COMMON FALLACIES IN SOOT-FALL COMPARISONS OF DIFFERENT CITIES

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It is but natural that those who are interested in the smoke situation of a particular city should raise the question whether the conditions there are better or worse than those in some other city. The difficulties of making just comparisons of the conditions of different cities on the basis of published data do not appear to be generally recognized. It is deemed worth while, therefore, to point out some of the difficulties in making comparisons of conditions in different cities. Some of these are tabulated below.

1. The number of observation stations is rarely, if ever, sufficient to give an accurate average for the city. For example, in Chicago, a city having a population of between three and four million, only about 20 dust-fall stations (Bundesen, 1930) were operated and the distribution of these over the city was far from uniform.

2. The area of the city limits over which the average is calculated varies widely from city to city. For example, the corporate area of Baltimore (Shrader, Coblentz, and Korff, 1929) is three times that of Milwaukee, yet its population exceeds that of Milwaukee by only about 25 per cent.

3. Atmospheric contamination, as measured, is more or less dependent upon weather conditions such as wind velocity and temperature, factors which are variable from year to year in any city.

4. The quantity of dust-fall alone is not a satisfactory measure of atmospheric smokiness in any locality. In certain industrial centers, such as Pittsburgh (Meller, 1924) the smoke nuisance has been greatly reduced at the expense of blowing the less objectionable ash into the atmosphere thereby actually increasing the total quantity of dust-fall.

5. Neither the combustible matter alone nor its effect in combination with ash furnishes an entirely satisfactory basis for comparing atmospheric contamination in different cities. These factors and others, such as the quantity of tar and sulfuric acid, and especially weather conditions which in combination with smoke increase the formation of fog and reduce the incidence of solar utra-violet light, contribute to the injurious effects of smoke.

6. There is lack of uniformity from city to city in the location of dust-fall receptacles with respect to the type of contamination measured. For example, in Chicago (Bundesen, 1930) the collecting receptacles were attached to street posts only 10 feet above the street. As a result dust from the street, from the tops of buildings, and from building operations was collected. In Baltimore (Shrader, Coblentz,

and Korff, 1929) collecting cups were placed at street levels at points where they could be closely watched. At representative points for central Manhattan, E. E. Free (1931) observed that the number of dust particles per cubic foot of air was as much as 100 per cent greater at the first floor level than at the seventeenth floor level.

7. Depending upon the analytical procedure adopted "total solids precipitated" from the atmosphere may or may not include the soluble portion. MacIntire and Young (MacIntire and Young, 1923) reported an 8-year average of 51.5 pounds per acre of non-acid sulfate sulfur equivalent to 218.6 pounds of $CaSO_4$ in rain water at the University of Tennessee Experiment Station. This is equivalent to approximately 70 tons per square mile of $CaSO_4$ not included in the usual "dust-fall" or "soot-fall" determinations.

8. The volume of dust or soot collected probably depends upon the size and shape of the soot-fall receptacles. In Rothamsted, England, over a period of 28 years Lowes, Gilbert, and Warington (1881) found that with a gauge 6 feet by 7 feet 3.2 inches (embracing a surface of 0.001 acre), the increase amounting to an average of 9.8 per cent more than with an ordinary 5-inch copper gauge. They reported that deposits of snow, mist, dew, and hoar-frost are distinctly greater with the larger gauge. Variations in the depth of jars for the collection of dust or soot doubtless cause variations in the quantities of material collected. It is reasonable to assume that wind may blow out soot and dust from shallow receptacles more easily than from deep vessels.

9. The usual object of an atmospheric survey is to determine the distribution and sources of atmospheric contamination within the city rather than to find out whether conditions are better or worse than in other cities. For example, in the smoke survey of Grafton, West Virginia (Monnet and Hughes, 1924), the map shows that there were many more stations for the measurement of soot-fall along railroads than elsewhere. The average soot-fall for these stations is not a fair index to smoke conditions over the corporate area as a whole. A recent U. S. Geological Survey (Collins and Williams, 1933) shows that for the whole area of the United States an average of not more than 2 parts per million of sulfate is present in rain water, yet the average reported by Riffenburg (Riffenburg, 1925) from more than 200 journal articles without regard to the location of sampling points or methods of analysis is 5.0 parts per million.

Comparisons of soot-fall in different cities, therefore, should be made with reservations and apologies. After all, from the standpoint of smoke abatement measures, the mere ability to state that the number and magnitude of such offenses as throwing brick bats or belching forth smoke are greater in one city than in another is less important than the ability to single out and focus attention upon individual offenders. There is some justification, therefore, in the failure of many cities to follow the recommendations of the Mellon Institute and of the Bureau of Mines respecting the locations of soot-fall stations.

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