basis for designing and constructing external partition walls of relatively high resistance to rain water penetration. Before establishing the criteria of resistance for walls and taking the required steps, it is essential that certain determinations, based on an analysis of climatological conditions obtaining in a given region, are made in order to protect against rain water penetration (3).

In many countries there are observations and studies being made of oblique rainfall which causes the phenomenon of rainwater penetration of buildings' exterior walls. In Poland oblique rainfall has thus far not been studied utilizing directional pluviographs, which instruments would allow the magnitude of the rainfall and its pressure on the vertical surfaces of the walls to be recorded. However, usable results can be obtained by analytical methods -- by using simultaneously gathered pluviographic and anomometric data. Such a task was taken up by the Institute of Construction Technology with the cooperation of the Institute of Meteorology and Water Management (IMGW).

The IMGW has a considerable amount of pluviographic data from more than 50 localities, however compatible material was available only from 14 stations, uniformly distributed across the country, which disposed of parallel results for measurements of both parameters. It was taken into account in the investigation that the pluviographic data were given according to local time, while the hourly anemometric observations were made according to GMT.

Experimental work of this type was initiated by American researchers in the National Bureau of Standards. These researches had a utilitarian character (1, 2). Their goal was to determine the resistance of small-scale brick walls to rain water penetration, as well as to classify the studied walls and determine their time of use for building construction on the Atlantic coast. In the post-war years, along with the development of industrial construction, there has been a considerable increase of interest in the problem of rain water penetration resulting from the effect of rains of the external walls of a building.

Within the framework of the International Construction Council (CIB) there arose in 1955 a Working Commission on Rain Penetration, whose task was, first of all, to unify the methodology of research and the means of evaluating climatological elements producing the penetration. Currently the Commission numbers 23 members representing 17 countries from all the continents -- this indicates the seriousness of the undertaking. The problem can be reduced to the following particulars:

1) Defining the climatological elements causing rainwater penetration through building walls;

2) Research into the mechanism of rain water penetration through building walls;

3) Describing methods of measuring the amount of rainfall on building walls, and its pressure;

4) Describing methods of investigating wall resistance to rain water penetration; and

5) Describing the principles and means for protecting walls from rainwater penetration.

The fundamental climatological element producing rain water penetration is oblique rain acting upon the wall's surface as well as the winds accompanying rainfall. The measure of the rain's action is the amount following on a unit of surface in a specified time. This amount is variable and dependent upon the character (intensity) of the rainfall and the velocity of the accompanying winds. There two quantities determine the rain's angle of incidence and allow the calculation of the amount of water falling on a vertical surface in relation to the depth of the rainfall as measured by meteorological stations (working on a horizontal surface).

Winds accompanying rainfall exert a certain force or pressure on a building's walls.

This pressure influences decisively the magnitude of rainwater penetration through the walls. The amount of water acting on the wall is reduced to a certain degree by the evaporation of part of the water from the wall surface. The rate of the water's evaporation depends upon the wind speed and the temperature and humidity of the external air, while these last two meterological factors influence, though less importantly, the amount of water acting on the wall surface.

By rain penetration we intend, in line with the definition provided by the aforementioned CIB Commission, the pervasion of fallen water into a wall's interior through its surface facing or via the window interstices or the interstices around any other construction installation in a building's wall. Fallen water may thereby penetrate into the interior surface or remain undetected in the wall's interior. The movement of water in wall partitions occurs by the working of many secondary forces produced by capillary action, diffusion, gravitational attraction, the pressure of wind, and temperature.

Obviously in walls made of porous and permeable materials, without joints or fissures (4, 5), fallen water, after penetrating the surface facing, penetrates the interior partition by capillary action. Under the pressure of a heavy rainfall, when the flow of water is greater than capacity of capillary action, the excess water penetrating the wall material flows along the wall forming a film of variable thickness. When there is a long lasting rainfall, not allowing the wall time to dry, the amount of water penetrating into the interior of the partition increases.

In walls of microporous materials, with a pore diameter of less than 0.01 mm, the humidity gradient as well as the humidity increase in a unit of time depends primarily on the material's capillary properties. The amount of water transmittal along the route in a unit of surface and time will attain (2, 6):

$$G = K_w \frac{dw}{dx} (mm \cdot h)$$

where $\frac{dw}{dx}$ = humidity gradient

K_w = coefficient of humidity conductivity (analagous to the coefficient of heat conducting)

In medium and macroporous walls an additional factor affecting the amount of water penetrating into the wall's interior is the pressure of the wind acting on the fallen water on the wall's surface. This can be expressed by the formula (2):

$$Q = k \cdot F \cdot sd \cdot i$$

where F - partition surfaces

sd - filtration time

$i = H_w/d$ - hydraulic gradient

H_w - height of water column, producing a pressure equal to the force of the wind

d - thickness of the partition

k - coefficient of proportionality

In reality, the partition material has numerous fissures and cracks causing shrinkage. The fissures constitute a convenient means for infiltration, thus rendering the phenomenon of water penetration into a wall's interior yet more complex.

This investigation utilized pluviographic data from the six summer months V-X. There were used the following: R - depth of rainfall (in mm), T - time of rainfall duration (in minutes), v - velocity of the accompanying wind (in m/s) and wind direction.

Pluviographs used at meteorological stations register rainfall on a horizontal surface. In order to calculate rainfall on a vertical surface the following formula was used:

$$Rv = R \cdot tg\psi$$

where Rv - rainfall on vertical surface (mm)
R - rainfall on horizontal surface (mm)
ψ - angle of incidence of the rainfall

The angle of incidence depends on two component quantities: a) the terminal velocity of a falling raindrop, V_k, and b) the speed of the wind accompanying the rain, V_w. Assuming that these quantities are constant during the duration of the rainfall, it can be stated that:

$$V_w/V_k = tg\psi$$

Combining both formulae we attain:

$$Rv/R = V_w/V_k, \text{ where}$$

$$Rv = R\, V_w/V_k$$

The above formula is the basic calculation for rainfall on a vertical wall. In this formula the two quantities, R and V_w, are recorded by the meteorological stations, whereas the terminal velocity V_k is not recorded, but taken from BEST (table 1) according to raindrop diameter.

1. Średnica kropel wody (mm)	0,5	1,0	1,5	2,0	2,5
2. Końcowa prędkość kropel wody V_k (m/s)	1,98	3,97	5,39	6,40	7,23

TABLE 1

Key
1. diameter of water drop (mm)
2. terminal velocity of the water drop V_k (m/s)

In table 2 are given, according to the same author, the angles of incidence for rain at given drop diameters and given wind velocity.

1. Prędkość wiatru (m/s)	2. Kąt padania deszczu przy określonej średnicy kropel (mm)			
	0,5	1,0	2,0	3,0
1	26°50'	14°50'	9°00'	7°20'
5	68°20'	51°30'	38°00'	32°30'
10	78°50'	68°30'	57°20'	51°50'
15	82°30'	75°10'	66°50'	62°20'
20	84°20'	78°50'	72°20'	68°30'

TABLE 2

Key
1. wind velocity (m/s)
2. angle of incidence for rain at given drop diameters (mm)

From the relationships presented in table 2 it results that the rain's angle of incidence increases proportionately to the velocity of the accompanying wind, given a constant drop diameter, and in inverse proportions to the drop diameter of a given wind velocity. Both tables allow us to calculate the magnitude of oblique rain. The size grading of water drops in rainfall depends on many factors, however, for practical purposes, it is assumed that it is solely a function of the intensity of the rainfall:

$$D = 2{,}23\ I^{0{,}182},$$

where D - conventional figure for drop diameter
I - intensity of the rainfall (mm/h)

The above method was used in an effort to determine the median value for the diameters of rain drops falling on a building's walls during violent rainstorms (table 3). Calm interludes, which constituted 3-4% during these rainstorms, were disregarded.

As an example, we cite below, for one typical station, the amounts of oblique rainfall in relation to the total amounts of rainfall for an eight-year period.

TABLE 3

1 Warszawa-Okęcie 1956—1963

	V	VI	VII	VIII	IX	X	4 Suma opadów
2 Ru	57,9	53,8	66,8	54,0	39,8	17,2	2.19,5
3 R	60,8	57,9	67,9	58,7	42,2	18,6	305,5
Ru/R	0,95	0,93	0,99	0,92	0,94	0,95	0,95

Key
1. Warsaw - Okęcie
2. Ru - oblique rain
3. R - freezing rain
4. Total precipitation

Literature

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COMPARATIVE MEASUREMENTS OF PRECIPITATION

by

Stefania Kowalczyk

IMGW - Network Organization and Inspection Department

1. Purpose and Scope of the Investigation

The problem of precipitation measurement accuracy has not yet been solved satisfactorily, and thus remains an open question. Precipitation is one of the few meteorological elements whose measurement from purely practical considerations requires more accurate determination. This is because it comprises the chief source for the supply of the pure water, indispensible to mankind. Occasionally understanding the water balance for the very small territory of a river basin is limited to understanding those elements of the balance which allow for relatively simple and easy measurement. Precipitation measurement seems on the surface unusually simple. In reality it is not so, for precipitation is an intermittent phenomenon, appearing in different forms and with varying intensity. The chief efforts in the field of improving the methodology of precipitation measurement has been in the use of radio-location and optical methods, the chief principal advantage of which is that they provide precipitation information not for a given point, but for a whole region. These avenues of investigation have the best prospects, yet there remains the need to improve the method of precipitation measurement by means of precipitation meters -- even if it were only to determine improvements for the observations already made for many years.

In 1968 in Leningrad at a meeting of experts working within the Conference of Directors of the Hydrological-Meteorological Service of the Socialist Countries, the need for cooperative research in the measurement of various types of precipitation using precipitation meters was stressed, the goal being the unification of the methods and instruments of measurement. As a result of this resolution, the GGO produced a description of conducted precipitation measurement which indicated the systematic errors involved:

- Due to the effects of dampness on the measuring instruments;
- Due to evaporation from the precipitation meter in the interval between measurements;
- Due to the influence of wind effects the flight path of a raindrop or snow flake.

2. Selected Problems from the Literature Concerning Precipitation Measurement

Many countries in recent years have undertaken work on the quantitative determination of the systematic errors in precipitation measurement, taking into account the type of precipitation meter used in each country. In the USSR a series of experimental tests were conducted using different precipitation meters of different kinds. Among others, the HELLMANN meter was installed, which is used in the Polish meteorological system. A series of works were published dealing with this topic.

Struzer discusses the problem of the error in precipitation measurement produced by the effect of wind velocity. The author states that in the majority of cases, the wind velocity increases over the opening of a precipitation meter. This is because the precipitation meter constitutes an obstacle which essentially changes the velocity and direction of the wind in its immediate vicinity. The flight path of a raindrop or snow flake is distorted, causing the number of them falling into the precipitation meter to be smaller than falling in the intake surface. The negative effect is the more marked, the greater the wind speed or the smaller the raindrop or snow flake size. In order to eliminate the influence of the wind on the measurement, various forms of screens are used. Struzer states that the effect of these screens on the accuracy of the measurement is particularly strong at lesser wind speeds. At higher speeds, and especially during blizzards, the screens do not play a significant role. Blizzards cause the precipitation meter to record so-called "false precipitation" -- thus in the USSR where blizzards are a common phenomenon, precipitation meters are installed at a height of two meters over the snow to eliminate the storm's effect on the magnitude of precipitation recorded.

Wind, producing swirling over the precipitation meter, causes the collected snow to be drawn away. This effect of the wind's action depends on its velocity, and the relationship between the collecting vessel's depth in comparison to its diameter. This phenomenon is most frequent with relatively low air temperature, for then the snowflakes are small and do not agglutinate. By installing inserts (cross-lattices) in winter, significant leeching of precipitation is prevented.

Bogdanowa presents the quantitative characteristics of the wind's influence on precipitation measurement at a given intensity. We know that during a single storm its intensity may vary. It is stated that during light precipitation the inaccuracy of its measurement is greater and vice-versa. In order to determine these relationships, the so-called parameters of precipitation structure were calculated -- that is, the percentage relationship of the sum of all precipitation exhibiting an intensity of ≤ 0.03 mm/min, to the overall amount of precipitation in a given period (a month).

According to Bogdanowa, the error in measuring fluid precipitations results from wind action, and at given velocities the following results are attained.

1 Prędkość wiatru na wys. 2 m m/s	2 Błąd pomiaru %	3 Liczba przypadków
0 — 2	3	1 829
2,1 — 4	5	1 455
4,1 — 6	7	594
6,1 — 8	9	207
8,1 — 10	10	83

Key:
1. Wind speed at a height of 2 m, m/s
2. Measurement error, %
3. Number of examples

Nieczajew described precipitation diminution produced by the effects of dampness on the Tretiakow precipitation meter. These diminutions amount to 0.2 mm for each measurement according to Nieczajew. The annual total correction of the precipitation meter for this cause amounts to 5-12% of the total precipitation on an average.

The magnitude of the precipitation diminution due to dampness's effect on the instruments is due to a series of factors, namely:

- The relationship of the internal surface area of the precipitation meter to its intake area

- The lengths, number, and type of connections in the precipitation meter
- The internal surface smoothness of the precipitation meter
- The adhesive qualities of the color used to paint the interior of the precipitation meter
- The waterproofness and the degree to which the material is soaked, and also the water flowing through it.

Soviet meteorologists experimentally have ascertained that there are small diminutions due to dampness in equipment with smooth surfaces, as for instance glass, copper, or well-galvanized steel. Surfaces more resistant to water, for instance plastic, or those covered with water-resistant laquer allow greater losses because on the wall of the instruments drops are formed (which do not drip down, or even dry up).

Precipitation losses from dampness in plastic collectors or those with coatings of water-resistant laquer attain 0.4 to 0.5 mm, galvanized ones - 0.2 mm, copper and glass - 0.1 to 0.5 mm -- for each measurement.

Nieczajew and Melikiszwili discuss the problem of evaporation from various types of precipitation meters installed in different climatic regions of the USSR.

Melikiszwili calculated the intensity of evaporation in mm/hr for various pluviometers at different wind velocities in different degrees of relative air humidity.

The precipitation losses from evaporation were calculated for liquid precipitation according to the following method: In cloudless weather a pre-measured amount of water was poured into two pluviometers. The instruments were installed in a meteorological test area. At the end of the day, or before a rain started, measurements were made. The difference between the amount of water poured into the pluviometer and the amount which could be poured out represented the amount of evaporated water. These experiments were repeated many times to attain an average evaporation for precipitation. Precipitation losses to evaporation amounted to, in some cases 100% of the rainfall. This phenomenon can be observed as especially severe at high air temperature and light precipitation.

There has not yet been worked out a method to determine the magnitude of precipitation evaporation at constant consistence. Soviet authors state that for each type of precipitation meter there must be devised an appropriate experimental method.

Gorbunowa discusses the results obtained by making certain modifications in the Hellmann pluviometer, used in the meteorological networks in Poland, Hungary, and East Germany.

The Polish version of the Hellmann pluviometer measures only liquid precipitation. The instruments are installed two meters above the surface of the ground. Measurements are taken daily.

Some of the results obtained from these investigations are:

- The Polish pluviometer if installed in a hole to gather true precipitation, collects more precipitation than does the Tretiakow type O-1 M pluviometer under the same conditions. The difference decreases with the growth of the significance of the precipitation structure paramater, i.e., (as has been noted above) the relative percentage of precipitation with a $\leq$ 0.03 mm/min. intensity in relation to the sum of total daily precipitation.

- It is found that there is spattering of rain into the Hellmann pluviometer resulting from the bouncing off of raindrops from the brass indentations which are found on the upper part of the pluviometer at a 47° angle of inclination.

(It must be noted that this problem currently does not affect our (Polish) system, because the pluviometers used by us have bands with a 30° angle of inclination.)

- Losses to humidity by the Polish pluviometer were twice determined, and it was found they are significantly less than for the Tretiakow O-1 pluviometer, but the losses increase when greater amounts of water are introduced. According to Gorbunowa the humidity losses for the Hellmann pluviometer are as follows.

1967

Wysokość opadu (mm)	0,0—0,5	0,6—1,5	1,6—3,5	>3,5
straty na zwilżanie (mm)	0,1	0,2	0,3	0,4

1970

Wysokość opadu (mm)	0,0—2,0	2,1—4,0	4,1—10,0	>10,0
straty na zwilżanie (mm)	0,1	0,2	0,3	0,4

Key: 1. Depth of precipitation (mm)
2. Losses to humidity (mm)

The differences in results from 1967 and 1970 are found in the fact that the 1967 measurements were taken with new pluviometers, and in 1970 -- with those in use in the system for four years. The precipitation losses to humidity from the Hellmann pluviometer's collector were defined as 0.1 mm for each measurement.

In the investigations described above the amount of evaporation from the Hellmann pluviometer was also determined; it was found to be so slight that the correction might be eliminated from the calculations.

The wind's influence on the indications of the Hellmann pluviometer, however, is very great, especially in the case of solid precipitation of low intensity, i.e., up to ≤ 0.03 mm/min. The primary cause suggested is the lack of shielding from the wind and the consequent drawing off of collected precipitation. This last phenomenon is especially observable when the temperatures are adequately low.

3. Results of Comparative Measurements of Precipitation by the IMGW

At the end of 1968, in conformity with the determinations of the Conference of Directors of the Hydrological-Meteorological Service of the Socialist Countries, there began comparative precipitation measurement using three types of precipitation meters, namely: the Hellmann pluviometer (drawing 1), used in the Polish observational system;

the Tretiakow 0-1 precipitation meter, the standard precipitation measuring instrument in the USSR (drawing 2), and the IRPG (Interim Reference Precipitation Gauge) precipitation meter (drawing 3). All of these precipitation meters were installed at a height of one meter. The measurements were performed at the 4 meteorological stations: Lodz-Lublinek, Nowy Sacz, Warszawa-Bielany, and Zakopane. The methods of measurement and reporting data were those given by the GGO.

The results of the investigation from the period 1969-1970 do not allow for far reaching conclusions, i.e., for the quantitative determination of the magnitude of corrections for the Hellmann pluviometer; however they do signal certain correctnesses and the necessity of conducting further research in this area.

The IRPG-type precipitation meter collected more precipitation than either the Tretiakow meter or the Hellmann pluviometer, especially the latter. This is illustrated to a certain degree in drawing four which gives the annual precipitation amounts for the years 1969 and 1970. These differences were more accurately found by percentage values in Table 1, which shows the relationship of the amount of precipitation meter to the amount of precipitation for the Hellmann pluviometer at a height of one meter. In the table are also presented (for Warsaw) percentage values of the relationship between the precipitation from three precipitation meters at a height of one meter to the amount of precipitation according to the Hellmann pluviometer installed in a hole with the intake surface at ground level, but without a splash quart. These last relationships are illustrated by drawing 5.

[illegible]	[illegible]		[illegible]		IRPG		Tretiakow		IRPG		Tretiakow		Hellmann		IRPG		Tretiakow	
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1970	1969	1970	1969	1970	1969	1970	1969	1970	1969	1970	1969	1970
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	/107/	-	105	112	144	115	[illegible]	135	-	-	-	-	-	-
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	/134/	-	108	[illegible]	179	/157/	163	160	-	-	-	-	-	-
[illegible]	137	135	147	[illegible]	[illegible]	-	97	112	164	[illegible]	[illegible]	123	-	-	-	-	-	-
[illegible]	[illegible]	121	109	118	100	-	95	113	185	113	101	105	-	-	-	-	-	-
[illegible]	119	109	100	102	115	-	104	106	109	110	89	99	93	88	102	98	83	92
[illegible]	108	114	104	102	-	-	103	103	108	112	90	102	94	92	102	104	85	95
[illegible]	114	108	103	105	126	-	107	108	100	105	93	108	95	97	96	102	88	105
[illegible]	112	114	102	103	119	-	105	102	102	109	92	104	96	97	97	106	88	101
[illegible]	130	119	100	103	118	-	112	-	102	119	[illegible]	105	91	93	93	112	80	98
[illegible]	128	110	99	105	106	115	100	101	106	114	[illegible]	102	91	91	96	104	88	93
[illegible]	113	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	97	110	77	102
[illegible]	145	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	-	-	-	-	-	-

Table 1: Comparison of the amount of precipitation in percent according to the IRPG and Tretiakow precipitation meters, versus the precipitation according to the Hellmann pluviometer at a one meter height, and the comparison of the amount of precipitation according to the IRPG, Tretiakow and Hellmann precipitation meters versus the amount according to a Hellmann pluviometer installed at ground level without a guard.

KEY: (1) Percentage of precipitation compared to precipitation from 1-meter-high Hellmann pluviometer; (2) Percentage of precipitation compared to precipitation from recessed, unshielded pluviometer

It should be explained that the measurements with the recessed precipitation meter were preformed only during the period of rain precipitation, about which more will be said later. The recessed Hellmann pluviometer showed more precipitation than the Hellmann or Tretiakow which were mounted at a height of one meter.

The frequency of daily precipitation differences at intervals of every five mm (drawing 6) indicates that approximately 40% of the totals of daily precipitation from the IRPG precipitation meter agreed with the daily amounts for the Hellmann pluviometer, about 50% exceeded them, and only 10% were lower. For the Tretiakow precipition meter the corresponding totals were: 40% equal, about 40% higher, and about 20% of the daily amounts of precipitation were lower than the amounts of the Hellmann pluviometer.

As the GGO determined, the greatest effect of the wind on precipitation is at a precipitation intensity of $\leqslant$ 0.03 mm/min. Thus there was calculated the percentile rate of such precipitation in the total montly precipitation amount for a given station. The calculated amounts are found in table 2. Precipitation at such an intensity is recorded most rarely in summer months, and most often in spring and autumn months, when it may comprise as much as 100% of the daily total.

1. Stacja	M-c	1969 Suma ogólna opadu mm 2.	1969 Suma opadu o intens. ≤ 0,03 mm/min 3.	1969 N %	1970 Suma ogólna opadu mm 2.	1970 Suma opadu o intens. ≤ 0,03 mm/min 3.	1970 N %	Uwaga 4.
Warszawa-Bielany	IV	.	.	.	.	.	.	
	V	38,4	19,9	52	-	-	-	W r. 1970 rozpoczęto obserwacje od 17.V. 4.
	VI	42,7	14,6	34	33,2	13,8	42	
	VII	36,3	13,3	37	-	-	-	VII.1970 - działanie pluwiografu złe 7.
	VIII	82,1	35,5	43	52,5	14,7	28	
	IX	-	-	-	35,9	14,5	41	IX.1969 - zły zapis na pluwiogramie 8.
	X	17,2	8,2	48	54,8	48,0	88	
Łódź-Lublinek	IV	-	-	-	17,6	10,8	61	IV,V.1969 - brak obserwacji 9.
	V	-	-	-	69,9	24,0	34	
	VI	60,0	13,8	23	50,6	19,8	39	
	VII	45,6	18,0	39	140,2	39,9	28	
	VIII	38,1	30,1	42	29,6	11,0	37	
	IX	8,1	4,5	56	38,5	17,2	45	
	X	10,0	6,2	62	50,9	33,7	66	
Nowy Sącz	IV	Zapisy na pluwiogramach wątpliwe 5.			.	.	.	
	V				58,4	34,0	58	
	VI				125,7	25,5?	20	
	VII				196,7	71,4?	36	
	VIII				-	-	-	VIII.1970 - zapis na pluwiogramie wątpliwy 10.
	IX	"	"		48,5	16,3	34	
	X	"	"		15,9	13,2	83	11. pluwiograf zdjęto 14.X.70

Table 2: Relationship of the monthly precipitation amount at an intensity of $\leqslant$0.03 mm/min. to the total amount of precipitation, in percent.

Key

1. Station
2. Total amount of precipitation
3. Amount of precipitation at an intensity of $\leqslant$0.03 mm/min.
4. Remarks
5. Entries on pluviogram doubtful
6. In 1970, observation began on May 17
7. July 1970 - the pluviograph functioned poorly
8. September 1969 - a mis-entry on the pluviogram
9. April, May 1969 - lack of observations
10. August 1970 - entry on pluviogram doubtful
11. Pluviograph disconnected on October 14, 1970

For objective reasons in 1971 comparative precipitation measurements were halted at the following stations: Warsaw-Bielany, Łódź-Lublinek, and Nowy Sącz. However, in 1973 on the advisement of the XXII[nd] Session of the Executive Committee of the ŚMO, the measurements were recommenced, although on a slightly different (enlarged) range. The organization of these measurements and the results obtained shall be reported in the next issue of Gazeta Obserwatora IMGW.

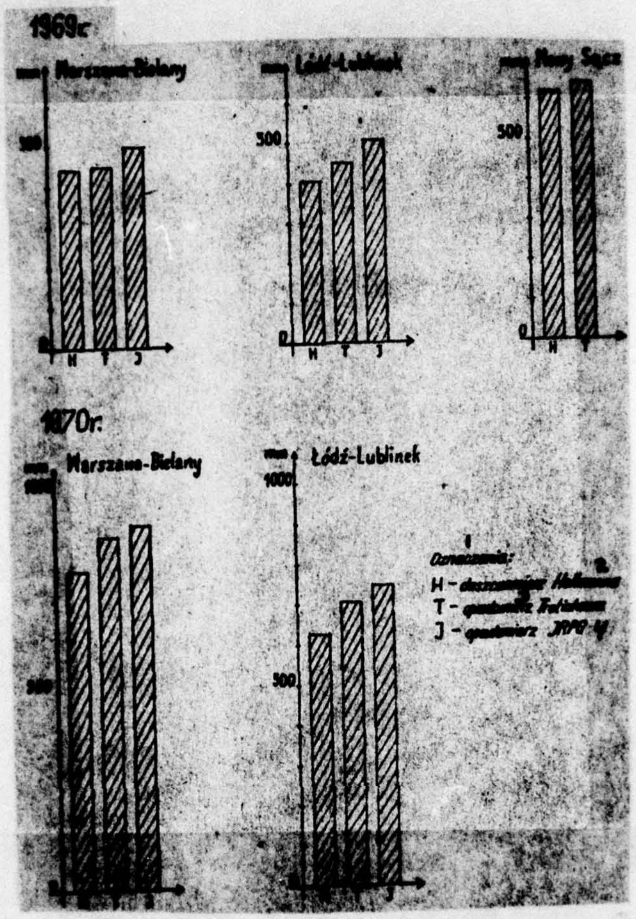
Drawing 1:
The Hellmann Pluviometer

Drawing 2:

The Tretiakow Precipitation Meter

Drawing 3:

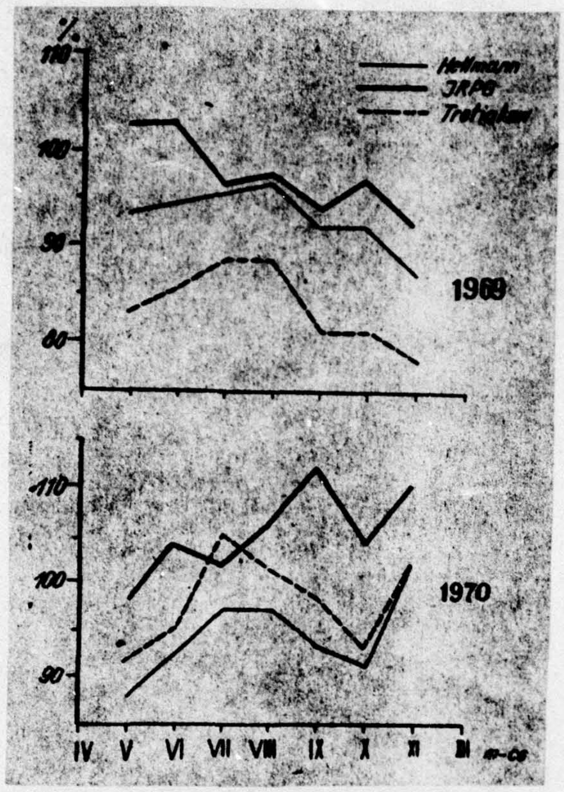
The IRPG Precipitation Meter



Drawing 4: Annual Amounts of Precipitation

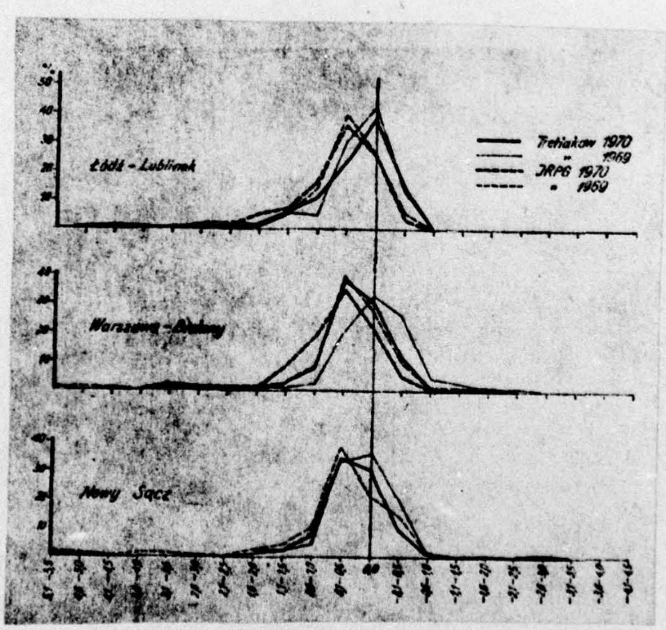
Key:

1. Notation
2. Hellman pulviometer
3. Tretiakow precipitation meter
4. IRPG precipitation meter



Drawing 5:

Comparison of Precipitation Amount in percent according to the Hellmann, IRPG, and Tretiakow precipitation meters -- from a one m. height, to the precipitation according to a Hellmann precipitation meter at ground level.



Drawing 6:

Frequency of deviation of daily precipitation in percent of the IRPG and Tretiakow precipitation meter from the precipitation according to the Hellmann precipitation meter.

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