VISIBILITY TRENDS IN MEXICO CITY

With 9 figures and 1 table

ERNESTO JAUREGUI

Introduction

Visibility deterioration is one of the first effects of air pollution noticeable to the inhabitants in large cities. The gradual but uninterrupted decrease in the transparency of the air in urban areas originates from an increase in airborne contaminants as a consequence of increased activity related with urban growth.

Since the 1940's the cities in Latin America with a population more than 100,000 have grown by more than 5% annually (TERNENT 1975). Mexico City has been no exception to this general trend. During the last 30 years the population of the capital has increased six times and at present there are an estimated 14 million inhabitants. Its urban area has expanded at an accelerated rate accordingly, covering at present more than 800 km². A large proportion of the industry of the country is concentrated in the capital and its metropolitan area, where more than 2 million motor vehicles contribute to pollute the urban air.

The mountains surrounding the basin are instrumental in reducing ventilation and therefore, the frequency of light winds or calm conditions is relatively high. As a consequence, dilution and transport of air pollutants usually takes place at a slow rate during the first part of the daylight hours, especially during winter mornings, when surface temperature inversions are more frequent (JAUREGUI 1973).

In the present study visibility data for the Tacubaya Observatory (located west of the downtown) are analyzed in order to determine changes in the transparency of air during the last four decades.

The data

The data consist of estimates of visibility routinely made (using a code) from the Observatory in the NE direction, that is toward the centre of town at 10 a. m. Average monthly values of visibility were computed for the available period of 1937–1980. The 10 a. m. visibility values were selected since at about this hour two contributing factors for the increase in turbidity take place:

a) a peak in vehicular emissions occurs,
b) the surface inversion is usually in the process of breaking off thus favouring fumigation conditions.

Fig. 1 shows the diurnal variation of suspended particles (respiratory fraction) for two stations located in the north of the city. The curves show a marked diurnal oscillation with maximum and minimum values occurring at 10 and 14 hours respectively. The large amplitude observed throughout the year indicates that: (a) turbulent mixing in the vertical is very effective in drastically reducing the concentration level of suspended particles once the surface inversion has been dissolved; and (b) the wash-out effect during the rainy season does not appear to be of importance in removing the smaller suspended particles.

The changes in the height of the urban mixing layer are important in determining the dilution rates and therefore the changes in visibility. In this respect, the height of the mixing layer in Mexico City increases very rapidly from inversion break-off time until it reaches its maximum value shortly after noon time. Fig. 2 shows the seasonal variation of the maximum mixing depth (MMD) using the 6 a. m. radiosonde observation at the airport and the maximum temperature at the Tacubaya Observatory. Higher mixing depths (around 3 km) and therefore better dilution conditions occur in the afternoon during the warm season (March-May). With the arrival of humid and less stable air during the rainy season, MMD's are sufficiently deep to thoroughly dilute pollutants. At the same time the wash-out effect contributes to a reduction of the large suspended particles in this period, but not necessarily to visibility improvement.

Visibility, as is generally accepted, though influenced by large particles, is most affected by the more numerous small particles with a diameter close to the predominant wavelength (0.5 μm) (WAGGONER a. CHARLSON 1975).

Visibility restriction by fog is much less likely to occur at the selected hour (10 a. m.) in the urban area, since relative humidity is usually between 60 and 70% in the western part of the city, where humidity data are available (fig. 3).

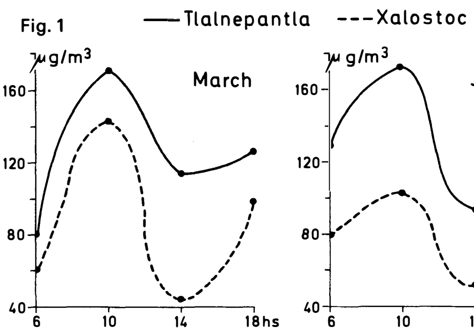
Radiation fog is more often observed in winter mornings in the suburbs (especially near the airport) rather than in the downtown area where higher temperatures prevail due to the nocturnal heat island (JAUREGUI 1973).

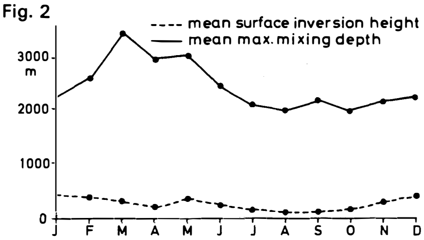
The larger surface-inversion depths observed in the dry season (fig. 2) imply a longer morning period till break-off time and, consequently, higher frequency of low visibilities during this period. This may be clearly seen in fig. 4 where the diurnal variation of visibility is shown for Tacubaya Observatory for two representative years: 1937, that is before the phenomenal growth of the city and 1966. In the 1960's the minimum visibilities occured at about 10 a. m., whereas at the beginning of the period minimum values were observed earlier in the morning, or closer to minimum temperature time. A shift for the occurrence of maximum visibilities with time is also noticeable; the peak in visibility being observed in the 1960's at the end of the daylight hours.

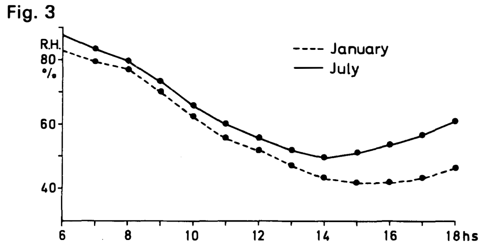
Results

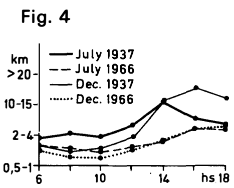
On the average, a general decrease in visibility is observed. During the 1940's average visibilities (at 10 a. m.) were from 4 to 10 km; they decreased steadily to 1 to 2 km up to the first half of the 1970's (fig. 5). However, the 5-year average variation of visibility for the second half of the seventies shows a marked decrease, almost for every month (only January and July are shown). No attempt was made to smooth the data in order to numerically quantify the trend. Instead, five-year averages for every month were computed for the period 1940–1979 (fig. 6).

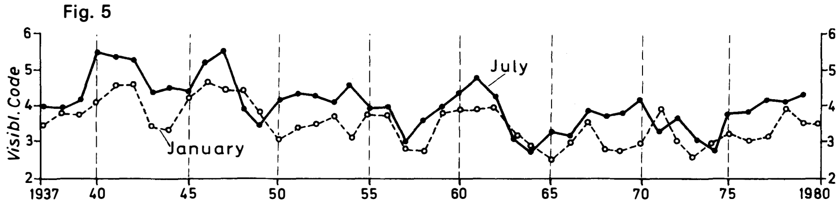
Visibility Code		
1 <0,5 km	3 1,0-2,0 km	6 10,0-15,0 km
2 0,5-1,0 km	4 2,0-4,0 km	7 15,0-20,0 km
	5 4,0-10,0 km	8 >20,0 km

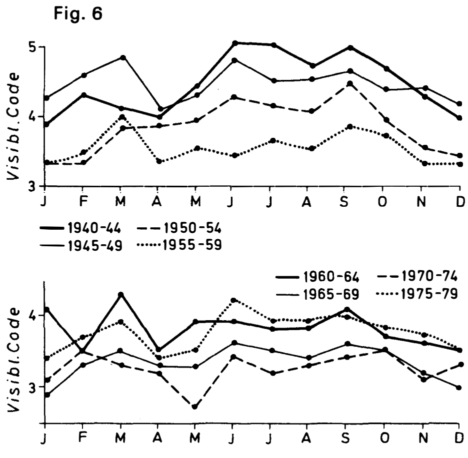












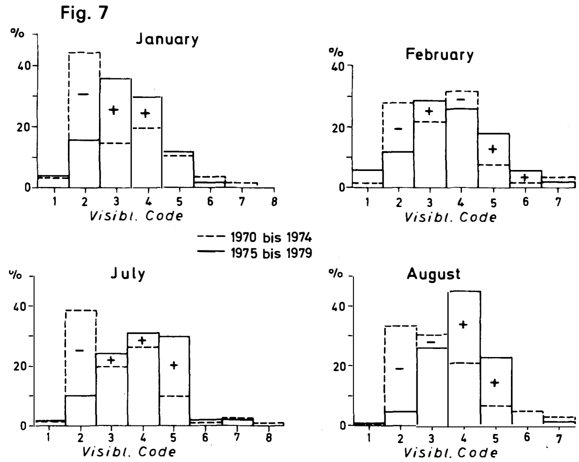


Fig. 1: Diurnal variation (average of hourly values) of suspended particles (respiratory fraction) at urban stations NW (Tlalnepantla) and NE (Xalostoc) of downtown Mexico City for March and July, 1976

Fig. 2: Mean maximum mixing depth and mean surface invasion height in Mexico City, 1976 (after Jauregui 1979)

Fig. 3: Diurnal variation of relative humidity in Mexico City (Tacubaya), 1979

Fig. 4: Diurnal variation of visibility in Mexico City (after Jauregui 1973 b)

Fig. 5: Fluctuations of average visibility (at 10 a.m.) in Mexico City, 1937–1980

Fig. 6: Five year average variation of visibility, 1940–1979

Fig. 7: Frequency distributions of visibility categories in Mexico City (at 10 a.m.), 1970–1979

A general decrease in the visibility values is observed for the period 1940–69 when comparing the second with the first five-year average value of each decade, especially during the rainy season. This decrease seems to have been more persistent throughout the year during the 1960's, when winter values exhibit a marked decrease as well.

Table 1: Five-year average values of visibility (10 a.m.) in Tacubaya Observatory 1960–1969

	J	F	M	A	M	J	J	A	S	O	N	D	Year
1960–64	4.1	3.5	4.3	3.5	3.9	3.9	3.8	3.8	4.1	3.7	3.5	3.5	3.8
1965–69	2.9	3.3	3.5	3.3	3.3	3.6	3.5	3.5	3.6	3.5	3.2	3.0	3.3
Change (%)	-29	-6	-19	-6	-15	-8	-8	-11	-12	-5	-11	-14	-13

Averaged over the year, the decrease amounts to 13% during the 1960's (table 1).

During the 1970's the trend changes; that ist, five-year average values for the second half of the decade show a substantial increase with respect to the first half of the seventies. The increase ist more marked during the rainy season.

In order to find out what ranges of visibility were responsible for the changes in the trend during the seventies, five year frequency visibility values were calculated. Results are shown in fig. 7. It can be seen that frequency distributions show a marked reduction (20% or more) in the frequency of so called 'bad visibilities', from 0.5 to 1 km. Also, in some months there is an increase in the frequency of intermediate visibilities, that is in the range from 1 to 4 km (code 3 and 4). Moderate increases in 'good visibilities' (code 5; 4 to 10 km) are also observed for some months (May to October). On the other hand, no appreciable change in the frequency of very good visibilities is observed for the decade. This was to be expected, sonce excellent visibilities were observed for only short periods of time and are associated mainly with a cold-front passage over the valley.

When cumulative frequencies of various visibility classes are computed for the two five-year periods in the seventies, it can be seen that the median value increased during the second half of the seventies with respect to the first five years. This increment was more marked during the rainy season (fig. 8).

When a similar comparison in the frequency of five-year average visibility classes was made for the two previous decades (in the 1950's and 1960's, when no restriction to emission of pollutants existed) a contrasting picture emerged. During the second half of the 1950's the frequency of bad visibilities increased with respect to the first half (classes 1, 2 and 3; from 0.5 to 2 km), while moderate visibilities (4 to 10 km) remained unchanged or showed a moderate decrease. These differences were, in most of the cases, statistically significant (in June, July and August) at the 0.1 level of significance.

Finally, when the frequency of various visibility categories observed during the first third of 1980 are compared with the five-year values of the first half of the seventies, it is apparent that a marked decrease in the frequency of bad visibilities has occurred in 1980 (fig. 9).

Fig. 9

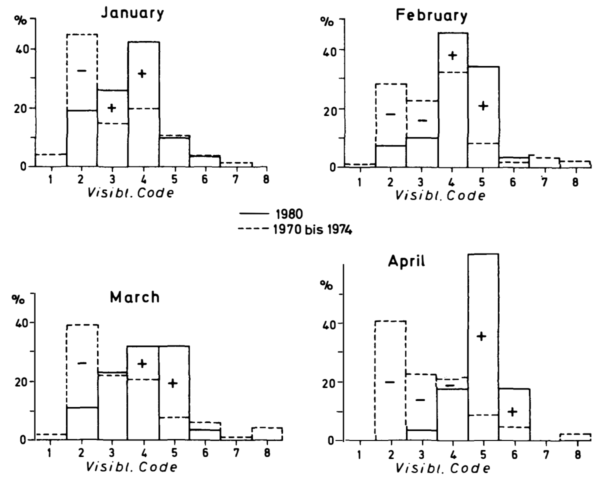


Fig. 9: Frequency distributions of visibility categories in Mexico City, 1970–1974 and first third of 1980

Fig. 8

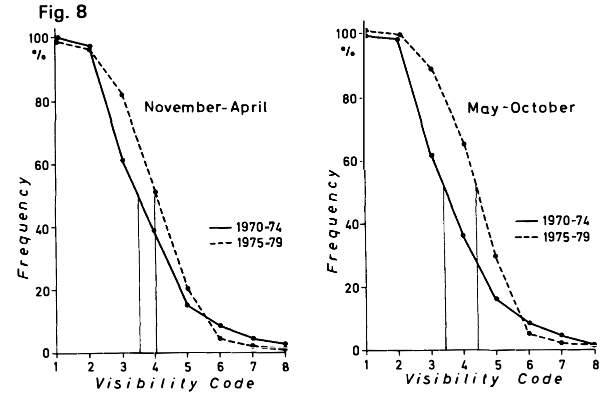


Fig. 8: Cumulative frequency of visibility categories in Mexico City, 1970–1974 and 1975–1979

Concluding remarks

Visibility data analysis for Mexico City from 1940–1980 shows that there has been a trend of decrease for the period 1940–1974. During the 1975–80 period, visibility in the capital city has undergone a gradual improvement consisting in a decrease in the frequency of bad visibilities (0.5–1 km). If it is accepted that visibility data are representative of the airborne mass of fine or respirable particulates, and insofar as this relationship is valid, the airborne mass of respirable particulates has varied downward in West Mexico City during the last years of the period examined. However, the low frequency of excellent visibilities has not appreciably varied during the same period. The observed changes in visibility toward a better air transparency could be related to actions taken by environmental authorities in Mexico to reduce pollutant emissions during the second half of the 1970's.

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WILDBEWIRTSCHAFTUNG IN SÜDWESTAFRIKA/NAMIBIA[1]

Mit 2 Abbildungen und 3 Tabellen

JÜRGEN BÄHR

Summary: Game cropping in South-West Africa/Namibia

In many of the world's arid areas extensive pastoral farming has led to excessive demands upon the natural resources. In the search for ecologically adapted forms of land use discussion has recently turned increasingly to game cropping measures. The case of SWA/Namibia serves to present a number of possibilities for increased utilisation of game. These concern especially the sale of live animals and skins, trophy hunting and the systematic cropping of game for the sale of meat. These two latter categories of utilisation in particular have recently enjoyed a great increase in intensity, so that the gross turn-over of game cropping has increased almost two-fold between 1974 and 1980. Two-thirds of this falls to the share of trophy hunting and the sale of meat (predominantly from state-controlled nocturnal hunts), whereas the sale of live animals and skins has dropped to only 12% (compared to over 60% in 1974). There are at present just about 300 registered game farms in the whole country; the average number of culls in the cropping of game during the period 1979–81 was approximately 50,000 animals (predominantly springboks). It is to be expected that game cropping will increase still further in significance, especially in the more arid parts of the country, since the profitability of the farming economy here is already now in danger.

In vielen Trockengebieten unserer Erde hat die extensive Weidewirtschaft zu einer übermäßigen Beanspruchung der natürlichen Ressourcen und damit zu einer nachhaltigen Veränderung und Schädigung der Vegetationsdecke geführt. Nicht überall ist dieser Prozeß so weit fortgeschritten, daß man schon von „Desertifikation" sprechen kann. Aber auch abnehmende Tragkraft der Weiden, vermehrte Erosionsschäden und Ausbreitung der Verbuschung sind Hinweise auf eine zu starke Belastung der natürlichen Futtergrundlage. Bei der Suche nach ökologisch angepaßten Landnutzungsformen werden neuerdings vermehrt Maßnahmen der Wildbewirtschaftung diskutiert. Eine solche Alternative zur herkömmlichen Viehhaltung bietet sich insbesondere für diejenigen Trockenregionen an, in denen es noch große Wildbestände gibt. Dazu zählen neben Teilen Ost- und Zentralafrikas (ERZ 1967), der Kalahari (KLIMM 1976; v. RICHTER 1979) und einzelnen Regionen in Südafrika (SKINNER 1975) auch große Gebiete Südwestafrikas/Namibias (Abb. 1)[2]. Vor allem die Halbwüsten des Landes (Abb. 2) stellen schon heute Konkurrenzzonen zwischen Wild- und Haustiernutzung dar. Denn unter den hier gegebenen ökologischen Bedingungen kann ein Wildtierbestand aus dervorhandenen Vegetation mehr und besseres Fleisch produzieren als ein Haustierbestand. In Anlehnung an ERZ (1967, S. 32ff.), MANSHARD (1974, S. 121/122), FIELD (1979, S. 67ff.) und ANDREAE (1980, S. 84/85 u. 1983, S. 232ff.) können dafür folgende Gründe angeführt werden:

1. Die auf den Farmen gehaltenen Rinder und Schafe nutzen die vorhandene Weide lediglich selektiv, da sie vorwiegend Gräser fressen. Dagegen ernährt sich die Wildpopulation von weitaus mehr Pflanzenarten und Planzenteilen. Die Bestockung kann daher beim Wild höher als beim Haustier sein.

2. Viele Wildtiere sind in physiologischer Hinsicht besonders gut an die Lebensverhältnisse in ariden Räumen angepaßt, so daß auch während längerer Dürreperioden nur verhältnismäßig geringe Viehverluste auftreten.

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[1] Der Deutschen Forschungsgemeinschaft, die in den Jahren zwischen 1979 und 1982 einen mehrfachen Aufenthalt des Verfassers in Südwestafrika/Namibia unterstützt hat, sei auch an dieser Stelle dafür sehr herzlich gedankt.

[2] Eine Nutzung der Wildtierbestände als zusätzliche Proteinquelle wird zwar auch in feuchteren Regionen Afrikas und insbesondere in den von der Tsetsefliege verseuchten Gebieten erprobt, jedoch stößt hier allein schon das Abschießen der Tiere auf weit größere Schwierigkeiten als im offenen Grasland, und die bisherigen Erfolge sind entsprechend gering (vgl. PULLAN 1981 für Sambia).