Kawagoe und Shiba einem doppelten Spannungsverhältnis ausgesetzt. Als zentripetale Zentralorte und Wanderungszentren sind sie für ein weiteres Hinterland kaum besonders attraktiv. Die Zentralisationsspannungen führen über sie hinaus direkt zum Hauptzentrum. Ihre Entwicklung wird von zentrifugalen Kräften der Ballungskerne gesteuert. Sie wachsen, – jedoch nicht aus eigener Kraft – sondern als Satelliten.

Demgegenüber steht die sich eigenständig verstärkende regionale Vormacht der Präfektur-Hauptorte, die echte Regionalzentren geworden sind. Sobald es ihnen gelang, konkurrierende Nachbarstädte funktional zu überschichten und größenmäßig zu überholen, wuchs und wächst ihr Vorsprung unaufhaltsam weiter. Das ist Aomori gegenüber Hirosaki erst halb, Sapporo gegenüber Asahikawa und Otaru bereits voll gelungen. Mentalität und Wanderungsverhalten der japanischen Bevölkerung unterstützen den Prozeß der Selbstverstärkung, der das Modell des „Großen Tokyo" auf verschiedene „Klein-Tokyos" im ganzen Land überträgt.

D. Ansätze zur Abschätzung künftiger Wanderungstendenzen

Versucht man abschließend ein Urteil zu den eingangs im Zusammenhang mit den Thesen Toshio Kurodas aufgeworfenen Fragen nach der künftigen Entwicklung der Binnenwanderung in Japan, so werden bei aller Vorsicht und Zurückhaltung, die für einen westlichen Beobachter in ostasiatischen Entwicklungsfragen unerläßlich sind, aus der intensiven Beschäftigung mit Wanderungsproblemen doch einige grundsätzliche Vorausschätzungen für die nächsten Jahre möglich sein:

1. Für eine grundsätzliche Umkehrung der Tendenz der Binnenwanderung bestehen bisher keine Anzeichen. Die Entleerung der ländlichen Gebiete wird weiter anhalten; eine zahlenmäßige Abschwächung der Landflucht ist jedoch aus Kapazitätsgründen sicher.
2. Hauptanziehungsgebiet werden die großstadtorientierten pazifischen Ballungsräume bleiben. Dabei wird sich eine weitere zunehmend großräumige Ausweitung der Ballungszonen in Verbindung mit dem Bau neuer Strecken des Schienenschnellverkehrs und neuer Autobahnen abzeichnen.
3. Eine weitere Verstärkung der zwischenstädtischen Wanderungen wird sich auch auf den Austausch zwischen den Ballungsgebieten auswirken. Eine Stufenwanderung wird sich nur da vollziehen, wo klare zentralörtliche Hierarchien vorliegen.
4. Das Prinzip der Wanderungs-Zentralität außerhalb der Ballungsgebiete wird in erster Linie den größeren Regionalzentren mit mehr als 300 000 Einwohnern zugute kommen. Kleinere Landeszentren werden mit der Ausdünnung ihres ländlichen Umlandes weiter abnehmen. Die dominierenden Präfektur-Hauptstädte werden am stärksten weiterwachsen.

Es wird abzuwarten sein, in welchem Maße die großangelegten Pläne des neuen japanischen Ministerpräsidenten Tanaka zu einem grundsätzlichen „Umbau der japanischen Inseln" in konkrete Raumordnungsmaßnahmen umgesetzt und verwirklicht werden. Die übermäßige Verdichtung von Industrie, Bevölkerung und Verkehr in den Ballungsgebieten sowie die weithin bereits unzumutbaren Umweltbelastungen und Schädigungen lassen eine Wende der staatlichen Raumpolitik als längst überfällig erscheinen. Doch ist Skepsis geboten. Schon heute wehrt sich die Bevölkerung in den ländlichen Randzonen gegen ein weiteres Ausufern und Verlagern der Industriezonen. Auf jeden Fall wird eine großräumige Strukturpolitik der Regierung die hier aufgezeigten Trends der Wanderungszentralität bei ihren Planungen mit berücksichtigen müssen, um zu realitätsgerechten Lösungen zu gelangen.

THE URBAN CLIMATE OF MEXICO CITY

With 15 figures and 13 tables

ERNESTO JAUREGUI

Zusammenfassung: Eine Darstellung der Klimaelemente für das Stadtgebiet von Mexiko-Stadt führt zu dem Ergebnis, daß vorwiegend antizyklonale Wetterlagen, mangelnde Ventilation und die Ausbildung einer innerstädtischen Wärmeinsel die Auswirkungen der Luftverunreinigung in Mexiko-Stadt erheblich vergrößern. Eine negative Beziehung konnte außerdem zwischen der Intensität des Wärmeinseleffektes und der Windgeschwindigkeit der „Großraumwinde" nachgewiesen werden. Das Ausmaß der Luftverunreinigung zeigt tages- und jahreszeitliche Schwankungen, die einerseits auf die in den Nachtstunden besonders intensiv ausgebildete Wärmeinsel und andererseits auf den jahreszeitlichen Wechsel von Regen- und Trockenzeit zurückzuführen sind. In diesem Zusammenhang spielt die Dispersion der natürlichen Aerosole in den Monaten am Ende der Trockenzeit, in denen die feinkörnigen vulkanischen Aschen im Hochbecken von Mexiko vegetationslos dem Windangriff ausgesetzt sind, eine große Rolle. Es kann gezeigt werden, daß Staubstürme im Stadtbereich von Mexiko-Stadt im Monat April in maximaler Häufigkeit auftreten und sowohl durch lokale Konvektion als auch durch Vorticityadvektion im 200 mb-Niveau ausgelöst werden.

Für die Monate der Regenzeit kann nachgewiesen werden, das die räumliche Verteilung der Niederschläge in Mexiko-Stadt erheblich durch den Einfluß der innerstädtischen Wärmeinsel bestimmt wird. In großer Häufigkeit werden in den zentralen Teilen der Stadt die höchsten täglichen Niederschlagssummen registriert.

Mexico City was founded on a small island on Lake Texcoco in 1344. At the time of the conquest the city was destroyed and later reconstructed by the Spaniards in 1522. Since the valley of Mexico is an interior basin, flooding of the urban area was frequent and in order to control the drainage of excess waters of Lake Texcoco an outlet towards the Gulf of Mexico was constructed in 1789. As the city grew, the water areas became smaller due to sedimentation and reclamation. Today, about 4/5 of the large (about 450 km²) urban area stand on the ancient lake sediment plains; the rest lies on hilly terrain to the West and South.

Being surrounded by mountains that stand some 800 m or more high above the bottom of the elevated (2250 m above sea level) valley, the city is poorly ventilated by winds; this and other circumstances favour the sharpening of some of the elements of the urban climate of the capital.

1. Urban Characteristics. A rough indication of the nature and density of urban development in Mexico City is given in fig. 1. Greater building density is located along two main thouroughfares: Paseo de la Reforma – Avenida Juarez and Avenida Insurgentes which make a cross point some 4 km West of the old downtown district where the streets are narrower. The rest of the urban area is characterized by rather wide streets particularly to the South and West where housing densities are low and open spaces more frequent.

2. Climatological Records. Air temperature and rainfall measures have been taken in Mexico City since about the beginning of the nineteen twenties; but regular observations began from 1940 on. There are about 30 climatological stations within or near the capital, sending every month daily records to the Meteorological Service in Tacubaya Observatory (fig. 1). Other weather elements like fog, cloudiness, thunderstorms and prevailing wind are also observed. Although not ideally distributed over the urban area, the stations are sufficient for studying the variations of climatic elements in the city and the surrounding country.

3. Weather Types. Anticyclonic weather types prevail during the dry season (October to April) in Mexico City; they are associated with dry conditions and light winds. The major fluctuations of temperature in winter in Mexico are produced by the cold polar outbreaks. The frontal passage is sometimes a rather sharp temperature discontinuity due to cold air advection. In a study of the winter climate of Mexico covering a five year period record, Hill (1969) points out that in 75% of cold spells the period for Mexico City lasted for only 12 hours and during this time 96% of all temperature drop associated with the front occurred. The average temperature drop recorded by the passage of each front is 3 °C, according to this author.

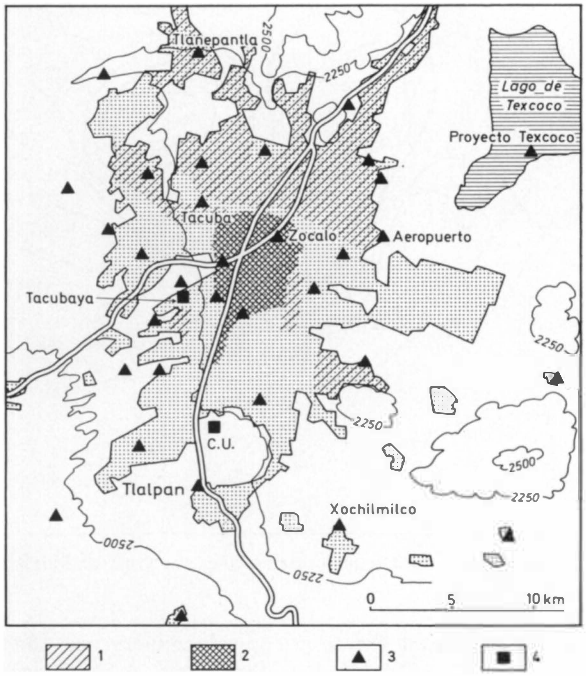

Fig. 1: Built-up areas and station location
1 industrial areas; 2 high density of buildings; 3 climatic station; 4 observatory

A study of the frequency of surface weather types in Mexico made by the author (Jauregui, 1971) for the period 1919–38, revealed that cold fronts passing over Veracruz on the southern Gulf of Mexico coast, are most frequent from October until March, as can be seen in table I. However, not all these cold fronts affect Mexico City, cold air masses being frequently shallow, only 80% of winter fronts sweeping over the Gulf of Mexico reach the elevated valley of Mexico (Hill, 1969).

Table I: Average frequency of surface cold fronts crossing over the Southern Gulf of Mexico (Period: 1919–38) (Jauregui, 1971b)

J	F	M	A	M	J	J	A	S	O	N	D	YEAR
6.2	5.5	5.6	3.8	2.5	0.5	0.1	0.0	0.9	6.3	7.4	6.8	45.6

Dominguez (1940) describes this cold weather type as producing a uniform, often thick cloud cover, which on occasions lasts for many days (see also Klaus, 1971). At other times polar continental air masses penetrating far into the plateau area bring cold but clear weather with very little associated cloud. Fig. 2 illustrates a characteristic cold frontal situation.

During the wet season cloudiness and precipitation are associated with the Easterly Trade current; much of the rain falls during thunderstorms connected with wave distrubances or with the existence of a hurricane or other tropical depression in the vecinity of either (or both) the Pacific or Gulf coasts; in the middle of

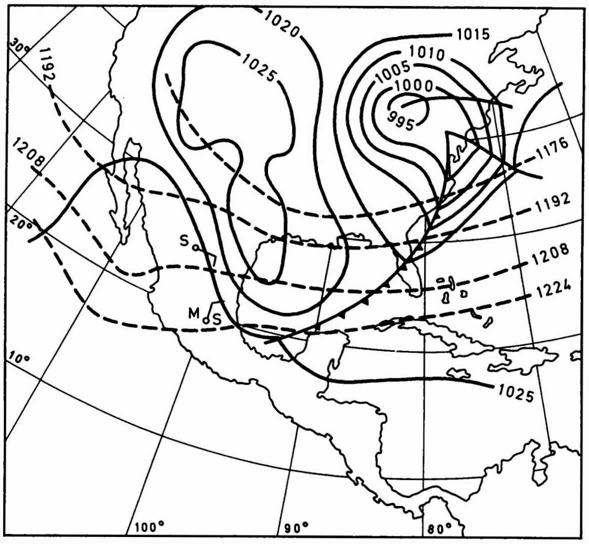

Fig. 2: Typical cold front crossing over the Gulf of Mexico

the rainy season the intertropical convergence zone (ITZ) may be displaced as far North as Acapulco, producing squally weather in Mexico City.

At other times rain is the result of strong convection and relief. A secondary minimum of rainfall is observed in July or August due to a temporary return of anticyclonic conditions when the semi-permanent Bermuda – Azores High is split in two cells by an elongated trough located along the United States Atlantic coast (see Mosino, and García, 1968).

4. Precipitation. Table II shows the average distribution of precipitation for Tacubaya Observatory located on hilly terrain to the West of downtown.

Table II: Mean Monthly precipitation in Mexico City (1921–45) (in mm)

J	F	M	A	M	J	J	A	S	O	N	D	YEAR
13	5	10	20	53	120	170	152	130	51	18	8	750

But precipitation amounts vary within the urban area. Orographic effect is evident in the cloud and precipitation isoline configuration as can be seen in figures 3 and 4. Cloudy skies and rain are more frequent over the hills to the South and West; on the central plains near Lake Texcoco however, precipitation is scarce to the point that the climate may be classed as semi-arid (BS in Köppen's classification).

5. Temperature. Mexico City exhibits many of the features of tropical mountain climates having a small annual temperature range as can be seen in Table III. However, a high diurnal temperature range is observed, particularly during the warm period (March–May); once the rains start, the temperatures go slightly down, (see table IV) and a decrease in the diurnal variation results as minimum temperatures rise in part due to higher moisture in the air.

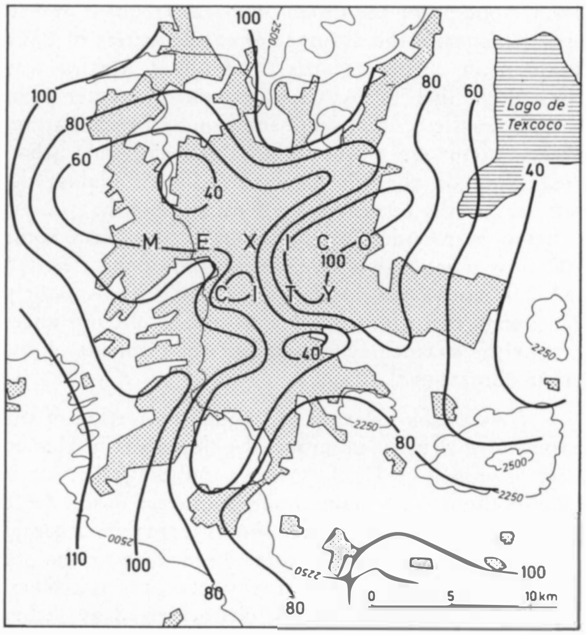

Fig. 3: Average annual number of cloudy days

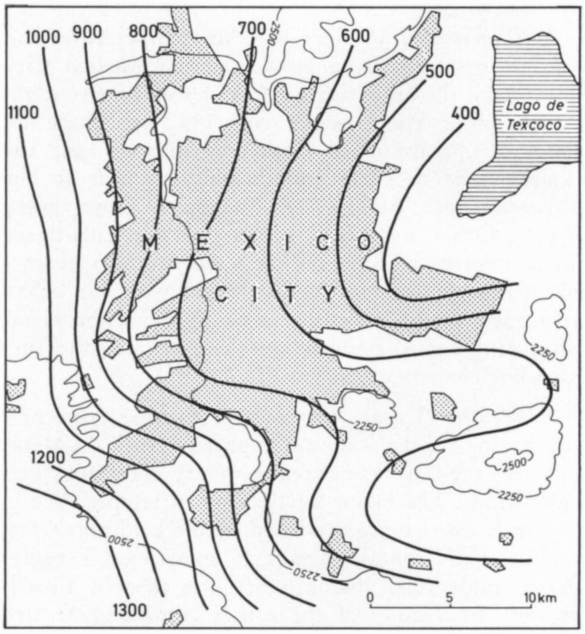

Fig. 4: Mean annual precipitation (mm)

Table III: Mean monthly temperature (DEG C) for Mexico City (Tacubaya) 1951–60

J	F	M	A	M	J	J	A	S	O	N	D	YEAR
13	14	17	18	18	17	16	16	16	15	14	13	15

Table IV: Mean monthly maximum and minimum Temperatures for Mexico City (Tacubaya) 1945–65

J	F	M	A	M	J	J	A	S	O	N	D
24.4	26.9	30.1	30.4	30.3	28.5	26.0	25.9	25.6	25.4	25.0	23.9
0.1	1.5	3.5	5.1	7.0	8.4	8.1	8.2	7.0	4.0	1.9	0.8

The central areas of Mexico City are warmer than the surrounding districts (similar results have also been observed by LAUER (1970) and GÄB (1970) for the nearby city of Puebla); average annual temperatures are greater by 2° than those of the suburbs as can be seen in figure 5. In table V a comparison of minimum average temperatures is made between a central and a rural station. The city influence is stronger on radiation-type weather during the dry period and weaker during the wet season (May–September).

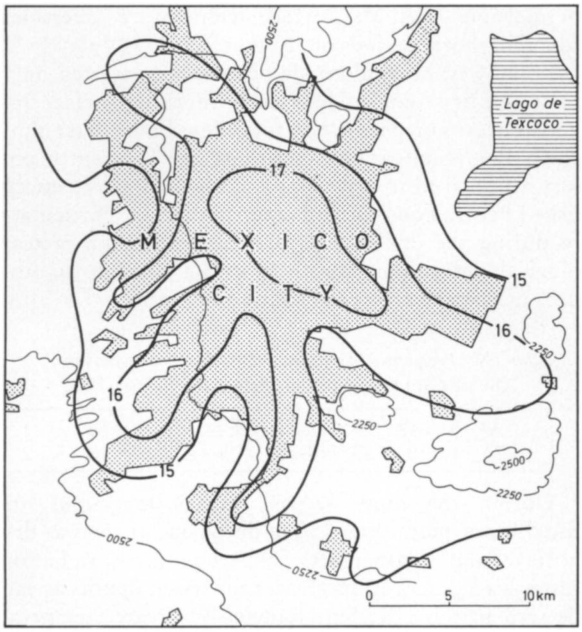

Fig. 5: Mean annual temperature (Deg. C)

Table V: Average differences in minimum Temperatures between an urban (C. F. E.) and a rural (Los Reyes) Station in Mexico City (DEG. C)

J	F	M	A	M	J	J	A	S	O	N	D
7.6	7.6	7.7	6.5	6.5	4.9	3.5	3.4	5.1	7.3	6.9	9.9

Intense heat islands in Mexico City develop during the dry season as a result of strong temperature inversions; under these conditions cooling at night-time is less inside of the built-up area than in the surrounding districts due to the absorbtion and re-radiation of energy from the urban surfaces by the elevated layers of polluted air. As a result of the heat island above Mexico City's urban area there is a marked reduction in frost occurrence as one nears the center of town; the average number of night frosts is reduced from 70 per year in the rural areas, to 40 in the suburbs, with no frosts occurring in the center of town.

6. Atmospheric Pollution. In the 1920's Mexico City's residents could see very often the snow-capped volcanoes that surround the valley to the East, shimmering majestically 50 km away. This degree of visibility used to be common, but not any more; as the capital and its neighbours grew, the industry grew with them and the air became more and more polluted. Uncontrolled emissions from factories and the ever increasing number of vehicles, all contributed to the loss of transparency.

Visibility has been reduced on the average from 10–15 km in the 1930's to 2–4 km and poor visibilities are now much more frequent (30% or more) than 30 years ago as shown elsewhere (JAUREGUI, 1958, 1969) (see figs. 6 und 7).

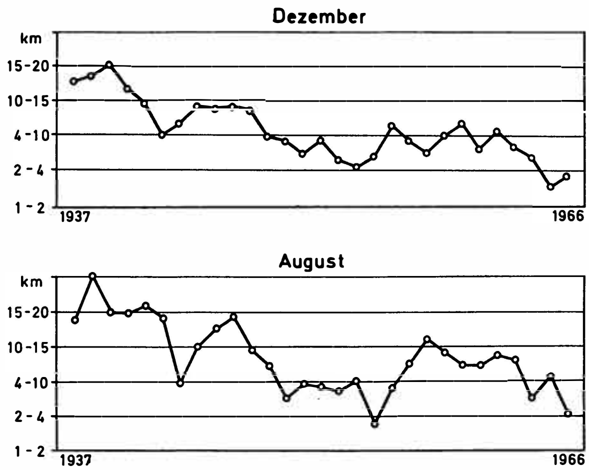

Fig. 6: Mean visibility variation in Tacubaya Observatory at 2 p.m. for the period 1937–66

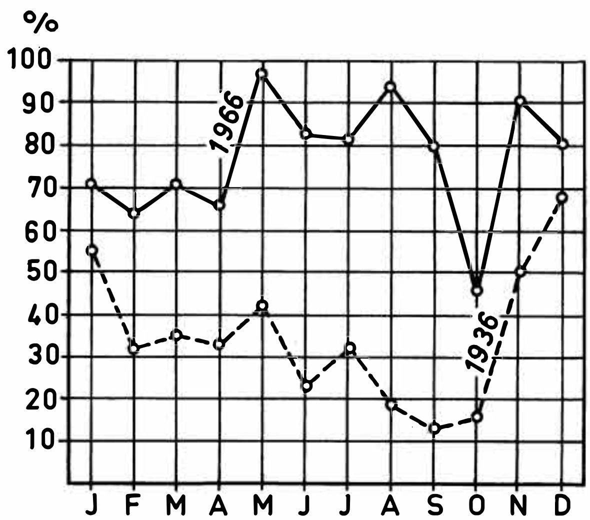

Fig. 7: Frequency of visibilities less than 2 km at 10:30 A.M. from Tacubaya Observatory for 1936 and 1966 (JAUREGUI, 1969)

The characteristics of air pollution in Mexico City are marked by the nature of the dominant effluents (high sulphur petroleum products) and the peculiar climatology of the valley (high persistence of anticyclonic weather with clear calm days and surface temperature inversions).

T u r b i d i t y   m e a s u r e m e n t s. Measurements of the instantaneous direct solar radiation carried out in Mexico City by GALINDO (1962) for the period 1957–58 show a decrease of 10% with respect to the early measurements by GORZYNZKI in 1911–28, as can be seen in table VI; also, when GALINDO's values of the Linke-turbidity factor are compared with those for London in the 1960's, it can be readily appreciated that Mexico City's air was at the time more polluted than that in London (table VII).

Table VI: Direct solar radiation instantaneous maximum values for Mexico City (urban Station in Tacubaya) for the Period 1911–28 and University City (suburban Station) for 1958 (GALINDO, 1962)

	J	F	M	A	M	J	J	A	S	O	N	D
Tacubaya	1.63	1.66	1.54	1.56	1.52	1.54	1.48	1.53	1.57	1.60	1.57	1.63
Univ. City	1.49	1.49	1.46	1.34	1.24	1.31	1.32	1.38	1.41	1.37	1.30	1.31

Table VII: Linke turbidity Factor for London (KEW) and Mexico City (University City)

	winter	spring	summer	fall	year
London	4.1	4.9	5.1	4.5	4.6
Mexico	4.4	6.0	6.5	5.5	5.7

However, since the Clean Air Act of 1956 was enforced, London has gained about 40% more sunshine by reducing drastically coal smoke, whereas no measures have yet been taken in Mexico City to check the constantly rising level of air pollution.

Moreover, irradiation of exhaust gases in clear days leads to photochemical smog and eye irritation is frequently experienced by Mexico City residents. Although the identity of the exact compounds produced in the photochemical smog, which are responsible for eye irritation, has not been quite established, studies of typical irradiation smog, like the one observed in Los Angeles, indicate that the initial reactants are hydrocarbons (oleofins, nitric oxide and oxigen). These hydrocarbons originate almost in total from auto exhaust (HAMMING and MACPHEE, 1967). Since sunny days are very frequent in Mexico City during the long dry season (see table VIII), it is reasonable to expect that similar chemical reactions in the capital's atmosphere lead to the production of eye irritation compounds.

Table VIII: Average number of bright sunshine (hours per month) in Mexico City (Tacubaya) and London (KEW)

	J	F	M	A	M	J	J	A	S	O	N	D	Year
Mexico	259	227	271	238	235	178	186	189	144	192	203	233	2555
London	49	63	110	168	198	219	193	190	137	96	55	40	1460

S u r f a c e   t e m p e r a t u r e   i n v e r s i o n s. It is well known that atmospheric pollution is associated with stable lapse rates or temperature inversions near the ground. In an urban area like Mexico City located in a sheltered valley and during nights with high net outgoing radiation, there may be a simultaneous development of both a temperature inversion and a light local wind flowing down the hills to the North, West and South. In table IX is shown the frequency of morning (6 A. M.) surface temperature inversions for the short period of August 1971 – July 1972 (regular 6 A. M. radiosonde observations started only since the first date). These early morning surface inversions do not persist but for a few hours after sunrise (when fumigation conditions are frequently observed) until near dry adiabatic lapse rates are established before noon by abundant insolation, particularly during the dry season; only under certain metear ological conditions are they strong enough to appear also in the afternoon sonde observation.

Table IX: Frequency of surface temperature inversions in Mexico City for the period August 1971–May 1972

A	S	O	N	D	J	F	M	A	M	J	J
7	10	9	15	19	21	25	23	27	18	5	2

During the rainy season surface inversions are usually not more than 150 m deep; but as soon as dry anticyclonic weather sets in, strong night radiation losses lead generally to greater inversion depths as can be seen in table X. Simultaneously, greater temperature differences between surface and top of inversion are also more common during the dry season (table XI), which would mean that temperature gradients in the stable layer remain more or less the same throughout the year.

Table X: Frequency of surface inversions in Mexico City According to depth (%)

Top of Inversion (meters)	Au	Se	Oc	No	De	Ja	Fe	Mar	Ap	May	Jun	Jul
30– 50	16	0	0	7	5	0	0	0	0	0	0	0
51–150	50	56	38	13	23	23	36	17	15	19	0	50
151–250	17	33	35	47	23	23	32	35	41	45	60	50
251–400	17	11	37	27	23	36	16	14	30	12	40	0
401–600	0	0	0	6	21	14	8	30	11	18	0	0
600	0	0	0	0	5	4	8	4	3	6	0	0

Table XI: Frequency of isothermal surface layers and temperature inversions in Mexico City according to temperature difference between surface and top of layer (in %)

Intensity (°C)	Au	Sep	Oc	No	Dec	Jan	Feb	Ma	Ap	May	Jun	Jul
0	66	20	25	7	17	13	8	26	8	28	80	50
1	0	50	50	33	33	9	4	19	15	22	20	50
2	33	20	13	13	28	27	16	12	26	39	0	0
3	0	10	0	40	22	20	14	26	29	11	0	0
4	0	10	12	7	11	20	24	13	15	0	0	0
5	0	0	0	0	0	8	8	0	7	0	0	0
6	0	0	0	0	0	3	8	0	0	0	0	0
6	0	0	0	0	0	0	13	0	0	0	0	0

The strongest heat islands observed in Mexico City are associated with these deep dry season inversions which in turn are conductive to higher pollution concentrations. The wind was calm in 82% of all cases when a surface inversion was observed during the period under study; under these conditions it is likely that a very light centripetal circulation would generate across the marginal thermal gradients fomenting the slow drifting of pollutants towards the central areas, as reported for other cities (CHANDLER, 1965, DAVIDSON, 1967). Pollution can, under these circumstances, rise to high level values before the surface inversion is destroyed by insolation, or a fresh outbreak of polar continental air arrives sweeping away the offending gases. It is only in these post-front situations that the traditional transparency of the thin air of the capital is restablished and for a day or two the residents of Mexico City can again admire the beauty of the surrounding mountains.

It should be noted however, that when compared with conditions in other large cities at sea level, similar air pollution levels at any time of the year would be more aggressive in the capital of Mexico; since the partial pressure of oxigen at 2250 m high is only 77% of that at sea level, the inhabitants need a greater volume of air for lung ventilation, as pointed out recently at the International Colloquium on the Physiology of the Human Body in High Altitudes, held in La Paz, Bolivia under the auspices of the World Health Organization.

Air polution measurements. Statistics for SO_2 concentrations are available for the year 1962 from a study made by BRAVO and VINIEGRA (1966). Figure 8 shows the average sulphur dioxide levels from 30 points of observation, in mg/100 cm²/day for the dry month of October 1962. The values decrease away from the center except towards the Tlalnepantla suburban industrial area where a secondary peak is observed, but in general, average smoke concentrations are more than three times those of the outer suburbs. It should be noticed from this figure also that towards the West, at the foot of the hilly terrain, pollution gradients are slightly more intense as would be expected from the topography.

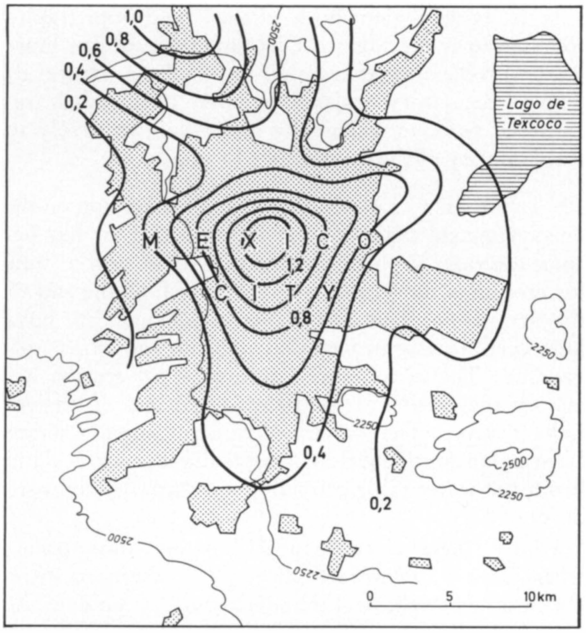

Fig. 8: Sulphur dioxide distribution (in mg SO_3/dm²/day) for october 1962 (after BRAVO and VINIEGRA, 1966)

Regular sulphur dioxide and smoke records exist for the city since August 1967 for five sites in the urban area (these have been augmented to 10 since 1970). Figure 9 shows the monthly variation of smoke concentrations for the first five stations for which data are available (MARQUEZ, 1969). These smoke concentrations are obtained by drawing for 24 hours a known volume of air through a filter paper and measuring the darkness of the stain. A seasonal variation is evident for all stations, but particularly for the one located in the center. Higher concentrations of smoke occur during the dry months due to both a high frequency of intense surface radiation inversions and a strong heat island. The decrease in smoke levels during the rainy season is the result of both, a reduced frequency of surface inversions and also of atmospheric scavenging by precipitation.

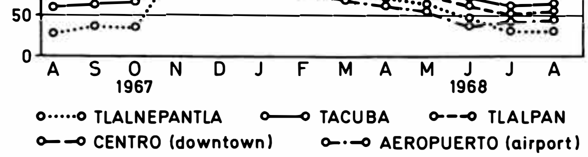

Fig. 9: Monthly variation of smoke concentration in Mexico City for 5 points (MARQUEZ, 1969)

It is evident that both climate and topography combine to make Mexico City smog one of the more urgent problems of the capital to be solved. However, despite regulatory legislation since 1971, much remains to be done technically and administratively to ensure purity of the capital's air for the future.

N a t u r a l a i r p o l l u t i o n. Wind erosion on the dusty semiarid plains to the North and East has become a serious problem for the capital. A crucial time for erosion is the January-April period, at the end of the dry season. The inhabitants of Mexico City have long been accustomed to these storms known as ‚tolvaneras'. The areas more liable to wind erosion are mainly the dried soils of the exposed bed of ancient Lake Texcoco. The scarcity of rain and the dry winds from polar continental air masses dry the surface and lower the water table providing very dry top soil conditions.

Under these circumstances blowing dust occurs when intense downdrafts during the afternoon from the so called ‚high-level thunderstorms' sweep over the plains (see KRUMM, 1954). The most dense duststorms are associated with these dry thunderstorms at the end of the dry season, when westerly winter circulation is giving way to the moist easterly current. These storms peculiar to the semiarid plateu areas of North America have been described by HARRIS (1959) for the locality of El Paso Texas. Convective heating during sunny days permit few high-level thunderstorms to develop over the hot plains of the valley of Mexico, producing only a trace of precipitation at the surface because of the extremely high rate of evaporation in the hot dry air beneath the cloud. The downdraft winds associated with the storm stir up huge clouds of dust lasting several hours.

Once the dust cloud is formed it usually drifts across the urban area from NE to SW. Visibility may be restricted to near zero for the first hour and airport operations must be paralized during this period. The little rain that reaches the ground from the high cloud bases has collected so much dust in its fall that this precipitation is named ‚mud rain' by Mexico City dwellers.

As the leading edge of the dust wall moves across the city from the North or East it loses strength by deposition and in some cases the dusty air does not reach the southern sector of town. Figure 10 shows the mean monthly amount of dustfall for the year 1959 as measured by BRAVO and BAEZ (1960). It is evident that the North and East fringes are the most affected by these phenomena.

Duststorms occur mainly between January and May during the dry season, with the greatest number in February – April as shown in table XII. The yearly occurrence of blowing dust is similar to that observed in other semiarid regions of the world like Kasakhstan in the virgin land region of the Soviet Union where these phenomena have a frequency of 50 to 60 days/year (ZAKHAROV, 1966).

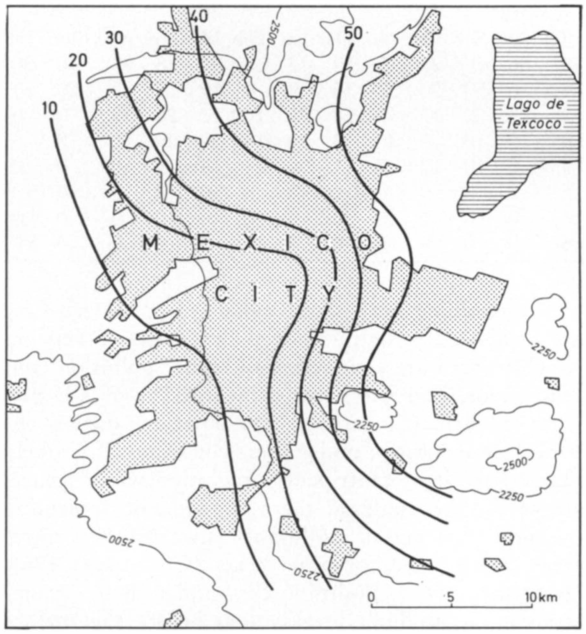

Fig. 10: Mean monthly dustfall (in tons/km²) for 1959 (after BRAVO and BAEZ, 1962)

Table XII: Average frequency of duststorms in Mexico City as observed from Tacubaya (urban Site) for the period 1923–58 (JAUREGUI, 1960)

Duration	J	F	M	A	M	J	J	A	S	O	N	D	Year
One hour	7	9	13	10	7	7	3	1	1	2	3	5	68
Three hours or more	4	5	7	4	2	2	1	0	0	0	1	2	28

When they are not produced by dusty winds associated with the arrival of a cold front, duststorms form in the valley of Mexico mainly during the afternoon and may last from one hour up to five hours. Table XIII shows the frequency (and corresponding average wind intensity) of duststorms as observed from the airport, located on the shores of Lake Texcoco, for different hours of the day. In the middle of the dry season more than 70 percent of these dusty winds occur between 3 to 8 P. M., the average wind velocity being 15 to 20 mph.

7. The Heat Island. Many authors have investigated in a great number of cities the so-called urban heat island effect resulting from the contrasting heat responses of city/rural surfaces. In order to study this phenomenon a series of temperature measurements were carried out by the author. Between October 1968 and February 1969, traverses were made in clear calm nights, with a psychrometer attached to the right windshield wiper of a back-motor car at about one

Table XIII: Frequency of duststorms and associated wind velocity (in mph) for different hours, as observed from the Airport (in percent) (JAUREGUI, 1971) *(lower number is average wind speed)*

Period of Day	J	F	M	A	M	J	J	A	S	O	N	D
12 to 14	7	4	20	3	18	2	–	–	–	–	16	35
	15	23	21	15	21	5	–	–	–	–	19	21
15 to 17	29	39	31	52	46	37	–	100	100	–	54	48
	13	18	17	19	19	17	–	18	16	–	18	20
18 to 20	15	53	40	33	29	60	100	–	–	–	19	3
	14	15	17	15	18	15	–	–	–	–	11	10
21 to 06	10	4	6	12	7	–	–	–	–	–	9	10
	11	9	8	13	5	–	–	–	–	–	7	10
06 to 11	–	–	3	–	–	–	–	–	–	–	2	3
			25								30	20

meter above the street during approximately two hours. Speeds were always sufficient to secure adequate ventilation of the instrument. An example of the two dimensional form of Mexico City's heat island is shown in fig. 11 illustrating the conditions at 04: 15 – 06: 15 A. M. on February 23 1969, with clear skies and wind calm. The urban area of the capital produces under these conditions a well marked temperature gradient. A slight displacement of the heat island towards the SW is observed. Towards the West edge of the city cold air drains downslope from the open country hills into the urban fringes and a slight sharpening of the edge of the heat island is observed there.

Due to the great extension of Mexico City's urban area, it was only possible, with one vehicle, to survey the heat island as far as the suburbs. Fortunately however, the climatological network extends further away

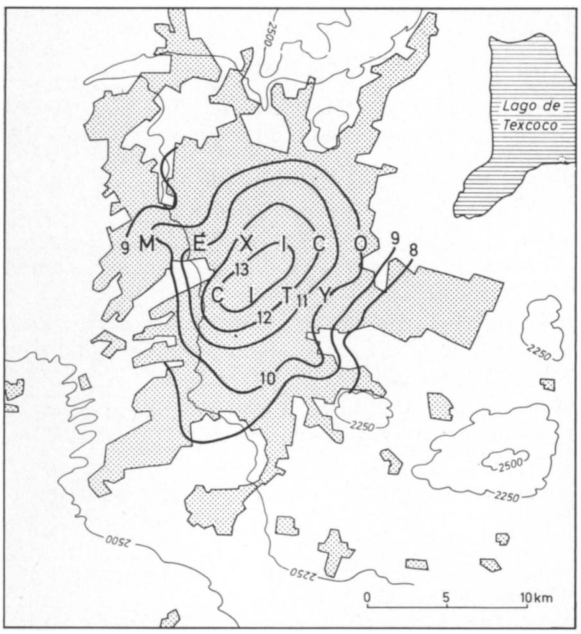

Fig. 11: Temperature distribution in Mexico City on 23 February 1969 between 04: 15 and 06: 15 A.M.

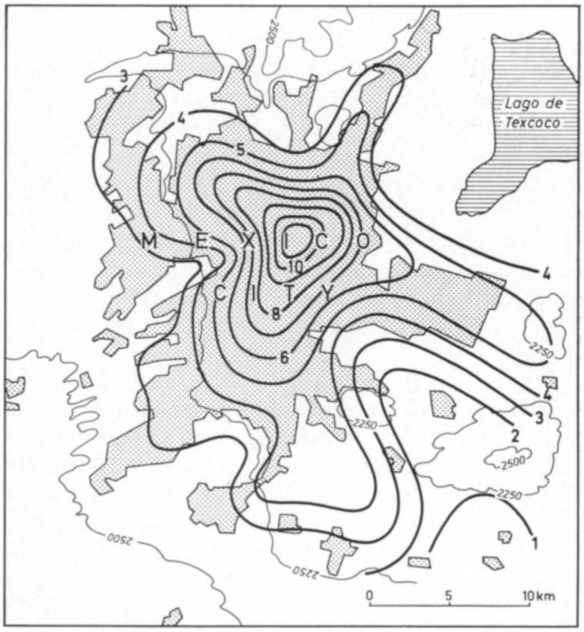

Fig. 12: Minimum temperature distribution for 8 February 1972 (Deg. C)

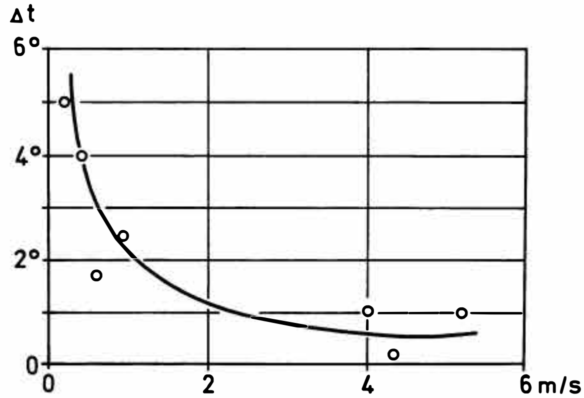

Fig. 13: Urban/country temperature contrast and intensity of synoptic wind in Mexico City

to the neighbouring rural areas. Using data from these stations, isotherms of minimum temperature were also drawn under different meteorological conditions to show the heat island effect. Fig. 12 illustrates conditions for the clear, calm morning of February 8 1972. City/rural temperature differences appear more marked in this example and the temperature gradient is more strong on the urban fringes at the foot of the hills the West and North where cold air flows downslope. An intense surface temperature inversion (3°) was present in this particular night; in other cases when no inversion was observed, the heat island was found to be most likely weak. On the other hand, geostrophic wind speeds greater than 3–4 m/s near the ground prevent the formation of the heat island (fig. 13).

8. The Urban Rain Island. Apparent urban-produced precipitation increases have been studied by many authors (Kratzer, 1954, Emonds, 1954, Eriksen, 1964, Changnon, 1970, Dettviller, 1970). The major potential effects mentioned in the literature are increased convection from added heat, added updraft motions from friction barrier effects and added freezing and condensation nuclei. Although only the orographic effect on precipitation is evident for the annual distribution of rainfall in Mexico City (see fig. 4), a marked high area of precipitation is often found for individual storms over the capital during the rainy season.

Figure 14 shows the distribution of rainfall for July 26 1971. This map was constructed from the daily rainfall figures (during the 24-hour period ending at 8 A. M.) at 33 urban and suburban stations. The observed distribution suggests that heavy precipitation over the central urban area could be initiated by either (or both) the higher temperature or the added updraft motions generated by the city. In some cases the area of maximum rainfall is diplaced to the South or West by the prevailing Easterly or Northeasterly current. At other times the rain island may drift so far to the West that the urban effect can hardly be distinguished from the orographic uplifting by the mountains to the West and South.

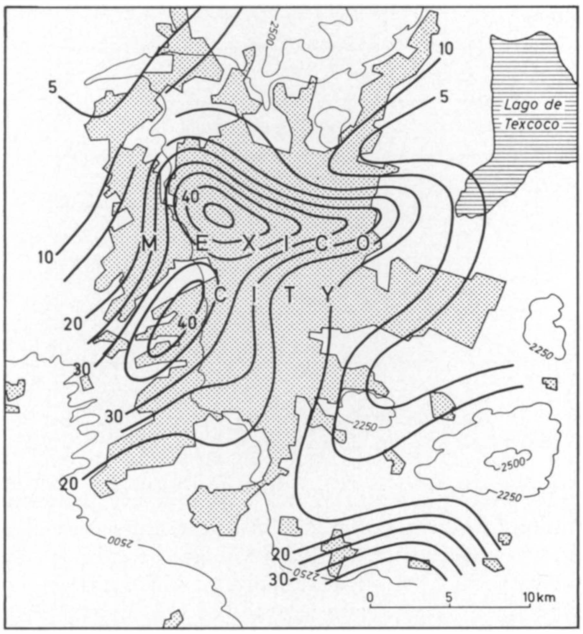

Fig. 14: Distribution of 24-hour rainfall for 26 July 1971 (mm)

The effect of the city is also evident when average frequency of days with more than 20 mm rain in 24 hr over a period of several years is plotted for the urban area; a maximum appears near the old center of town. As well developed cumulus embedded in the Trade current approach the limits of the urban area from the East during the rainy season, they encounter additional updraft currents originated by the city. As a result, thunderstorms develop quite frequently along the eastern fringes as can be seen in figure 15 where the distribution of average annual number of thunderstorm days has been plotted.

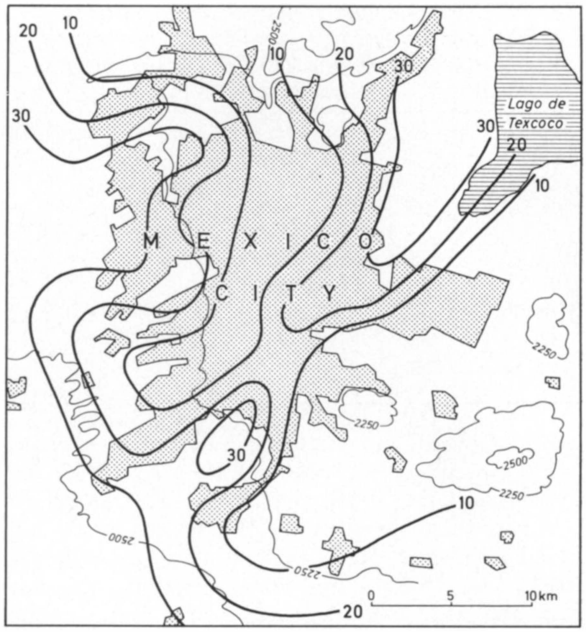

Fig. 15: Average annual number of days with thunderstorm

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STAND, AUSWIRKUNGEN UND AUFGABEN DER CHILENISCHEN AGRARREFORM

Beobachtungen in der nördlichen Längssenke Mittelchiles

Mit 5 Abbildungen, 4 Photos und 3 Tabellen

KLAUS ROTHER

Summary: The current position, tasks and effects of agrarian reform in Chile. Field observations in the northern Valle Longitudinal of central Chile.

This paper, based on fieldwork in 1972, describes the characteristics and position of the reform programme in Chile and stresses the typical differences between the terms of office of the Frei and Allende governments. The author then investigates the effects of legislative measures on the rural landscape of the northern Valle Longitudinal of central Chile and concludes that:

1) the ownership and field patterns have largely survived the introduction of communal ownership,
2) the co-operative principle is dominant in farm operation. In many co-operatives there are clear tendencies to demarcation of individually used plots in order to work independently and profitably,
3) land use has become more intensified regionally than was the case before reform, but stock farming has stagnated,
4) division in the social structure of rural areas have become deeper,
5) scattered settlement and small hamlets have become denser.

In conclusion, the future tasks of Chile in relation to the overall situation in the country are discussed.

Seit kurzem ist das interdisziplinäre Gemeinschaftsprojekt der Arbeitsgemeinschaft Deutsche Lateinamerikaforschung (ADLAF) „Entwicklungsprobleme im außertropischen Lateinamerika in historischer, geographischer und regionalpolitischer Sicht“ im Gange, das von der Stiftung Volkswagenwerk finanziell getragen wird. An ihm arbeiten die Lateinamerikanische und Iberische Abteilung des Historischen Seminars der Universität Köln, das Geographische Institut der Universität Bonn (Lehrstuhl: Prof. Dr. W. Lauer) und das Forschungsinstitut der Friedrich-Ebert-Stiftung in Bonn-Bad Godesberg zusammen. In einer „Modellstudie Chile“ sollen spezielle Entwicklungsprobleme unter dem Aspekt des Stadt-Land-Gefälles dargestellt werden. Die Forschungsschwerpunkte der beteiligten Geographen, die in diesem Land z. T. größere Vorarbeiten geleistet haben (s. BÄHR 1972, S. 283), sind 1. die Migrationsprobleme als Folge von Standortverlagerungen des Bergbaus im Großen Norden, 2. die Wandlungen der Sozial- und Siedlungsstruktur im südchilenischen Seengebiet seit dem Abschluß der Rodungskolonisation und 3. die Probleme des Kleineigentums in der Zentralzone im Zusammenhang mit Landflucht und Verstädterung und die Agrarreform. Zu diesem letz-