Bristol on the 31st. The average precipitation was 4.90, or 1.01 above normal; the greatest monthly amount, 12.03, occurred at Iron City, and the least, 2.01, at Newport.

The weather was, on the whole, favorable to wheat. The plant generally has good stands, is well rooted and stooled. In some eastern counties of the middle section considerable injury to early wheat by fly is reported, but altogether the prospect for wheat was better at the end of December than for many years.—*H. C. Bate.*

Texas.—The mean temperature, determined by comparison of 39 stations distributed throughout the State, was 1.8° below the normal; there was a general deficiency ranging from 1.0 to 3.8, with the greatest over the extreme western portion of southwest Texas; the highest was 90°, at Jasper on the 9th, and the lowest, 11°, at Amarillo on the 14th. The average precipitation, determined by comparison of 43 stations distributed throughout the State, was 1.25 above the normal; There was a slight deficiency over the eastern portion of north Texas, nearly normal conditions prevailed over the panhandle, west Texas, and the extreme western portion of the coast district, while over the other portions of the State there was a general excess ranging from about 1.00 to 4.23, with greatest in the vicinity of Huntsville. The greatest monthly amount, 8.06, occurred at Huntsville, and the least, 0.21, at El Paso.

The ground has been in good condition for plowing, and a great deal of this work has been done preparatory for planting spring crops. There is, however, a great deal of plowing yet to be done. There was too much rain for winter wheat in a few localities, otherwise the weather has been exceptionally favorable for the crop. Seeding was completed during the early part of December and good stands and rapid growth are reported generally. Some correspondents report that wheat prospects are better at this season than for years. Early sown has grown very rapidly and is being pastured. The acreage sown is not as great as it would have been had the weather been more favorable for this work during October and November, but the acreage is generally good.—*J. L. Cline.*

Utah.—The mean temperature was 25.2°, or 1.5° below normal; the highest was 74°, at Elgin on the 1st, and the lowest, 26° below zero, at Scipio on the 19th. The average precipitation was 0.95, or 0.04 below normal; the greatest monthly amount, 2.35, occurred at Soldier Summit, and the least, a trace, at Frisco and Pahreah.—*L. H. Murdoch.*

Virginia.—The mean temperature was 37.0°, or about 2.0° below normal; the highest was 73°, at Blacksburg on the 12th, and the lowest, 11° below zero, at Marion on the 31st. The average precipitation was 2.00, or 0.98 below normal; the greatest monthly amount, 4.06, occurred at Burkes Garden, and the least, 0.18, at Newport News.

The progress of the crops throughout the month was unusually favorable.—*E. A. Evans.*

Washington.—The mean temperature was 37.3°, or 2.7° above normal, the highest was 71°, at Bridgeport on the 9th, and the lowest, 2° below zero, at Waterville on the 18th and at Hooper on the 19th. The average precipitation was 4.79, or 0.97 below normal; the greatest monthly amount, 22.16, occurred at Clearwater, and the least, 0.58, at Ellensburg.—*A. B. Wollaber.*

West Virginia.—The mean temperature was 33.3°, or about 2.0° below normal; the highest was 77°, at Nuttallburg on the 22d, and the lowest, 17° below zero, at Green Sulphur Springs on the 31st. The average precipitation was 2.81, or 0.22 below normal; the greatest monthly amount, 4.46, occurred at Central Station, and the least, 1.22, at Parsons.—*E. C. Vose.*

Wisconsin.—The mean temperature was 21.2°, or slightly above normal; the highest was 58°, at Sharon on the 8th, and the lowest, 20° below zero, at Butternut on the 29th. The average precipitation was 1.62, or 0.36 above normal; the greatest monthly amount, 2.80, occurred at Whitehall, and the least, 0.40, at Lincoln.—*W. M. Wilson.*

Wyoming.—The mean temperature was 21.1°, or 2.3° below normal; the highest was 68°, at Cody on the 25th, and the lowest, 29° below zero, at Bittercreek on the 21st. The average precipitation was 0.69, or nearly normal; the greatest monthly amount, 1.90, occurred at Centennial and at Fort Yellowstone, and the least, trace, at Cody.—*W. S. Palmer.*

SPECIAL CONTRIBUTIONS.

RECENT PAPERS BEARING ON METEOROLOGY.

W. F. R. PHILLIPS, in charge of Library, etc.

The subjoined list of titles has been selected from the contents of the periodicals and serials recently received in the library of the Weather Bureau. The titles selected are of papers or other communications bearing on meteorology or cognate branches of science. This is not a complete index of the meteorological contents of all the journals from which it has been compiled; it shows only the articles that appear to the compiler likely to be of particular interest in connection with the work of the Weather Bureau:

Science. New York. Vol. 10.
Clayden, A. W. Dark lightning. P. 973.
Quarterly Journal of Royal Meteorological Society. London. Vol. 25.
Dickson, H. N. Mean Temperature of the Surface Waters of Sea round British Coasts and its relation to Mean Temperature of the Air. P. 227.
Schaw, H. Some Phenomena connected with the Vertical Circulation of the Atmosphere. P. 305.
Scott, R. H. Heavy Falls of Rain recorded at seven Observatories connected with the Meteorological Office, 1871–1898. P. 317.
Baxendell, J. New Self-recording Anemoscope. P. 326.
Mossman, R. C. Average Height of the Barometer in London. P. 330.
Das Wetter. Berlin. 16 *Jahrg.*
Kassner, C. Wogenwolken. P. 265.
Wirz, — Beiträge zur Klimatologie des Grossen Belchen (1394 m. Höhe). P. 283.
Geographische Zeitschrift. Leipzig. 5 *Jahrg.*
Meinardus, W. Meteorologie und Klimatologie. Der VII internationale Geographenkongress zu Berlin. P. 692.
Journal de Physique. Paris. 3*me série. Tome* 8.
Folgheraiter, — Sur les variations séculaires de l'inclinaison magnétique dans l'antiquité. P. 660.
Philosophical Magazine. London. Vol. 49.
Davison, Charles. Earthquake Sounds. P. 31.
La Nature. Paris. 28*me Année.*
Meriel, P. de. Le cyclone des Antilles. P. 107.
Plumandon, J. R. Le froid dans la France centrale. P. 93.
Scientific American. New York. Vol. 82.
—— How a Weather Map is Made. P. 38.
Comptes Rendus. Paris. Tome 129.
Poincare, A. Mouvements barométriques provoqués, sur le méridian du Soleil, par sa marche en déclinaison. P. 1290.
Scientific American Supplement. New York. Vol. 49.
Bryan, G. H. Resistance of the Air. P. 20116.
Ciel et Terre. Bruxelles. 20*me Année.*
Arctowski, H. Rapport préliminaire sur les recherches oceanographiques de l'Expédition antarctique belge. P. 503.
Dewert, J. L'hiver de 1740. P. 508.
Annalen der Hydrographie und Maritimen Meteorologie. Hamburg. 28 *J.*
Messerschmitt, J. B. Ueber die Halophänomene. P. 32.
Bolletino Mensuale, Soc. Met. Italiana. Turin. Ser. II. Vol. 9.
Roberts, G. I Vortici. P. 47.
Terrestrial Magnetism and Atmospheric Electricity. Baltimore. Vol. 4.
Elster, J. and Geitel, H. Ueber die Existenz electrischen Ionen in der Atmosphäre. P. 213.
Tillo, Alexis de. Sur la rélation qui existe entre la répartition des éléments magnetiques et la distribution général des mers et de la température moyenne annuelle à la surface du globe. P. 237.
Luedeling, G. Ueber die tägliche Periode des Erdmagnetismus und der erdmagnetischen Störungen an Polarstationen. P. 245.

RATIO OF THE DISCHARGES OF THE CHAGRES RIVER AT GAMBOA AND BOHIO TO THE RAINFALL IN THE WATERSHED ABOVE THESE PLACES.

By HENRY L. ABBOT, U. S. A., Engineer of the New Panama Canal Co., dated Paris, December 9, 1899.

In my note on the regimen of the Chagres River there is an almost complete collection of the monthly mean discharges, in cubic meters per second, as measured during seven years at Gamboa and Bohio. These values are here given in Tables 1 and 2. A few observations that are missing have been supplied by the figures in brackets which also enter into the mean values of the summary, except for April, 1893, at Bohio, where, because of the small flood which occurred there at that time, we have adopted ten-sevenths (1.43) of the corresponding discharge measured at that time at Gamboa.

TABLE 1.—*Monthly discharges, in cubic meters per second, as measured at Gamboa.*

Year.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Annual mean.
1891...	58	27	17	15	98	67	107	79	86	126	212	145	86
1893...	44	39	32	110	68	77	82	161	100	101	154	274	104
1894...	142	36	21	16	48	70	205	133	145	133	185	301	120
1895...	110	[32]	31	35	81	87	89	128	107	134	110	128	89
1896...	101	36	18	38	126	107	74	66	77	76	[159]	145	85
1897...	50	21	14	26	98	67	107	116	109	99	148	212	88
1898...	140	27	17	56	57	44	85	61	38	[139]	113	45	68
Means	92	31	21	42	82	74	107	106	95	114	154	178	91

TABLE 2.—*Monthly discharges, in cubic meters per second, as measured at Bohio.*

Year.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Annual mean.
1891...	76	39	17	17	67	91	136	128	280	96	431	630	167
1893...	[126]	[44]	[25]	[157]	[129]	140	216	305	217	243	334	525	204
1894...	200	51	31	22	95	121	176	184	211	265	360	356	178
1895...	129	39	30	30	118	122	130	196	164	196	173	197	127
1896...	134	44	25	48	140	119	89	99	168	180	215	171	119
1897...	58	45	20	25	226	119	145	206	195	212	197	193	137
1898...	169	44	35	46	67	80	174	164	104	196	244	84	117
Means	126	44	26	50	120	113	152	183	191	198	278	308	149

TABLE 3.—*Precipitation in millimeters.*

Months.	Bohio.				Gorgona.			
	1896.	1897.	1898.	1899.	1896.	1897.	1898.	1899.
January	.....	.....	.....	239	.....	.....	.....	96
February	.....	.....	89	114	.....	.....	5	51
March	.....	.....	77	88	.....	.....	0	84
April	.....	206	269	.....	.....	66	35	.....
May	397	471	371	.....	229	638	128	.....
June	217	358	502	.....	173	344	111	.....
July	141	402	888	.....	131	345	470	.....
August	.....	640	973	.....	.....	430	505	.....
September	.....	444	.....	.....	.....	406	.....	.....
October	.....	661	717	.....	.....	366	196	.....
November	.....	497	554	.....	.....	182	244	.....
December	.....	560	162	.....	.....	201	100	.....
Sums	755	4,239	4,545	436	533	2,878	1,794	231
Totals		9,975				5,436		
	Gamboa.				Colon.			
January	.....	.....	.....	127	.....	.....	.....	176
February	.....	.....	3	44	.....	.....	9	165
March	.....	.....	0	34	.....	.....	40	32
April	.....	82	36	.....	.....	95	120	.....
May	85	443	135	.....	418	415	326	.....
June	84	321	118	.....	216	478	416	.....
July	147	231	468	.....	345	357	556	.....
August	.....	437	512	.....	.....	438	277	.....
September	.....	478	.....	.....	.....	437	.....	.....
October	.....	325	221	.....	.....	148	289	.....
November	.....	150	370	.....	.....	563	312	.....
December	.....	219	61	.....	.....	480	202	.....
Sums	316	2,686	1,924	205	979	3,411	2,547	373
Totals		5,131				7,310		

As regards the ratio between the quantity of water flowing from the upper basins of the Chagres and the water falling into it, we must acknowledge that no information in our possession can inspire us with much confidence for want of an adequate number of numerous and well-distributed observations. Nevertheless, relying upon careful observations made at Colon by the engineers of the Panama Railroad during several years and including all the months in the above-mentioned tables, it has seemed to me interesting to make a study of the data actually available, in order to set forth the relation between the values at Colon and those for the rainfall stations of the company in the basin of the Chagres. By discarding all interpolations, we shall be able to make use of complete rainfall observations made at Bohio, Gorgona, Gamboa, and Colon during twenty-five months only, the values of which are given in Table 3.

Gamboa and Gorgona are situated near together in the basin of the Lower Chagres not far from the Pacific Ocean. Bohio is in the same basin, but nearer the Atlantic Ocean. Consequently the mean rainfall of these two regions may be considered as that of the basin including that of the canal. As regards the Upper Chagres above Gamboa, it must be observed that the course of the river is nearly parallel to the Atlantic coast, and quite near to it. Thus the assumption of an equal rainfall in this region and at Colon is quite reasonable. The following is a comparison between the rainfalls based on the above figures:

Rainfall at Colon during the 25 months..... 7,310 mm.

Rainfall in the valley of the Chagres River=

$$\frac{9,975}{2} + \frac{5,436+5,131}{4} = 7,629 \text{ mm.}$$

By increasing these figures slightly I think we may adopt the rainfall at Colon as representing the average rainfall in the basin of the Chagres above Bohio without departing too far from the truth. If this assumption is well founded, we have the necessary data for studying the ratio of the quantity of water flowing in the bed of the river to the quantity of water falling into its basin above Bohio during the seven years whose monthly amounts are given above. The following values are taken from my note on the climatology of the Isthmus:

TABLE 4.—*Precipitation at Colon, in millimeters.*

Years.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Sums.
1891...	64	13	38	18	584	203	356	406	444	444	495	108	3,168
1893...	44	97	46	205	167	313	292	384	252	312	452	786	3,350
1894...	186	42	9	55	250	311	485	585	477	315	601	688	3,904
1895...	98	48	58	552	426	235	484	359	307	418	520	399	3,849
1896...	102	33	51	229	418	216	345	394	326	355	397	474	3,340
1897...	87	1	7	95	415	478	357	438	437	148	563	480	3,506
1898...	128	9	40	120	326	416	556	277	260	289	312	202	3,025
Means	94	35	35	181	369	310	408	406	358	326	477	441	3,449

The areas of the basins above Bohio and Gamboa being 670 and 420 square miles, respectively, the ratio between the rainfall and the water flowing in the bed of the river may be computed month by month. For example, we find at Bohio in July:

$$\frac{\text{Discharge of the Chagres at Bohio in July}}{\text{Rain falling into its basin}} = \frac{152 \times 3,600 \times 24 \times 31}{0.403 \times 670 \times 1.610^2} = 0.58.$$

In this way the ratios in Table 5 are determined.

TABLE 5.

Months.	Ratio.		Months.	Ratio.	
	Bohio.	Gamboa.		Bohio.	Gamboa.
January	2.07	2.41	May	0.50	0.55
February	1.39	1.97	June	0.54	0.57
March	1.15	1.48	July	0.58	0.65
April	0.46	0.54	August	0.70	0.64
			September	0.80	0.63
			October	0.94	0.86
			November	0.87	0.77
			December	1.08	0.99
Seasonal averages	1.27	1.60	Seasonal averages	0.75	0.71

Annual average at Gamboa, 1.00; annual average at Bohio, 0.92.

Without placing too great reliance on these figures, we may, from the well-marked differences between the results for the dry season and those for the rainy season, conclude that during the rainy season the Chagres must receive a great deal of water from the soil by infiltration. This is ordinarily the case with rivers flowing through similar regions. In fact, we already knew this by observing considerable outflows of water occurring in January, although there were no rains. This condition is very advantageous to the canal as regards the supply of water for the summit level during the dry season.

It may be further remarked that these annual mean ratios agree well with results well known in the United States, where the following figures are accepted:*

For rivers flowing from mountains or steep, rocky hills...	0.80 to 0.90
In forests and swampy regions.....	0.60 to 0.80
In undulating meadows with forests.....	0.50 to 0.70
In cultivated flat prairies.....	0.45 to 0.60

Fig. 1 represents the outflow and the amount of rainfall given by the above tables and the correlated positions of the sun in its annual course.

ADDENDUM, DATED DECEMBER 14, 1899.

During the current year observations have been resumed at Alhajuela, including daily measurements of discharge, automatic water level records, the rainfall, and hourly registrations by a self-registering thermometer and barometer. The usual records have been continued at Gamboa and Bohio. Rating tables, giving the discharges corresponding to the the different water levels, have been prepared at all three posts based for Alhajuela on over 350, for Gamboa on over 1,450, and for Bohio on over 1,000 actual gagings. As a check on the daily discharge measurements the volumes are computed, from these rating tables, at two-hourly intervals, thus correcting for any sudden changes in water level by day or by night, and determining the discharge with extreme accuracy.

These more elaborate discharge determinations, together with the additional rainfall observations at Alhajuela, furnish data for a more exact estimate of the ratio between rainfall and drainage than was possible in the foregoing study. The automatic water levels and the rainfall observations at Alhajuela were begun last June, and the numerical data to date (the mean monthly discharge in cubic meters per second, and the monthly rainfall in millimeters) are given in the following table:

TABLE 6.

Month.	Bohio.		Gamboa.		Alhajuela.		Colon.
	Discharge.	Rainfall.	Discharge.	Rainfall.	Discharge.	Rainfall.	Rainfall.
1899.							
July	112	451	73	240	61	297	763
August	162	330	113	278	91	259	376
September	120	226	83	342	66	305	186
October	140	491	89	202	73	301	382

The desired ratio between precipitation and drainage at Bohio (and similarly at Gamboa) has been found by dividing the mean monthly discharge there, as determined at two-hourly intervals, by the sum of the products of the mean rainfall at Bohio and Gamboa, at Gamboa and Alhajuela, and at Alhajuela and Colon multiplied by the areas of their several basins. The results for the four months now available are in so good accord with the above 7-year table, that its general trustworthy character seems to be confirmed, as appears from the figures in Table 7.

*Hydraulic and Water Supply Engineering. By J. T. Fanning, C. E., page 77.

TABLE 7.

Month.	Ratio at Bohio.		Ratio at Gamboa.	
	Calculated.	Above table (mean of 7 years).	Calculated.	Above table (mean of 7 years).
1899.				
July	0.42	0.58	0.40	0.65
August	0.84	0.70	0.94	0.64
September	0.73	0.80	0.90	0.63
October	0.65	0.94	0.68	0.86
Means	0.66	0.75	0.73	0.70

But a knowledge of the discharge at these three important posts enables the value of the ratio between downfall and drainage to be computed, independently, for the two basins lying between Bohio and Gamboa, and between Gamboa and Alhajuela, of which the areas are more accurately known than that of the Upper Chagres. Moreover, the rainfall having been noted at each of their extremities, the mean values are probably better determined. These local ratios, based on the contributions of the lower tributaries and the corresponding rainfall, are found to be the following: For the basin between Bohio and Gamboa (250 square miles), in July it was 0.47; in August, 0.66; in September, 0.52; and in October, 0.61, giving a mean of 0.57. For the basin between Gamboa and Alhajuela (130 square miles), it was in July 0.36; in August, 0.65; in September, 0.48, and in October, 0.45, giving a mean of 0.49. Thus, in whatever way computed, the numerical value of this ratio in the valley of the Chagres varies only within limits usual in such districts, and thus indirectly furnishes a new confirmation of the accuracy which characterizes the hydraulic and other investigations of the New Panama Canal Company.

COMPARATIVE RAIN GAGE READINGS AT ATLANTA, GA.

By ALFRED J. HENRY, Chief of Division.

A series of comparative measurements of the rainfall at several points in Atlanta, Ga., extending over eleven months, has just been completed.

The Weather Bureau Office in that city was moved to the United States Customhouse, May 1, 1891. The customhouse is provided with a hip roof, surmounted by a tower. The wind instruments were given a satisfactory exposure on the top of the tower, but it was not possible to secure a position for the rain gage that should be fully removed from the influence of the tower. It was known that the position of the gage was faulty and gave deficient measurements of precipitation with northeast winds, but the amount of the deficit was a matter of conjecture until after the recent comparative measurements were begun. A rain gage was taken to the residence of the official in charge of the station, about a mile northeast of the customhouse, and given a good ground exposure. The measurements at the two locations, customhouse and the residence of the official in charge, (which for convenience will be designated A and B, respectively), were as follows: February 1899, A, 6.62 inches; B, 7.88 inches. March, A, 5.38 inches; B, 7.06 inches. April, A, 1.71 inches; B, 2.09 inches. The discrepancy between the catch at A and B, respectively, may be attributed in part to the effect of the tower at A, and in part to the fact that ground exposures catch, on the average, from 5 to 10 per cent more rain than roof exposures.

In May, 1899, an option was secured on quarters in the Prudential Building, which, it may be remarked, is provided with a flat roof and offers fairly good exposures for the various instruments used by the Weather Bureau, but the removal of the station to the Prudential Building was not accomplished until July 1, 1899.