

The irregularity in the curve at 110 miles is due to the high habitation ratio in the Klerksdorp district. This points to the high degree of urbanisation in this district and to the existence (and possible development) of an important urban centre or centres. This high degree of urban development is primarily due to gold mining in the district which lies in the western arm of the "Golden Arc" from 90 to 120 miles from Johannesburg. At 70 miles the curve rises steeply and becomes almost a straight line (exponential curve) to attain a higher value at 10 miles than any of the other metropolitan communities, namely, 1153.

3. Sector Curves (FIGS. 32a and 32b):

Because of the scale of the initial base map and the converging nature of the zones, values could only be determined for zones more than twenty miles from the centre, thus resulting in the curves terminating at 30 miles, that is, the average for the 20 to 40 miles zone. Only four of the curves begin at 190 miles because the metropolitan community in the other sectors does not extend to the 200 mile limit, the maximum distance for which the habitation ratios were determined.

Viewing all the zonal curves together significant groupings may be made.

(a) Secondary Peaks. At 70 miles secondary peaks occur in Sectors IV and VII, making Heilbron and Koppies sub-foci in the former, while P-thal is an influential centre or sub-focus in the latter sector. In none of the other sectors are sub-foci so close to the metropolitan focus.

The curve of Sector VI has two secondary peaks showing the influences of Standerton at 90 miles and Volksrust at 130 miles. At 190 miles a higher value is recorded than at 170 miles, but this is due to the very small area between 180 and 200 miles in this sector.

.../ Sectors

Sectors I, II and III display secondary peaks at 110 miles from the focus, thus indicating the existence of important sub-foci, urban centres or urbanised zones which are strong enough to disrupt the expected population pattern in the metropolitan community and to establish their own spheres of influence. These centres are Lichtenburg, the mining centres in the Klerksdorp district and Kroonstad respectively. It is, however, not only the peaks which indicate important urban centres, but the flattening of the curves may do so as well. Centres responsible for such a flattening are not as influential as those forming a distinct peak but are, nevertheless, important sub-foci. Accepting these flattenings as indicative of other influential centres, Sector V may possibly be grouped with the above three sectors even though the curve only begins at 130 miles. Reitz (and Vrede) being the chief sub-foci, but a more likely explanation is provided in the next sub-section (i.e., 3b).

b. Secondary Troughs: The secondary troughs or the valleys in the curves mark the division between the spheres of influence of the focus of the metropolitan community and the sub-foci surrounding it.

A more likely explanation of the flattening of the curve between 110 miles and 130 miles in Sector V is that it is a secondary trough. On closer inspection of the habitation ratios in areas adjacent to Sector V in the communities of Bloemfontein and Durban, it is evident that there is no secondary peak in the habitation ratios of this sector within the Johannesburg metropolitan community, but that the peak lies outside the community in the Bethlehem-Harrismith area.

In Sector III the demarcation between the spheres of influence of the sub-focus and the metropolitan focus lies at 90 miles.

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The demarcations in Sectors I and II are fixed at 70 miles. In Sector VI a distinct trough occurs at 110 miles. This trough, however, demarcates the boundary between Volksrust and Standerton. The trough between the latter, the nearest sub-foci to the metropolitan focus, and the metropolitan focus is at 70 miles as is indicated by the termination of the flattening in the curve.

Of all the secondary troughs, those in Sectors IV and VII lie closest to the metropolitan focus, namely at 50 miles.

(c) Positive Crossing of the Mean Curves by Sector Curves:

The grouping of sectors according to the point at which the curves finally cross the mean curve positively is significant, since this allows for a determination of the relative differences in the urbanisation of sectors and the ratios, indicated by the mean curves that may be expected.

The curves of three sectors, namely, I, V and VI cross the mean curve at distances which are relatively close to the focus, namely between 50 and 60 miles. The curves of Sectors II and III cross the mean between 140 and 145 miles, and lie close to that of the Johannesburg metropolitan Community. Urban habitation ratios in Sectors IV and VII are higher than the mean and do not cross the mean curve at any stage.

Firstly, it is noticeable that all the sector curves which cross the mean urban metropolitan community curve close to the focus, namely sectors I, V and VI are the curves drawn for predominantly agricultural areas. The furthest crossing point of these three, is the result of Sector VI containing the national road to Durban. It is to be noted that this curve also crosses the average curve at 130 miles, that is, the effect of Volksrust.

Secondly, Sectors II and III extend along the national

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roads to Kimberley and the O.F.S. respectively. In the case of the former, gold mining is the outstanding factor allowing for a secondary peak at 110 miles where the habitation ratio is 58 persons per square mile higher than the average for that distance and ratios which are higher than the Johannesburg ratios after crossing the mean curve. The national road in Sector III links the Witwatersrand to the O.F.S. goldfields, again pointing to the effect which a national road, here combined with gold mining, has on the urban habitation ratios.

Thirdly, Sector IV includes Sasolburg and the surrounding coalfields as well as a large portion of the Vereeniging-Vanderbijl Park industrial complex, resulting in a curve which is well above the average, although it must be taken into account that the curve begins at 130 miles. Sector VII included part of the productive Eastern Transvaal Highveld agricultural area, but even so the curve is very close to the average between 190 and 110 miles. At 30 miles this curve attains a higher value than any of the other sectors at this distance because of the influence of the East Rand (Springs) and the developing goldfields east of the Witwatersrand (Kinross area).

It is thus seen that four sectors have higher urban habitation ratios for all or most of the distances and three have higher values only relatively close to the focus. This indicates that there is a greater amount of urbanisation in most of the Johannesburg metropolitan community than in the mean metropolitan community. In fact, the curve crosses the individual curves of the other three metropolitan communities at 135 and 140 miles.

(d) Johannesburg's Sphere of Influence. By making use of the urban habitation ratio curves as determined, it is possible to demarcate two spheres of influence, an inner and an outer sphere. The boundary of the inner sphere coincides with

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the secondary trough in the curves of the various sectors and where these troughs are not well defined the flattenings of the curves provide the basis for division. This method was followed in order to draw the boundary line in FIG. 33. The inner line thus shows the division between the sphere of influence of the focus, namely Johannesburg, and the separate spheres of influence of the sub-foci surrounding the metropolitan focus. These sub-foci are markedly influential causing a significant irregularity in the habitation ratio curve of the metropolitan community.

The outer boundary is less well defined. To determine this boundary relatively accurately the habitation ratios of sectors in all the surrounding metropolitan communities, Pretoria, Durban and Bloemfontein, must be determined. The lowest ratios in the areas between these metropolitan communities will indicate the boundary line. Exceptions arise where sub-foci are on or close to the metropolitan community boundary, such as the O.F.S. goldfields between Johannesburg and Bloemfontein. In this study this boundary was not determined as described above, but the curves of Sector III in conjunction with the mean of Bloemfontein and Sectors V and VI suggests that the outer boundary lies somewhere between 110 miles from Johannesburg and 70 miles from Bloemfontein. The O.F.S. Goldfields lie in this area pointing to the transitional nature of this boundary. Further the boundary between the two metropolises under consideration as determined geometrically is also located in this area. When habitation ratios are determined for the area adjacent to Sector VI then it appears that the boundary between Johannesburg and Durban metropolitan communities lies at 160 miles from Johannesburg, that is, midway between the latter and Durban. The coincidence with the geometrically¹ determined metropolitan community is striking. .../The

1. See p 143.

The results as described above suggest that the geometrically determined boundary for any metropolitan community is very satisfactory when taken as the outer limit of the influence which the focus has on the urban habitation ratios of its surrounding territory.

If a metropolis were situated in an agricultural area the effect of the focus would be more easily noticeable than in a case like Johannesburg where its metropolitan community contains mining communities where the chief consideration for the siting of urban centres is the presence of the mineral to be mined, thus disrupting the more even distribution of urban centres as determined by the needs of purely agricultural communities.

D. ANALYSES OF RURAL HABITATION RATIO CURVES:

1. Mean Curve:

FIG. 31 shows the mean curve for the rural habitation ratios and the individual curves of the four metropolitan communities which determine it. With the exception of a very slight secondary peak at 130 miles, obviously the result of high ratios at this distance in the metropolitan community of Durban, the curve shows increasing habitation ratios as the focus is approached. The consistently high ratios in the metropolitan community of Durban are chiefly due to the large rural populations in the large number of Bantu Homelands throughout Natal, the Transkei and Pondoland and to the large rural Asiatic populations in certain of the magisterial districts in Natal, such as Inanda and Lower Tugela. The peak at 130 miles results from large rural population concentrations in the Transkei. The high ratios at the greater distances from Pretoria are also due to such concentrations in the Bantu Homelands of the North-Eastern Transvaal. In the metropolitan community of Bloemfontein the highest ratios are found in the good agricultural areas of the North-Eastern O.F.S.

2. Johannesburg Mean Curve:

The ratios in the Johannesburg metropolitan community approximate/ best the mean ratios of the four communities but are less than the mean except at 190 miles. The peak at 170 miles, because of the small area which is covered in this zone, is not significant. The ratios increase gradually as the focus is approached, from a value of 18 at 190 miles to 34 persons per square mile at 30 miles from the focus. The steepness of the curve increases rapidly from 70 miles. At 30 miles there is a sharp drop in the curve to the lowest ratio recorded in the community, namely 17. This is the result of the magisterial districts of the Witwatersrand being classified as urban, despite the intensive agricultural pursuits carried on near the focus (intensive dairying within a radius of 25 miles from Johannesburg).

3. Sector Curves:

(a) Secondary peaks. Secondary peaks for Johannesburg are not as well defined as those in the sector curves drawn for the urban habitation ratios. Flattenings of the curves seem to occur more frequently. This indicates that the influence of sub-foci are not displayed as markedly on the rural populations surrounding them as in the case of urban populations.

Taking the flattenings into account, three sectors have secondary peaks at 130 miles, namely, Sectors I, IV and V. In Sector I equal ratios occur over a distance of 60 miles, primarily the effect of Lichtenburg, thus coinciding with the secondary peak in the urban habitation ratios. Considering that the curve for Sector V commences at 130 miles, the result is the same as that of Sector I, but there is no correlation at this distance between the urban and rural ratios for Sector IV.

The peak in Sector II occurs at 110 miles, illustrating clearly the effect which the goldfields in the Klerksdorp district

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have on the rural population.

At 90 miles both Sectors III and VII show flattening of the curves. In the latter sector, the flattening is brought about by Bethal, which coincides with the secondary peak in the urban ratios. The rural habitation ratios in this sector are practically the only ratios, in any case the only significant ratios, which are higher than the average for the four metropolitan communities. These high values stem from the rich agricultural lands in this sector.

At 190 miles the peak of Sector VI (and VII) occurs, but since the reliability of the ratios increase with the size of the zone and this zone only covers a small area at this distance, the high ratios are not regarded as very significant. The peak, if it does exist, lies beyond 150 miles.

(b) Secondary Troughs. These valleys or troughs in the curves mark the division of the spheres of influence between the sub-foci and Johannesburg.

The furthest trough from the focus occurs in Sector VI at 150 miles. This sector is closely related to Johannesburg because of its importance as a supplier of fresh milk which in turn stems from the speed with which commodities can be transported to the focus on the national road linking the Rand and Durban.

The trough in Sector IV is found at 110 miles, deviating greatly from the urban habitation ratio pattern.

The boundary between Johannesburg and Klerksdorp lies at 90 miles which suggests that the influence of Klerksdorp on the rural surroundings is not as marked, relatively speaking, as found with the urban ratios. This, however, is possibly due to the urbanisation in the area being related to mining. At this distance also lies the boundary between Johannesburg and the Vrede-

-Reitz area (or Harrismith-Bethlehem).

Three sectors have secondary troughs at 70 miles. In Sector I this is the boundary between the focus and Lichtenburg. Because of the equal ratios between 130 and 70 miles, it is however, difficult to demarcate this boundary clearly, but because the curve rises at 70 miles, the boundary is located at this distance. This boundary coincides with the inner boundary of the urban influence of the focus. In Sector III and VII the boundaries between the focus and the Kroonstad area and Bethal respectively also lie at 70 miles. In the latter sector, Bethal causes a flattening in the curve which then rises very rapidly from 110 miles.

FIG. 33 indicates Johannesburg's influence on the rural habitation ratios in its metropolitan community as determined by considering the secondary troughs and flattenings in the various sector curves.

(c) Final Decrease in Habitation Ratio (FIG. 33). Of the four metropolitan communities considered, two show an increase in the habitation ratios up to 10 miles, that is the nearest point for which ratios were determined. Johannesburg and Bloemfontein, however, show a drop in the habitation ratios from a distance of 30 miles. This result for Johannesburg is understandable because most magisterial districts close to Johannesburg, especially to the east, are classed as "urban" according to census definitions. In the case of Pretoria, the increase up to 10 miles is due to the large size of the magisterial district, which unlike the magisterial districts on the Rand, makes for a rural population which results in a rural habitation ratio being determined for an area so close to the focus. The fact that the ratio is highest in this community, taking the above into consideration, nevertheless, indicates that there is a tendency for ratios to increase toward the focus, although the increase possibly does

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not extend to as close to 10 miles from Pretoria.

Considering the various sectors in the metropolitan community of Johannesburg, it is seen that in Sector II the decrease already starts at 70 miles from Johannesburg. The point from where this decrease begins coincides with the inner urban sphere of influence, that is, the point where the urban habitation ratio begins to increase towards the focus. This again appears to suggest the influence of mining activities in this sector. The only other sector where such a coincidence is found is in Sector VII where the decrease is from 50 miles. This is also a sector where gold mining has expanded rapidly in recent years. Sector VI also decreases from 50 miles.

Since there must be a decrease in the habitation ratios of the other four curves at some stage, the average Johannesburg curve suggests that the decrease is from about 30 miles from the focus.

(d) Positive Crossing of the Mean Curve by Sector Curves.

Of all the sector curves only three are positive in relation to the average at one or other stage. Between 190 and 165 miles Sectors VI and VII are positive, but as explained previously, because of the small areas of these two sectors not much importance is attached to this fact. Between 115 and 105 miles Sector I just becomes positive, the result of ratios in the Klerksdorp area. Sector VII is again positive between 100 and 45 miles (Ermelo and Bethal). This stresses the importance of the Eastern Transvaal Highveld as an agricultural area which is able to carry a high rural population.

E. RANK CORRELATION COEFFICIENT.

It was further investigated whether any correlation exists between urban and rural habitation ratio rank with distance since any such correlation ...

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would be highly significant in pointing out the effect which urban settlements would exercise on their rural surroundings. The method used is called the Spearman's Rank Correlation Coefficient, the formula being as follows:

$$R = 1 - \frac{6 \sum d^2}{n^3 - n}, \text{ where } R \text{ is the required rank correlation coefficient, } d \text{ is the rank difference between the urban and rural data, } d^2 \text{ is the square and } \sum d^2 \text{ is the sum of the squares, and } n \text{ the number of pairs of occurrences. The method is given below and is applied here to only one of the distances.}$$

Sector	Urban Rank	Rural Rank	d	d ²	R (110 miles) = 1 - $\frac{6 \sum d^2}{n^3 - n}$
I	6	7	1	1	= 1 - $\frac{6 \times 20}{7^3 - 7}$
II	1	1	0	0	
III	2	3	1	1	= 1 - $\frac{120}{343 - 7}$
IV	3	4	1	1	
V	7	5	2	4	= 1 - $\frac{120}{335}$
VI	5	2	3	9	
VII	4	6	2	4	= 1 - 0.357
			$\sum d^2 = 20$		
					= + .643

Although some positive relation is suggested, it is statistically not significant at the 5% or smaller levels, since a value of at least .85 is significant at the 5% level, when the degree of freedom is 5.

The results are tabulated below:

TABLE 29: Correlation Between Urban and Rural Habitation Ratios with Distance in the Metropolitan Community of Johannesburg.

Distance in miles from focus	Rank Correlation Coefficient	Degrees of Freedom (n-2)	Significant Level %
30	++.214	5	--
50	---.929	5	1
70	++.500	5	--
90	++.536	5	--
110	++.643	5	--
130	++.608	5	--
150	++.867	3	--
170	++.967	2	--
190	+1.000	2	--

All but one coefficient are positive and there is a definite tendency for the correlation between urban and rural ranks to increase as the distance from the focus increases. Except for the one negative correlation coefficient - significant at the 1% level - none of the positive coefficients are significant. The fact that the number of zones is less beyond 130 miles, leading to a subsequent reduction of "n" and that the areas of the zones tend to be smaller in relation to their distance from the focus may very well have affected the results. Both these effects stem from the shape of the Johannesburg metropolitan community. The results, nevertheless, suggest, firstly that a closer relationship exists between the degrees of urbanity and rurality as the distance from the metropolitan focus becomes greater. Secondly, the results indicate that although there is a general increase in the urban ratios of the individual sectors as the focus is approached, and an increase in the rural ratios till relatively close to the focus, an increase in the urban ratio does not necessarily lead to a corresponding increase in the rural ratio. Stated differently, the relative ranks of rural ratios do not necessarily change to the same extent as urban ratio ranks change. Of all the sectors, Sector I displays the best relationship, the urban and rural ranks coinciding for five distance zones, and for the remaining four distance zones the ranks (d) never differ by more than 1, with the urban rank being the higher in all four cases.

It is thus obvious that no clear correlation exists, but that, generally speaking, urbanity and rurality do increase toward the metropolis up to a certain point from where rural activities and occupancy decrease in intensity because of the predominant urban usage of the land until the former completely disappears from the scene. (These results are similar to the findings of Bogue (1950) though he did not determine the correlations between

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urban and rural habitation ratios.

F. POPULATION GROWTH ^{RATES} STATISTICS.

1. Comparisons. It has been ascertained that Johannesburg as a metropolitan centre effects the population habitation ratios, especially urban habitation ratios, in the metropolitan community for which it is the focus. To attempt any measurement of the urban population in its metropolitan community it is essential to compare the population growth of the metropolitan focus with other metropolises, not only on a national level, but also internationally. Such a comparison will indicate whether Johannesburg is in any way exceptional or whether it merely follows a pattern similar to other metropolises.

In a report on the growth rate of 906 metropolitan areas (M.A.'s) Gibbs (1961) tabulated his findings for twelve "World Regions", and in his comparison states, "Perhaps the most outstanding feature (TABLE 30) is that the growth rates in the less industrialised regions (Southern Asia, the Middle East, and Southern Africa¹) appear to be much higher than those in the highly industrialised regions (Oceania, North America, and Western Europe)" (p384). Further, the greatest regional differences in M.A. growth rate is furnished by Europe and Southern Africa. 85.2% of Western Europe's M.A.'s increased at a rate of less than 2.0%, whereas in Southern Africa none of the M.A.'s had rates less than this value. TABLE 31 incorporates some of Gibbs' findings and compares the South African M.A.'s with other African, European and United States M.A.'s

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1. Southern Africa includes M.A.'s from Angola (1), Congo (2), Ghana (1), Kenya (1), Madagascar (1), Tanganyika (1) and South Africa (8).

TABLE 30 : Percent of Metropolitan Areas in Each World Region Growing at less than a Designated Rate, Circa 1941 - 1953 (Gibbs 1961 p384).

WORLD REGIONS	RATE OF GROWTH (Average annual percent increase).														
	-3.0	-2.0	-1.0	0.0	1.0	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	
South Africa						0.0	23.7	40.0	53.3	66.6	73.3	80.0	86.7	93.4	
Middle East				0.0	15.4	23.1	46.2		61.6	77.0	94.2	100.0			
Southern Asia	0.0	0.9	1.8	3.6	9.0	37.8	72.0		87.3	94.5	100.0				
Oceania			0.0	9.1	27.3	54.6	100.0								
North America		0.0	1.3	3.8	11.9	46.9	69.4	81.9	93.2	97.0	100.0				
Western Europe	0.0	0.4	0.4	9.4	46.2	85.2	99.1	100.0							
World	0.0	0.2	0.5	4.8	20.3	46.5	68.2	83.2	92.5	96.4	98.2	99.2	99.5	99.7	

TABLE 31: Growth Rates¹ of Selected Metropolitan Areas
(Gibbs 1961).

World Region	Metropolitan Area	Period ²	Growth Rate ³	Growth Rate ⁴
North Africa	Cairo	37-47	4.6	
	Algiers	48-54	3.1	
Southern Africa	Accra	31-48	2.9	
	Nairobi	48-56	6.9	
	Bloemfontein	46-51	3.2	2.9
	Cape Town	"	4.1	
	Durban	"	4.9	3.1
	East London	"	2.3	
	Johannesburg	"	2.7	2.5
	Port Elizabeth	"	5.1	
	Pretoria	"	3.2	4.9
	Vereeniging-Vanderbijlpark	"	7.3	4.5 ⁵
North America	New York - North-Eastern New Jersey	40-50	1.0	
Western Europe	Paris	36-54	0.4	
	London	31-51	0.4	

1. Average annual percent increase in population as calculated by the formula $r = 200(P_2 - P_1) / y(P_2 + P_1)$, with r the average annual percent increase, P_1 the population at the beginning of the period, P_2 the population at the end of the period, and y the number of years in the period (Gibbs 1961 p386).
2. The initial and terminal years of the growth period.
3. Growth rates as given by Gibbs.
4. Growth rates as determined for the 39 year period, 1921 - 1960.
5. Vereeniging only.

It immediately becomes apparent that compared to three of the largest urban concentrations in the Western World, Southern Africa's M.A.'s are expanding much more rapidly. South Africa, although it has the largest number of M.A.'s in Africa is not outstanding as a country of rapid metropolitan development in this continent. Fixing attention on Johannesburg, it appears that, with the exception of East London, Johannesburg displays the lowest growth rate of South African M.A.'s. When compared, the

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growth rate as given by Gibbs for the period 1946 to 1951, when taken over a longer period, is less in all cases. The differences are considerable in some of the cases (Durban and Pretoria), but Johannesburg shows a difference of only 0.2%.

By determining the population growth rates of urban centres in the community it will be attempted to indicate the effects, whether advantageous or disadvantageous, which Johannesburg has had or is still having on the urban centres in its community, and or in fact whether the focus has any effect at all on the population growth or urban development of these centres.

FIG. 34 depicts the growth rates of four metropolitan foci (a), the seven sub-foci (b), and a number of urban centres of various sizes in the different sectors (c), and two centres which lie to the north of Sector VII (d).

2. Metropolises (FIG. 34a). Because the discussions on population have only taken into account Durban, Pretoria and Bloemfontein in addition to Johannesburg, the same procedure is followed here. Since the population of each metropolis is made up of people living in the municipal area and those living in the rest of the metropolitan area¹, three curves are drawn, one for each metropolitan area (M.A.'s) as a whole, for the municipal areas and for the rest of the metropolitan areas.

Of the four metropolitan areas, Johannesburg had the largest population in the M.A. as a whole and in the two areas forming the M.A. However, the population growth rate by no means places Johannesburg foremost among the metropolises as will be seen from the discussions of the periods of growth and from TABLE 31. .../Considering

1. Usage of the term is similar to that of the Bureau of Census: "... large towns which consist of the parent municipality together with adjoining areas which are urban in character, and which are economically and socially linked with the parent town" (Bureau of Census, 1962 pvii).

Considering the full period for which growth rates were determined, the tendency was as follows:

- (i) the 1921 to 1936 period saw Johannesburg as the most rapidly expanding metropolis;
- (ii) the 1936 to 1951 and the 1951 to 1960 period brought a decrease in the rate of development of Johannesburg, an increase in the rate of the other centres and a subsequent passing of the Johannesburg growth rates, both municipal and the "rest" of the M.A.;
- (iii) the most rapid rate of development took place in all centres, to the partial exclusion of Bloemfontein, in the areas outside the municipal areas.
- (iv) Although the most rapid development took place in the extra-municipal areas, it is only in Johannesburg where the number of people in these outside areas approaches the number of people within the municipal area, the latter exceeding the former by approximately 38,000. The very large population in the outside areas of Johannesburg results from the great number of Bantu living here. In fact, they constitute 85% of the total number of people in the areas forming the "rest" of the M.A.
- (v) Although Johannesburg is no longer the most rapidly developing metropolis, a similar pattern of development is followed by the other metropolises only at a later period.

Since the importance of the Johannesburg M.A. has been shown in the light of developmental trends in other M.A.'s, it will be significant to compare the growth rates of Johannesburg with those of the sub-foci.

3. Sub-foci (FIG. 34b). The growth of the M.A. of Johannesburg and that of the extra-municipal area is compared .../with

with the seven sub-foci, one in each sector of the metropolitan community. A pattern very similar to that displayed by the metropolises appears. (i) Johannesburg is the most rapidly developing centre prior to 1936. (ii) The 1936 to 1951 period saw an increase in the rates of growth of the sub-foci to such an extent that all but one of the rates surpassed that of the Johannesburg M.A. (iii) The nine years prior to 1960 led to all the sub-foci developing at a rate greater than Johannesburg. (iv) The growth rates of the sub-foci lie between the rates of growth of the Johannesburg M.A. and the greater growth rate of the area referred to as the "rest" of the M.A. This stresses the importance and attraction of Johannesburg as a source of labour supply to the Bantu who are housed mainly in the townships to the south west of the metropolis.

4. Urban Centres (FIG. 34c).

a. Sector I. Prior to 1936 only Krugersdorp's (1887¹) growth rate exceeded that of the Johannesburg M.A. The following fifteen years saw Roodepoort (1886) and Koster (1931) as the most rapid developing centres. Prior to 1960 Koster alone surpassed the growth rate of the metropolitan focus.

As far as size is concerned, Roodepoort and Krugersdorp are in a size class of their own in this sector. Roodepoort, the centre closest to Johannesburg, took the lead from Krugersdorp, so that in this sector the sizes of urban centres decrease with an increase of distance from the focus.

b. Sector II. The relatively recent establishment of urban centres in this sector is attributed to gold mining activities. Of the several townships proclaimed since 1937, Carletonville (1948) has become the urban nucleus with a population in 1964 of more than 85,000. Westonaria (1938) though

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1. Date of proclamation.

proclaimed ten years prior to Carletonville has by no means developed as rapidly as the latter.

All towns had steeper growth rates than the metropolitan focus since, 1951, with Carletonville even surpassing the growth rate of the "rest" of the Johannesburg M.A.

Carletonville, Potchefstroom and Westonaria are in the same size category.

c. Sector III. Only two Orange Free State towns, Parys and Vredefort (1892), both primarily service centres in an agricultural area, lie within this sector. The growth rates of the centres are very similar, and both surpassed that of Johannesburg after 1951 and display increasing rates of development.

d. Sector IV. This is the industrial sector of the Johannesburg metropolitan community since in it lie Vereeniging (1892), Vanderbijl Park and Sasolburg (1954). All centres in this sector of new urban development display very rapid growth rates which exceed that of Johannesburg, while Meyerton, 10 miles from Vereeniging and an developing industrial centre, has a growth rate greater than the "rest" of the M.A.

e. Sector V. Since this sector is agricultural in nature, the urban centres mainly provide the necessary services. Frankfort (1868) has a relatively low rate of increase compared to most of the urban centres dealt with so far. Villiers (1890) approximates that of the Johannesburg M.A., while Tweeling displays a very rapid rate prior to 1936, a decreased rate in the following years and after 1951 a decrease in the number of inhabitants occurred.

f. Sector VI. Four of the centres lie on the national road from Johannesburg to Durban, a link which would tend to promote urban development. Alberton (1905) and Balfour have rates of growth greater than that of Johannesburg for the

full period under discussion, while Nigel (1912) exceeds the latter's rate prior to 1936. This town has a rate of growth which decreases rapidly, especially since 1951. Alberton displays a remarkably even rate for the 39 years under consideration. According to census it is part of the Germiston M.A. However, it appears to have developed as a dormitory for both Germiston and Johannesburg, and is now rapidly becoming an industrial centre of its own standing. Again it is noticeable, in the absence of gold mining, that the centre of most rapid growth is situated close to the metropolitan focus.

g. Sector VII. Of all the sectors, Sector VII is the most highly urbanised. Of the eighteen largest urban centres, including metropolises, in South Africa, five are situated here. Two of these centres are indicated by the Bureau of Census as being metropolitan in character but they will not be dealt with as such, since in the case of Germiston (1887) the individual municipalities comprising the "rest" of the M.A. are discussed as separate centres while in the case of Benoni the "rest" has only shown a noteworthy increase until 1936 and an actual decrease in numbers has occurred since 1951. Further, population of the "rest" of the M.A. consists partially of inhabitants of agricultural holdings, and the total population is relatively small compared to the population of the municipal area.

Prior to 1936, the Johannesburg growth rate surpassed those of Benoni, Germiston and Boksburg (1887), and was equalled by that of Elsburg. The 1936 - 1951 period shows the same pattern with Germiston equalling the Johannesburg growth rate, and Brakpan and Springs having smaller rates. The period before 1960 saw Benoni, Germiston, and Delmas as surpassing the growth rate of Johannesburg.

.../Germiston

Germiston shows the most regular growth and though exceeded by Springs and Lenoni in size of population in 1936, it surpassed both towns in population size to become second only to Johannesburg on the Witwatersrand. The increase has been due to its proximity to Johannesburg and its strategic position on the railroads of the Witwatersrand and Southern Transvaal and South Africa.

The urban centres on the Witwatersrand in this sector fall in the same size category. Bedfordview and Elsburg, though separate municipal areas, are not well-developed urban centres because they are primarily residential in character, and are regarded rather as part of the Germiston M.A., especially Elsburg, since the former probably centres an equal amount on Johannesburg.

5. Other Urban Centres (FIG. 34d).

Two centres not discussed so far because they lie north of Sector VII between the Witwatersrand and Pretoria are Edenvale and Kempton Park (1903). Both centres have experienced phenomenal growth during the past, growth rates which in part surpass that of the rest of the Johannesburg M.A. Their rapid development stems from their becoming two of the most important dormitory towns for the industrial and commercial hubs of the Central Witwatersrand. According to census Edenvale lies within metropolitan Germiston, but because of its industrial and commercial development it is regarded here as a distinct urban centre in contrast to Elsburg and Bedfordview mentioned above.

Conclusion.

Johannesburg, though a fast developing metropolis in relation to metropolitan growth rates in the world's highly industrialised countries, is by no means an exception in Africa and in South Africa. In its own metropolitan community its

.../growth

growth rate generally surpassed that of towns in the 1921-36 period. The 1936-51 period indicates an increased rate of urban development in the community so that the growth rates of most towns approximated that of the Johannesburg metropolitan area. After 1951, however, Johannesburg's growth rate was surpassed by the rates of most towns. The rest of the metropolitan area maintained a high rate of development throughout the period under consideration, but it too was surpassed by the growth rates of several towns during the latter part of the period.

Throughout the Johannesburg metropolitan community, especially in more recent years, urban growth has generally been greater than that of the Johannesburg municipal area, and it is difficult to determine Johannesburg's role in this development. However, an apparent tendency was for the centres nearest to the focus to develop most rapidly so that their population sizes even surpassed those of former larger towns. Such development is illustrated by Germiston and Roodepoort. Johannesburg's influence as a focus is further exemplified by the rapid development rates of towns assuming the role of dormitories primarily for the focus, for example, Edenvale and Kempton Park, as well as by the development of the areas outside the Johannesburg municipal area. Besides these influences on towns, suburbs and peri-urban developments in an area which includes Roodepoort, Kempton Park, Germiston, Albertyn, and the South-Western Bantu Townships, Johannesburg must exercise a less direct influence on the rates of growth of urban settlements beyond this inner core. This influence would stem primarily from Johannesburg's role as the economic focus of the Southern Transvaal and from its importance as South Africa's principal market.

G. URBAN SIZES IN THE JOHANNESBURG METROPOLITAN COMMUNITY.

Johannesburg and the other Witwatersrand towns were not

.../established

established originally to perform certain required functions for a surrounding rural territory, but arose from the discovery of gold, that is, they are not typical central places, and therefore no theoretical pattern of spatial distribution as outlined by Christaller (1933) and other investigators can exist.

In TABLE 32 the size-categories have not been selected at random in a continuum of urban sizes, but the divisions seem relatively clear cut when the urban population sizes are ranked. It need be noted here that urban centres, especially when they develop rapidly as in the case of the more recently established gold mining and industrial towns may pass from one category to another. Although this division of centres according to size is illuminative, it is doubted strongly whether any functional basis for such divisions exists.

TABLE 32 indicates the sizes of urban centres (as in 1960) and their distances from the metropolitan focus. It is apparent that the number of towns decrease as the distances from the focus increase and that the larger towns are relatively close to the focus. However, in a metropolitan region such as the Witwatersrand the initial effect of the gold mining activities in the older centres, and the present effect in more recently established centres, must be kept in mind. To isolate these effects is virtually impossible, but there is no doubt that gold mining has been replaced as the most important activity in many of the Witwatersrand towns, and that secondary industries have replaced the once major activity thus allowing centres to continue their development. Other factors apart from the location of the gold bearing reefs have come into play and it is here that the effect of Johannesburg as the metropolitan focus has influenced the developmental pattern of its surrounding urban centres.

.../TABLE

TABLE 32: Urban Size and Distance from the Metropolitan Focus, Johannesburg, 1960.

Population Size	Distance in Miles					
	Focus	0-20	20-40	40-60	60-80	80-100
+150,000 (I)	Johannesburg					
50,000 (II)		Germiston Benoni Roodepoort Krugersdorp Brakpan Boksburg	Springs Vereeniging Carletonville			
15,000 (III)		Edenvale Alberton Kempton Park	Randfontein Vanderbijl Park Nigel Westonaria		Potchefstroom	
6,000 (IV)			Heidelberg Meyerton	Sasolburg	Parys	
2,000 (V)			Delmas	Balfour	Kester Ventersdorp Villiers Vredefort	Frankfort
900 (VI)			Fochville	Greylingstad Devon		Tweeling

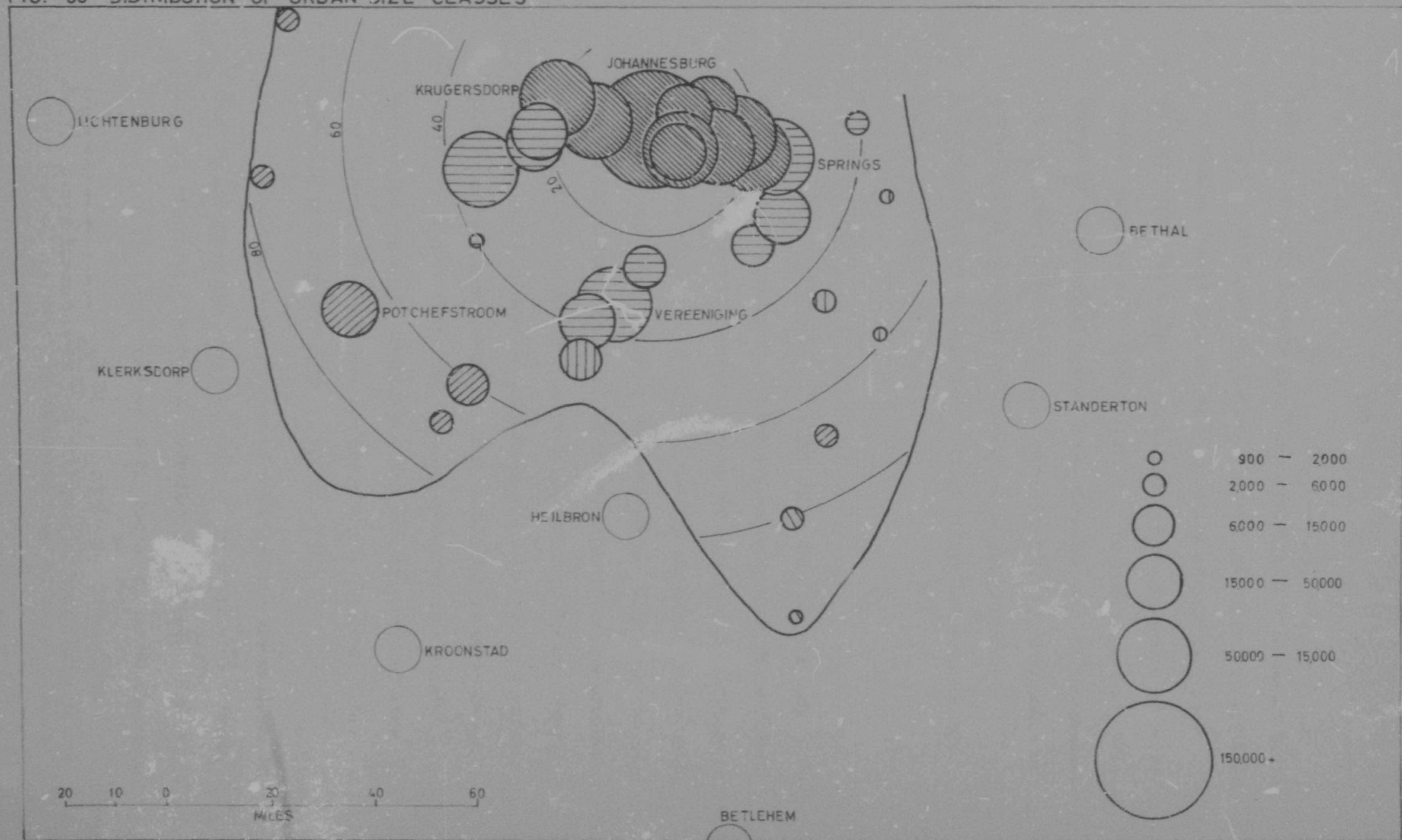
FIG. 35 clearly shows the great concentration of centres on the Witwatersrand and the extensions of the gold mining area, as well as in the Vereeniging area. An application of Bogue's (1950) sectors does not explain the pattern satisfactorily because of the fixing of the settlement landscape by the occurrence of gold and in the Vereeniging area due to the specific requirements which are fulfilled in that area. Taking Bogue's criterion for a metropolis (a population exceeding 100,000), Sectors III and IV, (the route to Bloemfontein passes through both sectors) and Sectors V and VI (two main routes to Durban), would be classed as inter-metropolitan sectors having populations exceeding 25,000. The intermetropolitan sectors contain more centres than the others, but as indicated above, this may not be ascribed to their position along the main routes, though the routes may be an additional factor affecting their growth.

Mention has been made above that Johannesburg has affected the developmental pattern of its surroundings. Berry (1960) quotes that Bogue observed the metropolis as a factor affecting the size and location of hinterland cities, and that Isard and Whitney found that "(a) core cities have appropriated trade in general merchandise and apparel at the expense of cities within a 20-mile radius; (b) sales of immediate consumer goods have been usurped least; (c) per capita sales figures reveal a general retail site selection in favour of metropolitan centres when compared with cities located within a 20-mile radius of these metropolitan centres" (p112)¹. Twenty miles was the commuting distance at the time of their study. Relating growth with the development of the motor vehicle, Berry states, "Perhaps the most important reason for growth of metropolitan communities is investment in

.../new

1. Effects (a) and (b) are true also in the case of Johannesburg as indicated in Chapter V in the section dealing with retail trade. Effect (c) was not investigated.

FIG. 35: DISTRIBUTION OF URBAN-SIZE CLASSES



new and improved highway facilities, leading to a reduction of the friction of space and to increased specialisation and interchange. One implication of this is the possibility of commuting over greater distances which, in turn, implies the expansion of metropolitan communities¹" (1960 p 112-3). He concludes that, "The impact of an expanding metropolitan community upon an independent central place hierarchy is two-fold: in the development of a population: function imbalance, and in the progressive specialisation of the business pattern within the metropolitan community" (p116).

H. CONCLUSION.

The discussions and findings in this chapter were centred on the metropolitan community as defined by Eogue (1950). By making use of the habitation ratio of magisterial districts an analysis of the urban and rural population structure in Johannesburg's metropolitan community was attempted. This resulted in the identification of several sub-foci, important urban centres in their regional setting, and a delimitation of Johannesburg's urban and rural spheres of influence, areas in which the metropolis's influence on urban and rural population is experienced. Results further indicate that a positive correlation exists between the degree of urbanisation and ruralisation, but statistically the findings were not significant. The correlation increases with distance from the focus.

As regards the spacing of urban centres the presence of gold mining which has been the *raison d'être* of several centres, does not allow for a uniform distribution of centres. However, a tendency for the larger centres to be located closer to the focus

.../than

1. "A metropolitan community is that part of this region that lies within the daily commuting range of the metropolis" (Berry 1960 p113).

than the smaller centres is discernable.

In conclusion it may be stated that Johannesburg is definitely the focus of a surrounding area and its presence exercises an influence on the population size of nearby towns and on the rural population of its surrounding territory lying within its metropolitan community.

CHAPTER X.

CONCLUSION.

An urban centre or urban concentration, whether town, city or metropolis, is not an independent structure but is part of an economic, social and administrative organisation. It is part of man's total organisation of space. An urban centre is therefore not contained within specifically delimited administrative confines and its limits are not indicated by the termination of the physical city, that is the built-up area: it has relationships with the area around it.

A major problem in urban geography is to define the city's limits and this is achieved by "...disentangling the regional component and examining the multitude of tributary areas served by, and serving, the city;" (Dickinson 1964 p227). The multitude of functions located in our modern cities each have their own tributary area or sphere of influence.

The relations of the city may be grouped into four categories (Dickinson, 1964): 1) trade relations, 2) social relations, 3) the movement of people to and from the city, and 4) the impact on land uses. The objective of this study was a geographical analysis of Johannesburg's sphere of influence. In compliance with the above four categories of relationships the criteria selected to define the cities sphere of influence (limits) and illustrate its mutual relations with its surrounding countryside, were economic, social and administrative in nature, but the specific factors employed are by no means exhaustive. The criteria were, however, not dealt with in these categories as such but mainly in terms of the services, and functions provided by Johannesburg for its surroundings, and in terms of the environments provision of the metropolis' area.

The objective did not merely intend a delimitation of

.../the

the sphere of influence, but also attempted an investigation of the portrayal of this influence on its surroundings. The influence could in fact be observed in the type of agricultural land use close to the metropolis, as well as in the population distribution pattern of surrounding urban and rural settlement.

Johannesburg is inseparable from the Witwatersrand urban complex and as focus of this complex it has become the chief administrative, financial, economic and social centre of attraction, resulting in a daily ebb and flow-type of movement of people travelling by motor car, bus and train into and from the Central Business District and the industrial areas of the metropolis. It is this flow of people and vehicles which probably illustrates best Johannesburg's influence in its urban surroundings.

Studies have indicated that a city's influence diminishes as the distance from it increases and that typical relationships exist with its surrounding countryside. Findings indicate that three broad zones exist (Dickinson 1964). The urban complex terminates at the limits of the rural-urban fringe (urban tract). A second zone extends to about 15 to 20 miles from the centre (city settlement area) - a zone of daily contact. A third zone is the outer range of the sphere of influence (city trade area). Bogue (1950) calls the first 25 miles the "zone of direct participation", and identifies a "zone of interchange" extending between 25 and 65 miles, and beyond 65 miles a "zone of exchange" is recognised.

Ideally these zones or spheres of influence of differing intensity consist of concentric zones with the city as focus. In the case of Johannesburg this ideal pattern is disrupted by the linear urban development of the Witwatersrand due to the gold mining pattern and by the presence of the Republic's administra-

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