

## Mean heat island intensities at Delhi — Assessed from Urban Climatological data

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**ABSTRACT.** Based on data collected from 11 Urban Climatological stations in Delhi during 1976, mean heat island intensities at Delhi have been assessed from analyses of minimum temperature fields in different months. It has been found that maximum monthly mean heat island intensity at Delhi was of the order of about 5 deg. C during March in the congested and heavily populated area near Subzi Mandi, and the minimum was about 0.8 deg. C during July. A cold pocket was also observed near South Patel Nagar where congestion is less. Further, the magnitude of maximum monthly mean value of the difference in maximum temperature between a location having the highest maximum temperature and a location having the lowest maximum temperature (on the same day) did not exceed 1 deg. C during any month.

### 1. Introduction

The effect of urbanization on temperature field have been studied in great detail by various workers (Chandler 1965, Nkemderim 1976, Oke and Maxwell 1975 and Padmanabhamurty and Hirt 1974). Large number of workers had collected the meteorological data for the above studies by conducting mobile surveys in different cities under different meteorological conditions. Though the mobile surveys give quick results, they have their own limitations. As such, it is desirable to collect meteorological data from different locations in a city continuously for a longer period for detailed study of the effect of urbanization on temperature field. At Delhi, a network of Urban Climatological (UC) stations equipped with the instruments for recording various meteorological parameters such as dry bulb, maximum and minimum temperature, wind and rainfall has been established. In the present paper, results as obtained from the study of maximum and minimum temperature data collected from the above network have been presented.

### 2. Climatological features of Delhi

Delhi city has a population of about 60 lakhs and encompasses an area of 1485 sq km. Broadly, Delhi can be divided in two parts (i) old Delhi with central densely populated built-up area and

(ii) New Delhi with well-planned construction having plenty of open space. Extreme dryness with hot summer and cold winter are the characteristic features of the climate of Delhi. The year can be broadly divided into four seasons. Cold season starts in late November and extends upto the beginning of March. January is the coldest month. Winter is followed by hot season lasting till the end of June when the southwest monsoon arrives over Delhi. Monsoon continues till the last week of September. October and November, the post-monsoon months, constitute the transition period from the monsoon to winter conditions. Winds are generally light during the post-monsoon and winter months. They strengthen during the summer and monsoon months.

### 3. Network of Urban Climatological stations

It had been planned to establish a network of 20 Urban Climatological (UC) stations in a phased manner at different locations in Delhi. While selecting the location of the UC stations, factors like density of population, terrain and location of different industries were taken into account. Till the end of 1975, 11 stations had been under operation in the above network. The results which have been presented in this report are based on the studies of the data obtained from the 11 stations only. In addition to the Urban Climatological stations the data obtained from

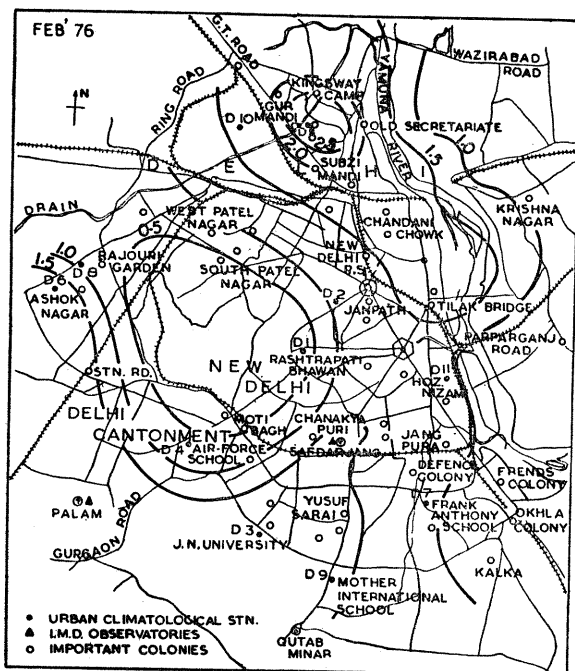


Fig. 1. Isolines of monthly mean heat island intensity at Delhi during February 1976

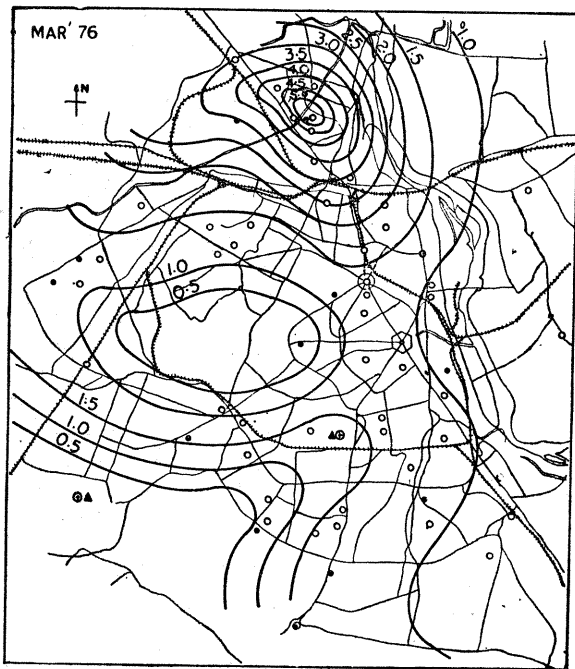


Fig. 2. Isolines of monthly mean heat island intensity at Delhi during March 1976

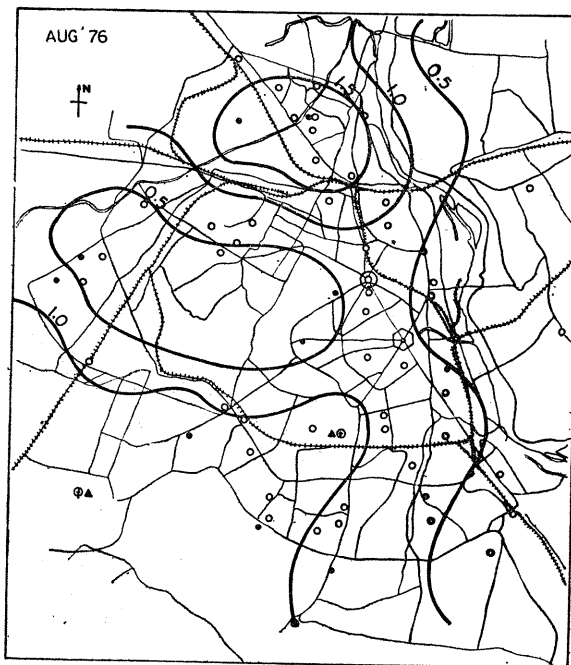


Fig. 3. Isolines of monthly mean heat island intensity at Delhi during August 1976

two regular India Met. Dep. observatories at Palam Airport and Safdarjung Airport have been also utilised for the above studies. Figs. 1-3 show the locations of Urban Climatological stations, regular India Met. Dep. observatories and important localities at Delhi. Though few Urban Climatological stations had been under operation since 1972 but continuous data from most of

the stations are available only from 1976. The present study is, therefore, based on continuous data collected during 1976 only. Further, since sufficient stations were not equipped with wind and rainfall measuring instruments, study of these parameters could not be undertaken and as such results of study of temperature data only have been presented here.

## 4. Analysis and study of temperature data

At each of the UC stations, observations are taken at about 10 A.M. daily. Instead of studying the temperatures as obtained directly from different UC stations, difference in temperature between Palam Observatory and Urban Climatological stations has been examined. This helped in indirectly checking the accuracy of the observations from different Urban Climatological stations. Palam has been chosen as a reference station, since it is expected to have meteorological conditions representative of a rural station in view of its location in a comparatively open area at the outskirts of Delhi. This aspect is corroborated from the temperature observations also, for example, daily minimum temperatures are observed to be lower at Palam than at most of the UC stations. Daily difference in the temperature (maximum as well as minimum) between Palam and Urban Climatological stations has been studied. The difference in minimum temperature fields gives directly the heat island intensity. The data is plotted on a map and analysed. Monthly, mean of the daily temperature differences have been computed for maximum as well as minimum temperature for the purpose of plotting on the maps. These maps thus provide the mean picture of heat island intensities averaged over different meteorological conditions during the month. Due to various reasons it has not been possible to get continuous data from all the Urban Climatological stations in some months and as such it has not been possible to draw the isolines (heat island intensity) for all the months. It is well-known that temperature differences between a rural and an urban station are more pronounced and consistent during minimum temperature epoch. This is mainly due to the fact that winds are either calm or rather weak during the minimum temperature epoch in the morning than during afternoon when temperature reaches its maximum value. Maps showing monthly mean maximum temperature differences have not, therefore, been presented.

Figs. 1-3 show the isolines for monthly mean minimum temperature differences for the months of February, March and August 1976 at Delhi. Monthly maximum mean heat island intensities for different months (from minimum temperature data) have been indicated in Table 1.

## 5. Discussion

From the climatological point of view, *i.e.*, when winds are light, maximum heat island intensity is expected during February or March and minimum heat island intensity is expected during summer and monsoon months. It can be seen from Figs. 1 and 2 that an intense heat island had

TABLE 1

Monthly maximum mean heat island intensities at Delhi during 1976

Month	Monthly mean heat island intensity (°C)	Month	Monthly mean heat island intensity (°C)
Jan	2.3	Jul	0.8
Feb	2.7	Aug	1.0
Mar	5.1	Sep	1.6
Apr	1.9	Oct	—
May	1.0	Nov	—
Jun	1.1	Dec	1.8

developed near Sabzi Mandi area in Old Delhi during March. It is interesting to note that a comparatively cold pocket existed in the South Patel Nagar area. The heat island intensity was observed to increase as one moved from Palam Airport area towards Air Force School area with a maximum at 1.5 deg. C near Central School Sector VIII area and then its intensity decreased. It reached its minimum value of 0.5 deg. C or so near South Patel Nagar, and then again started increasing till it reached its maximum value near Sabzi Mandi area. Heat island intensity decreased on either side of the above heavily congested area. Bahl and Padmanabhamurty (1977) had also obtained similar temperature pattern during mobile temperature surveys at Delhi. The primary heat island which they obtained in their mobile surveys is situated a little southeast of the location that has been obtained in the present study. Since the values of isotherms near Chandani Chowk and Sabzi Mandi area are not much different from those obtained by Bahl and Padmanabhamurty (1977), it can be assumed that the heat island intensities would not be much different between Sabzi Mandi and Chandani Chowk area. The cold area as obtained in the present study coincides with that reported by Bahl and Padmanabhamurty (1977). Maximum monthly mean heat island intensity of about 5 deg. C (Fig. 2) was observed during March 1976 near Sabzi Mandi area. This value is little lower than the peak value of 6.9 deg. C obtained by Bahl and Padmanabhamurthy (1977) during the same period as expected. Minimum monthly mean heat island intensity of 0.8 deg. C was observed during July 1976. From Figs. 1-3, it can also be seen that during winter months isotherms are closely spaced, giving rise to steep gradient, whereas, during August isolines are flat. Further, from Table 1, it can be seen that the heat island intensity is minimum during July (during monsoon) and it slowly builds-up reaching maximum value during March,

As mentioned above, monthly mean values of the daily difference in the maximum temperature between Palam and UC station were also computed. However, the data did not show any definite trend. As such, it has not been possible to draw any conclusive remarks from analyses of the maximum temperature field. However, the analyses of the above data indicated that the magnitude of maximum monthly mean value of the difference in maximum temperature between two locations having highest and lowest maximum temperatures (during a day) may not exceed 1 deg. C during any month.

#### 6. Conclusions

(i) Maximum monthly mean heat island intensity at Delhi was of the order of about 5 deg. C during March and was minimum during July (about 0.8 deg. C).

(ii) Monthly mean heat island intensity was maximum in the congested and heavily populated area near Sabzi Mandi. A cold pocket was also observed, near South Patel Nagar where congestion is less.

(iii) Steep gradient in the isolines for heat island intensity was observed during winter months whereas during monsoon the gradient was flat.

(iv) Magnitude of maximum monthly mean value of the difference in maximum temperature between two locations having highest and lowest maximum temperatures during a day did not exceed 1 deg. C during any month.

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