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Heat island intensities over Brihan Mumbai on a cold winter and hot summer night

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सार - 16 जनवरी 1997 को बृहत मुम्बई क्षेत्र में एक मोबाईल तापमान सर्वेक्षण किया गया। संयोगवश शीत ऋतु की यह सबसे ठंडी रात थी। तटीय सीमा से दूर शहर के अंदरूनी भागों में मोटे रूप से तीन उपनगरीय रेल पथों के साथ-साथ तीन स्थानों में निश्चित उष्ण वायु की भिन्न दिशा में ऊष्मा के क्षेत्र पाए गए। इस अध्ययन के परिणाम 70 के दशक के पूर्वाद्ध में डेनियल और कृष्णमूर्ति (1973) और तत्पश्चात् मुखर्जी और डेनियल (1976) द्वारा किए गए इसी प्रकार के अध्ययनों के परिणामों से बिल्कुल भिन्न पाए गए हैं। उन्होंने शहरीकरण के अन्य कारकों की तुलना में क्षैतिज तापमान वितरण पर समुद्र के उल्लेखनीय प्रभाव का पता लगाया। उन्हें मालाबार हिल, गिरगाऊम और कुफे परेड के क्षेत्रों में ऊष्मा के क्षेत्रों का भी पता चला। 22 वर्षों के अंतराल के पश्चात् किए गए सर्वेक्षण से यह पता चला है कि नगर और उपनगरों में तापमान के वितरण में उल्लेखनीय सुधार आया है तथा ऊष्मा क्षेत्रों के बनाने तथा उनकी विद्यमानता को बनाए रखने में समुद्रीय प्रभावों का स्थान शहरीकरण के प्रभावों ने ले लिया है। पूर्ववर्ती सर्वेक्षण के परिणामों की पुष्टि करने और उष्मा क्षेत्रों की तीव्रताओं में मौसमी परिवर्तनों का मूल्यांकन करने के लिए 16 जनवरी 1997 को किए गए सर्वेक्षण की तरह ही उन्हीं स्थानों पर 11 मई 1997 को सुबह एक और मोबाईल तापमान सर्वेक्षण किया गया। बाद में किए गए सर्वेक्षण से पहले के सर्वेक्षण के अनुरूप ही क्षैतिज तापमान वितरण का पता चला है जबकि इसकी तुलना में शीत ऋतु के दौरान यह इस सर्वेक्षण में पाई गई ऊष्मा क्षेत्र की तीव्रता 11.8° से. मात्र 5.5° से. थी।

ABSTRACT. A mobile temperature survey of Brihan Mumbai (Greater Bombay) was undertaken on 16 January 1997 which incidentally turned out to be the coldest winter night. Heat islands were found well inside the city, away from the coastal boundary, within a distinct tongue of warm air splitting in three branches roughly along the three sub-urban railway tracks. The finding of the study were in sharp contrast with similar studies conducted during the early seventies by Daniel and Krishnamurthy (1973) and later by Mukherjee and Daniel (1976). They found a remarkable influence of sea on the horizontal temperature distribution in comparison to other factors of urbanisation and noticed the heat island over Malabar Hill, Girgaum and Cuffe Parade area. The survey conducted after a span of twenty-two years, showed that the temperature distribution in the city and suburbs has been modified significantly and that the effect of urbanisation has overtaken the effect of maritime influence in the formation and maintenance of heat islands. Another mobile temperature survey was conducted during the early hours of 11 May 1997 on the same lines as survey conducted on 16 January 1997, to confirm the findings of earlier survey and to assess seasonal changes in the intensities of heat island. This later survey showed similar pattern of horizontal temperature distribution, though the intensity of heat island observed was only 5.5° C as compared to 11.8° C observed during winter.

Key words – Heat island intensity, Mobile survey, Mapping of temperature

1. Introduction

The spatial variation of temperature generally shows that cities are warmer than the nearby surrounding areas particularly during nights with clear skies and light winds. This is because of population concentration, industrial activities and dense built up areas. The higher temperature regions in the interior of a city have been known as 'heat islands'. The well formed heat island triggers a local wind circulation system in which surface winds converge towards the centre of heat island. This in turn results in concentration of pollutants inside and over city areas. Because of its profound effects on the city environment, the study of heat island, assumes

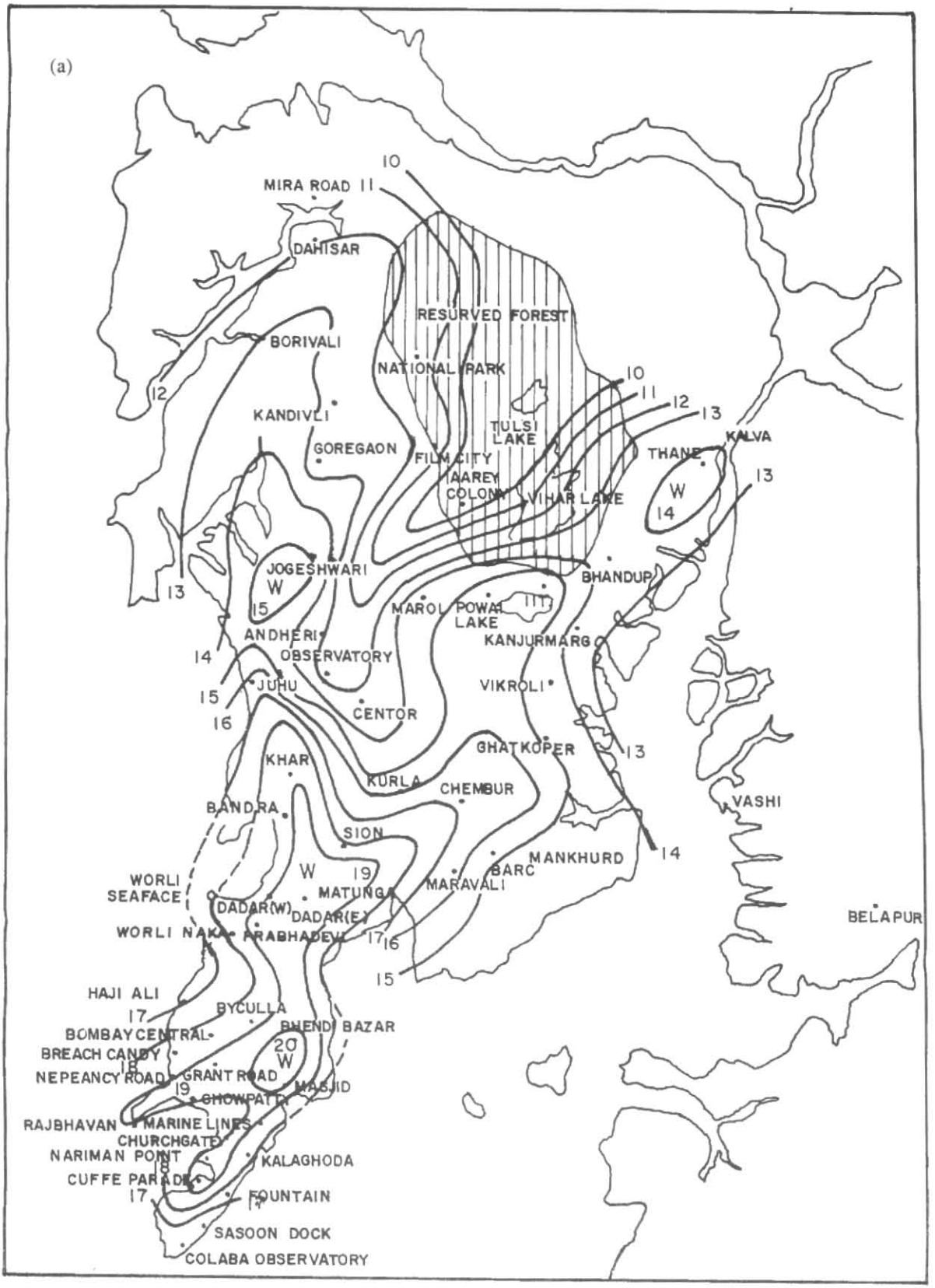

Fig. 1(a). Surface temperature distribution over greater Mumbai isotherm (°C) on 16 January 1997 at 0600 IST

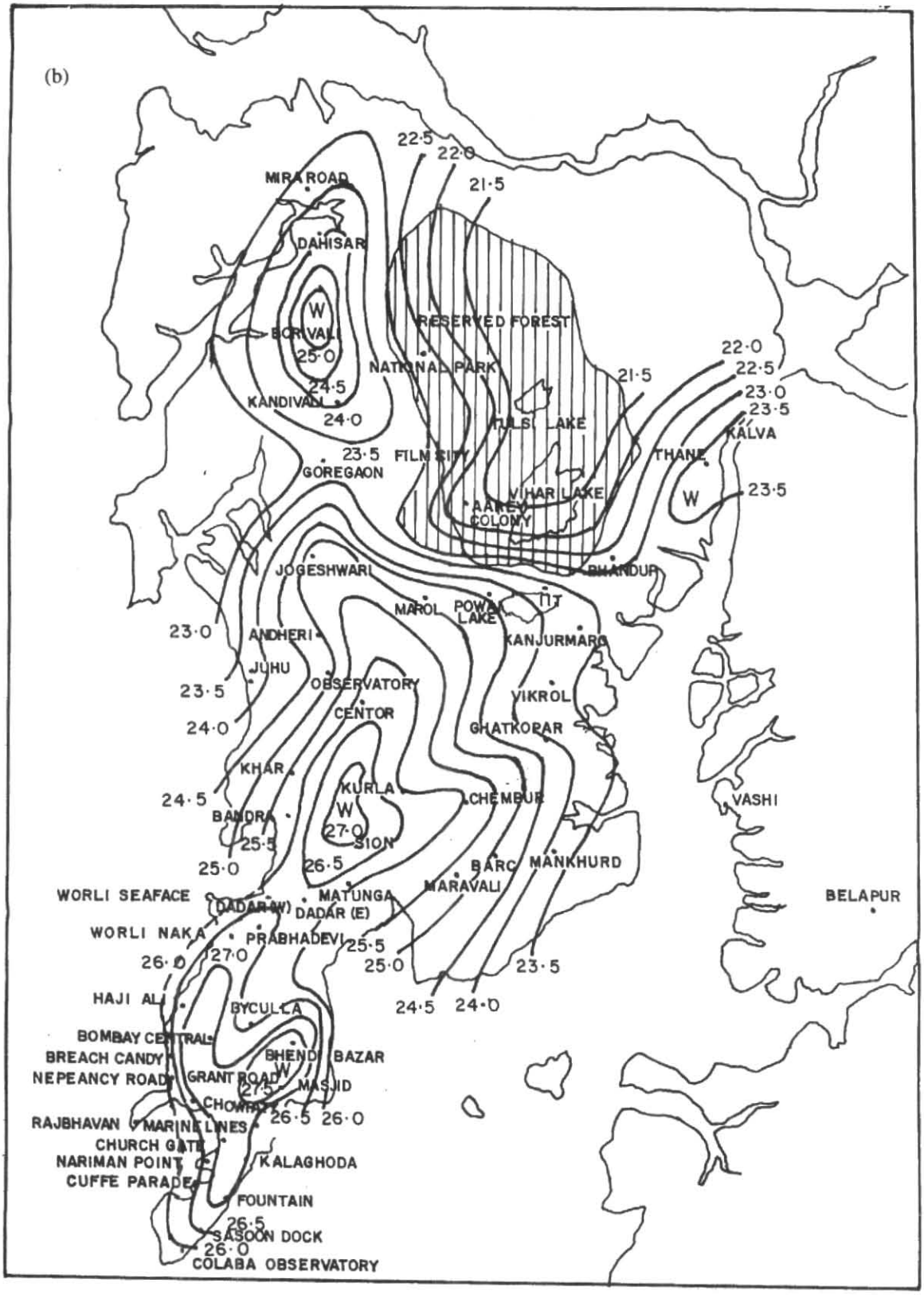

Fig. 1(b). Surface temperature distribution over greater Mumbai isotherm (°C) on 11 May 1997 at 0600 IST

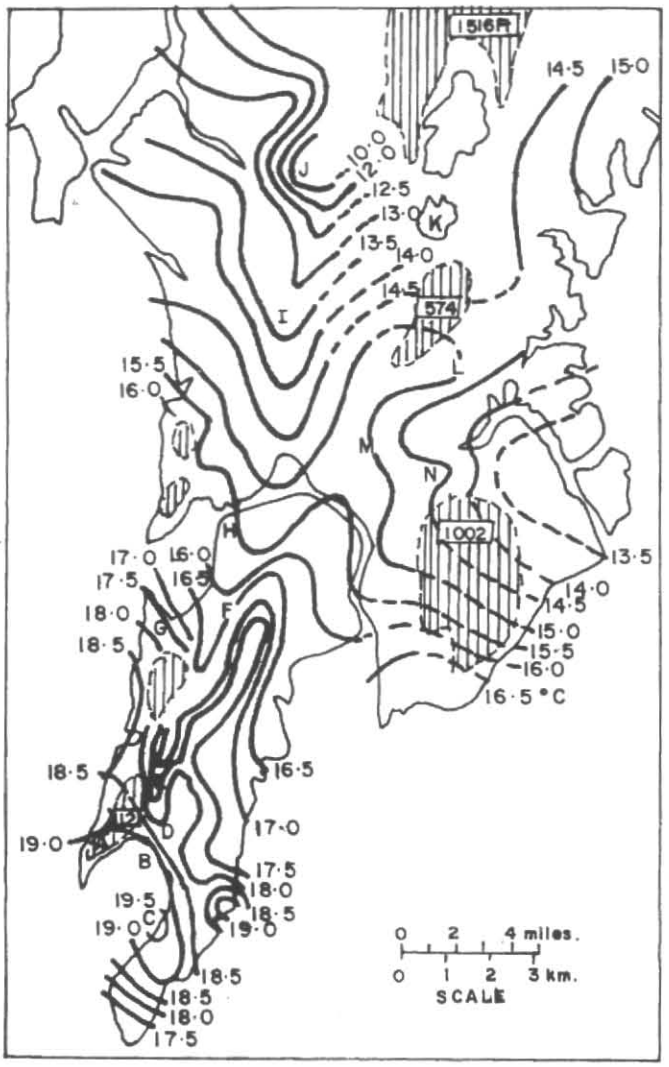

Fig. 2. Surface temperature distribution over greater Mumbai isotherm (°C) on 11 January 1975 at 0600 IST

great significance, particularly in respect of thickly populated and highly industrialised metropolis like Mumbai.

Mumbai (Lat. 18° 56′ N Long 72° 52′ E) situated on west coast of India has been a major centre of industrial and economic activities. Mapping of urban temperature field over Mumbai was undertaken by Daniel and Krishnamurthy (1973) and Mukherjee and Daniel (1976). The latter study which was based on mobile temperature observations during a cold January night, showed warm pockets over Malabar Hills, Girgaum and Cuffe Parade with the highest temperature contrast between urban and rural suburbs, of about 11° C. The city of Mumbai has witnessed rapid urbanisation, increased industrial activity and massive growth in population during the last twenty-two years. As a result, city has grown into a Mahanagar of 430 sq. km. It is now an urban octopus whose tentacles encompass towns outside the municipal limits, like Thane, Kalyan etc. Though the southern business district still remains the vital core of the metropolis, the industrial activity has increased enormously in the suburbs and the extended suburbs. The present study is an attempt to assess the impact of these changes on the heat island intensities over the city of Mumbai.

2. Observation

The mapping of temperature over the city was done through mobile surveys on the morning of 16 January

1997, on the same lines as adopted by Mukherjee and Daniel (1976). The period of observation was chosen between 0230 and 0600 IST when the temperature trend curve is generally flat. This turned out to be the coldest morning of the month this year with Santacruz observatory recording a minimum of 11.9° C. Two teams started in vehicles simultaneously from Colaba and Santacruz at about 0230 IST, after intercomparing their whirling psychrometers with the screen thermometers. To obtain the trend of temperature, data from thermographs at Colaba and Santacruz observatories and temperature readings of automatic weather station located at the office of Thane Belapur Industrial Association, Thane, were used. These trends were used to reduce the observed temperature values to a single time of 0600 IST.

To assess the persistence and seasonal changes in the intensities, of heat island from winter to summer, the experiment was repeated on the early morning hours of 11 May 1997 (a hot summer day), with identical route and logistic arrangements as in the winter experiment. The two teams encountered calm wind conditions over the entire survey routes and the sky was cloud free during both the experiments. These conditions provided ideal conditions for the establishment of heat island.

3. Discussion

The result of the winter and summer surveys are shown in Figs. 1 (a & b) respectively. The result of the survey conducted about 20 years ago, by Mukherjee and Daniel (1976), is shown in Fig. 2, for comparison purposes. It can be seen that the growth in population and industrial activity during the preceding twenty or so years have significantly modified temperature distribution in the city and suburbs. While the warm tongue extending from south Mumbai to Sion Kurla can still be seen as in the earlier study, the picture further north has completely changed. The tongue of warm air now is seen to split in three branches from there on. These branches extend towards Chembur/Mankhurd, Thane and Jogeshwari/ Borivali areas, roughly along suburban railway tracks.

The winter survey [Fig. 1 (a)], revealed that warm pockets of air, are located over Bhindi Bazaar, Jogeshwari and Thane areas. The warm pocket of air over Jogeshwari area found during this survey, is in sharp contrast with the colder air located over there during the earlier survey (1976). The summer survey [Fig. 1 (b)] shows warm pockets of air located over Bhindi Bazaar, Sion-Kurla, Chembur, Thane and Borivli areas though over all pattern of temperature distribution resembles with the winter survey. It is also seen that the heat islands are located well inside the city, away from the coastal boundary. In the survey by Mukherjee and Daniel (1976), the heat islands were noticed over the coastal parts of south Mumbai and were attributed, partly, to the maritime influence on the temperature distribution. The present surveys show that the heat islands noticed now are the result of urbanisation and that maritime influence has no significant role to play in their development or maintenance. The shaded area in Figs. 1 (a & b) is hilly region. The current surveys have shown sharp temperature contrasts to the west, south and southeast of this hilly region. The highest contrast of about 11.8° C, was observed during winter survey while a contrast of 5.5° C was observed during summer survey. In both the surveys the region of highest temperature contrast is located to the west of this hilly region. The higher temperature contrasts could well have been caused by katabatic flow from the hills.

The difference between urban and rural temperatures observed during winter survey was of the order of 11.8° C, which almost tallies with the survey (11° C) by Mukherjee and Daniel (1976), while summer experiment showed a difference of 5.5° C. The mean heat island intensity over Mumbai can thus be taken to be of the order about 8.5° C with a maximum intensity of about 12° C in winter and a minimum of about 5.5° C in summer.

4. Conclusions

The survey has shown that the rapid urbanisation and the population growth in the city of Mumbai during the preceding twenty years has significantly altered the surface temperature distribution over the city as compared to the distribution observed during earlier survey. Heat islands noticed in the current surveys are located in the interior of the city and are spread over central and northern parts of the city in addition to the southern parts of the city. The mean heat island intensity over Mumbai is of the order about 8.5° C with a maximum intensity of about 12° C in winter and a minimum of about 5.5° C in summer.

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