

ART. XXXVI.—*Mean Annual Rain-fall for different Countries of the Globe*; by Dr. ALEXANDER WOEIKOF of St. Petersburg, Russia.

PROFESSOR E. LOOMIS having published in this Journal a paper on the rain-fall of the world (Contributions to Meteorology, paper xvi), inviting meteorologists to give supplementary information on this subject, I readily accept this invitation, having myself given much attention to the subject. I must remark first on the exceeding inaccuracy of the geographical delineations used on the map, (mountains, lakes, rivers, etc.,) an inaccuracy which, however, certainly did not mislead Professor Loomis, when he was drawing his lines of equal rain-fall for countries where observations are wanting, and where the geographical configuration and notices of travelers are the only objects which give a basis to the hypotheses. I will give only examples in relation to Africa and Asia. On the first continent not only are none of the equatorial lakes given, but even no mountains in Abyssinia, while we find "Donga Mountains," between 4° – 6° N. and 20° – 30° E., which have no existence. In Asia the Stanovoi watershed between the systems of the Lena and Amur is given as if it was a high mountain chain; the same is to be said of the slope of the Mongolian plateau north of Pekin, while between 25° – 40° N. and 96° – 110° E., no mountains are shown, while this region comprises West China, Kukulnor and Eastern Thibet, and has some of the highest chains of Asia.

I come now to Professor Loomis's work in Europe. The shades are mostly right, except—

1. Sicily, which has, in its greatest part less than $25''$.
2. Portugal, where the author cites the old and erroneous

figures for Coimbra, while Professor Hann has some years ago proved, by the results of the new observations, that it has a rain-fall not much above that of Lisbon.

3. Scandinavia, where the fall above 50'' is restricted to a few exceptional places, near high mountains of West Norway, like Bergen and Florø. Even Christiansund has much less. Eastern Norway and the interior valleys (Christiania, Dovre) have less than 25''.

In what concerns European Russia, the shading is perfectly right, as I have found by a new and more extensive collection of data. The frontier of the fall of more and less than 10'' is also in the main right, except in the vicinity of Orenburg, where it should be drawn somewhat more to the south.

In Asia, north of the Tropics, there is more to change. Thus the zone of less than 10'' in the Arabo-Caspian steppes and vicinity is too large in Professor Loomis's map. It does not stretch so far to the north and northeast, and certainly does not reach to the foot of the Altai, where the rains of summer and the snows of winter are rather abundant. On the east coast of the Caspian, Krasnovodsk (40° N.) has also more than 10''.

There is a great rain-fall on the south shore of the Caspian, as well as on the south part of the western shore; on the latter Professor Loomis has the station of Lenkoran 51.7''.

The country about Lake Balkash and the upper Irtysh is very dry, it being really a continuation of the Arabo-Caspian steppes, there being a broad gap in the mountains. The dry region in Mongolia and Eastern Turkestan must be extended westward so as to include Yarkand and Kashgar; on the north, on the contrary, it does not extend as far as shown by Professor Loomis, Kiakta and Ourga having more than 10''. The good pasture and forest in this region prove that the two latter stations are not exceptional. I should rather include most of the basin of the Yang-tze and eastern Indo-China in the region having more than 50'', though I have no observations to prove my case. But the known humidity of the region, the luxurious vegetation, the immense floods of the rivers* corroborate my opinion. Eastern Java seems to have less than 75'', as is seen by the 5½ years of Surabaya and 2 years, 1879-80. It would be safe to give 50''-75'' to the islands east of Java so far as Sumbawa, and a shade less to Flores and Timor, while Banca, Billiton and the Moluccas and Southern Philippines have probably over 75''.

As to British India, Professor Loomis has made a good use of the numerous observations there.

* See E. L. Oxenham, Inundations of the Yang-tze-Kiang, in Jour. Roy. Geogr. Soc., 1875, p. 170.

In Western Asia the region of 10''–25'' is probably in closer proximity to mountains than shown in Professor Loomis's map, extending far to Shiras along the mountains of southern Persia, and not so far to the south in southeast Syria and Mesopotamia. In Arabia a closer approximation of the rainy regions to the mountains is also what must be the case.

As to Africa, Professor Loomis has made good use of the observations and general information of travelers, with the exception of Abyssinia, which has certainly more rain than indicated by him. That North America north of the Tropic is accurately represented by Professor Loomis is easily understood. I would only ask, is it not probable that Northern Canada from about 50° N. lat. is less rainy than supposed by Professor Loomis, so that the more abundant rain of the coast of Labrador would be caused by its position relatively to the sea and mountains?

As to Central America, the dark shade given to Yucatan is rather doubtful. The short period of rain, the absence of mountains and the rather scanty vegetation, at least of Northern and Western Yucatan would rather point to less rain, though the porous nature of the limestone absorbs much water. So far as I could see and learn, Tehuantepec and Northern Yucatan must have about the same quantity of rain.

As to the Pacific coast, from about Tonalá to Panama it must have above 50''. A few observations made in Nicaragua give a large amount of rain, and Nicaragua is certainly less rainy than the coast of Soconusco about Tapachula and Guatemala. The city of Guatemala has a little less than 50'', but the plateau on which it is situated is generally dryer.

Tropical South America, at least its interior, is the part of Professor Loomis's map which is least accurate. I am at a loss to know on what account the Amazonian country is supposed to have less rain than the dry "llanos" of Venezuela to the north of it. I consider it probable, that from the north coast to 15° S. lat., the only parts east of the Andes, where there is less than 50'' rain, are the llanos of Venezuela and perhaps part of the Magdalena basin. On or near the Amazon, we have Para, Manaos and Iquitos, which give more than 50''. The latter is especially interesting. The distance from the Andes is more than 200 miles, from the Atlantic more than 1000, the country perfectly level, and yet there are 111·8'' rain. Generally it is mentioned by travelers, that to the south of the Amazon the rains are less heavy, and yet San Antonio on the Madeira has 91·3''.

As to the west coast, the region of more than 75'' extends certainly to the equator, the provinces of Esmeraldas and Choco being described as exceedingly rainy. Farther to the south I would object to giving to Chiloe and the adjacent coast

less rain than to Concepcion and Valdivia. Professor Loomis probably made use of the observations at Aneud, Chiloe, and seeing that this place had less rain than Valdivia and Puerto Montt, took it as generally admissible for the latitudes above 41° S. on the west coast. But Aneud is protected by a rocky promontory on the west, that is, the wind and rain side, while the other two stations are open to the west.

In the LaPlata States the interior is very dry, only the eastern slopes of the mountains and their vicinity have more rain. Now all the interior stations from which we have rain observations, are so situated, and all except Mendoza give much more rain than would be the average of more evenly distributed stations. We know that westward from the stations of Cordoba, Tucuman, Salta are the States of Catamarca, Jujuy, San Luis, which are so dry that even good pasturage is scarce. It would thus be safe to extend the region with less than $10''$ much to the eastward, and that of $10''$ – $25''$ also.

As to Australia, the region of $25''$ – $50''$ in the north of the Continent probably extends along the coast somewhat to the southwest from the position given it by Professor Loomis. As to that of less than $10''$ there is no reason why we should admit that it is so very restricted in the interior as in Professor Loomis' map. We have no observations from an extensive district, but what we know of the dryness of the interior allows us to make this very probable supposition.

On the whole, Professor Loomis's work is certainly a good one, but on account of what I have mentioned above, a revised edition of the map is yet desirable.

I would besides draw attention to some perplexing and erroneous designations of the countries and regions in which are situated some of the stations mentioned by Professor Loomis. I give here some of them, with the corresponding numbers of Professor Loomis's table.

254 *Ragusa*, European Turkey. Is situated in the Austrian province of Dalmatia.

363 *Ajansk*, Russia. As other places in Siberia are cited as such, it would be better to mention Ajan, the exact name, as being in Eastern Siberia. The same applies to 524 *Nertschinsk*, 522 *Irkuzk*; 646 *Kjachtu*, 510 *Enisseisk*; while 512 *Tobolsk*, 516 *Tomsk*, 517 *Ischim*, 519 *Omsk*; 520 *Isalair* (*Salair*), 643 *Barnaoul*, 644 *Akmolinsk* are situated in Western Siberia.

521 *Nikolaiewsk*, 525 *Blagowestchenck*, 526 *Chabarawka*, 528 *Vladivostok* are placed by Professor Loomis in China, while they are in Eastern Siberia (in the Amur and Littoral provinces).

The appellation Tartary applied to 529 *Tushkent*, and 647 *Irgis* is wanting in precision. If it is meant for the Kirghiz

steppes, Russian Central Asia and the Khanates of Khiva and Bokhara, then the following stations should also be included in it: 649 *Raïmsk*, 650 *Fort N. 1*, 652 *Novo Petrovsk*, 653 *Nakust Mekuss*, 654 *Petro-Alexandrovsk*.

I give below some data about rain-fall, especially in relation to countries which, in my opinion, are not correctly represented in Professor Loomis's map.

Names of Places.	Lat.*	Long.*	Ht. met'rs	No. of Years	Rain. Inch's.	Authority.
Manaos, Brazil	—3° 8'	—60°	37	1	55·24	Zeitschr. v. 8, p. 267
Iquitos, Peru	—3 44	—73° 8'	95	1	111·8	
S. Antonio, Madeira, Brazil	—9 5	—64	---	1	91·3	
Pernambuco, Brazil	—8 4	—34 52	3	4	108·4	Zeitschr., v. 15, p. 492
Surabaya,	—7 13	112 48	---	5½	71·7	Zeitschr., v. 14, p. 216
Passoercean,	—7 38	112 56	4	2	63·1	
Probolingo,	—7 44	113 13	10	2	57·33	Zeitschr., v. 8, p. 56
Besœki, } Eastern Java.	—7 43	113 41	2	2	57·76	
Sitœbondô,	—7 41	114 2	80	2	57·05	Bergsma Z. 1879 and 1880
Banjewang,	—8 13	114 23	5	2	68·83	
Amboina, } Moluccas	—3 42	128 10	---	2	190·50	
Banda,	—4 32	129 53	---	2	135·77	}
Urga, N. Mongolia	47 55	103 50	---	6	10·13	
Kiakhta, } S. E. Siberia	50 21	106 25	---	4	10·09	
Irkutsk, }	52 17	104 22	---	6	17·38	}
Barnaul,	53 20	83 57	---	41	9·50	
Akmolinsk, } S. W. Siberia	51 12	77 23	---	6½	9·53	
Semipolatinsk, }	50 24	80 13	---	5	8·39	Met. Annalen
Salair (Altai), }	54 15	85 47	346	4	13·0	
Vladikavkas, N. Caucasus	43 0	45 3	---	8	34·04	
Stavropol	45 5	41 53	---	13	27·74	}
Poti, } E. co't of Bl'k Sea.	42 10	41 40	---	10	65·92	
Suchum-Kale, }	42 58	40 53	---	3½	50·51	
Dachovsky-Possad, } Trans-Caucasia	43 34	39 42	---	9	80·81	}
Novorossissa, }	44 43	37 46	---	4	30·02	
Sevastopol, Crimea	44 36	33 32	---	14	15·37	
Christiania, } S. Norway	59 55	10 43	---	7	21·18	Zeitschr. v. 4, p. 508
Sandôsund, }	59 5	10 28	---	7	23·01	
Christiansund, } W. Norway	63 7	7 45	---	7	33·18	
Aalesund, } co't	62 29	6 9	---	7	45·53	}
Catania (E.), }	37 24	15 3	---	12	18·05	
Syracuse (E.), }	37 4	15 17	---	10	18·27	
Palermo (N.), }	38 7	13 19	---	61	23·27	Fischer, Klima der Mittel-meerländer Gotha, 1879
Sciacca (S. W.), }	37 30	13 5	---	10	22·26	
Oporto, Portugal	41 9	—8 36	---	10	56·34	
Coimbra, Portugal	40 13	—8 25	---	6	34·0	}
Lissabon, Portugal	38 43	—9 10	---	20	28·80	

* The sign — stands for lat. S. and long. W.

† The observations were continued only ten months and gave 49·9'', the two remaining, July and August are interpolated.