THE WORK OF THE WEATHER BUREAU FOR RIVER INTERESTS ALONG THE OHIO RIVER.[1]

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At the beginning of the river service by the Weather Bureau in the Ohio Valley the principal object was to forecast the flood stages. At first the flood stages were forecast for the larger cities only, but gradually this service was extended to include all portions of all the rivers in the Ohio Valley. This is a large and very important service and continues to become more and more important as the industries and population of the valley increase, but to-day we are not so much concerned with "much" water as we are with "little" water in the river.

To meet the ever-increasing demands of the river interests, first with the construction of the dams and later with the operation of those completed, there has been developed, or, rather, is being developed (the system is not complete), the greatest and most intense system of low-water river forecasting known in the history of the service. The total drainage area of the Ohio Valley is 210,000 square miles, the Ohio River is nearly 1,000 miles long, and there are several thousand miles of tributaries. Every square mile of surface and every mile of the rivers and streams must be watched in forecasting the changes at the low stages. A flood out of one of the smaller tributaries will have practically no effect on the flood stages in the Ohio River, but a moderate rise in the same tributary will flood a dam in the Ohio below the mouth of the tributary. If this water comes out unexpectedly, it may be an impediment to navigation and may even result in considerable damage; but if its coming is known in advance, even though it may come at night, it may be just the water needed to fill some pool farther down the river.

Aside from the 52 dams completed, under construction, or proposed in the Ohio River, there are more than 90 others in the tributaries, all to supply water for river transportation.

The intelligent operation of these dams requires the greatest possible refinement in forecasting the daily changes in the flow of water. When the dams are down and the river is falling and will continue falling for several days, the lock master at each dam must begin at just the right time to raise the wickets, and he must raise them at just the right rate so as to fill the pool with water, but without causing such a low stage of water below the dam that navigation will be interfered with or stopped. If the river is going to stop falling and begin to rise before a 9-foot stage is reached, the wickets should not be put up, as a sudden rise would flood the dam, in which case the wickets could not be lowered; while, on the other hand, if the river is allowed to fall nearly to the 9-foot stage before the wickets are raised, it is impossible to fill the pool and at the same time to maintain a 9-foot stage below the dam. When the dams are up and the rise is coming down the river, the lock master must be advised of the approach of this rise and the amount of the same. If the rise is small and does not exceed the 12-foot stage, the bear traps are opened or a few of the wickets are lowered to let the rise pass, but if the rise will exceed the 12-foot stage all of the dam must be lowered. If the dam is flooded before all of the wickets are lowered, they stick up in the bottom of the river and form a most serious obstruction to navigation. As the changes at the dams control to a certain extent the stream flow, it is necessary for the forecaster to be advised of these changes before they are made so as to make allowance in his forecasts for the change in the amount of water flowing in the stream. As it often requires a day or more time to raise the wickets at a dam and several hours to lower them, and as these changes should be made when the river stage is between 9 and 12 feet, the river forecasts are of the utmost importance in the effective operation of the dams. At the dams under construction the low-water river forecasts are of great importance.[2]

At the Cincinnati station, we publish the river bulletin as a portion of the weather map. The bulletin is not as complete as we should like to have it, but it is as complete as the space will permit. In addition to the distribution by means of the weather map, the river bulletin is telegraphed to all the other large cities along the river in this district and distributed either by the press or by special bulletins. Similar distribution of the river information is made from the other district centers as Louisville, Parkersburg, Pittsburgh, etc. Every daily newspaper in the cities on the Ohio River should publish the river bulletin and every one in the Ohio Valley should have a weather bulletin.

The weather service and the river service are very closely connected; in fact, they must be worked together. We have had an excellent example of this in the Ohio Valley during the last few days. About 10 days ago a large shipment of coal was brought down from the Kanawha River to Cincinnati on an "artificial wave." This was a fine accomplishment, but due to the unusually dry weather the wave took all of the extra water there was in the river and the result was that many rivermen had boats "hung up" along the river. The weather map for Saturday showed that there had been general rains to the westward of the valley with heavy rains in Oklahoma and floods in the rivers in that and the adjoining States, while in the Ohio River at the same time some of the lowest stages of record were being reported. General rains for the Ohio Valley frequently, and in fact, usually, come from the southwest and to this extent conditions looked favorable for some water for the Ohio River, but we took pains to state on the weather map for that day that the rain area was moving very slowly, and light scattered showers only, if any, would fall in the Ohio Valley during Sunday.

The weather bulletin on the map for Monday morning stated: "The showers in the Ohio Valley (during Sunday) were practically all in that portion of the valley north of the Ohio River, and of no value in raising the water in the Ohio River," but, "there were fair indications Monday morning that general showers would occur in the Ohio Valley during Tuesday or Wednesday." This gave the rivermen time to collect their scattered crews and to "get up steam" ready to start the boats with the first small rise out of the tributaries.

During Monday night the center of a tropical storm moved in from the west Gulf and at observation Tuesday morning this storm was central over northern Louisiana and headed toward the Ohio Valley. The front edge of the rain area had advanced northeastward about 400 miles during the preceding 24 hours and had just reached the southwestern edge of the Ohio Valley. The weather forecast that morning stated that the southwestern rain area would cover the lower Ohio Valley during Tuesday and most of the valley during Wednesday, and the river forecast at the same time was that the Ohio River would continue low during Tuesday night, except in the pools, but would probably begin rising Wednesday. The map for this morning, Wednesday, shows that the rain area has extended eastward as far as Cincinnati and Lexington, Ky., in the middle Ohio Valley.

The bases for all of these forecasts were weather conditions outside of rather than within the Ohio Valley. In an article published a few years ago in the *Proceedings*

[1] An address given at the meeting of the Ohio Valley Improvement Association, Cincinnati, Ohio, Oct. 17, 1923.

[2] Extract from Forecasts of river stages and floods in the Ohio Valley: Their importance to commerce and in conserving life and property, by W. C. Devereaux, in *Proceedings of the Second Pan American Scientific Congress, Section II.*

of the Second Pan-American Scientific Congress it was stated that: "The third step in the development of the river (forecast) service will be reached when the forecaster can calculate the future height of the water for each station in his district as soon as the storm appears on the weather map. As far as known no attempt is being made at the present time to do this, and as the problems are numerous and very complex it possibly will never be attempted, but it is impossible to be sure of what the future may hold." I believe now that we are making considerable progress in that direction.

To do these things and many others not mentioned, to follow the course of storms and rains across the country, follow the water into the streams, and to precede it down the river to the mouth and to mark at each station and at each dam when it will arrive and how high it will be, require specially trained men and a technical and scientific organization. We do not have the divine-given power, as some seem to believe, of reaching up into the sky and pulling down the desired information, but we must solve our problems and do our work in a natural and scientific way.

The river work of the Weather Bureau in the Ohio Valley has grown rapidly during the last few years, but the facilities for doing the work have not been increased in the same proportion. The number of employees in the Cincinnati office is the same as it was 10 years ago, and during that time the river work probably has doubled. We have been able to take on much of this additional work through the splendid cooperation of the United States Engineers and the daily newspapers in this district. We have been urged and even commanded by our superior officers to economize and to use efficient business methods, and we have complied to the best of our ability. Both of these terms are rather elastic and like all elastic objects can be stretched only to a certain limit. We have stretched the river service to the limit with the funds available and it does not cover the work as it should be covered. There is not a station on the Kentucky River. We do not receive a telegraphic report of a river stage or of the amount of rainfall from a single station in that large and important valley. The rainfall areas over the Kentucky Valley move directly over the Licking and then the Big Sandy and the Kanawha Valleys, and the waters from all of those rivers reach the Ohio at vital spots. As stated in the last report of the Chief of the Weather Bureau, "More river-gaging stations and much more intensive measurement of precipitation are needed. These things can be accomplished with a very reasonable increase in appropriations, and it is hoped that funds will soon be available. As it is, the service is virtually at a standstill so far as field extensions are concerned. One vital need is that of an engineer who can serve as a field man, inspecting stations, making repairs to equipment, making surveys for the establishment of permanent bench marks and other measurements of precision. These surveys are of highest importance."

NOTES, ABSTRACTS, AND REVIEWS.

A CORRECTION.

An abstract entitled "The size of meteors" written upon the recent work of Lindeman and Dodson was reprinted in the MONTHLY WEATHER REVIEW for June, 1923, page 316. The authors have stated to the editor that their view as expressed in the closing paragraph of the above-named abstract is better represented by the following: "Our view is that the short-wave radiation from the sun must give rise to the formation of ozone, and while this will never be found in more than a small pro portion, it may greatly modify the radiative equilibrium. Thus, it is known that all the sun's radiation of shorter wave length than 3,000 Å is absorbed in the upper air and will raise the temperature at those heights considerably. The earth's radiation will only be absorbed by ozone over a small range of wave length, about 9.5 μ, and the temperature can never be raised above approximately the temperature of the stratosphere by this cause."

CENTRAL METEOROLOGICAL OBSERVATORY AT TOKYO BURNED.

American friends of Japanese meteorologists will be interested in a recent letter from Dr. S. Fujiwhara, of the Central Meteorological Observatory at Tokyo. Doctor Fujiwhara reports that in the great fire which followed the recent severely destructive earthquake in Japan the main building of the Central Observatory was destroyed. Many instruments and books were lost, and the official residences of the staff were burned. Fortunately, the Tokyo meteorological records covering a period of 40 years were saved.

Doctor Fujiwhara reports the interesting fact that hourly observations were continued throughout the fire, and that at midnight, when the main building was burned, the temperature in a shelter about 200 feet distant rose to 46.4° C. (115° F.). This effort to keep a continuous record in spite of the great difficulties under which the observers were working evidently is characteristic of the efforts that are being made to restore normal conditions as rapidly as possible.—*C. L. M.*

GREAT BRITISH DROUGHTS.

Mr. Chas. Harding in *Nature*, July 14, 1921, discusses briefly the record of droughts in Great Britain in connection with the one which has prevailed since October, 1920. Since that time the rainfall at Greenwich Observatory has been but 9.78 inches, or 56 per cent of the normal. The controlling factors of the weather associated with drought in Great Britain have been a low barometer to the north of the British Isles and a relatively higher barometer with anticyclonic conditions in the south of England; in other words, an extension of the Azores HIGH toward and over southern England and the Channel.

Mr. Harding's definition of absolute and partial drought is particularly interesting. The writer of this note, in compiling the statistics of drought published in Bulletin Q–Climatology of the United States, adopted the following as applicable to the United States east of the 100th meridian. A drought was considered to have existed whenever the rainfall for 21 days or longer amounted to 30 per cent less of the seasonal normal.

Mr. Harding defines absolute drought as a period of more than 14 days without rain, and partial drought as a period of more than 28 days the aggregate rainfall of which does not exceed 0.01 inch per diem.—*A. J. H.*